24th October 2025

An Coimisiún Pleanála
64 Marlborough St,
Rotunda,
Dublin 1, D01 V902

Our reference no: 25-99C&LQL01

RE: Proposed Windfarm development of 7 Turbines, 110kV substation and associated works within the townlands of Leitrim, Lumville, Ballinla, Clarkeville, Ballyfore Big, Ballyfore Little, Ballyeakin and Ballykilleen, in (Coolestown By) Co. Offaly

An Coimisiún Pleanála - Case reference: PAX19.323579

Dear Sir/Madam,

We, Colm & Louise Quinn and our children Adam, Emma and Isabelle of Ballymoran House, Edenderry, Co. Offaly wish to make the following objections against the above SID application for the following reasons outlined below and can confirm that our property is located as per the attached map.

This objection should be read in conjunction with the objections put forward by LCIEA Limited, Lumville Stud Farm, Edenderry and BallyM Charolais Herd, Ballymoran Farm, Edenderry.

This objection should also be read in conjunction with the attached technical report by Martin Lavelle, BE. MBA, FIEI, C.ENG.
It should also be read in conjunction with the attached Peer Review of Proposed Ballinla Wind Farm Planning Application prepared by Huson & Associates, W Les Huson BSc(Hons) MSc CPhys MInstP MIoA MAAS and the attached report of Ms. Brenda Dowling. These reports go to the heart of both the validity of the application in the first instance and major technical considerations and reason as to why the application should be refused.

At our meeting held on 5th September with Mr. George O'Connor and Mr. John Lowry of Statkraft, Colm outlined the health issues he has been experiencing as a result of the operation of the existing Cloncreen Wind Farm, which is situated approximately 2kms from our home, Ballymoran House.
These include persistent sleep disturbance and deprivation caused by turbine noise and light flicker, which have had a serious impact on his sleep and overall wellbeing.

Colm is the owner and Managing Director of a leading BMW retailer in Ireland, employing approximately 160 people across four locations. The ongoing sleep disruption from Cloncreen Wind Farm has led to significant tiredness and reduced concentration during the day, affecting his ability to carry out the demanding duties associated with his executive responsibilities. These concerns are particularly relevant in relation to the proposed Ballinla Wind Farm, as the turbines are planned in much closer proximity to our dwelling, with the nearest turbine located approximately 850 metres from Ballymoran House, our home. This raises a serious risk that the adverse effects already experienced at Cloncreen could be further intensified at Ballinla, posing substantial implications for both Colm's health and professional functioning.

Additionally, Louise suffers from a long-standing history of chronic and inflammatory musculoskeletal conditions, including osteoarthritis, Heberden's inflammatory osteoarthritis, migraine, and bilateral occipital neuralgia which have been verified in writing by Louise's Consultant, for privacy purposes, we are not attaching the letter but it is available to ABP if required.
These conditions already have a significant impact on her quality of life and her ability to manage pain and maintain restorative sleep. Her symptoms are frequently triggered or exacerbated by vibration, noise, and lack of rest — all of which are potential effects associated with wind-turbine operation.
The presence of low-frequency noise and shadow flicker may further aggravate her migraines and neuralgia, disturb her sleep patterns, and increase overall fatigue. Given the proposed proximity of the nearest turbine at approximately 850 metres from Ballymoran House, this distance is insufficient to safeguard against these impacts, particularly for individuals with chronic pain or neurological sensitivities. The cumulative effect of the proposed Ballinla Wind Farm therefore presents a serious and foreseeable risk to Louise's health and wellbeing.

It is also important to note that our daughters, Emma and Isabelle, both reside at Ballymoran House and have pre-existing medical conditions which heighten their vulnerability to environmental disturbance.

Emma suffers from severe asthma, while Isabelle has been diagnosed with polyarthritis, a condition that causes joint inflammation and pain. Both Emma and Isabelle are involved in the day-to-day activities of the BallyM Charolais Herd, Ballymoran Farm and Lumville Stud Farm.

Both young women require stable, low-stress living conditions and adequate rest to manage their symptoms. The potential impacts associated with the proposed Ballinla Wind Farm — including low-frequency noise, vibration and shadow flicker — have the potential to aggravate these conditions by disrupting sleep, increasing fatigue, and exacerbating respiratory and inflammatory responses. As can be seen from all the above current detailed baseline health status reports are in place for the household.

Given the proximity of the nearest turbine at approximately 850m from our home, Ballymoran House, and only approximately 200-250m from our farm, these risks are of serious concern and we strongly believe that there is no alternative but to seek the refusal of this proposed development.

Ballymoran House, our home, was built circa 1800 and is a Protected Structure (Reg. No. 14911022) listed under the Architectural, Social, and Technical categories of special interest. The proposed development would see Turbine No. 5 situated approximately 850 metres from our home, which is occupied year-round as our full-time family home.

As Ballymoran House is a Georgian structure, it retains its original single-glazed sash windows, which cannot be altered due to heritage restrictions. The close proximity of the proposed turbines at Ballinla Wind Farm raise serious concerns regarding further noise pollution and low-frequency sound impact. These factors would significantly affect the amenity and comfort of our home and would definitely have adverse effects on the health and wellbeing of those residing within it. These affects are also dealt with in further detail in the Peer Review Report of Huson & associates.

Research indicates that the *wake effect* from nearby turbines can result in a localised temperature drop of up to 3°C. Any sustained decrease in ambient temperature would have a serious and lasting impact on the health and quality of life of our family. The inability to modify Ballymoran House to improve insulation due to its protected status makes this impact particularly concerning.

We particularly wish to highlight that Ballymoran House was not referenced in the Inspector's Report (ABP-318203-23) compiled by Tomás Bradley for An Bord Pleanála on 22 December 2023. This omission is exceptionally concerning given that the report successfully identifies and records other heritage and archaeological features in the area.

Ballinla House —**which is unoccupied** — is cited in the same report as a protected structure under the heading of Built Heritage in addition to 2 ringforts recorded by the National Monuments Service and The Grand Canal, which is recognised as a Built Heritage feature.

It is therefore difficult to understand why our home, Ballymoran House, a protected and occupied Georgian dwelling of recognised architectural and historical importance, was not included in the same assessment, particularly given its proximity to the proposed development site and its direct exposure to potential impacts.

We believe the concerns outlined above warrant careful review and consideration. The omission of Ballymoran House — a protected and family occupied Georgian dwelling of recognised architectural, social, and technical importance — from the existing

assessment is deeply troubling, given the potential impact of the proposed development on its setting, structure, and residents.

We respectfully urge you to refuse the proposed development in light of these heritage, health, and safety concerns and to ensure that the protection afforded to Ballymoran House under the Record of Protected Structures is fully upheld

In addition to the farmlands at both Ballymoran Farm and Lumville Stud Farm, the gardens at our home, Ballymoran House are home to a range of wildlife, including protected species such as long-eared owls and kestrels, both of which are afforded protection under national and EU wildlife legislation.

The established woodland, mature trees, and traditional field boundaries provide vital foraging, nesting, and shelter habitats. Any large-scale disturbance, such as that associated with the construction and operation of the proposed Ballinla Wind Farm, poses a risk of habitat disruption, displacement, and long-term behavioural change within these protected wildlife.

In conclusion, we fully recognise the importance of green energy but this area is already littered with Wind Farms and surely, we cannot be expected to facilitate the construction of more.

Further to the above I have the following further concerns:

1. The visual affects of such large turbines is simply a matter of fact and the utter proliferation of such large turbines in the immediately surrounding area is something that does not appear to exist elsewhere. We recognise the importance of green energy, but this area surely cannot be expected to carry far more than its fair share and to now be expected to carry even more of this share.

2. The red lights at night time will be a significant issue for the dwelling houses on our farm and again the cumulative effect of this together with existing red lights in the vicinity is something that we feel is very unfair for us to have to tolerate forever and extending into the lifetimes of our children.

3. Due to the proximity of the turbines and the number of them we are extremely concerned regarding the wake affect on us and the future viability of elite equine stock on our lands.

4. Is the future development of the our farm now to be effectively sterilised due to the presence of the windfarm either by refusal of planning permission or the simple desire of people and the next generation not wanting to live here?

We are aware that there is cross community support against this development, and fully support the objection of our neighbour's, including those with very significant health, equine and animal welfare concerns.

We truly believe there is nothing to recommend this application to us or to the people of this area and we call on An Comisiún Pleanála to refuse permission for this application for all of the reasons outlined above.

Yours Sincerely.

Date: 24/10/2025

Colm, Louise, Adam, Emma & Isabelle Quinn, Ballymoran House, Edenderry.
R45 FD37

Ballinla Wind Farm

ENGINEERING & ARCHITECTURE

2km Buffer outlined Blue, 1km Buffer outlined Magenta

Location of dwelling house

- Turbines
- Substation
- Site Entrance
- TDR
- 1km Buffer

LCIEA Landholding shaded Blue (Lumville Stud)

Colm & Louise Quinn Landholding shaded Blue (Ballymoran Farm)

T1 T2 T3 T4 T5 T6 T7

Dunville · Mooneysland · Ballymacwilliam · Mountwilson · Laurencetown · Rhode · Ród · Clonin · Clonin Barrow Hill · Rhode Village · Fahy · Ballynamona · Ballystrig · Rathmoyle · Thornastown · Thornwell · Ballybrittan · Togher · Rathcobican · Rogerstown · Ballinla · Ballycolgan · Clonlack · Rathmore · Ardbash · Drumcooly · Clarkville · Lumville · Ballyfore Little · Leitrim · Clonmeen · Earthwork · Ballymoran · Rathgreedan · Ballyhugh · Newtown · Ballyhugh or Springfield · Esker Beg · Ballycon · Ballinrath · Ballykilleen · Rathlumber · Sandyhill · Rathvilla or Rathclonbrackan · Ballynakill

Grand Canal Way · Slí na Canálach Máire · An Chanáil Mhór · Grand Canal · Slí na Canálach · An Chanáil Mhór · L5013 · R441 · R400 · R402 · Industrial Railway · Queen River · Philipstown River · Esker Stream

0 0.75 1.5 3 km

Statkraft

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SUBMISSION ON BALLINLA WINDFARM
Pre-Planning: ABP – 318203-23
PAX19.323579

Preamble

The Author of this Submission believes in Proper Planning & Sustainable Development. For every Mw of renewable energy, a Mw from fossil fuel or nuclear fuel will be needed as a back-up when the wind doesn't blow or the sun doesn't shine & on top of this duplication, we also have to invest in Grid upgrades costing €billions.
We don't need duplication. We just need one system with capacity. Imposing excessive costs on the Citizen is a long way away from Proper Planning & Sustainable Development. The charging & curtailment charges being paid to developers remind one of the Cash for Ash scam in nIrl.

Summary of issues (not exhaustive):

- SID qualification >50Mw does not exist as output is 23.3Mw or less. This also means that Carbon savings are not realisable. Further reductions occur from wake lowering of ground temperature for km's downwind. This lowering of temperature reduces crop growth & sequestration of carbon.
- Separation distances do not comply with 2006 or 2019 Guidelines in order to squeeze extra turbines into site. Providing Grid references for Wind Turbine locations does not allow the normal Citizen to assess separation distances. Failure to provide turbine setback distances to achieve noise levels below 30dbA in low noise areas.
- The grid distances for sensitive houses do not correspond with the map locations & thus undermine the entire noise contour data & application. No reliance can be accepted for Appendix 10.6 results as the separation distances have been exaggerated.
- Refusal to provide Noise & Wake model. Lacunea must be provided when used to generate data.
- Noise & Wake model may be a wind tunnel calculation for one turbine & ignore turbulence & noise downwind with short separation distances & rain/ice effects.
- Existing negative effects of Infrasound/Seismic & future effects in karstic area.
- Nuisance: Webster/Rollo v Meenacloghspar Windfarm
- No Population health data effects provided.
- HSE require WHO 2018 Standard & 37dBa. Statkraft stated that they were complying with this, but their application does not comply.
- Design envelope illegal: Sweetman v ABP 2021 Derryadd Windfarm. Failure to provide Plans & Particulars of the proposed Windfarm turbines.
- Trespass on grass margin for grid connection & coloured red on application indicates an Invalid application.: Dromada Windfarm (ROI) Ltd v Cremins. ACP cannot grant permission for trespass against the Law. The colouring of the grid connection in red on local roads indicates that the applicant has control or ownership of the road, which is an invalid statement.
- Property Value reduction of >8%: Price Recovery after 10-years implied by Statkraft, where turbines were only 122.5m tip height (see below)
- Local Road access for passing bays not identified.
- Restricted Roads as per Offaly CDP.
- No traffic count data provided with 85% speed
- No Road Sight Distance Triangles provided at Regional Road R402 to Local Road L5006 & L5010 provided.
- No vertical Sight Distance Triangles provided or Forward visibility.
- No Road Safety Audit provided including Night-time audits for abnormal load deliveries.
- Existing Regional Roads are not Type 2 or Type 3 carriageways.
- No TIA provided.

- The developer should have conducted a structural assessment of the proposed haul routes which should have included the following:

a) Falling Weight Deflectometer (FWD) Testing and analysis.
b) Ground Penetrating Radar (GPR) and cores where required.
c) Road Condition Data (RCD) using a Road Surface Profiler (RSP) to include:
d) Digital video (chainage and GPS referenced).
e) Visual condition survey from video survey using pavement condition index (PCI).
f) Ride quality survey using international roughness index (IRI).
g) Transverse profile for rut depth.

Testing shall be conducted in accordance with:
- NRA "Guidelines for the use of the falling weight deflectometer in Ireland (July 2000).
- NRA HD 31/15 "Pavement assessment, repair and renewal principles (March 2015)."
- DTTAS "Guidelines on the depth of overlays to be used on rural regional and local roads (March 2014)."
- DTTAS/ RMO "Mechanical Road Condition Surveys- regional and local roads in Ireland (April 2015)."

The surveys shall be carried out in both traffic directions where the carriageway is greater than 5m. On narrow roads it is sufficient to carry out the survey in one direction only.

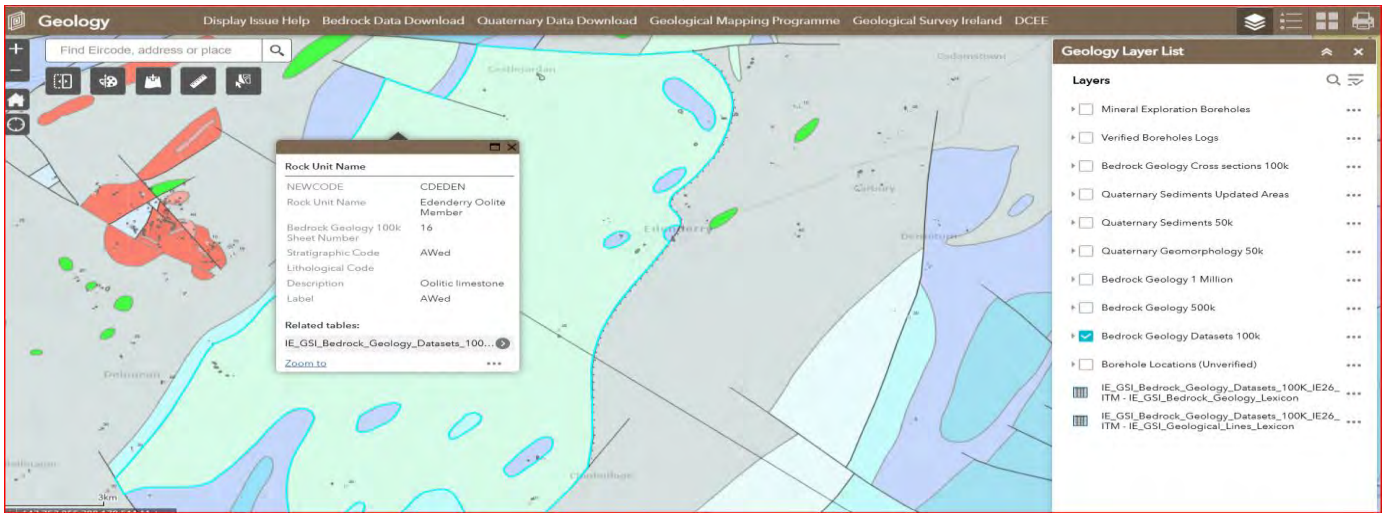
- Structural assessment of roads & bridges not provided.
- Oversail consents not provided. ACP cannot grant permission for trespass against the Law.
- Passing Bay consents not provided. The setback areas at existing rural houses that provide access & Sight Distance Triangles to the house are part of the Planning Approval & provided at the householder expense. These areas & sight distance triangles cannot be compromised. ACP cannot grant permission for trespass against the Law.
- Omitting major geological fault traversing the site that would create seismic infrasound vibration.
- Omitting seismic effect on existing wells/boreholes across the catchment
- Adverse impact on Traffic & Roads from a Nacelle weighing up to 400tonnes with dimensions 10.9m in length, 4.09m in width & 4.15m in height & on a 2-4 axle articulated flat-bed truck. With the weight of the truck included, the fully laden weight will be circa 450 tonnes. A 2-4 axle articulated flat bed truck is not capable of carrying this weight or permitted by law [S.I. No. 5 of 2003 Clause 13] & would severely damage roads, bridges & culverts
- Hedge/Tree cutting consents in front of 3rd Party properties not included. The Applicant is required to submit letters from any landowner confirming agreement to accommodation works including hedge trimming and/or pavement works. ACP cannot grant permission for trespass against the Law.
- S.I. No. 5/2003 – Road Traffic (Construction and Use of Vehicles) Regulations 2003

13. (1) Subject to Regulation 12 and to this Regulation, the weight laden of an articulated vehicle having a total of 4-axles shall not exceed 35 tonnes.
(2) The weight laden of an articulated vehicle having 4-axles may exceed 35 tonnes but shall not exceed 38 tonnes if the vehicle-
(a) consists of a 2-axle tractor unit and a 2-axle semi-trailer,
(b) is equipped with twin tyres and an air suspension system or an equivalent system on each driving axle,
I is equipped with a brake system approved in accordance with the requirements of the Directive 71/320/EEC of 26 July 1971[4] as amended by Directive 98/12/EC of 27 January 1998 [5] which includes antilock devices in addition to any other devices necessary for the satisfactory operation of the service brakes under all conditions of loading, and
(d) is equipped with a plate complying with the requirements of the Regulations of 2000.

- Birds: No assessment of Greenland Whitefronted Geese migration flypath barrier at Ballinla from Iceland to Wexford slobs. Adverse impact on the habitats of Birds, particularly migratory birds & bats. Adverse impact on Biodiversity including Bats & the flypath from Iceland to the Wexford slobs for migrating birds. The tip speed of the wind turbine at C92m/s indicates a speed of 331.2kph. No Bird or Bat could avoid such a speed.
  This site is on the flypath for Greenland White Fronted Geese in their migration from Iceland to Wexford Slobs. This application involves the installation of a further windfarm in a North-South alignment between

the existing Dernacat, Moanvane, Cushaling, Mount Lucas, Drehid, Cloncreen & Yellow River Windfarms. This application states that Ballinla would form a bridge between these existing windfarms. In effect, it would create a huge barrier to the migration of Greenland White Fronted Geese (as below).

- Usage of Percival 2003 for collision risks totally outdated, where wind turbines were far smaller with lesser impact on birds.
- Groundwater effect on existing wells/boreholes ignored.
- Adverse effects from Blade failure due to delamination at skin & adhesive, fatigue failures from cyclic loading, use of flammable laminates in blade construction.
- Adverse impact on drinking water catchment due to biohazards & the elevated risk of a major accident arising from a landslide event or underground coalmine collapse adjoining geological fault lines, the proposal would pose a serious danger to the environment potentially causing extensive pollution of waterbodies within and in the vicinity of the site. Given the extent of existing wind farm activity in the wider area, to which the proposed development would add to, the Bord Pleanala cannot be satisfied that the cumulative environmental assessment of the likely effects of



- Wake effects on downwind lands without landowners consents.

The windrose indicates that the prevailing wind for 59% of the year is from the South/Southwest direction. For a windfarm in a N/S alignment, this means lower energy generation due to wake effects, rain, turbulence & to the likelihood of Flicker on the houses to the North/Northeast. Dispute over wake losses between developers of two huge offshore wind farms one of many currently underway in UK planning system. Equinor and SSE 1/5/2025 say that wake losses caused by an RWE offshore wind project will cost their massive Dogger Bank arrays £582m ($778m) over their lifetime, arguing it would be "perverse" not to require mitigation or compensation as a result. The Norwegian oil major and British power giant submitted the estimate last week in the planning proceeding for Dogger Bank South, a 3GW project that German utility RWE is developing. **This indicates the similar losses to downwind property, agricultural lands & the availability of access to such data for the Wind Energy Industry to take such proceedings. This data is not included with this application.**

- The Wake effect on Climate where ground temperatures are lowered by 3degrees centigrade, leading to lower crop yields over the 40-50km envelope.
- The Wake effects on downwind turbines & associated noise due to turbulent air is not identified.
- The increasing turbine noise levels, over time with bearings wear, is not identified.
- The turbine noise numbers provided have no reference & are stated to be assumed & would seem to be wind tunnel values for a singular turbine.
- Effect on crops, cattle & horses not identified.
- Adverse impact on property & land values plus farm viability from downwind Wake effects.
- The attraction of insects to wind turbines & the attraction of bats to the insects is not addressed.
- The seismic effects on frogs, worms & herbivores, such as badgers are not addressed.

- The recent High Court decision in relation to the effect of Noise on health & property devaluation [Phase 2], plus the Victoria Supreme Court decision in Australia are ignored, while historical data, pre 2015, is quoted.
- The health & property value reports submitted are pre-2016 & have no relevance. Turbines were much smaller in that period. References to reports from central America with sparse houses is not relevant.
- Health effects. Adverse impact on human & animal health. No plans or designs or noise readings related to distances or wake effects provided.
- Peat drying effects from wake & road/foundation drainage resulting in increased carbon emissions. Adverse impact on shallow soils/Bog & potential for landslides. On the basis of the information submitted with the application, ABP cannot be satisfied that the proposed development would adequately mitigate risk associated with potential landslide as a consequence of the development of the proposed wind farm in association with seismic vibration through the foundations causing liquefaction of the shallow soils. In view of the above, it is considered that the proposed development would constitute an unacceptable risk of pollution of watercourses in the area. The proposed development would, therefore, be contrary to the proper planning and sustainable development of the area. Lands are not predominantly peat.
- Habitat Restoration ignored. Adverse impact on Restoration of nature as included in EU Directive. Reference number: 10.2/3/4
- Failure to comply with Survival Speed of 57kph as outlined in Vesta Brochure vis a vis Birr Meterological. Station Wind Gust speeds greater than 57kph, which are over this limit on 13% of time over 160-year period & constitutes a Health & Safety hazard to adjoining properties from destruction.
- Breaches of the Precautionary Principle on numerous grounds.
- Proximity to a Residential Cluster

The north-eastern part of the proposed development lies close to a concentration of existing dwellings on the L5050 These are illustrated on Figure 16.2 above.

Having regard to:

• the height of these turbines (185 m),
• their proximity,
• the lack of significant screening by existing topography or mature vegetation,
• the local concentration of rural dwellings compared to other equivalent areas in the general vicinity,
• the concentration of windfarms surrounding the rural community,
• the presence of a horse stud farm,
• the presence of a pedigree bull breeding farm,
• the orientation of the more-used amenity garden areas,
• the location of the turbines at a higher elevation than the dwellings, and
• the availability of alternative turbine locations within the applicant's holding, and having regard to the material supplied by the applicant, it appears that the proposed development will give rise to:
• a locally significant, avoidable, and concentrated adverse effect on the principal residential amenities of a concentration of dwellings, to such a degree as to constitute a disproportionate and unreasonable burden of avoidable impacts on residential amenity that could not reasonably be argued to constitute the proper planning and sustainable development of the area;
• a scale and quantity of development which, having regard to the significance of effects on the sensitivities of adjoining land uses, would constitute overdevelopment; and
• a magnitude of impact that, due to in-combination and cumulative effects, will amplify the perceived significance of other effects, such as noise, nuisance, and loss of amenity and land value.

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decision ([2021] IEHC 662), the High Court has also provided some clarifications on the scope and intent of its initial decision. In the meantime, the Derryadd and *Balscadden* decisions ([2020] IEHC 586) may lead to challenges for all developers of projects, in determining how much detail they need to give in the planning application while still retaining the flexibility needed for tendering.

Background

An Bord Pleanála (the **Board**) granted planning permission to Bord na Móna for a windfarm in Derryadd, County Laois through the Strategic Infrastructure Development (**SID**) provisions in the Planning Acts. A judicial review challenge was taken raising a number of issues with the Board's decision.

There were some particular features of Bord na Móna's planning application that are worth noting. The application was for permission for an *"envelope"* of up to 185 metres blade tip height with no specific details given of the hub height or the rotor diameter being proposed.

The High Court identified 3 core deficiencies with the planning application:

"Typical" details of several aspects of the development were given rather than precise details of the structures which were being proposed;

The application was for a *"design envelope"* rather than a structure of specified dimensions; and

There was some variation in the location of turbines/foundations and road layouts implied in the Environmental Impact Assessment Report (**EIAR**) submitted with the application.

What did the High Court Decide?

According to the High Court's initial judgment:

The PDR require developers to submit *"plans and particulars"* of their proposed development; "Plans and particulars" means something that is *"specifically measured and capable of being drawn on a plan. That cannot include a widely variable design envelope"*;

It is not acceptable to assess the proposed development on a *"worst case basis"*. It is not lawful for a developer to proceed on the basis that whatever is eventually constructed will have been properly assessed on the basis that the impacts of that development or indeed a development that is more impactful will have been assessed. The statutory obligation is to specify the particulars of the development for which permission is sought and *"not to seek permission for a project that is open-ended at one end of the scale and which could be anything up to a maximum specified"*. Further, the Court stated that a *"worst case analysis is also hopelessly subjective. What is the worst case scenario for one person at one location may not be considered as such by another person at another location"*;

There was much discussion of the so called *"Rochdale envelope"* (ie, basing the planning application and corresponding assessments on a range of potential designs and parameters).

The Court made the following points:

- The concept of the *"design envelope"* has, under English law, a written basis in national guidelines (NPS EN-1). There is no such written basis in Ireland, either in statute or in guidelines;
- The concept has no application to the statutory framework/requirement under the PDR to provide *"plans and particulars"*. It instead applies only to environmental assessment of that development;
- In the Rochdale case, the consent sought was an outline planning permission only and therefore it was more appropriate to talk of parameters in that context; and
- Rochdale was decided in 2001 and planning law has become much more complex in the intervening period.

The Court was also asked to find that the *"design envelope"* approach was contrary to the EIA Directive. The Court declined to rule on that question, but could do so in a future case. Under the EIA Directive, the obligation of a developer is to identify, describe and evaluate the impacts

of its proposed development on the environment. The Court may decide in a future case that it is not possible to meet this obligation unless the developer is describing and evaluating the impacts of a certain and defined project, rather than a range of possibilities.

Subsequent clarifications and leave to appeal

The High Court granted leave to appeal its initial decision to the Court of Appeal. It accepted that the *"practical operation"* of the planning system would be assisted by clarification of certain questions raised in relation to the initial decision (set out below). In doing so, the High Court clarified a number of points from the initial decision.

The Court noted that:
The initial judgment did recognise the legitimacy of a certain limited flexibility. What that flexibility could reasonably look like might vary from context to context;
The concept of limited flexibility, applied reasonably in a context-specific way, would appropriately balance the interests of developers and others. In particular, it would allow developers a margin to refine the exact design post-consent, but would also allow other participants sufficient certainty as to what the proposal in fact is;
There is no difficulty with the general concept of a design envelope provided it is within a certain limited flexibility, and no genuine planning issue is thereby created;
What might be regarded as a reasonable zone of flexibility may vary from context to context;
An affidavit on behalf of the Developer had referred to the Developer not being able to *"finally determine … the particular turbine design"*. The Court clarified that such final determination was not required by the initial judgment. The Developer's difficulty in determining the *"exact extent of turbine foundations, hard stands and other infrastructure"* could still be accommodated within a reasonable degree of flexibility because the initial judgment did not demand advance specification of the "exact extent" of those features;
The content of an application in the SID context is not quite as exacting as that in the normal planning context;
However, the SID framework only allows a reasonable albeit limited degree of flexibility (particularly in a changing context like wind turbines). However, a completely open-ended permission at one end of the scale goes far beyond what is necessary or appropriate; and
If the Board's decision or alternatively some instrument of general application were to say that the approval of plans and particulars based on a typical design had the effect that the developer could not depart substantially from such a design, then there would not be a problem. However, there was no such provision in relation to the Derryadd wind farm.
The High Court granted leave to appeal on the basis of the following questions (paraphrased):

1. Whether it is permissible to allow a variable design application that (i) goes beyond a reasonable limited degree of flexibility and/or (ii) could give rise to a genuine planning issue after the grant of development consent in the Strategic Infrastructure Development context.
2. Is it open to the Board in the present case to contend on appeal that approval of a *"typical"* design cannot be substantially deviated from, (a) not having clearly and/or effectively and/or at all made that point at the hearing; and/or (b) given that such a point contradicts the evidence before the court and the Board?
3. If the Board can make that argument, is that argument correct?
4. Insofar as a permission can lawfully allow a degree of flexibility, is the Board required to consider and assess the range of options within that flexibility as opposed to merely assessing the worst-case scenario?

The *Balscadden* decision

The High Court's decision in *Balscadden Road SAA Residents' Association v An Bord Pleanála [2020] IEHC 586* involved similar issues to those raised in Derryadd. In that case, the High Court overturned the grant of planning permission for a Strategic Housing Development because the

	plans submitted with the application did not include details of the sheet piling structures to be used in the basement. The High Court made the following observations: Where any structure is of a significant size, its dimensions and location constitute necessary information; The PDR require the application material to show the distances of the relevant structure to the boundaries of the site, but the application had not done so; There were two fundamental problems with the lack of formal drawings showing the dimensions and locations of the sheet piling for subterranean structures. First, it breached the requirement to submit drawings in accordance with the PDR. Second, the actual grant of permission was *"devoid of meaning"* because the permission was to construct the development in accordance with the plans submitted, but those plans did not include adequate details as to the location and dimensions of the sheet piling. SUPREME COURT: Crofton Buildings Management CLG & Stephanie Bourke v. An Bord Pleanála and Fitzwilliam DL Ltd. On appeal from: [2022] IEHC 704 Judgment delivered on 10 April 2024 [2024] IESC 12 *Although the issue of which development plan ought to govern remittal was raised in the determination and in the written submissions of the Notice Party, there was no real contest challenging the correctness of the High Court's finding that the development plan applicable to a planning decision is the development plan in effect on the day that the decision is made. Donnelly J. states that this accords with a general principle of administrative law, that in terms of administrative decisions, the decision must give effect to the law at the date of the administrative decision. Moreover, nothing in any of the relevant sections which have been referred to in submissions, be it ss. 2, 9 or 34 of the 2000 Act or s. 9(2) of the 2016 Act, requires the Board to have regard to anything other than the development plan in effect on the date of the decision in respect of an SHD under the 2016 Act. The judgment proceeds on that basis.* *20. With reference to those mandatory steps, the appellants stressed the importance of engaging with the policies and objectives of the development plan in operation at the time of the application.* *25. The specific development plan to which the Board must have regard on remittal was an issue that necessitated significant attention by the trial judge. Although no appeal was taken from the trial judge's finding that the Board must take into account the 2022 development plan, this issue was raised by this Court in its determination.* *26. The Board and the appellants maintained, as they had in the High Court, that the relevant legislation envisaged that there could only be one development plan in effect in the functional area of a given planning authority at any one time.* *27. The Board specifically referred to s. 9(2) of the 2016 Act and s. 34(2) of the 2000 Act. Section 9(2) of the 2016 Act provides that the Board, in considering the likely consequence for proper planning and sustainable development in the area, should have regard to inter alia, the provisions of the development plan, including any relevant local area plan. Section 34(2) of the 2000 Act provides that a planning authority (and the Board) is restricted to considering the proper planning and sustainable development of the area, regard being had to, inter alia, "the provisions of the development plan". The Board said that this can only be the development plan which is in effect when the decision is taken. Section 12(17) of the 2000 Act states that the development plan comes into effect on the day it is made.*	
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The Proposed Development to be assessed consists of the following elements:
• Seven Wind Turbine Generators (WTGs) (blade tip height 185m, refer to Table 2-1 for dimensions of each turbine) as shown in Figure 2.
• Seven WTG foundations and hardstand areas.
• One electrical substation (110kV) including independent power producer (IPP) substation and wind farm operations compound with associated ancillary buildings, security fencing and all associated works.
• One LiDAR station based on the ground.
• Two new site entrances from the L5010.
• New and upgraded internal site access tracks.
• All associated underground electrical and communications cabling connecting the proposed turbines to the proposed onsite substation.
• The TDR including temporary works on sections of the public road network and private lands along the turbine delivery route on the L-5006 and the junction of the R-402 and R-420.
• One temporary construction site compound and additional mobile welfare unit.
• One spoil deposition area.
• Landscaping.
• Associated surface water management systems.
The project considered in this report includes for an underground grid connection cable connecting the proposed onsite substation to the national electricity grid via the Philipstown 110kV Substation located in the townland of Ballykilleen, Co. Offaly. The cabling will be located within the public road corridor or existing tracks for its entire length. The total length of the Proposed Grid Connection Route is approximately 8km, the full length of the Proposed Grid Connection Route is located within Co. Offaly. The Proposed Grid Connection crosses one EPA registered watercourse (Leitrim Stream) and one rail crossing. Trenchless installation in the form of horizontal directional drilling (HDD) will be used at both these locations. To ensure clarity, the Proposed Grid Connection Route will be the subject of a separate future planning application.

Pre-Planning minutes: ABP-318203-23 Inspector's Report. Inspector: Tomás Bradley Date of Report: 18th November 2024

7.0 Legislative Context

7.1. Strategic Infrastructure Development

In the context of the prospective development, Section 2 (1) of the PDA defines 'strategic infrastructure' as including, *inter alia*:

(a) any proposed development in respect of which a notice has been served under section 37B(4)(a)

Section 37A of the PDA states that:

(1) An application for permission for any development specified in the Seventh Schedule (inserted by the Planning and Development (Strategic Infrastructure) Act 2006) shall, if the following condition is satisfied, be made to the Board under section 37E and not to a planning authority.

(2) That condition is that, following consultations under section 37B, the Board serves on the prospective applicant a notice in writing under that section stating that, in the opinion of the Board, the proposed development would, if carried out, fall within one or more Of the following paragraphs, namely—

(a) the development would be of strategic economic or social importance to the State or the region in which it would be situate,

(b) the development would contribute substantially to the fulfilment of any of the objectives in the National Planning Framework or in any regional spatial and economic strategy in force in respect of the area or areas in which it would be situate,

(c) the development would have a significant effect on the area of more than one planning authority.

The Seventh Schedule which sets out infrastructure developments for the purposes of Sections 37A and 37B and includes:

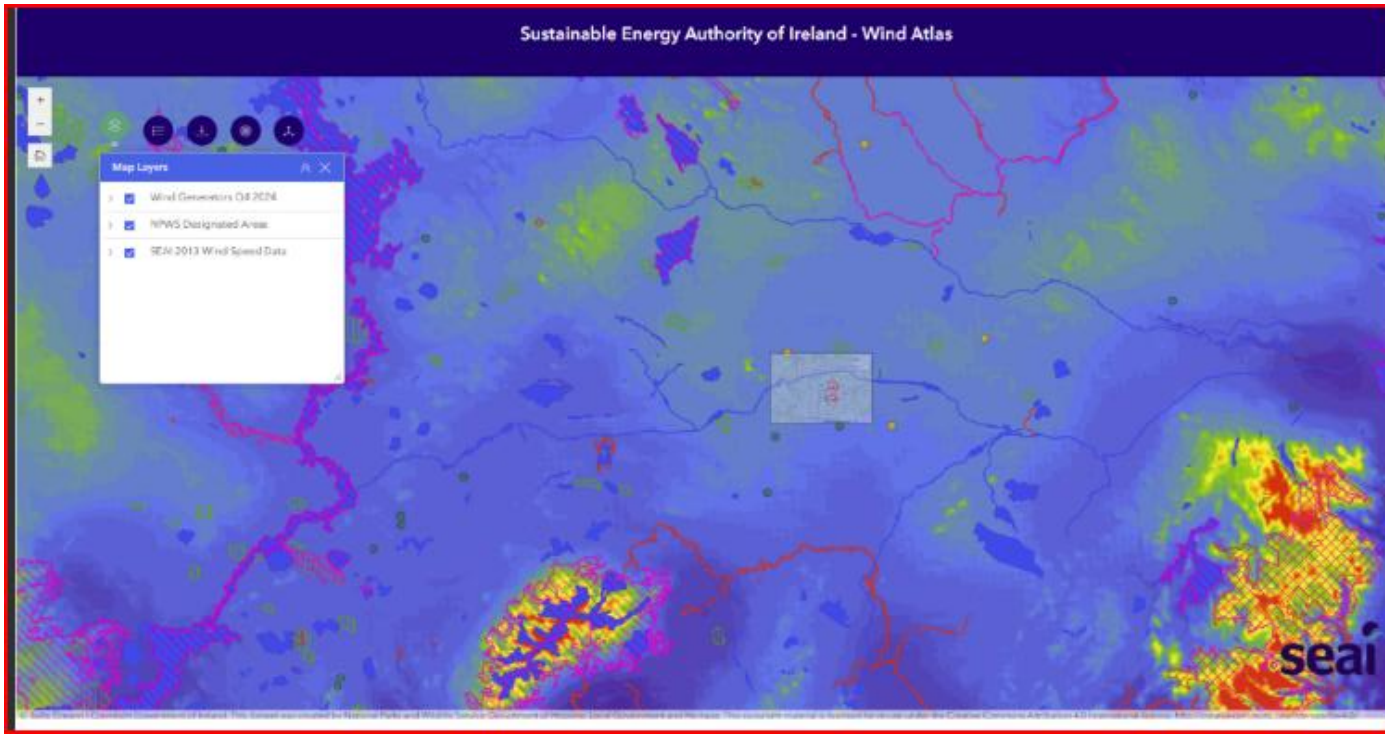
Energy Infrastructure

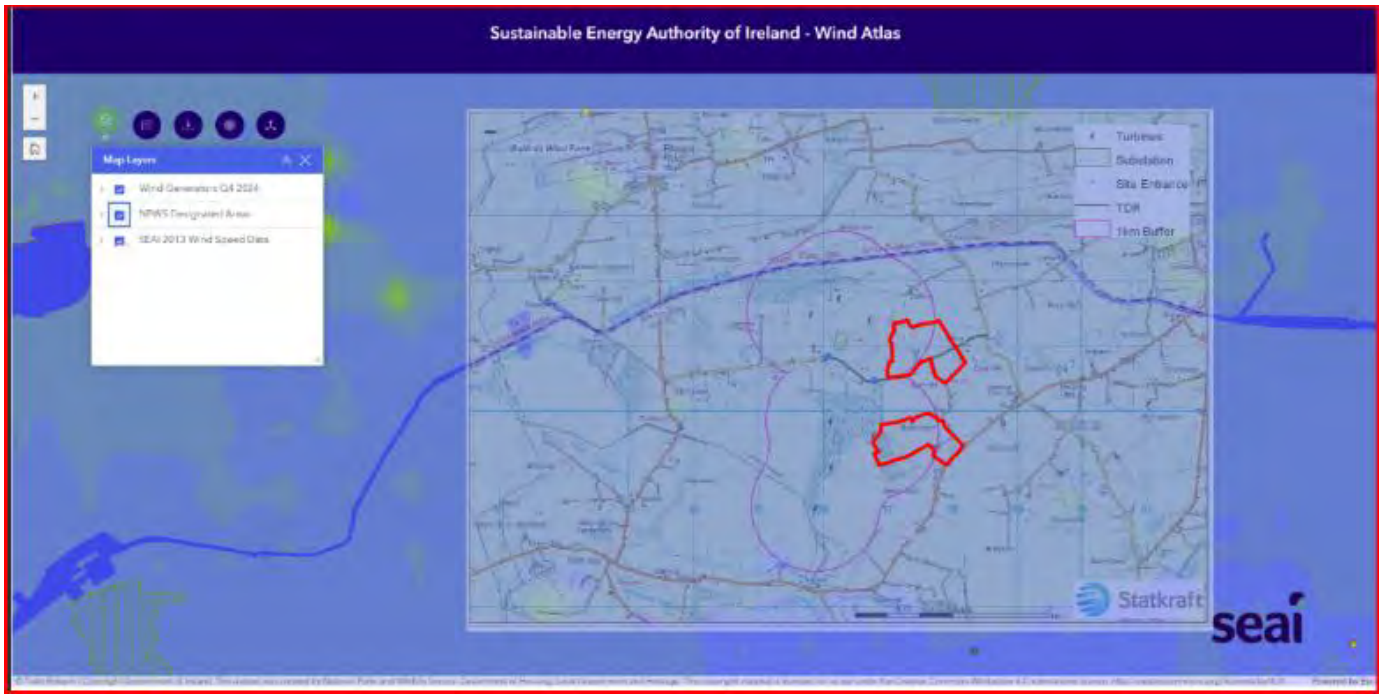
2.— Development comprising or for the purposes of any of the following:

....

— An installation for the harnessing of wind power for energy production (a wind farm) with more than 25 turbines or having a total output greater than 50 megawatts.

Note that this SID legislation does not mention Turbine capacity. It states Turbine output & such output relates to the site & the wind availability. The application indicates a wind speed between 7.9 to 8.1m/s for the site from SEAI Wind Atlas & EIAR Table 4.1. Using the average of 8m/s and the Vesta 7.2Mw Wind Turbine Power Table 4.1, we can see that the output per Turbine is c3.056Mw. For 7 Turbines, this indicates an output of c21.39Mw & not >50Mw. This 21.39Mw does not include the further power loss from wake effects due to lack of separation distances,


Sustainable Energy Authority of Ireland - Wind Atlas
Map Layers
seai


Sustainable Energy Authority of Ireland - Wind Atlas
Map Layers
Turbines
Substation
Site Entrance
TDR
16m Buffer
Statkraft
seai

6 Power Curves, Ct Values and Sound Curves, Mode PO7200

6.1 Power Curves, Mode PO7200

Air density [kg/m³]														
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**42**	32	33	34	35	36	37	38	39	39	40	41	43	44
3.5	**113**	70	74	77	80	84	88	92	96	100	104	108	117	122
4.0	**254**	168	176	184	192	200	207	215	223	231	239	246	262	269
4.5	**426**	306	316	327	338	349	360	371	382	393	404	415	437	448
5.0	**633**	466	481	497	512	527	542	558	573	588	603	618	648	663
5.5	**883**	660	680	700	720	741	761	781	802	822	842	863	904	924
6.0	**1189**	895	921	948	975	1001	1028	1055	1082	1109	1135	1162	1216	1242
6.5	**1549**	1174	1208	1242	1277	1311	1345	1379	1413	1447	1481	1515	1583	1617
7.0	**1969**	1502	1545	1587	1630	1672	1715	1757	1800	1842	1885	1927	2012	2054
7.5	**2449**	1876	1928	1981	2033	2085	2137	2189	2241	2293	2345	2397	2501	2552
8.0	**2994**	2302	2365	2428	2491	2554	2617	2680	2743	2806	2868	2931	3056	3118
8.5	**3607**	2782	2858	2933	3008	3084	3159	3233	3308	3383	3458	3533	3680	3753
9.0	**4277**	3317	3405	3494	3583	3672	3760	3848	3936	4024	4108	4193	[illegible]	4408
9.5	**4914**	3884	3987	4089	4191	4293	4392	4492	4591	4690	4765	4839	4945	4977
10.0	**5519**	4494	4610	4727	4843	4960	5061	5163	5264	5366	5417	5468	5525	5531
10.5	**6098**	5123	5253	5383	5512	5642	5734	5826	5918	6010	6039	6069	6091	6085
11.0	**6647**	5732	5872	6011	6151	6290	6369	6448	6527	6606	6620	6633	6634	6621
11.5	**7015**	6299	6431	6564	6696	6828	6871	6913	6956	6998	7004	7010	7006	6997
12.0	**7158**	6778	6854	6931	7008	7084	7102	7119	7137	7154	7156	7157	7155	7152
12.5	**7189**	7043	7074	7106	7138	7170	7174	7178	7183	7187	7188	7189	7189	7188
13.0	**7198**	7153	7162	7171	7180	7189	7191	7193	7195	7197	7197	7198	7198	7198
13.5	**7200**	7181	7185	7189	7193	7197	7197	7198	7199	7200	7200	7200	7200	7200
14.0	**7200**	7193	7194	7196	7198	7199	7199	7200	7200	7200	7200	7200	7200	7200
14.5	**7200**	7197	7198	7199	7199	7200	7200	7200	7200	7200	7200	7200	7200	7200
15.0	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
15.5	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
16.0	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
16.5	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
17.0	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
17.5	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
18.0	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
18.5	**7191**	7191	7191	7191	7191	7191	7191	7191	7191	7191	7191	7191	7191	7191
19.0	**7113**	7113	7113	7113	7113	7113	7113	7113	7113	7113	7113	7113	7113	7113
19.5	**6956**	6956	6956	6956	6956	6956	6956	6956	6956	6956	6956	6956	6956	6956
20.0	**6682**	6682	6682	6682	6682	6682	6682	6682	6682	6682	6682	6682	6682	6682
20.5	**6305**	6305	6305	6305	6305	6305	6305	6305	6305	6305	6305	6305	6305	6305
21.0	**5865**	5865	5865	5865	5865	5865	5865	5865	5865	5865	5865	5865	5865	5865
21.5	**5397**	5397	5397	5397	5397	5397	5397	5397	5397	5397	5397	5397	5397	5397
22.0	**4928**	4928	4928	4928	4928	4928	4928	4928	4928	4928	4928	4928	4928	4928
22.5	**4459**	4459	4459	4459	4459	4459	4459	4459	4459	4459	4459	4459	4459	4459
23.0	**3984**	3983	3983	3983	3983	3984	3984	3984	3984	3984	3984	3984	3984	3984
23.5	**3514**	3515	3514	3514	3514	3514	3514	3514	3514	3515	3514	3514	3514	3514
24.0	**3049**	3049	3049	3049	3049	3049	3049	3049	3049	3049	3049	3049	3049	3049
24.5	**2598**	2598	2598	2598	2598	2598	2598	2598	2598	2598	2598	2598	2598	2598
25.0	**2202**	2202	2202	2202	2202	2202	2202	2202	2202	2202	2202	2202	2202	2202

Note Ground levels at site are 80m – 92m Clause 8.3.2 Topography. Note air density 1.23kg/m3at sea level & 1.16 at 610m OD. Thus 1.17 at 90m as at this site

Altitude [ft (m)]	Temperature [°F (°C)]	Pressure [psi (hPa)]	Air density [lb / cu ft (kg / m³)]
sea level	59 (15)	14.7 (1,013.25)	0.077 (1.23)
2,000 (610)	51.9 (11.1)	13.7 (941.7)	0.072 (1.16)
4,000 (1,219)	44.7 (7.1)	12.7 (873.3)	0.068 (1.09)
6,000 (1,829)	37.6 (3.1)	11.7 (808.2)	0.064 (1.02)
8,000 (2,438)	30.5 (-0.8)	10.8 (746.2)	0.06 (0.95)
10,000 (3,048)	23.3 (-4.8)	10 (687.3)	0.056 (0.9)
12,000 (3,658)	16.2 (-8.8)	9.2 (631.6)	0.052 (0.84)
14,000 (4,267)	9.1 (-12.8)	8.4 (579)	0.048 (0.77)
16,000 (4,877)	1.9 (-16.7)	7.7 (530.9)	0.045 (0.72)

Conditions for Power Curve and C_t Values (at Hub Height)	
Wind Shear, α	0.00-0.30 (10-minute average)
Turbulence Intensity, *I*	6-12% (10-minute average)
Blades	Clean
Rain	No
Ice/Snow on Blades	No
Leading Edge	No damage
Terrain	IEC 61400-12-1
Inflow Angle (Vertical)	0 ±2°
Grid Voltage	Nominal Voltage ±2.5%
Grid Frequency	Nominal Frequency ±0.5 Hz
Grid Active Power (LV-side)	Per tabulated values in Section 6 and following sections
Grid Reactive Power (LV-side)	Power Factor 1.0

Note power curve condition for turbine output do not include for Rain, Snow, clean blades (no detritus from dead insects) & no damage to leading edge which would reduce output further.

9.0 Assessment

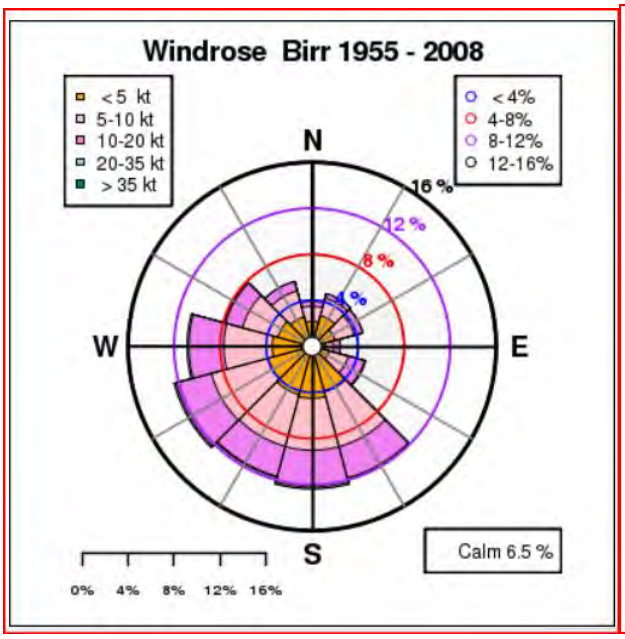
As clarified by the prospective applicant following the pre-application consultation meetings the proposed development will comprise of 7 turbines each with an output of 7.2 MW giving a range of between 50.4 MW.

This results in the nominal output exceeding the MW output by 0.4 MW. It is also noted that turbines have an output range, however, the applicant in its final letter does not mention this and cites a capacity of 7.2 MW only. On this basis of a maximum output it meets the threshold. The legislation does not set out or reference a minimum or maximum range for MW output. I note precedent ABP Ref: 312224 had the same MW output as Ballinla Wind Farm and was considered SID.

Note that the capacity is not the output & it doesn't meet the >50Mw threshold.

The Board should note that the prospective applicant was advised in its final meeting that any reduction in the number of turbines, for whatever reason, would likely have a material impact on whether the development constituted SID given it may not exceed the nominal megawattage. They were advised that the Board should be made aware of any such changes.

Separation distances between turbines are specified as 7 times diameter in the prevailing wind direction in the 2006 Wind Energy Guidelines [From Birr Windrose, this is from South to West]. This requires a minimum 7x162 = 1,134m separation distances between turbines].



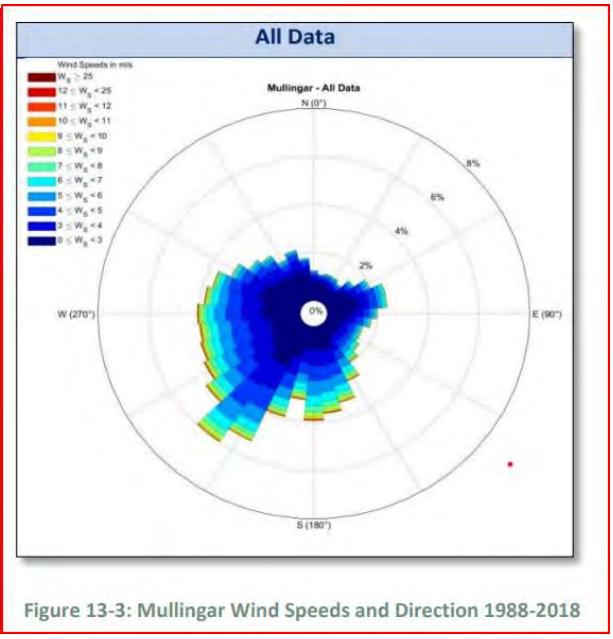


Figure 13-3: Mullingar Wind Speeds and Direction 1988-2018

Using the Grid references provided & Pythagorean Theorem, we find that separation distances are as outlined below ranging from 502, 584, 662, 697, 706, 825, 908 & 1,675m in Column 9. These measurements indicate gross non-compliance with 2006 Wind Energy Guidelines & draft 2019 Guidelines & will create far greater noise to adjoining properties. The applicant was obliged as part of the Pre-Planning to make the Board aware of such issues & didn't. It is simply not possible to fit 7 Turbines onto this site in compliance with the Guidelines. Note the Noise

levels for the Wind Turbine Vesta V162-7.2Mw at 500m, 750m, 1,000m & 2,000m from 41.8 to 28.7Dba without consideration of wind direction. Rain, Snow, etc.

The LA10 dBA is an average 10minute reading and doesn't reflect the actual noise levels on the ground. If a nuclear bomb exploded, its relative noise would be around 40dBA for LA10 dBA.

Equipment Description	Equivalent (average) Sound Levels (dBA)	Operational Noise Level at given distance considering equivalent (average) sound power emission levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
		5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Wind Turbine: Acciona AW125/3000	108.5	83.5	77.5	71.5	63.5	57.4	53.9	51.3	47.8	43.2	39.5	36.8	30.1
Wind Turbine: Goldwind GW165 6.0	112.6	87.6	81.6	75.6	67.6	61.5	58.0	55.4	51.9	47.3	43.6	40.9	34.2
Wind Turbine: Goldwind GW182 7.2	112.2	87.2	81.2	75.2	67.2	61.1	57.6	55.0	51.5	46.9	43.2	40.5	33.8
Wind Turbine: Nordex N163 / 5.X	109.2	84.2	78.2	72.2	64.2	58.1	54.6	52.0	48.5	43.9	40.2	37.5	30.8
Wind Turbine: Vesta V66, ave	110.4	85.4	79.4	73.4	65.4	59.3	55.8	53.2	49.7	45.1	41.4	38.7	32.0
Wind Turbine: Vestas V162-7.2MW	107.1	82.1	76.1	70.1	62.1	56.0	52.5	49.9	46.4	41.8	38.1	35.4	28.7

Note these readings are for periods of no rain, no snow or ice & clean blades & for singular turbines.

2006 Wind Energy Guidelines

5.13 Windtake

The question of windtake should be dealt with at scoping stage and/or during pre-application discussions, to ensure that any proposed layout of wind turbines takes into account the development potential of an adjoining site for a similar development. In general, to ensure optimal performance and to account for turbulence and wake effects, the minimum distances between wind turbines will generally be three times the rotor diameter (=3d) in the crosswind direction and seven times the rotor diameter (=7d) in the prevailing downwind direction. Bearing in mind the requirements for optimal performance, a distance of not less than two rotor blades from adjoining property boundaries will generally be acceptable, unless by written agreement of adjoining landowners to a lesser distance. However, where permission for wind energy development has been granted on an adjacent site, the principle of the minimum separation distances between turbines in crosswind and downwind directions indicated above should be respected.

Draft Revised Wind Energy Development Guidelines December 2019

4.9.6 Windtake

The question of windtake should be dealt with at scoping stage and/or during pre-application discussions, to ensure that any proposed layout of wind turbines takes into account the development potential of an adjoining site for a similar development. In general, to ensure optimal performance and to account for turbulence and wake effects, the minimum distances between wind turbines will generally be three times the rotor diameter (=3d) in the crosswind direction and seven times the rotor diameter (=7d) in the prevailing downwind direction. Bearing in mind the requirements for optimal performance, a distance of not less than two rotor blades from adjoining property boundaries will generally be acceptable, unless by written agreement of adjoining landowners to a lesser distance. However, where permission for wind energy development has been granted on an adjacent site, the principle of the minimum separation distances between turbines in crosswind and downwind directions indicated above should be respected.

Application Table 4-3:
T1 655751 (X) 731543 (Y)
T2 656181 (X) 731802 (Y)
T3 656655 (X) 731460 (Y)
T4 656053 (X) 729897 (Y)
T5 656718 (X) 729689 (Y)
T6 656060 (X) 729191 (Y)
T7 655818 (X) 728575 (Y)

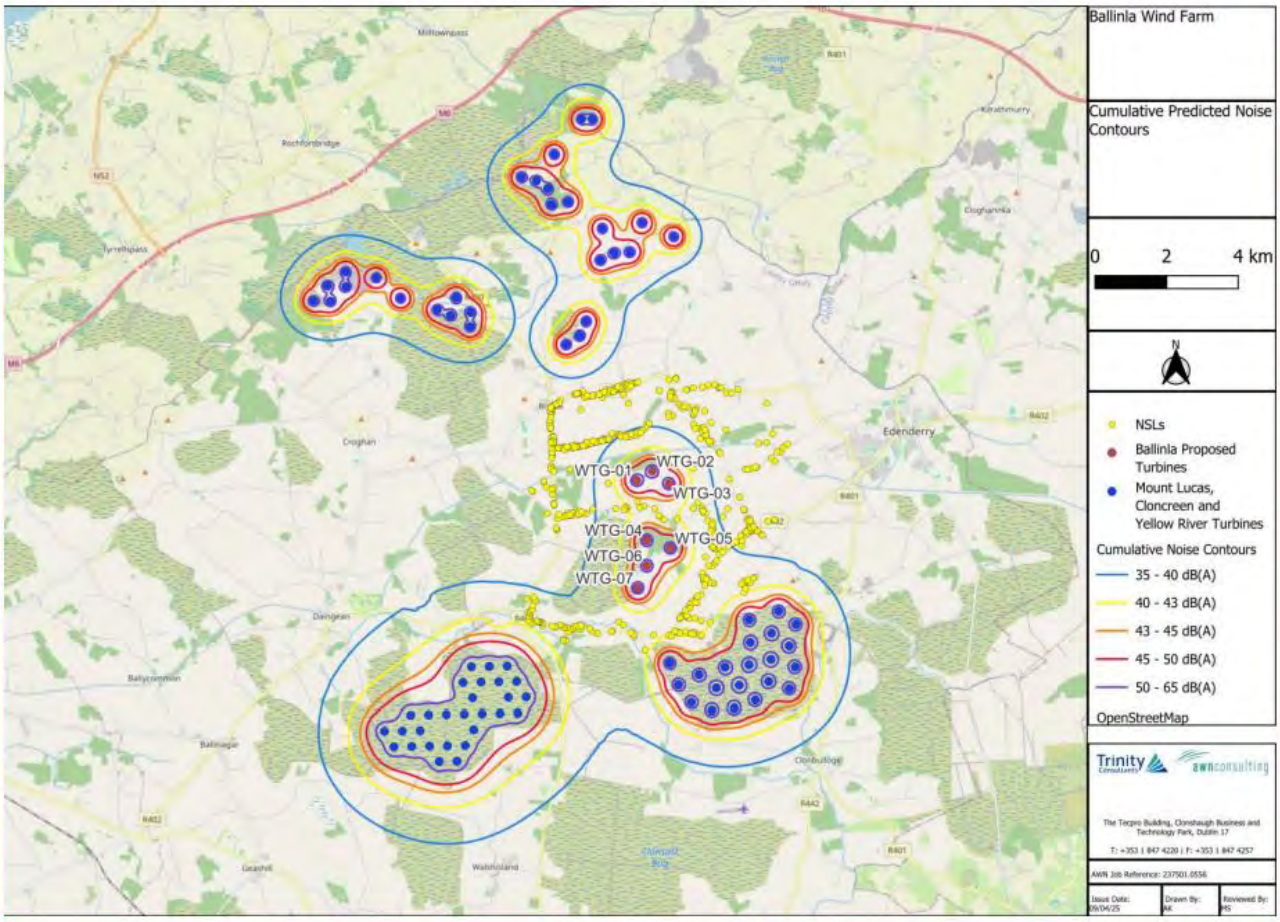
A	B	C	D	E	F	G	H	I
Turbine No.	X Coords	difference	Square of C	Y Coords	difference	Square of F	Sum squares of D & G	Separation Distance Square root of column H.
T1	655751			731543				
T2	656181	430	184900	731802	259	67081	251981	T1 – T2 502m
T3	656655	474	224676	731460	-342	116964	341640	T2 – T3 584m
T4	656053	-602	362404	729897	-1563	2442969	2805373	T3 – T4 1675m
T5	656718	665	442225	729689	-208	43264	485489	T4 – T5 697m
T6	656060	-658	432964	729191	-498	248004	680968	T5 – T6 825m
T7	655818	-242	58564	728575	-616	379456	438020	T6 – T7 662m
T1	655751	-67	4489	731543	2968	8809024	8813513	
T3	656655	904	817216	731460	-83	6889	824105	T1 – T3 908m
T4	656053	-602	362404	729897	-1563	2442969	2805373	
T6	656060	7	49	729191	-706	498436	498485	T4 – T6 706m

These separation distances are far lower than the 2006/2019 Guidelines minimum of 7x162= 1,134m.

Reference No. 1.1 : Characterizing the Wake Effects on Wind Power Generator Operation by Data-Driven Techniques. Astolfi, D.; De Caro, F.; Vaccaro, A., Energies 2023, 16, 5818. https://dx.doi.org/10.3390/en16155818

Wake interactions between nearby wind turbines represent the most important cause of producible energy loss in an operating wind farm. It is well known that the wind intensity downstream of a rotor gets reduced and that, if nearby wind turbines are not sufficiently spaced, the velocity deficit does not completely recover, thus affecting power production. In particular, on the one hand for offshore installations, it is convenient to maintain the layout of a wind farm as sufficiently compact to reduce Operation and Maintenance (OandM) costs but, on the other hand, if the layout is too compact the wake losses might reach 10–20% of the Annual Energy Production (AEP)

APPENDIX 10-7 PREDICTED CUMULATIVE NOISE CONTOUR



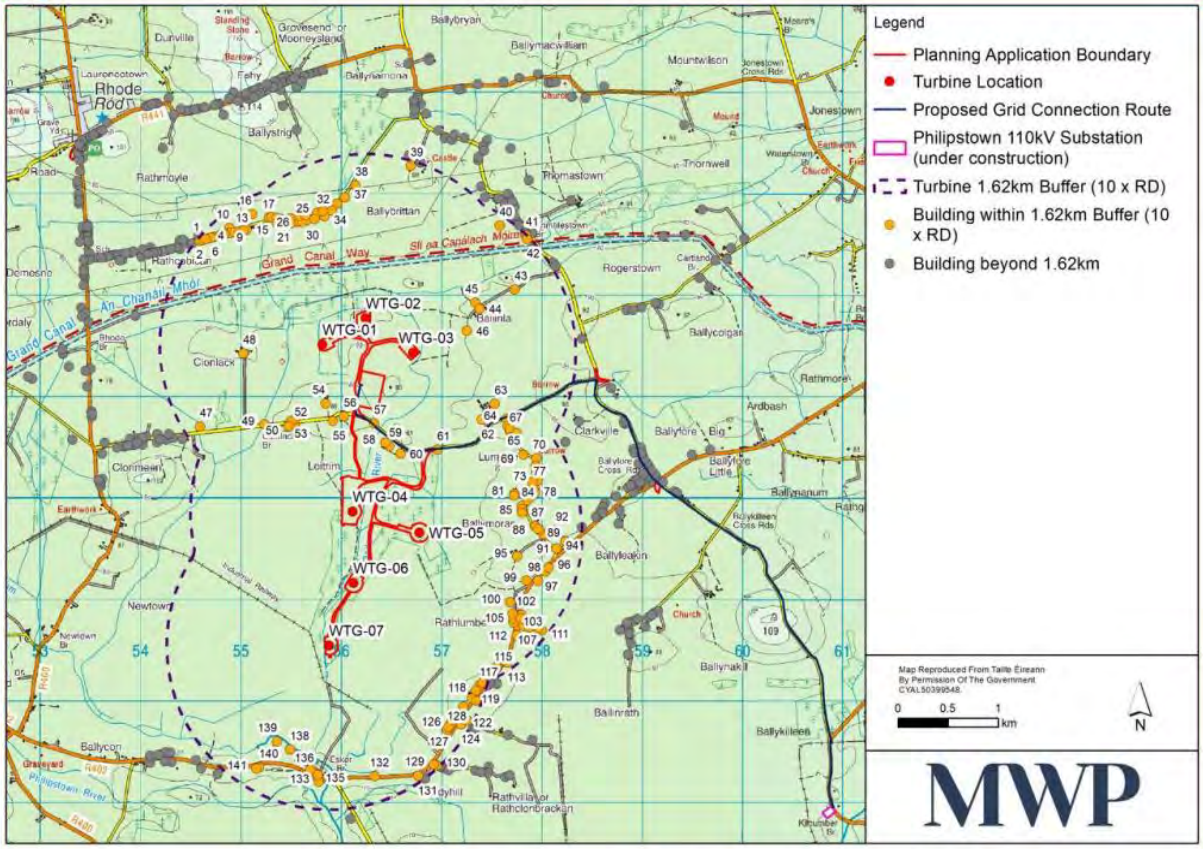


Figure 16-2: Residential Receptors within 10 x Rotor Diameters of a Turbine

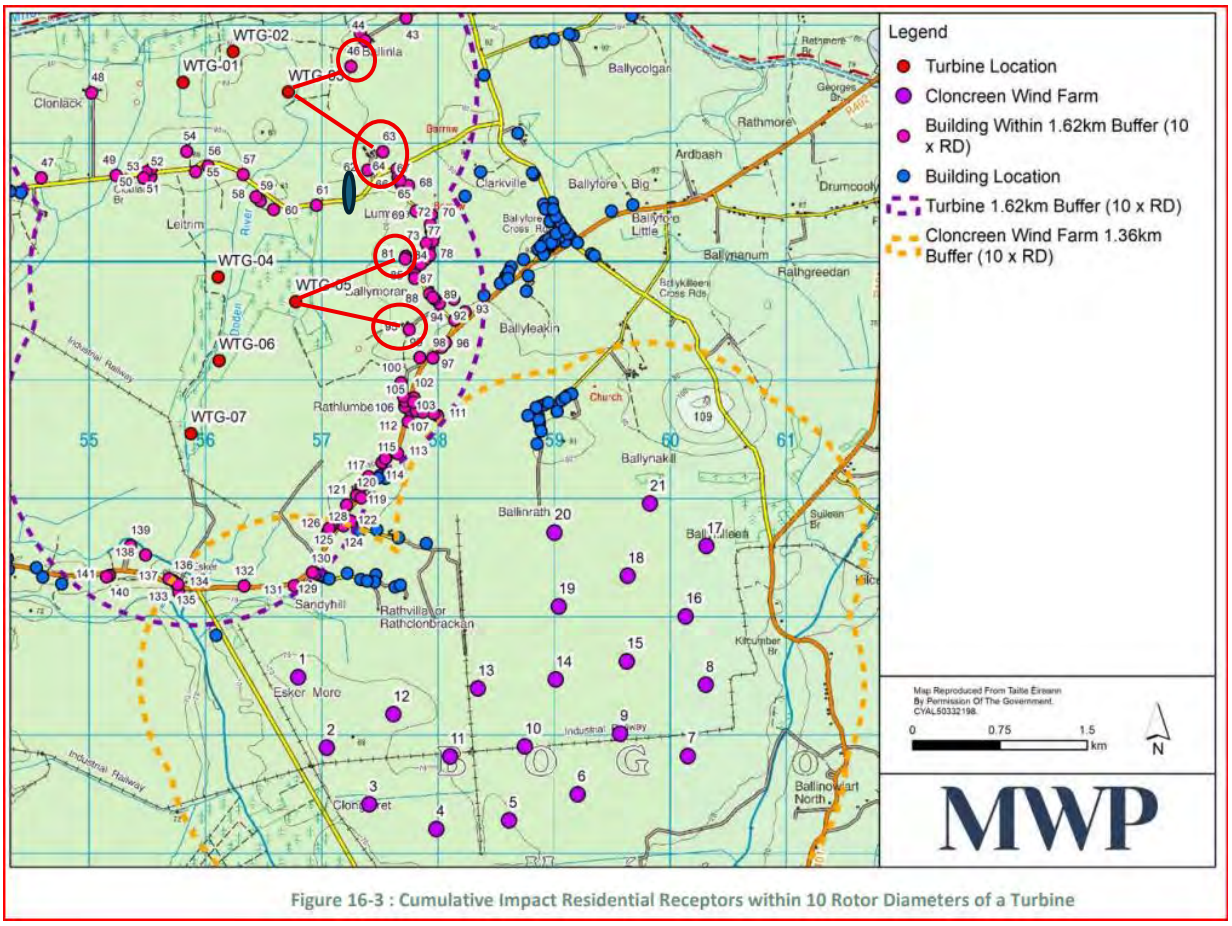


Figure 16-3 : Cumulative Impact Residential Receptors within 10 Rotor Diameters of a Turbine

Note that the house numbers on these two Figures are similar

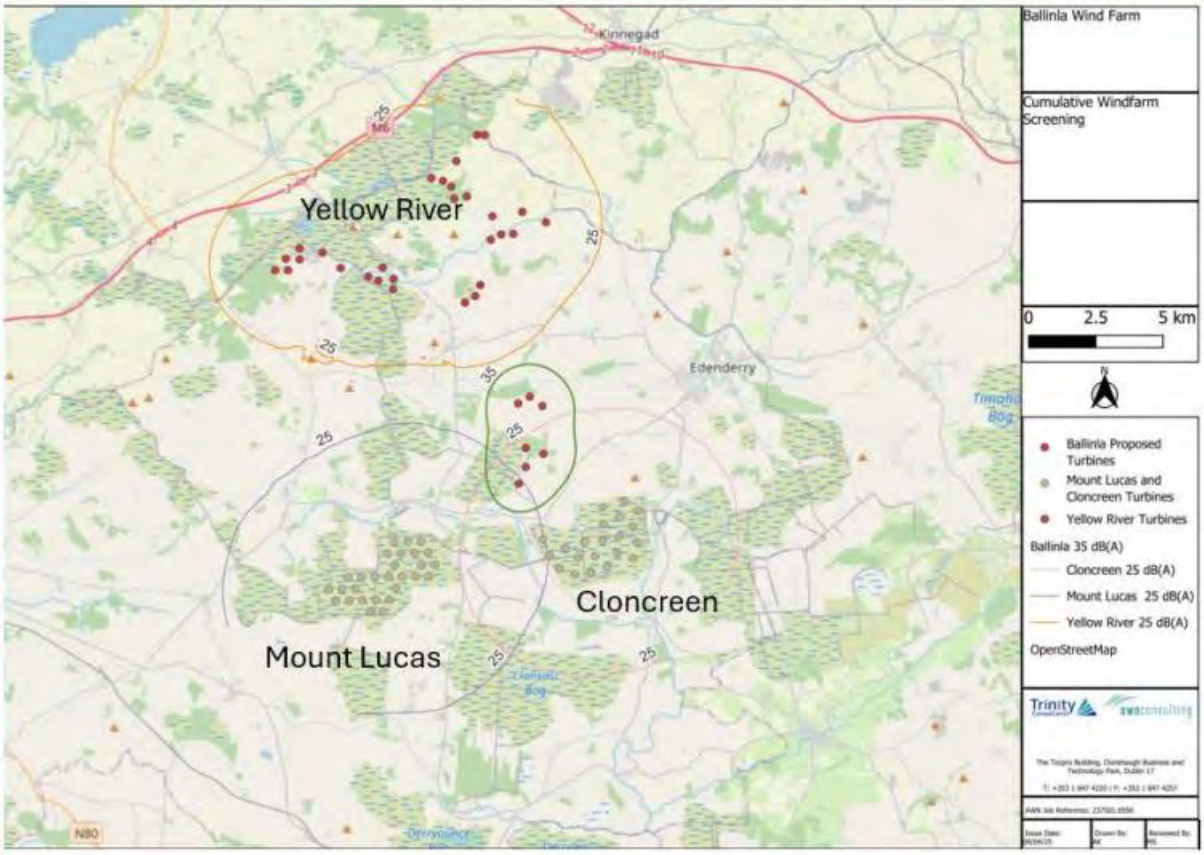


Figure 1: 35 dB L_{A90} contour for the Proposed Development (in green) and 25 dB L_{A90} contours from surrounding wind farms.

Note that the noise contours shown are for 35dBa for Ballinla & 25dBa for Cloncreen, Mount Lucas & Yellow River. Contours should have been shown for 37dBa (WHO), & 25dBa to create a proper overlapping picture of increased cumulative noise. This overlapping cumulative noise map will indicate the level of suffering that the local population already endure. Furthermore, in the absence of the noise model, one cannot check the input data from neighbouring existing windfarms.

APPENDIX 10-6 NOISE SENSITIVE LOCATIONS IN STUDY AREA (Houses selected) Note 1km grid on map in Blue

H046	657,461	728,331	H063	655,303	732,741	H064	653,455	730,831
H081	657,658	728,818	H095	653,992	733,894			

Pythagorean Theorem

Critical nodes	X-Coordinate	difference	Square of difference	y-Coordinate	difference	Square of difference	Sum differences columns 4 & 7	Square root to get distances between nodes m.
T3	656655			731460				
House 46	657461	806	649636	728331	-3129	9790641	10440277	T3 – Ho 46- 3231m
T3	656655			731460				
House 63	655303	-1352	1827904	732741	1281	1640961	3468865	T3 – Ho 63- 1862m

T3	656655			731460				
House 64	653455	-3200	10240000	730831	-629	395641	10635641	T3 – Ho 64- 3261m
T5	656718			729689				
House 81	657658	940	883600	728818	-871	758641	1642241	T5 – Ho 81- 1281m
T5	656718			729689				
House 95	653992	-2726	7431076	733894	4205	17682025	25113101	T5- Ho95- 5011m

The grid distances in Column 9 do not correspond with the map locations above & thus undermine the entire noise contour data & application. No reliance can be accepted for Appendix 10.6 results as the separation distances have been exaggerated. In the absence of the Noise & Wake Manufacturers Model plus the input data, which constitute Lacunae, this application must be invalidated. Are the "reduced" Noise records for the sensitive receptors based on increased distances from the Turbines?

In addition to the main development above, the prospective applicant is also considering a 110 kV grid connection including underground cable and upgrading of an external substation. This is expected to be a separate planning application.

This will likely entail 6 km of 110 kV underground cable on public roads to Philipstown 110 kV Substation (under construction) which is adjacent to Edenderry Power Station.

Note that the applicant has not provided landowner consents to lay these cables as required by law. (Reference 12.5) ACP cannot facilitate trespass. This constitutes an invalid application.

9.1.3. Other Issues

It should be noted that the underground cable to provide grid connection to the existing 110kV substation at Philipstown may become the subject of pre-application discussions with the Board in due course under the provisions of Section 182A of the PDA. It will be the subject of a separate planning application.

The applicant has failed to demonstrate that the proposed grid connection cable route running from the site to Philipstown sub-station is the optimal routing solution in line with objectives of the Climate Action Plan 2024 and NRA guidelines. No consideration is given to overhead or off-road connection. This concern highlights the absence of demonstrating that the proposed grid connection is technically feasible, the proposed development presents a significant risk to the local and regional road network.

This proposed grid connection infrastructure will severely limit the public road capacity and the Local Authority's ability to carry out its functions in respect of maintenance works and future services provision. The public road network is of limited capacity and grid connection installations risk restricting or sterilising the road network for future development. It impacts Road Authorities in terms of their ability to carry out its functions in respect of maintenance works and future services provision

TII in other applications, engaged with applicants at the EIAR scoping stage & set out the incompatibility of the road network with cable routing and highlighted that the road network may only facilitate minimal direct impact from cable routing proposals where they are routing is evidenced as the "optimal solution". TII have raised serious

concerns that these pre-application technical advices appear to be disregarded, which will undermine the maintenance of the safe and efficient operation of the road network and does not represent optimal compatibility of the network with the proposed energy generation project.

In TII's experience, grid connections accommodated on roads have the potential, inter alia, to result in technical road safety issues such as differential settlement due to backfilling trenches and can impact on ability and cost of general maintenance, upgrades and safety works to existing roads. This grid connection has to be of particular concern to the Local Authority as the public road is potentially being sterilised for private development use, due to the extent of the duct installation on narrow public roads. It is generally the Roads Department's preference that the ducting be provided in third party lands or via overhead lines. The lands to lay the grid connection are not under the control of the applicant. See Reference No. 12.

Roads Summary of Issues

The Regional Roads are not Type 2 or Type 3 Single Carriageways with capacities of 5,000AADT or 8,400AADT. The Regional Roads are Restricted Roads due to inadequate capacity as per Offaly County Development Plan [see Table 8.4 & Figure 8.10 below]. Photographs in application of delivery route do not indicate any hard shoulder or cycle facilities. See Clauses 15.3.1.1.1, 15.3.1.2.1, 15.3.1.3 for actual widths of roads

Table 8.4 Restricted Regional Routes in County Offaly

Restricted Regional Route	Location	Reason
R356	Cloghan to Banagher	Carrying Capacity
R400	Rhode to county boundary toward Rochfortbridge, link to M6	Carrying Capacity
R402	Ballina Cross to Edenderry	Carrying Capacity
R420	Tober to Tullamore	Carrying Capacity
R420	Tullamore to Portarlington	Carrying Capacity
R436	Ferbane to county boundary toward Kilbeggan	Carrying Capacity
R439	Birr to Banagher	Carrying Capacity
R445	Dunkerrin through Moneygall to county boundary	Carrying Capacity
R446	Horseleap to the county boundary towards Moate	Carrying Capacity
R440	Birr through Kinnitty to county boundary towards Mountrath	Amenity
R357	Cloghan to Shannonbridge	Amenity
R421	Tullamore to Kinnitty	Carrying Capacity and Amenity
R357	Cloghan to Blueball	Carrying Capacity and Amenity

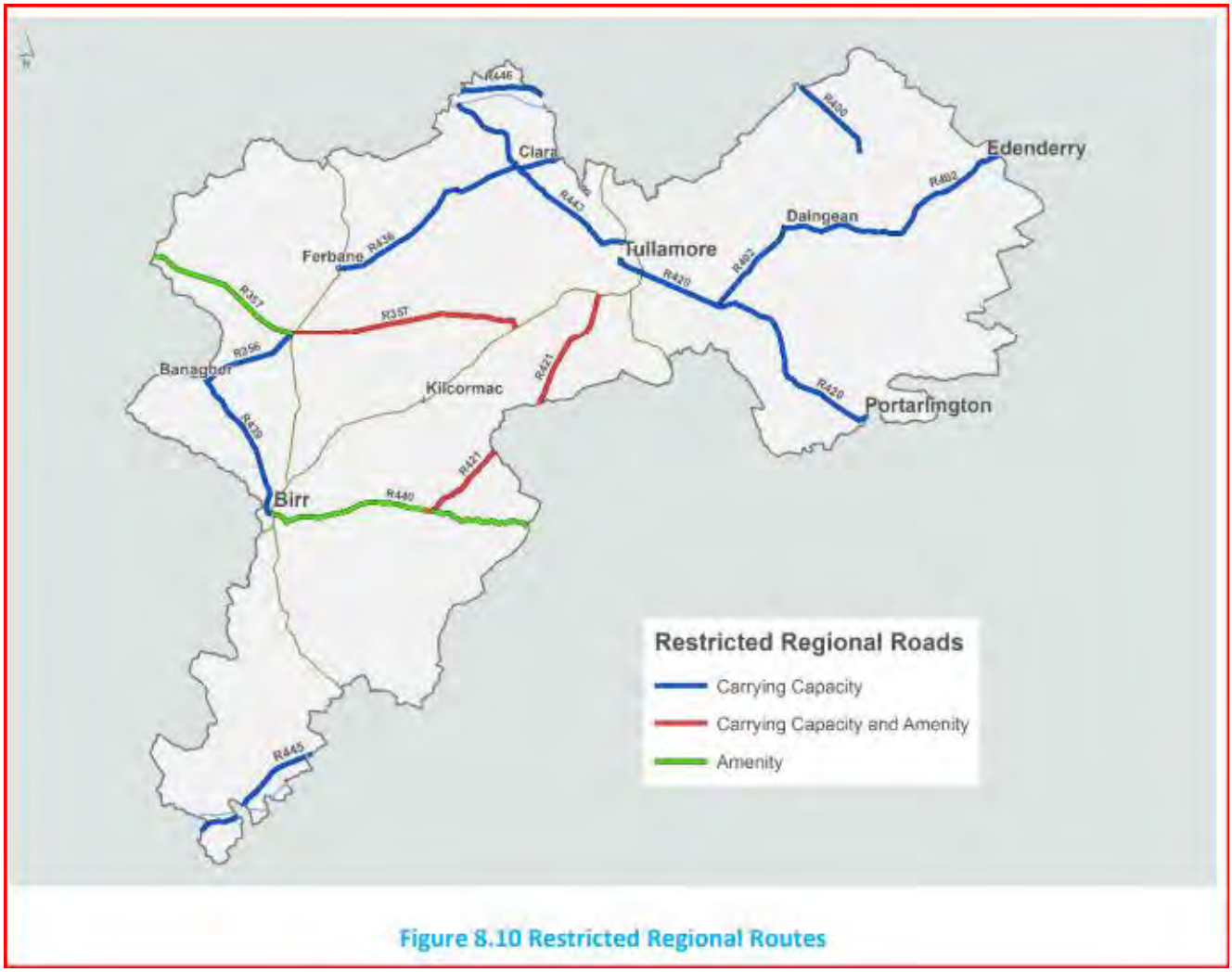


Figure 8.10 Restricted Regional Routes

7 APPENDIX 1 : CROSS SECTIONS FOR TYPE 2 & TYPE 3 SINGLE CARRIAGEWAYS.

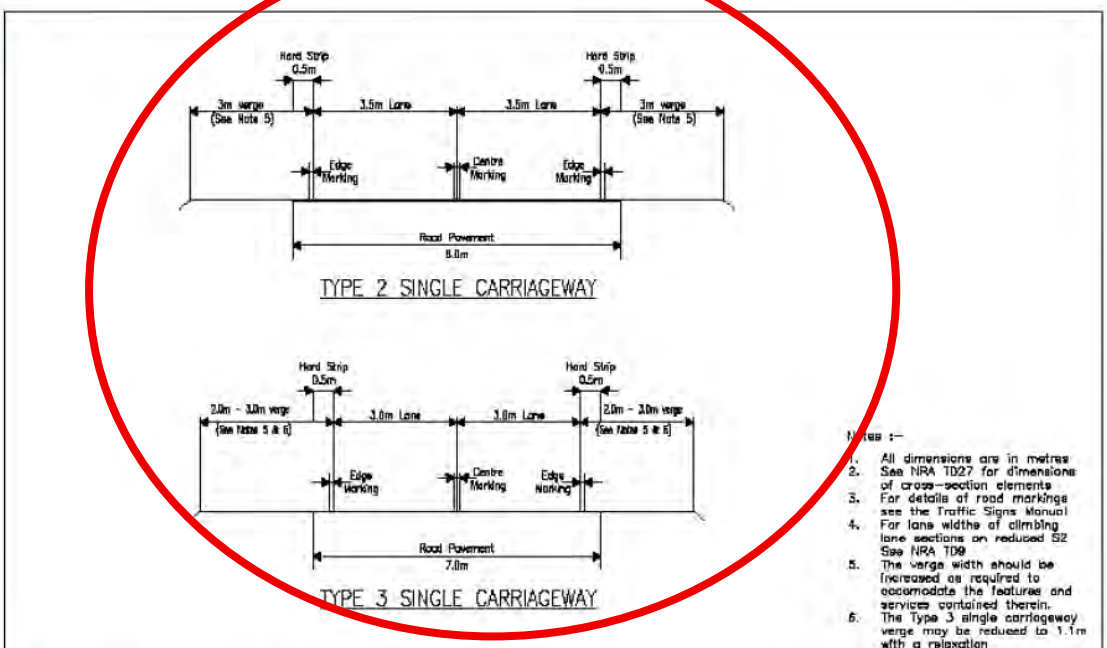


Table 3: Rural All-Purpose Roads - Dimensions of Cross-Section Elements Including: Slip Roads, Interchange Links and Loops

	Nearside				Offside		
	Verge [1,4,11]	Hard Strip [2]	Hard Shoulder [2]	Carriageway[2]	Hard Strip[2]	Verge[1,4]	Central Reserve[1,4]
MAINLINES Type 3 Single (S2)	5.00	0.50	-	6.00	-	-	-

Table 6.1 Recommended Rural Road Layouts

Type of Road[1]	Edge Treatment[6]	Access Treatment	Junction Treatment at Minor Road	Junction Treatment at Major Road
Type 3 Single (6.0m) Carriageway (National Secondary Roads Only)	0.5m hard strip	Minimise number of accesses to avoid standing vehicles and concentrate turning movements	Simple priority junctions[3]	Priority junctions, with ghost islands where necessary[3],or at-grade roundabouts
Type 2 Single (7.0m) Carriageway	0.5m hard strips	Minimise number of accesses to avoid standing vehicles and concentrate turning movements	Priority junctions, with ghost islands where necessary[3]	Priority junctions, with ghost islands[3] where necessary, at-grade roundabouts, compact grade separation where necessary
Type 1 Single[2] (7.3m) Carriageway	2.5m hard shoulders	Minimise number of accesses to avoid standing vehicles and concentrate turning movements	Priority junctions, with ghost islands where necessary[3]	Priority junction, with ghost islands[3], at-grade roundabouts or, compact grade separation where necessary
Type 3 Divided (7.0m + 3.5m) 2+1 lanes	0.5m hard strips	Minimise the number of accesses to avoid standing vehicles and concentrate turning movements.	Restricted number of Left-in/Left-out or ghost island priority junctions[3, 5]	Left-in/Left-out or ghost island priority junctions[3,5], u-turn facility with right turn[3], at-grade roundabouts, compact grade separation
Type 2 Divided[2] 2 +2 Lanes (2x7.0m) Carriageways.	0.5m hard strips	No gaps in the central reserve. Left-in / Left-out	No gaps in the central reserve. Left-in / Left-out	At-grade roundabouts and compact grade separation
Type 1 Dual[2] Divided 2+2 Lanes[4] (2x7.0m) Carriageways	2.5m hard shoulders	No gaps in the central reserve. Left-in / Left-out	No gaps in the central reserve. Left-in / Left-out	At-grade roundabouts and full grade separation
Motorway Divided 2 +2 Lane[4] (2x7.0m)	2.5m hard shoulders	Motorway Regulations	No gaps in the central reserve.	Motorway standards Full-grade separation
Wide Motorway Divided 2+2 Lane (2x7.5m)	3m hard shoulders	Motorway Regulations	No gaps in the central reserve	Motorway standards Full-grade separation

Notes:

1. *For details of the standard road cross-sections, see DN-GEO-03036 and the relevant TII Publications Standard Construction Details. The appropriate cross-section shall be selected with reference to the TII Project Appraisal Guidelines.*
2. *This road type may be used as an Express Road with the following conditions - access and junction control.*
3. *This junction type is not permitted on Express Roads.*
4. *Should the traffic assessment indicate that more than 2 lanes are required in each direction for a Standard Motorway or Type 1 Dual Carriageway, the additional lanes shall be a minimum width of 3.5m subject to curve widening.*
5. *Right turns off the Major Road only permitted at priority junctions located at single lane sections of Type 3 Divided Roads, right turns onto the Major Road are not permitted (see DN-GEO-03060).*
6. *Should the appraisal of pedestrian and cyclist facilities as outlined in Section 6.3 recommend an on-line, off-road facility, this facility should be included as an edge treatment.*

Table 4: Recommended Rural Road Layouts

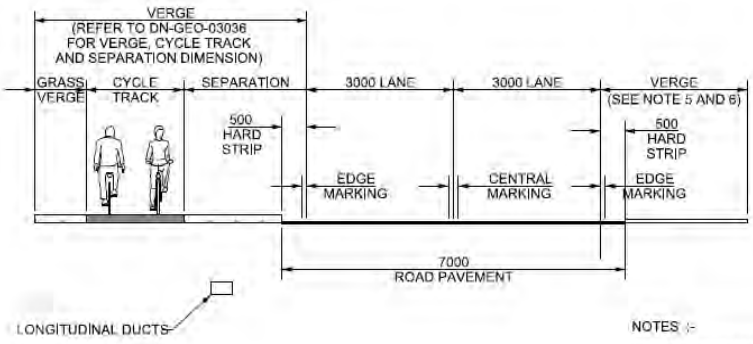
Type of Road [1]	Capacity (AADT) for Level of Service D	Edge Treatment	Access Treatment	Junction Treatment at Minor Road	Junction Treatment at Major Road
Reduced Single (7.0m) Carriageway S2	8,600	0.5m hard strips. Footways where required	Minimise number of accesses to avoid standing vehicles and concentrate turning movements.	Priority junctions, with ghost islands where necessary.	Ghost islands
Standard Single (7.3m) Carriageway S2	11,600	2.5m hard shoulders	Minimise number of accesses to avoid standing vehicles and concentrate turning movements.	Priority junctions, with ghost islands where necessary.	Ghost islands or roundabouts [2]

Introduction to Coordinated Link Design

2.6 Page 6/2, Table 4: Recommended Rural Road layouts
Delete Table 4 and replace with new Table 4

Table 4: Recommended Rural Road Layouts

Type of Road [1]	Capacity (AADT) for Level of Service D	Edge Treatment	Access Treatment	Junction Treatment at Minor Road	Junction Treatment at Major Road
Type 3 Single (6.0m) Carriageway S2	5,000	0. 5m hard strips. Cycleways where required	Minimise number of accesses to avoid standing vehicles and concentrate turning movements.	Simple priority junctions.	Priority junctions, with ghost islands where necessary.



NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. SEE DN-GEO-03036 FOR DIMENSIONS OF CROSS-SECTION ELEMENTS.
3. FOR DETAILS OF ROAD MARKINGS SEE THE TRAFFIC SIGNS MANUAL.
4. FOR LANE WIDTHS OF CLIMBING LANE SECTIONS ON TYPE 3 SINGLE CARRIAGEWAY SEE DN-GEO-03031.
5. THE VERGE WIDTH SHOULD BE INCREASED AS REQUIRED TO ACCOMMODATE THE FEATURES AND SERVICES CONTAINED THEREIN.
6. THE VERGE WIDTH SHOULD BE INCREASED AS NECESSARY TO ACCOMMODATE MANDATORY PEDESTRIAN/CYCLIST FACILITIES.
7. TWO WAY CYCLE FACILITIES SHOULD BE PROVIDED ON ONE SIDE OF THE ROAD UNLESS SITE SPECIFIC CONDITIONS REQUIRE FACILITIES ON BOTH SIDES.
8. LONGITUDINAL DUCTS ARE TO BE PROVIDED WITHIN A VERGE; REFER TO DN-ITS-03029 FOR GUIDANCE ON THE PROVISION OF LONGITUDINAL COMMUNICATION DUCTS. REFER TO CC-SPW-00500 AND CC-SPW-01500 FOR FURTHER DETAILS ON DUCT SPECIFICATION.

Construction & Commissioning

ROAD TYPE AND CROSS-SECTION
TYPE 3 SINGLE CARRIAGEWAY

STANDARD CONSTRUCTION DETAILS (SCD)	HISTORICAL REFERENCE	CLASSIFICATION SET	PUBLICATION DATE	PUBLICATION NUMBER		
				ACTIVITY	ITEM/AA	DRAWING NUMBER
	RCD/000/3	STANDARDS	DECEMBER 2017	CC	SCD	00003

Table 3 : Rural All-Purpose Roads
Dimensions of Cross-Section Elements
Including Slip Roads, Interchange Links and Loops

	Nearside				Offside		
	Verge [1,4]	Hard Strip [2]	Hard Shoulder [2]	Carriageway [2]	Hard Strip [2]	Verge [1,4]	Central Reserve [1,4]
MAINLINES Type 3 Single (S2)	1.1[10] to 3.0	0.50	-	6.00	-	-	-

Rural Areas

3.60 Cycle facilities provided on Type 2 and Type 3 Single and Dual Carriageway Roads in rural areas shall meet with the width requirements of NRA TD 300 and RCD's 000/2 to 000/5.

Table 1: Minimum Verge, Footway and Off Road Cycle Track Widths on Urban/Rural Roads

Usage	Minimum Footway/ Off Road Cycle Track Width (m)	Minimum Verge Width (m)
Footway Regular usage[1]	1.65	Single Carriageway 2.15 Dual Carriageway 3.15
Footway Occasional usage[1]	1.50	Single Carriageway 2.00 Dual Carriageway 3.00
Footway Mobility Impaired Users	1.80	Single Carriageway 2.30 Dual Carriageway 3.30
Urban Off Road Cycle Track	Width shall be as per the National Cycle Manual	Minimum raised verge width shall include the Segregation width and Cycle Track Width
Urban Shared Pedestrian and Cyclist Facilities	Width shall be as per the National Cycle Manual	Minimum raised verge width shall include the Segregation width and Cycle Track Width
Rural Cycle Facilities	Width shall be as per NRA TD 300 and RCD/000/02 to RCD/000/05	Minimum verge width shall include the Separation width, Cycle Track Width and grassed verge width

Notes:

[1]Regular usage occurs where there is a clearly defined local need with a predicted maximum flow of 25 or more pedestrians per hour, or footways are provided on contiguous sections.

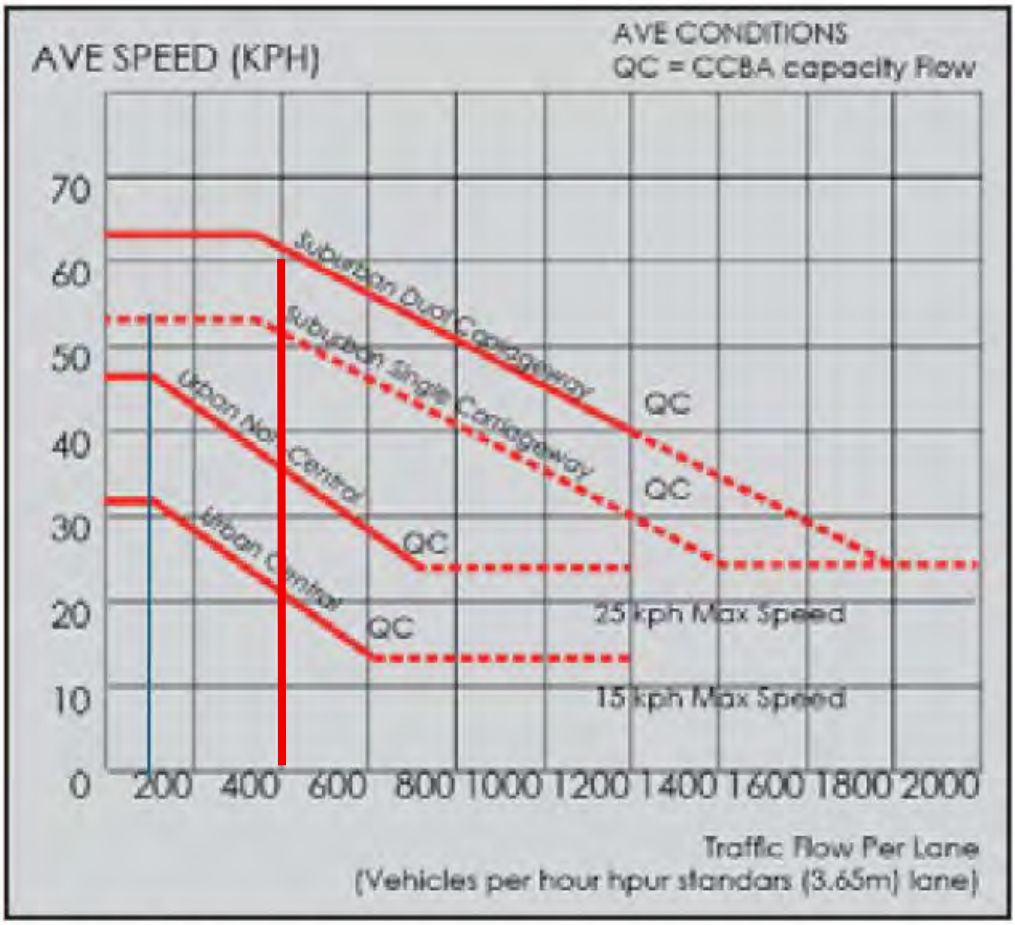


Figure 3.26: Extract from the Traffic Management Guidelines (2003) showing Traffic flow capacity increasing as speed reduces.

So, from DMURS Figure 3.26, the L5010 has a capacity flow of c400 vehicles per 3.65m lane per hour for Suburban single 50Kph. This is for one-way traffic. For 8 hours, this equates to 3,200 vehicles per day & not 5,000.

However, we have to factor-in the contraflow, which reduces this down to c1,600 vehicles per day (200 vehicles per hour over 8 hours). Note peak traffic of 440 vehicles per hour in Clause 3.11.1 This level of traffic would be over 100% of existing traffic & necessitates a TIA.

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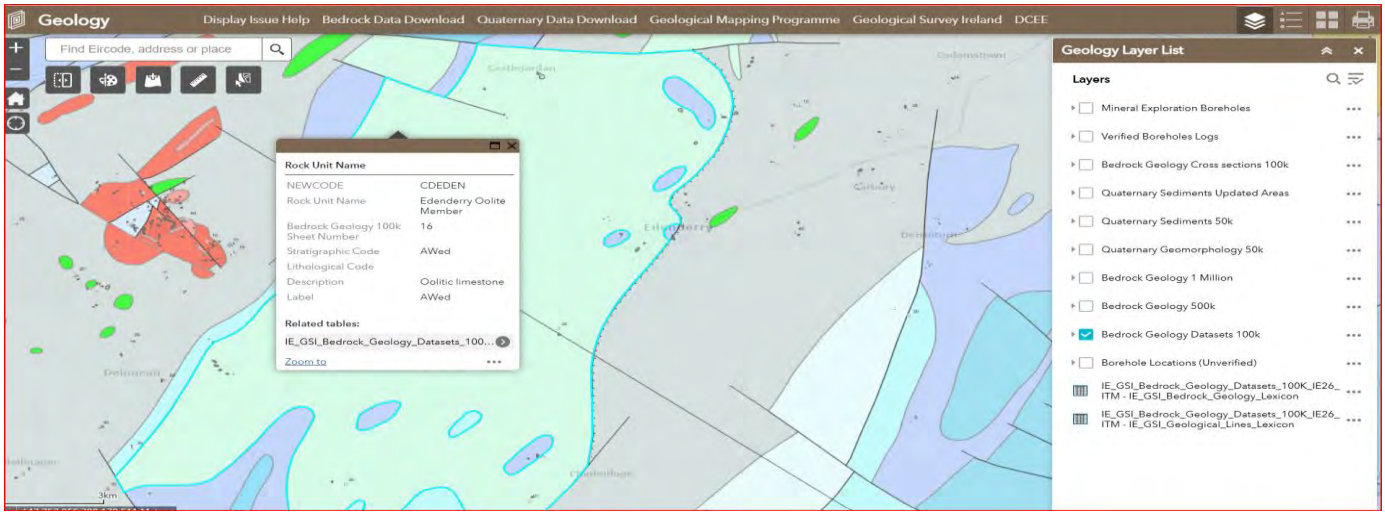
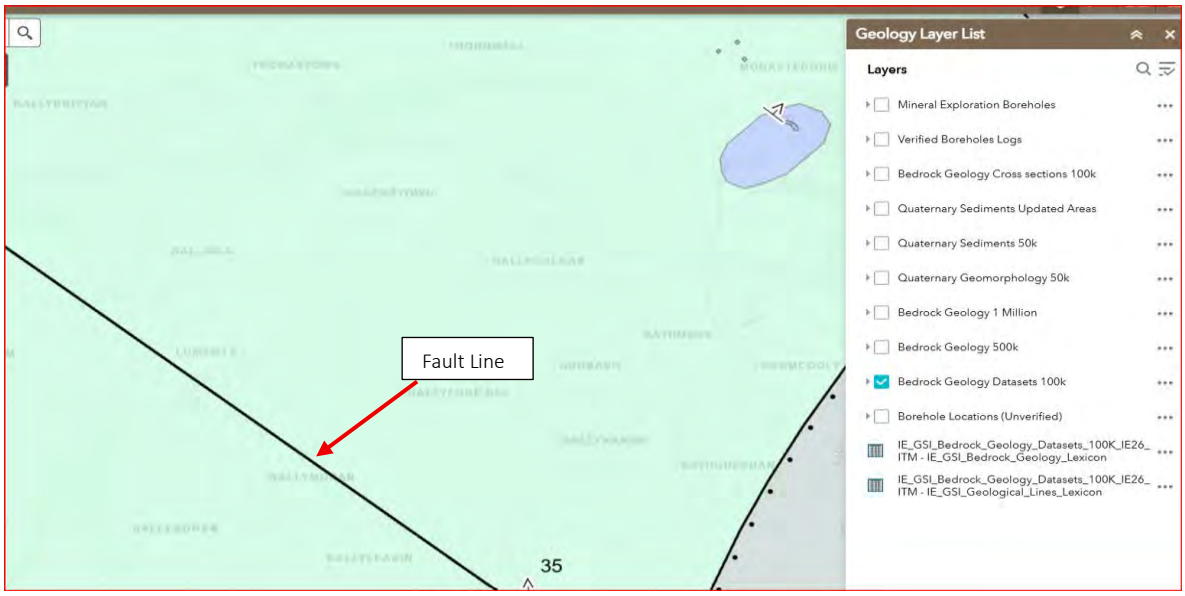
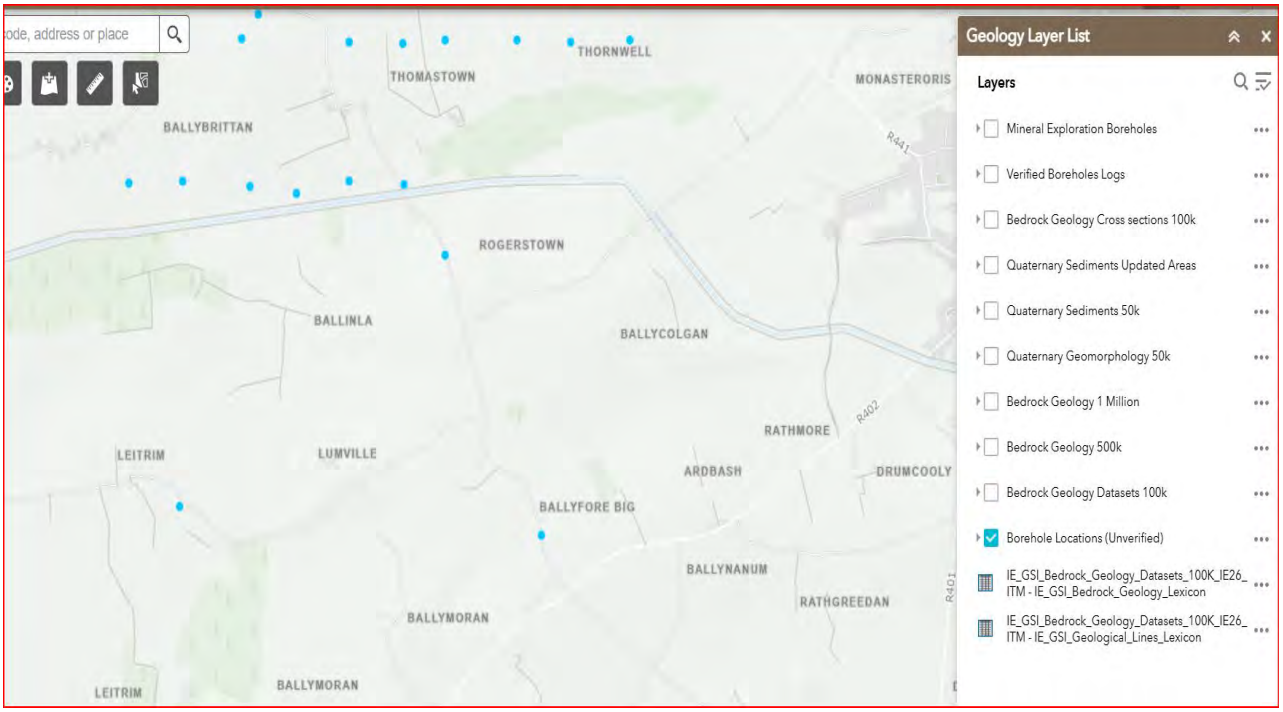


Fault line traversing site



Omitting effect of fault on existing wells/boreholes across the catchment



Groundwater Borehole locations

No assessment of Wake effects on farm crops, cattle or households.

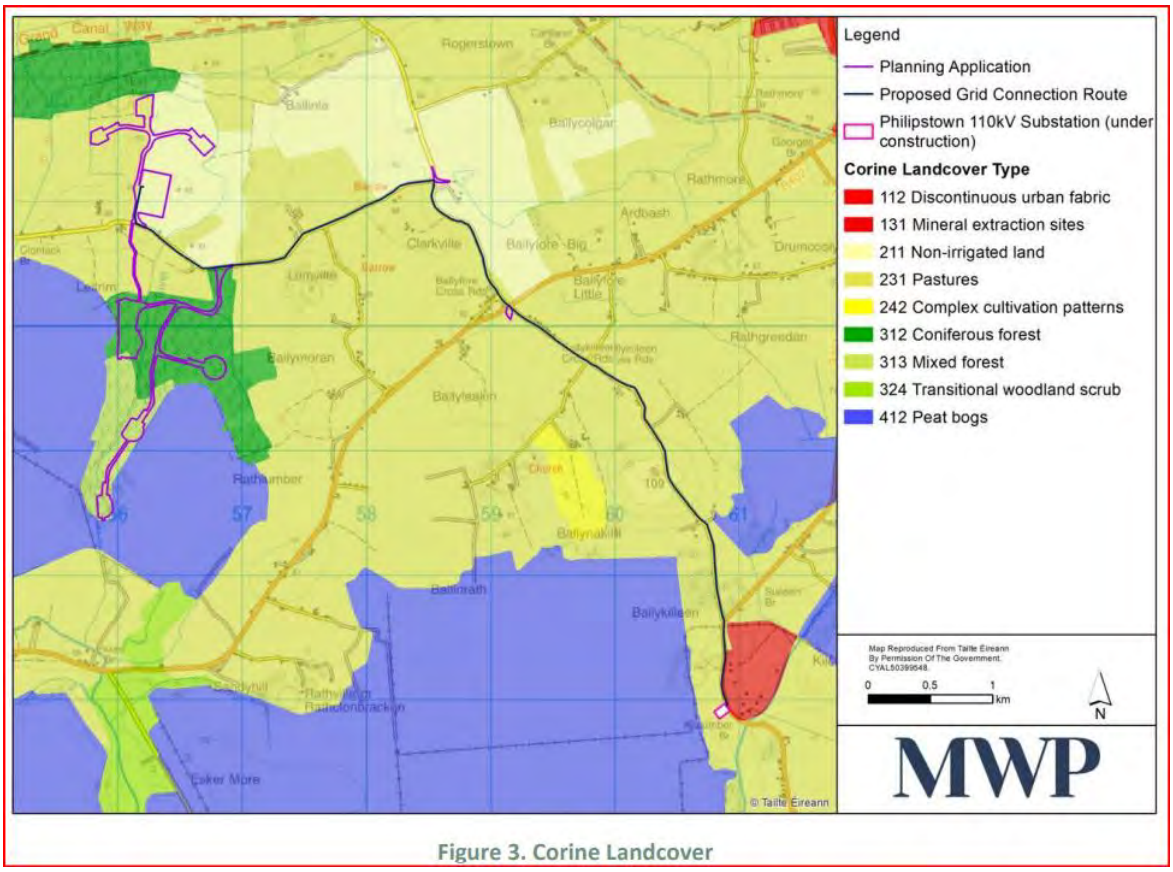
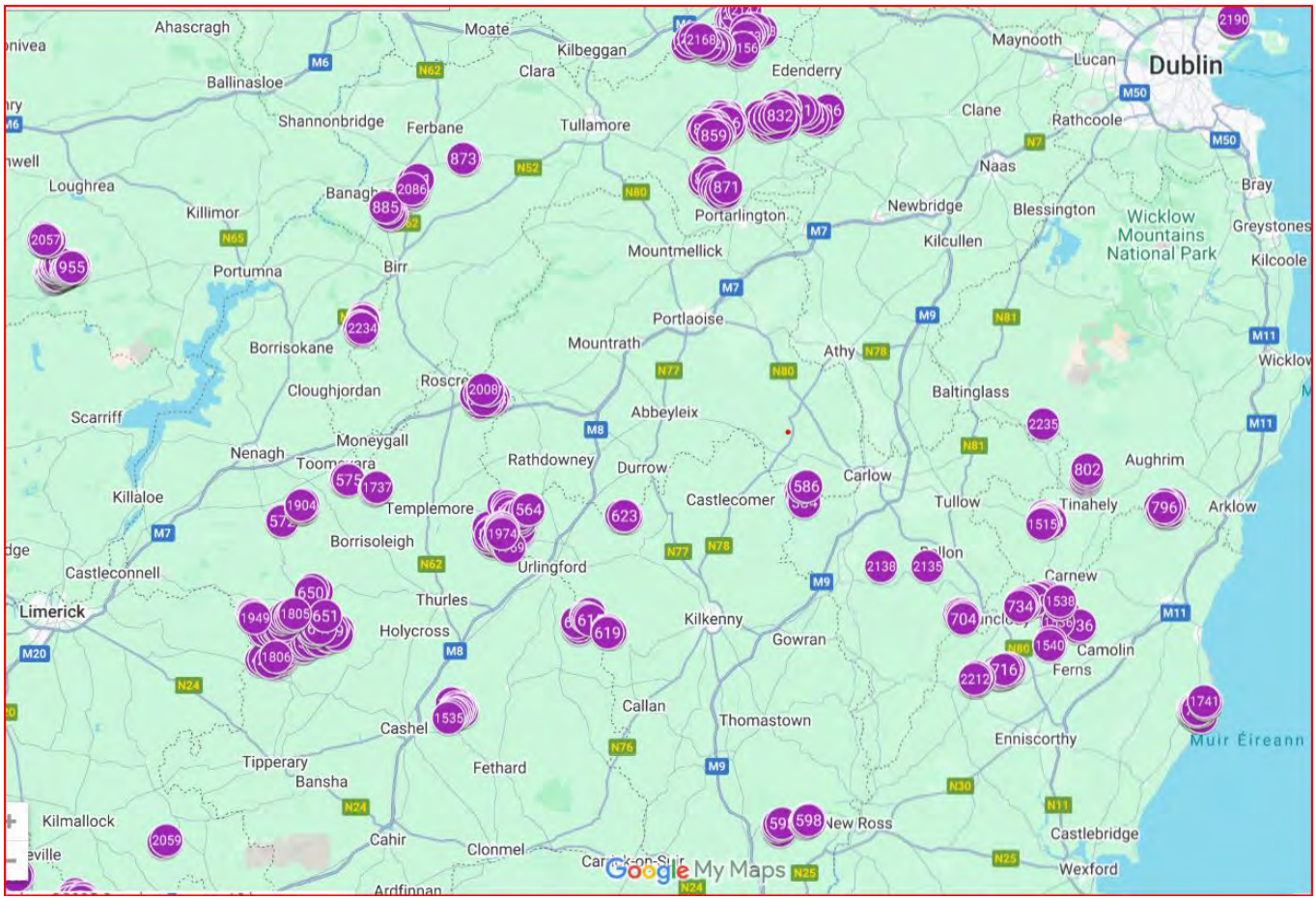


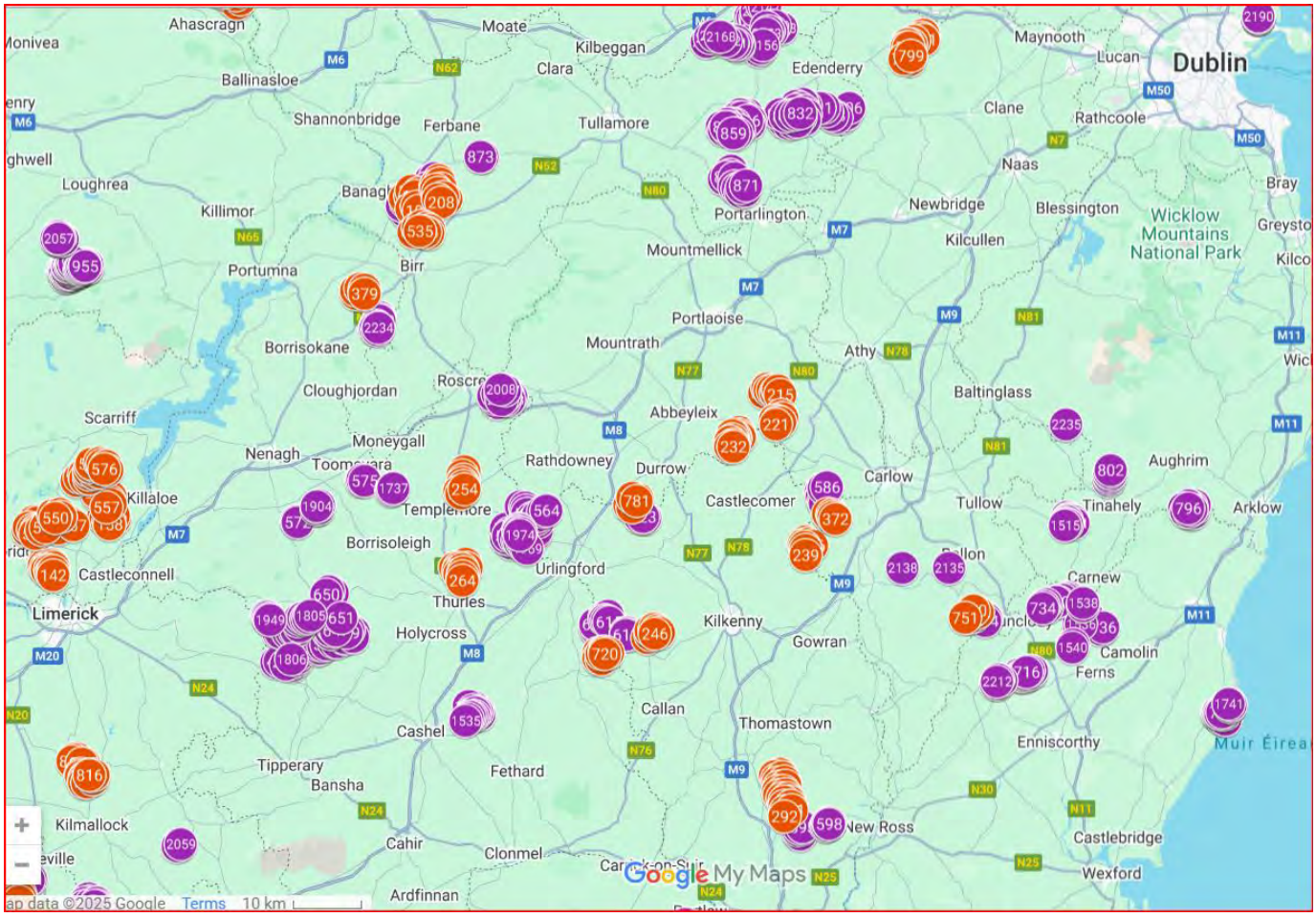
Figure 3. Corine Landcover

Landcover not peat.

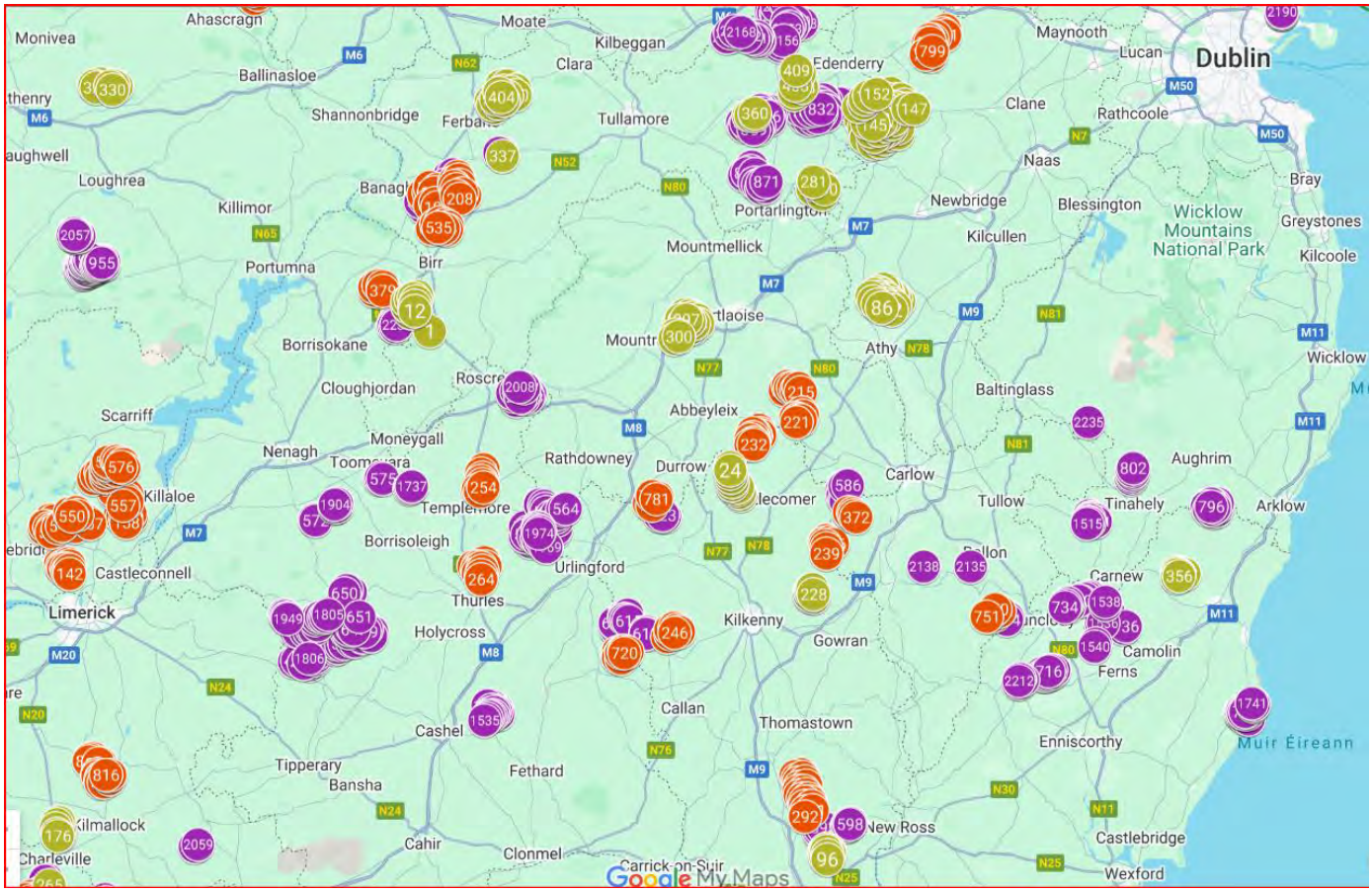
This site is on the flypath for Greenland White Fronted Geese in their migration from Iceland to Wexford Slobs. This application involves the installation of a further windfarm in a North-South alignment between the existing Dernacat, Moanvane, Cushaling, Mount Lucas, Drehid, Cloncreen & Yellow River Windfarms. This application states that Ballinla would form a bridge between these existing windfarms. In effect, it would create a huge barrier to the migration of Greenland White Fronted Geese.



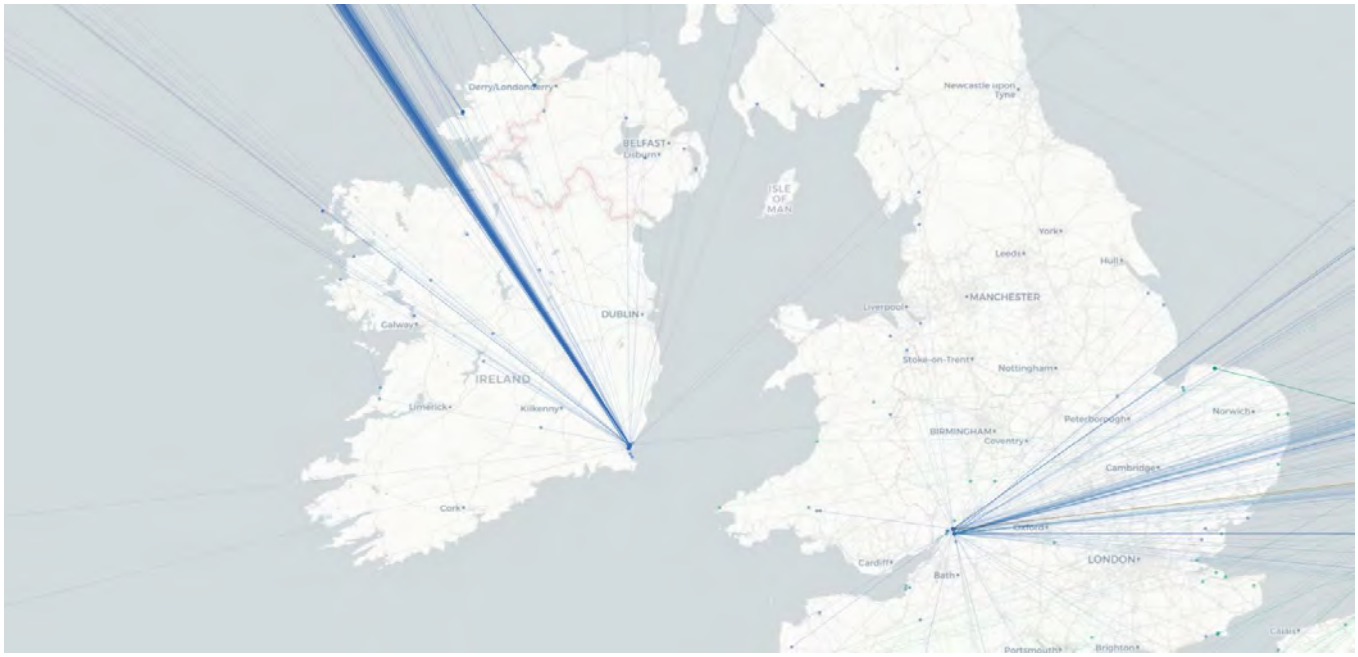
Existing Wind Turbines



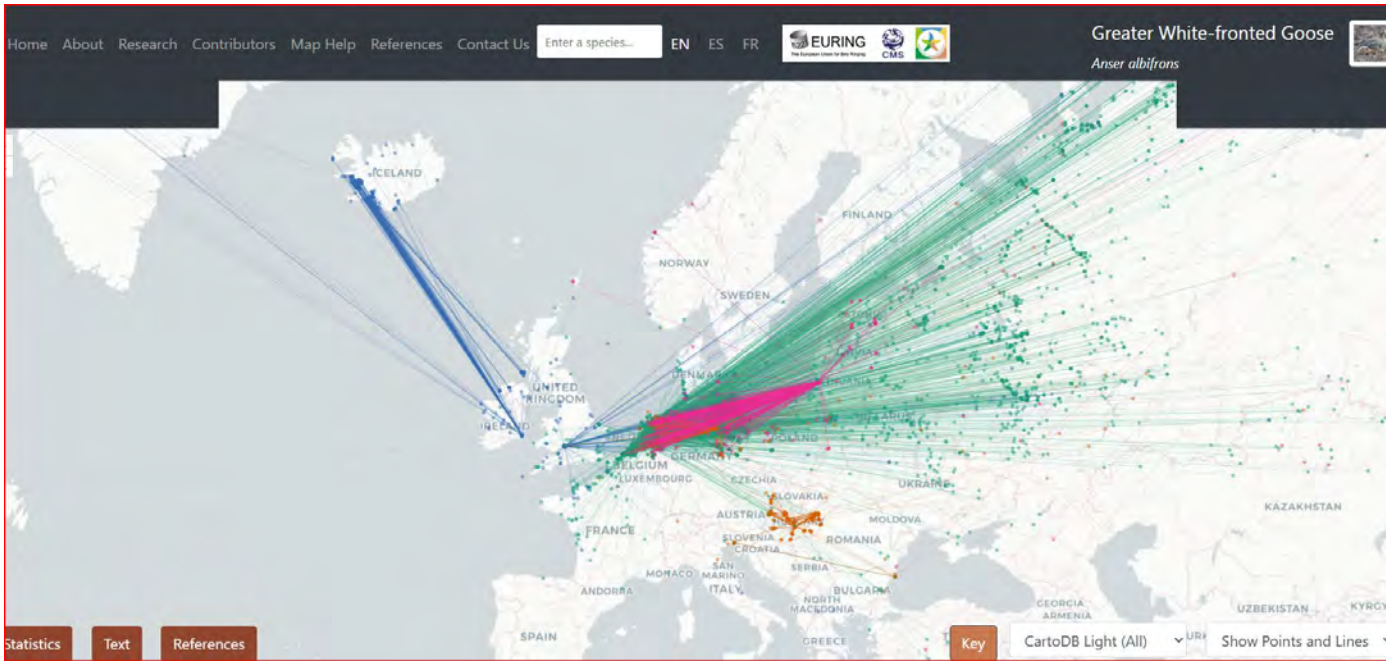
Existing & Proposed Windfarms

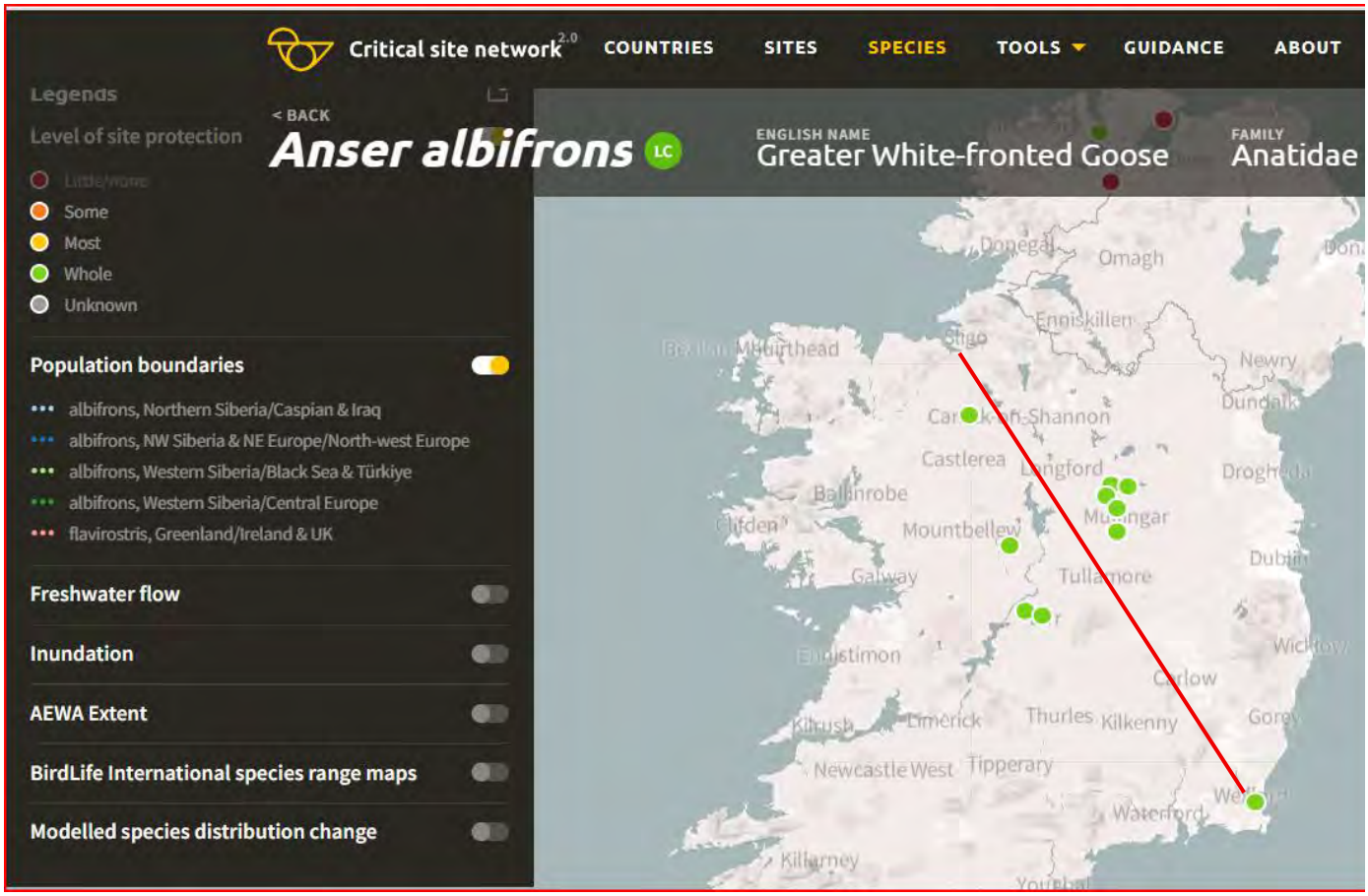


Existing, Proposed and in pipeline Windfarms



Migration route from Greenland White Fronted Geese to Wexford Slobs from Iceland. Note that the existing Windfarms at Mount Lucas, Yellow River & Ballinla create a 60km barrier to this migration.





Note Wexford Slobs & stop over sites around Mullingar on route to Iceland

Fox A. D., Glahder C. M. and Walsh, A. J. 2003. Spring migration routes and timing of Greenland white-fronted geese – results from satellite telemetry. – Oikos 103:415–425.

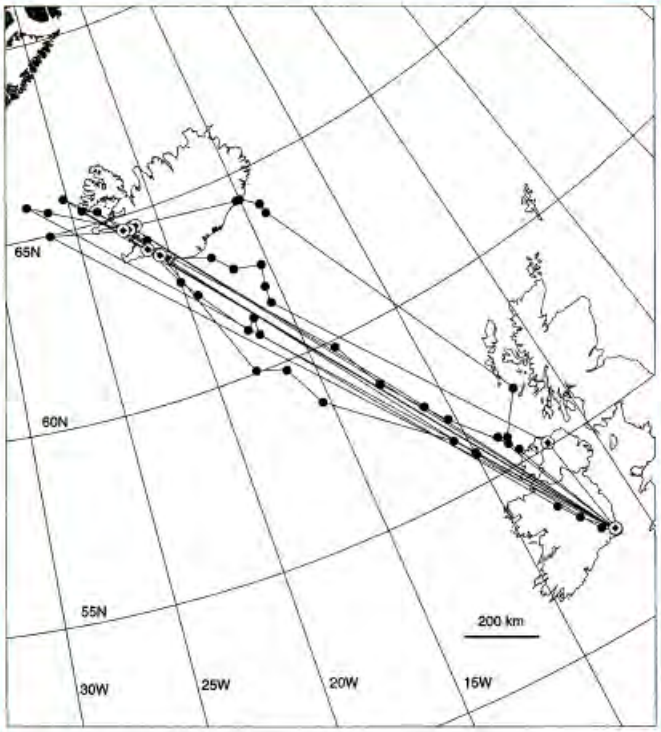
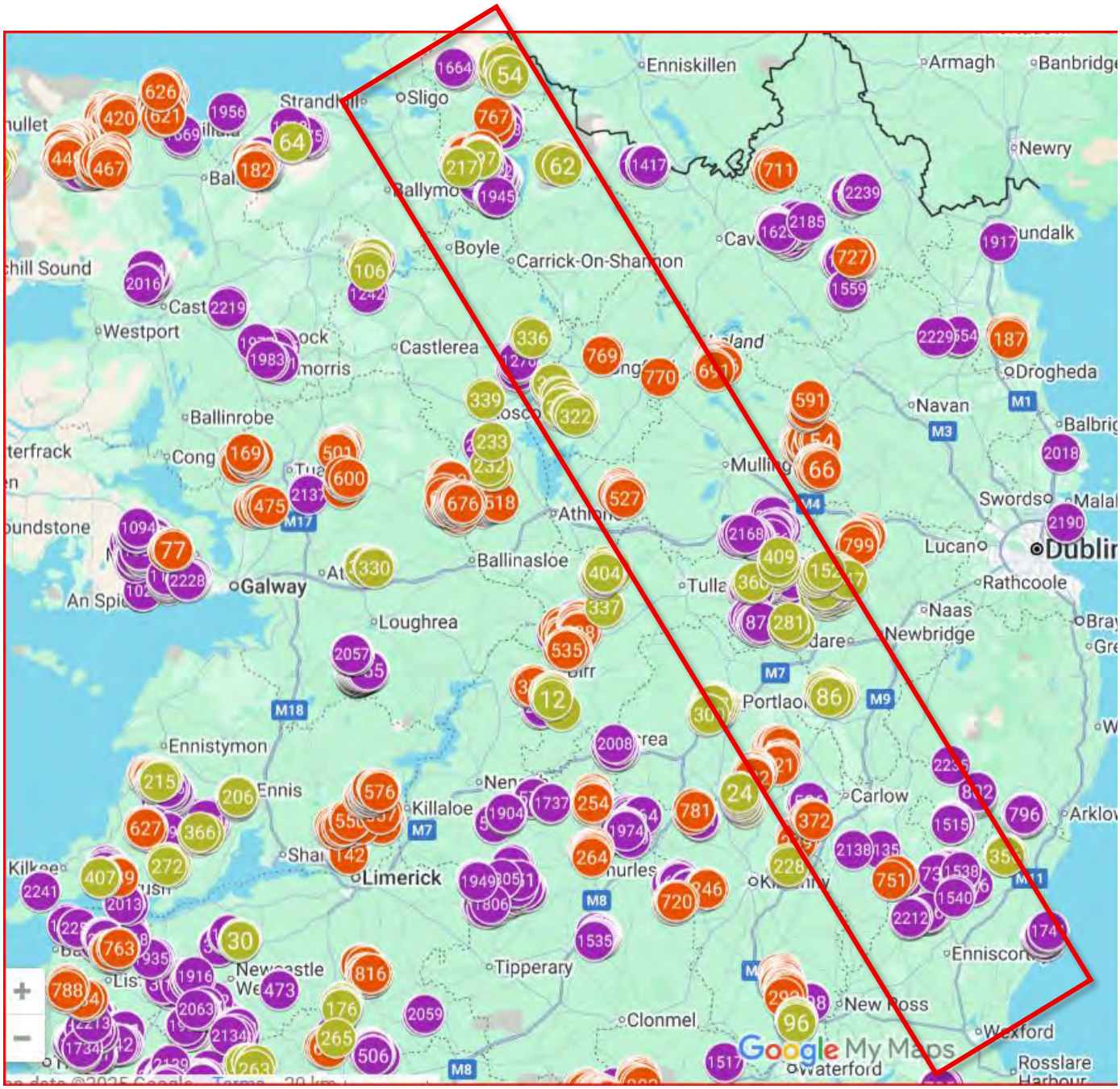


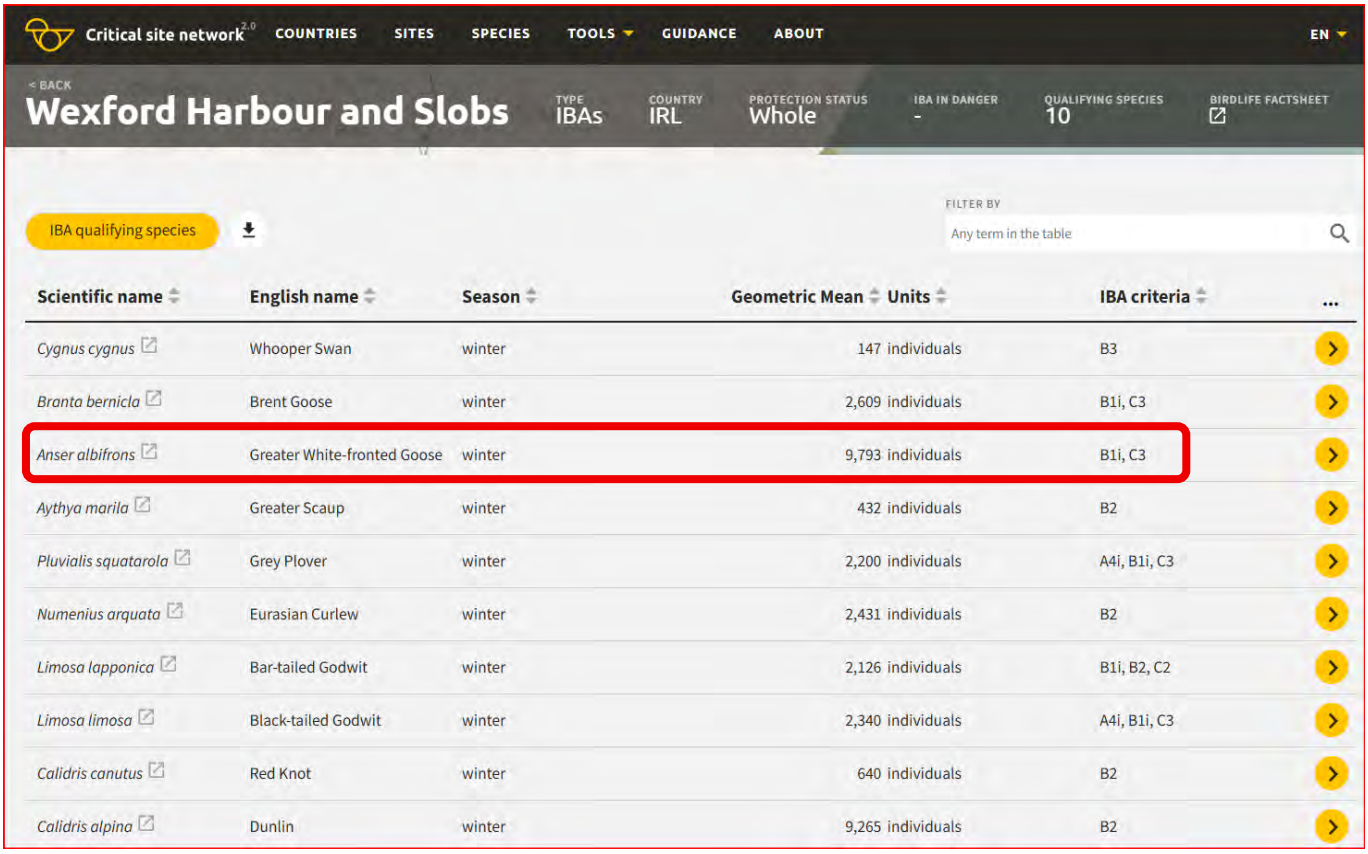
Fig. 4. Spring migration routes taken by 12 Greenland white-fronted geese fitted with satellite transmitters at Wexford, SE Ireland, to staging areas in SW and W Iceland during 1997–1999. Large black-centred dots: staging areas used for more than 2 days. Small black dots: up-link points during migration. Double stereographic projection generated in MapInfo, with lines indicating loxodromic distances between points.

Birdwatch Ireland

Winter visitor with very localised distribution, occurring mostly (up to 9,000 birds) at the Wexford Slobs, with smaller numbers (usually low hundreds) elsewhere. Wexford (North & South Slobs, Tacumshin Lake & Cahore Marshes), Loughs Swilly & Foyle in County Donegal, Lough Gara in County Roscommon, Midland lakes (Loughs Derravarragh, Iron, Owel & Ennell) in County Westmeath, Little Brosna in County Offaly and River Suck/Shannonbridge in County Roscommon are the most important sites.

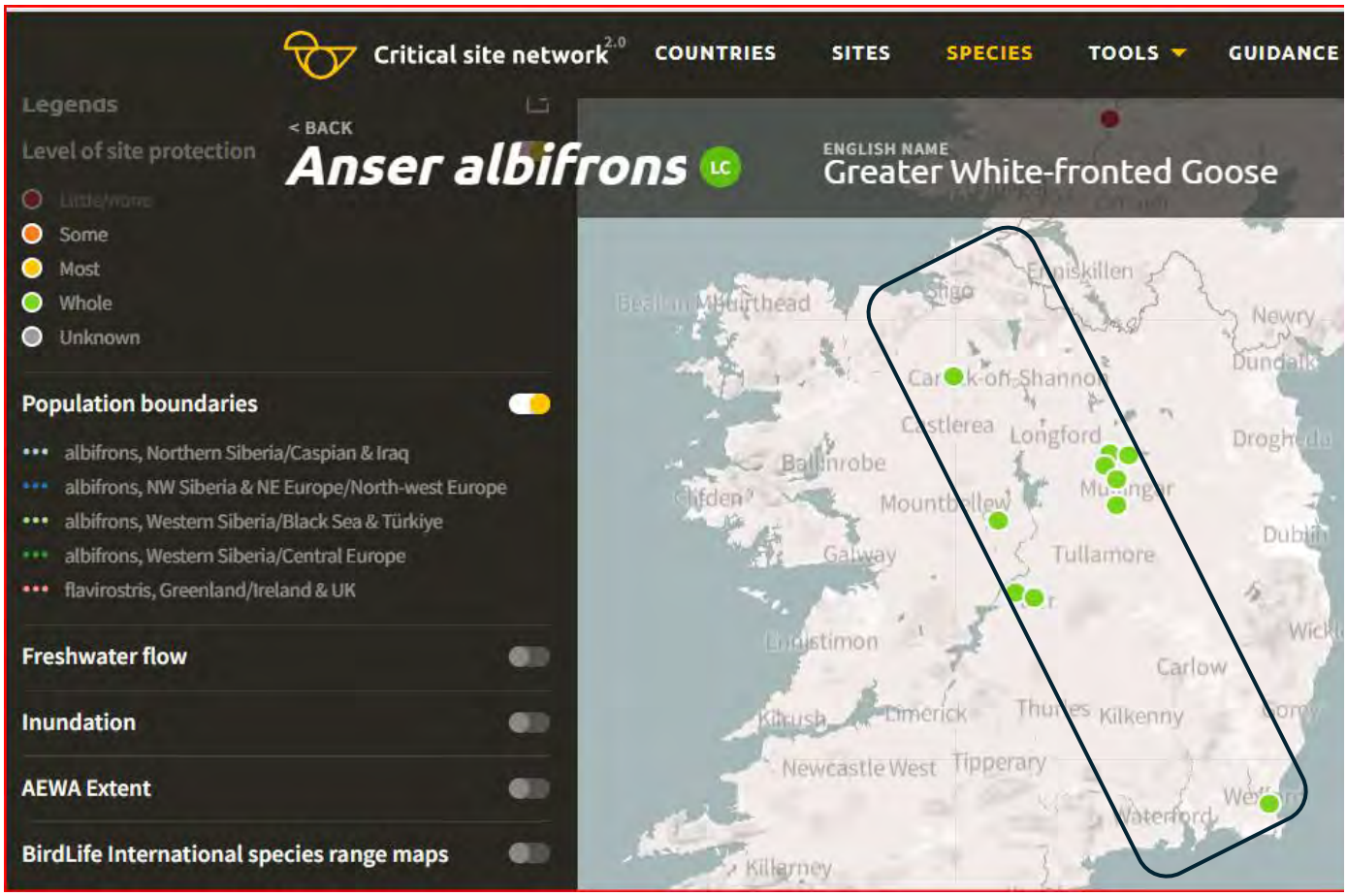


Windfarms & GWFG Migration route corridor. Note the windfarm barrier to flypath around Edenderry.



Scientific name	English name	Season	Geometric Mean	Units	IBA criteria
Cygnus cygnus	Whooper Swan	winter	147	individuals	B3
Branta bernicla	Brent Goose	winter	2,609	individuals	B1i, C3
Anser albifrons	Greater White-fronted Goose	winter	9,793	individuals	B1i, C3
Aythya marila	Greater Scaup	winter	432	individuals	B2
Pluvialis squatarola	Grey Plover	winter	2,200	individuals	A4i, B1i, C3
Numenius arquata	Eurasian Curlew	winter	2,431	individuals	B2
Limosa lapponica	Bar-tailed Godwit	winter	2,126	individuals	B1i, B2, C2
Limosa limosa	Black-tailed Godwit	winter	2,340	individuals	A4i, B1i, C3
Calidris canutus	Red Knot	winter	640	individuals	B2
Calidris alpina	Dunlin	winter	9,265	individuals	B2

Note almost 10,000 Greenland White Fronted Geese at Wexford Slobs



Reference 1.2: System impacts of wind energy developments: Key research challenges and opportunities
Russell McKenna, Johan Lilliestam, Heidi U. Heinrichs, Jann Weinand,Johannes Schmidt, Iain Staffell, Andrea N. Hahmann,Peter Burgherr, Arne Burdack, Monika Bucha, Ruihong Chen, Michael Klingler, Paul Lehmann, Jens Lowitzsch, Riccardo Novo, James Price, Romain Sacchi, Patrick Scherhaufer, Eva M. Scho¨ ll, Piero Visconti, Paola Velasco-Herrejo´, Marianne Zeyringer, and Luis Ramirez Camargo
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ENVIRONMENTAL IMPACTS

Impacts on ecosystems and wildlife

Onshore wind power deployment primarily affects bird and bat populations, even though wind turbines may also disturb and displace terrestrial mammals. Although there are no global estimates of yearly bird and bat fatalities caused by wind turbines, in the United States, with an installed capacity of 112 GW as of 2021, bird fatalities from turbine collisions number in the several hundreds of thousands annually. Species at higher risk are typically migratory, soaring raptors, or bats; the additional mortality due to collisions can be particularly relevant for populations of long-lived and slow-reproducing species, and collision with rotor blades and wind turbine towers might further endanger species already threatened with extinction. However, there are fewer bird collisions with wind turbines than with other structures like buildings, power lines, and communication towers, though some of these structures are also associated with infrastructure for wind turbines. From 2000 to 2020, wind farms had no discernible impact on bird counts in the US, whereas shale gas wells reduced numbers by 15%. But the displacement effect of new installations may in fact be specific to some species. Although previous research suggested bat fatalities caused by barotrauma, more recent studies identify direct blade and tower collisions as the main cause of fatalities.

Despite the growing body of literature on bird strikes in open landscapes, there is a significant lack of research on these impacts in shrub- and woodland environments.

Furthermore, noise pollution from wind turbine operations can negatively affect birds, bats, and non-volant and marine mammals, disrupting their nesting, breeding, and movement patterns, which may result in population decline and displacement. Some species avoid wind turbines due to noise, specifically during construction, whereas

others avoid areas with shadow flicker (see section health and annoyance). Although not a bat attractant, low-frequency noise emissions can disorientate bats, which makes hunting difficult. Land transformation related to the construction of wind farms can also affect habitat suitability for wildlife species. Landscape connectivity between habitats can become disrupted if wind farms are built in existing dispersal corridors. Already-isolated populations can face a reduced gene flow if areas in the vicinity of wind farms are avoided and alternative dispersal corridors are rare. In addition, direct mortality due to collisions with wind farms can affect population dynamics on a large scale. Some species might be able to adapt to altered habitat conditions after wind farm construction, whereas others might not become habituated. However, effects on population trends are difficult to assess because effects are highly site and species specific and long-term studies are rare. Adequate siting of wind farms is a promising approach to reduce impacts on wildlife, but because many species' habitat requirements change in the course of a year, it remains a challenging task, especially when considering ecological corridors and stepping stones. Micro-siting to avoid areas with high collision risk can reduce risks for birds, but it is more challenging for bats. A promising solution for on-site impact mitigation is to increase the cut-in wind speed from 3 to 4 m/s to 6 and 8 m/s for bats and soaring birds, respectively, as these animals have the highest flight activities at low wind speeds, while the production losses would remain modest. Temporary shut-downs triggered by visual or radar observations are also effective solutions to minimize collisions. Visual cues like painting at least one rotor blade black to reduce motion-smear have had limited testing but have shown promising results.81 Lastly, ultrasonic deterrent systems can reduce bat fatalities, though effectiveness can vary by species and environmental conditions.

Impacts on wind resources and weather

The increasing number and size of wind farms can affect local weather and climate patterns, though the magnitude of these effects is debated. There is broad evidence based on photographs, satellite imagery, measurements, and modelling. Wind turbines extract kinetic energy from the wind flowing through their rotors, replenished downstream of the flow above the wind farm. In large wind farms, the latter process cannot supply enough energy to compensate for lowered wind speeds, especially offshore. Hence, a large wind farm can significantly lower the wind speeds in its vicinity, up to a distance of tens of kilometres, thereby suppressing generation from nearby wind farms, as shown in Figure 1 for a possible 2030 wind farm scenario for the North and Baltic seas. The figure shows a possible 2030 scenario of wind farm development in the North Sea and the potential reduction in wind capacity factor induced by these wind farms. Early modelling studies argued that wind farm extractable energy was finite and limited to about 1 MW/km2 for massive wind farm clusters (i.e., of several gigawatts capacity spanning several thousands of km2). Still, recent research demonstrated that this limit can be considerably larger (up to 4 MW/km2) when wind speeds are high and persistent and turbulence can mix energy down from the free atmosphere above. Confirming these findings is challenging due to scarce observations and the limited sizes of presently operating wind farms. These impacts can be mitigated by strategically planning wind farm locations and sizes and limiting their capacity densities as well as during the operational phase within wind farms by so called wake steering. Thus, future wind energy development, particularly offshore, should consider potential wakes and efficiency losses and implement comprehensive international strategies for developing energy-abundant regions such as the North Sea. However, the growth of wind power will likely be restricted by economic or environmental factors rather than global geophysical limits. The operation of wind farms can also cause weather conditions to change locally. This can take the form of shifts in surface temperature (often leading to warmer surface temperatures at night and other weather parameters, such as precipitation and evaporation. The local temperature increases are occasional and typically confined to less than 1 ^{0}C when they occur and are limited to a few kilometers from the wind farm. Offshore wind farms could also affect waves, ocean currents, and sea surface temperatures. Although there is no definitive solution to mitigate the effects on the weather, it is crucial to acknowledge that, on average, they remain limited and much less significant than the global impacts of climate change. In sensitive areas, good spatial planning and coordinated approval processes can minimize the effects on weather and wind resources if they are expected to affect human activities.

SOCIAL, ECONOMIC, AND HEALTH IMPACTS

Land tenure (in)security

The transition to higher shares of wind power boosts the demand for land. The private appropriation of public land to secure access to and control over renewable (including wind) energy production has been referred to as ‘‘green grabbing.’’ This can come at the cost of prior land users and increase the vulnerability of traditional rural communities and Indigenous groups in particular due to the use of public land without free, prior, and informed consent, unfair contractual arrangements, and various forms of dispossession, including the prevention of access by legal means and physically by fencing. The impact of wind energy development on land tenure insecurity, especially for undesignated public and common lands, is addressed in several qualitative studies—in both the Global North and South. For instance, the installation of large-scale wind power in Norway has been described by Sa´ mi representatives as a form of ‘‘green colonialism,’’ pinpointing that these developments could intensify the continuation of historical struggles over land rights and territorial autonomy due to the non-recognition of Indigenous peoples. Similarly, in Brazil, a large share of wind corridors is in undesignated public lands, historically occupied by traditional communities struggling to regularize the ownership and use of common lands. The proposal of individual land leasing contracts for installing turbines in an already ill-defined communal land tenure system has also sparked conflict between Zapotec farmers, the government, and wind farm operators in the Isthmus of Tehuantepec in Mexico as well as in North Africa and the Middle East.

The diverse impacts of wind power development on land appropriation and control, which affect the rights of traditional communities or Indigenous people to territory and livelihoods, need to be linked to a set of compliance rules. These include procedural aspects such as securing their free, prior, and informed consent, addressing information asymmetries about the project’s specific local impacts, and offering fair and legally approved land leasing contracts as well as legal advice on land use. The issue of land ownership and rights is a key challenge to a just energy transition, particularly in recognizing the historical communal use of land by traditional communities and Indigenous people. Increasing the focus of spatial energy planning on land tenure issues, as well as integrating participatory and collaborative planning, can be helpful approaches for renewable projects to better consider local community needs, interests, and rights and to provide fair compensation and manifest co-benefits for immediately affected residents.

Landscape visual impacts

Another public concern is that wind turbines negatively impact the perception of landscapes, particularly untouched nature. This visual landscape impact is one of the main reasons for local opposition to onshore and offshore wind installations.

Acceptance of wind turbines is higher when they are placed in already unattractive landscapes, far from viewpoints, and with a limited number of turbines, but the cumulative effects may vary by location. Several studies have employed national datasets of landscape aesthetic quality (so-called ‘‘scenicness’’), based on survey-based ratings of representative landscape photographs, to quantify the costs incurred to power systems when excluding onshore wind potentials in landscapes with high aesthetic quality, showing a large range of impacts between countries

In addition, viewshed analyses, in which a three-dimensional space (the viewshed) within which one or more hypothetical wind turbines are visible, can aid in understanding the potential visual impact on sensitive receptors; however, these disregard people’s visual preference for certain landscapes over others. They may, therefore, be combined with measurements of visual features of landscapes, as a correlation between such metrics and rated landscape qualities has been found. Moreover, RE infrastructure such as wind turbines and power lines strongly influence the rated landscape coherence. Quantifying the landscape impact of wind turbines to improve placement decisions requires that both visibility and landscape quality are considered. Whereas the latter refer to changes in landscape quality and character, visibility impacts relate to (perceived) changes in views (of the landscape) and how these affect people. Approaches based on geographical information systems (GISs) have been proposed to estimate landscape coherence and wilderness using indicators calculated from datasets such as land cover, topography, and remoteness.

Similar approaches can be combined with visual impact assessments to develop robust, reliable, and scalable methods and tools for landscape impact assessments.

Health and annoyance

Noise emissions and the ‘‘flicker’’ of the rotating shadow from wind turbines are frequently discussed as negative impacts of wind farms. Although current evidence suggests that noise emissions from wind farms do not have a significant direct impact on nearby populations’ health, some studies have noted a correlation between noise-related annoyance and potential indirect effects on quality of life, such as sleep disturbance, increased stress, and related health concerns (e.g., elevated blood pressure and psychological distress). However, the causality and directionality of these effects remain unproven and require further research. The perception of noise seems higher in rural areas and around flat terrains. Although low-frequency noise emissions cannot be heard, they may still lead to annoyance, but the link between wind turbines and low-frequency noise has not yet been established. In addition, many studies show that only a small fraction of the population living near wind farms is disturbed by shadow flicker. Shadow flicker exposure does not necessarily lead to self-reported annoyance but rather subjective factors such as project appearance and general annoyance. However, the disturbance attributed to wind turbine noise emissions should be evaluated compared with other routine noise sources. In a controlled study, although subjects reported annoyance from the acoustic emissions of nearby wind turbines, health-related effects were specifically attributed to noise pollution from road traffic.

Noise impacts can be mitigated by appropriate wind farm planning and simulations, and it is suggested that a certain noise threshold be respected (e.g., 35–45 dB(a)), as is currently enforced in some countries. Likewise, for cases where high levels of modelled shadow flicker exposure and self-reported annoyance correlate, easy-to-implement solutions exist, such as curtailment after specific exposure thresholds. However, the probability of that correlation occurring is low because detailed shadow flicker simulations are an integral part of planning processes for wind farms and permission might not be granted in case thresholds would be exceeded (see, e.g., the German BImSchg). Nevertheless, the studies leading to that regulation were performed over 20 years ago when turbines were considerably smaller than today and were capable of generating a flickering effect of higher frequency.

Reference 1.3: Wind Farms & Health Literature Review- Chapman 2015
Summary of main conclusions reached in 25 reviews of the research literature on wind farms and health.
Compiled by Prof Simon Chapman, School of Public Health and Teresa Simonetti, Sydney University Medical School
simon.chapman@sydney.edu.au
Updated 10 April 2015.

The following Response is from the Australian Parliament in a reference to Health issues from windfarms.

Select Committee on Wind Turbines: Final report. August 2015. ISBN 978-1-76010-260-9

Wind turbines and ill-health

2.7 The committee has taken evidence from a number of people who reside in proximity to wind turbines who have complained of a range of adverse health impacts. These include tinnitus, raised blood pressure, heart palpitations, tachycardia, stress, anxiety, vertigo, dizziness, nausea, blurred vision, fatigue, cognitive dysfunction, headaches, nausea, ear pressure, exacerbated migraine disorders, motion sensitivity, inner ear damage and worst of all, sleep deprivation.

2.8 Dr Sarah Laurie told the committee:

The human cost of the failure to protect people from excessive noise pollution, especially at night, is terrible. I have personally helped to prevent a number of suicides of people who were utterly desperate because of theconsequences of excessive noise pollution and who reached out for help.

From my experience there is a subset of people who are terribly impacted very early on. Those people are the ones who tend to present with acute vestibular disorder type of symptoms—dizziness and motion sickness, which can be accompanied by extreme anxiety. Those people often just cannot last very long, and they move if they can.

2.9 Ms Janet Hetherington, an adjacent landholder to the Macarthur wind farm in south-west Victoria, relayed her own experience:

At my farm, I experience severe adverse health effects such as vibration, heart palpitations, tinnitus, head pressure, headaches, sleep deprivation, anxiety, night sweats, nausea, itchy skin, cramps, and ear, nose and throat pain. Twice now I have experienced horrendous pain in my chest stabbing through to my backbone in between my shoulder blades. I contemplated calling an ambulance both times but could not move to do so because of the severity of the pain. Ten minutes later it had dissipated, leaving me with great stress and anxiety and feeling washed out. All these sensations leave me drained in the morning. I find it very hard to start work that day.

2.10 Ms Anne Gardner also attributed her and her husband's ill health to the nearby Macarthur wind farm. She described the following symptoms:

My husband experienced bolts of pressure which tallied up with pressure peaks measured by Les Houston (sic) 86 per cent of the time while my husband was blind to the acoustic measurements of the time. Refer to his recap statement. I suffer day and night from headaches, nose and ear pressure, nausea, heart palpitations and chest burning from vibrations through the floor, couch, chair and in bed all night.6

2.11 Mr Clive Gare and his wife host 19 towers from the North Brown Hill wind farm located 17 kilometres from Jamestown in South Australia. Mr Gare told the committee:

After a short period of living with an operating wind farm, we had these products installed. I find that, because I work and reside in close proximity to the wind farm, I suffer sleep interruption, mild headaches, agitation and a general feeling of unease; however, this occurs only when the towers are turning, depending on the wind direction and wind strength. My occupation requires that I work amongst the wind towers during the day which means I suffer the full impacts of noise for days at a time without relief. The impacts are that we are not able to open our windows because of the noise at night and we are not able to entertain outside because of the noise.

In conclusion, if we did not have soundproof batts in VLam Hush windows [special window laminate designed to dampen noise], our house would not be habitable. In my opinion, towers should not be within five kilometres of residences, and I would personally not buy a house within 20 kilometres of a wind farm.

2.12 The committee notes that the Gares have received payment of $2 million over five years to host turbines and have reported serious adverse impacts. The committee notes, therefore, that their evidence is an 'admission against interest' and as such represents highly reliable evidence.

2.13 Mr John Pollard, a resident of Glenthompson near the Oaklands Hill wind farm in Victoria, told the committee:

The wind farm guidelines on health issues of this very serious problem have to be assessed. They will not acknowledge infrasound. I will relate one incident that happened in our home one night. My wife was sleeping in the chair beside me and I was watching television. This is after they had turned the turbines off. She was dead to the world and I was just watching the television. All of a sudden she woke up, completely startled and disorientated, and I was really worried about her because I thought she had had a stroke or something. Eventually she came to her senses and she said the turbines must be on. I said, 'No, they're not. It's 10.30. They turn off at nine o'clock.' I went outside and they were still running. So I thought that next day I would ring AGL. When I was about to ring, they rang me and said, 'I'm sorry, John. We forgot to turn the turbines off last night.'

2.14 Waubra resident Mr Donald Thomas identified hearing difficulties from the nearby Waubra wind farm turbines.9 He claimed that these difficulties disappeared when he left the area:

I went to the doctor with what I kept saying was a lot of ear pressure and earaches. I went to see a specialist, and my ears came back as being in good health and functioning pretty well, even though I have lost a lot of hearing. Basically, my left ear does not work too good… My ears—especially when I go to my Stud Farm Road property, I have ear pressure that can develop into a headache and rapid heartbeat. If I leave that area and go back to one of my other properties, that can settle back down.

2.15 Mr Peter Jelbart, a 25 year old who had lived with his family nearby the Macarthur wind farm in south-west Victoria, noted the difficulty of sleeping in the family home. He told the committee he had worked and slept unaffected in noisy environments outside of the family home in Victoria:

While I was working in Western Australia I used to do three weeks on, one week off and come home for a week. Over in Western Australia I was sleeping at times on the sides of busy highways and in the back of trucks with ice packs running… At home, I noticed pretty much from day one that there is a serious problem there. Something is completely different when sleeping. I would wake up after a couple of hours of sleep—at times, not even after a couple of hours—and have disrupted sleep that I have had nowhere else. There is a proper problem… Whether it is low-frequency noise and the infrasound combining with it, it seems worse when it is quiet. Around our house the yard is pretty well protected by trees. When it is relatively quiet around the house yard there is still a really soft drone that comes through and just gets into you. It is pretty hard to explain. There are probably a lot of people going through the same thing who will have the same trouble trying to explain it, especially to people who have not experienced it. The problem with it is, it also seems to affect different people over different periods of time.11

2.16 The committee has had the opportunity to take evidence from researchers in the United States and Canada who expressed their concern with the health effects of turbines. Ms Lilli-Ann Green is the Chief Executive Officer of a healthcare consulting firm in the United States. In 2012, Ms Green and her husband conducted interviews with people living near wind turbines in 15 different countries. As she told the committee: We have interviewed people on three continents who live more than five miles from the nearest wind turbine and are sick since wind turbine wind turbines need to be sited from people in order to do no harm. People report to us that over time their symptoms become more severe. Many report not experiencing ill effects for some time following wind turbine construction, meanwhile their spouse became ill the day the wind turbines nearby became operational. They speak of thinking they were one of the lucky ones at first, but after a number of months or years they become as ill as their spouse. Not one person who stayed near wind turbines reported to us that they got used to it or got better; they all became more ill over time… I really believe that we just do not have enough information yet. But throughout the interviews, country by country, people described the same symptoms. Many times they used the same phrases to describe them and the same gestures—and they were not speaking English. There is a common thread here.

2.17 Dr Jay Tibbetts, a medical practitioner and vice chair of the Brown County Board of Health in Wisconsin, drew the committee's attention to the board's October 2013 finding that the Shirley wind farm was a 'human health hazard'. Dr Tibbetts described how the declaration came about:

The [Board of Health] has been studying adverse health effects for the past 4 ½ years in the Shirley Wind Project. We have reviewed many peer reviewed studies, at least 50 medical complaints including ear pain, pressure, headache, tinnitus, vertigo, nausea, chest pain, chest pressure, loss of concentration, sleep deprivation and more, as well as more than 80 other complaints from citizens of Shirley Wind. There have been 2 formal studies of infrasound/low frequency noise by acousticians in 2012 and 2014. The latter study revealed symptom generating [Infrasound/Low Frequency Noise] at a distance of 4 ½ [miles].

2.18 The committee also heard of detailed research by Professor Emeritus Robert McMurtry from Western University in Ontario, Canada. Professor McMurtry made a number of points to the committee:

• adverse health effects have been reported globally in the environs of wind turbines for more than 30 years with the old design of turbines and the new;

• the wind energy industry has denied adverse health effects, preferring to call it 'annoyance'. Annoyance is recognised and was treated by the World Health Organization as an adverse health effect, which is a risk factor for serious chronic disease including cardiovascular and cancer;

• the regulations surrounding noise exposure are based upon out-of-date standards ETSU-97, which fail to evaluate infrasound and low-frequency

Professor Chapman and his critics

2.19 Professor Simon Chapman AO, Professor of Public Health at the University of Sydney, has been an outspoken critic of those who suffer ill-effects from wind turbines. In both his written and oral submissions, Professor Chapman cited many of his own publications in support for his view that:

…the phenomenon of people claiming to be adversely affected by exposure to wind turbines is best understood as a communicated disease that exhibits many signs of the classic psychosocial and nocebo phenomenon where negative expectations can translate into symptoms of tension and anxiety.

2.20 Several highly qualified and very experienced professionals have challenged this argument. Dr Malcolm Swinbanks, an acoustical engineer based in the United Kingdom, reasoned:

The argument that adverse health reactions are the result of nocebo effects, ie a directly anticipated adverse reaction, completely fails to consider the many cases where communities have initially welcomed the introduction of wind turbines, believing them to represent a clean, benign form of low-cost energy generation. It is only after the wind-turbines are commissioned, that residents start to experience directly the adverse nature of the health problems that they can induce.

2.21 The committee highlights the fact that Professor Chapman is not a qualified, registered nor experienced medical practitioner, psychiatrist, psychologist, acoustician, audiologist, physicist or engineer. Accordingly:

• he has not medically assessed a single person suffering adverse health impacts from wind turbines;

• his research work has been mainly—and perhaps solely—from an academic perspective without field studies;

• his views have been heavily criticised by several independent medical and acoustic experts in the international community; and

• many of his assertions do not withstand fact check analyses.

2.22 Professor Chapman has made several claims which are contrary to the evidence gathered by this committee. First, he argues that the majority of Australia's wind turbines have never received a single complaint. There are various problems with this statement:

(i) wind turbines located significant distances from residents will not generate complaints;

(ii) many residents suffering adverse health effects were not aware of any nexus between their health and the impact of wind turbines in order to make a complaint;

(iii) just because residents do not lodge a formal complaint does not mean they are not suffering adverse health effects;

(iv) data obtained by Professor Chapman from wind farm operators of the numbers of complaints lodged cannot be relied upon; and

(v) the use of non-disclosure clauses and 'good neighbour agreements' legally restricts people from making adverse public statements or complaints.

2.23 Second, Professor Chapman has argued that complaints of adverse health effects from wind turbines tend to be limited to Anglophone nations. However, the committee has received written and oral evidence from several sources directly contradicting this view. The German Medical Assembly recently submitted a motion

to the executive board of the German Medical Association calling for the German government to provide the necessary funding to research adverse health effects. This would not have happened in the absence of community concern. Moreover, Dr Bruce Rapley has argued that in terms of the limited number—and concentrated nature—of wind farm complaints:

It is the reporting which is largely at fault. The fact is that people are affected by this, and the numbers are in the thousands. I only have to look at the emails that cross my desk from all over the world. I get bombarded from the UK, Ireland, France, Canada, the United States, Australia, Germany. There are tonnes of these things out there but,

because the system does not understand the problem, nor does it have a strategy, many of those complaints go unlisted.

2.24 Third, Professor Chapman has queried that if turbines are said to have acute, immediate effects on some people, why were there no such reports until recent years given that wind turbines have operated in different parts of the world for over 25 years. Several submissions to the committee have stated that adverse health effects from wind turbines do not necessarily have an acute immediate effect and can take time to manifest.

2.25 Fourth, Professor Chapman contests that people report symptoms from even micro-turbines. The committee heard evidence that once people are sensitised to low frequency infrasound, they can be affected by a range of noise sources, including large fans used in underground coal mines, coal fired power stations, gas fired power stations and even small wind turbines. As acoustician Dr Bob Thorne told the committee:

Low-frequency noise from large fans is a well-known and well-published issue, and wind turbines are simply large fans on top of a big pole; no more, no less. They have the same sort of physical characteristics; it is just that they have some fairly unique characteristics as well. But annoyance from low-frequency sound especially is very well known.

2.26 Fifth, Professor Chapman contends that there are apparently only two known examples anywhere in the world of wind turbine hosts complaining about the turbines on their land. However, there have been several Australian wind turbine hosts who have made submissions to this inquiry complaining of adverse health effects.

Paragraphs 2.11–2.12 (above) noted the example of Mr Clive Gare and his wife from Jamestown. Submitters have also directed attention to the international experience.

In Texas in 2014, twenty-three hosts sued two wind farm companies despite the fact that they stood to gain more than $50 million between them in revenue. The committee also makes the point that contractual non-disclosure clauses and 'good neighbour' agreements have significantly limited hosts from speaking out. This was a prominent theme of many submissions.

2.27 Sixth, Professor Chapman claims that there has been no case series or even single case studies of so-called wind turbine syndrome published in any reputable medical journal. But Professor Chapman does not define 'reputable medical journal' nor does he explain why the category of journals is limited to medical (as distinct, for assertion. However, the committee does note that a decision to publish—or not to publish—an article in a journal is ultimately a business decision of the publisher: it does not necessarily reflect the quality of the article being submitted, nor an acknowledgment of the existence or otherwise of prevailing circumstances. The committee also notes that there exist considerable published and publicly available reports into adverse health effects from wind turbines.

2.28 The committee also notes that a peer reviewed case series crossover study involving 38 people was published in the form of a book by American paediatrician Dr Nina Pierpont, PhD, MD. Dr Pierpont's *Report for Clinicians* and the raw case data was submitted by her to a previous Australian Senate inquiry (2011) to which Dr Pierpont also provided oral testimony. Further, at a workshop conducted by the NHMRC in June 2011, acoustical consultant Dr Geoffrey Leventhall stated that the symptoms of 'wind turbine syndrome' (as identified by Dr Pierpont), and what he and other acousticians refer to as 'noise annoyance', were the same. Dr Leventhall has also acknowledged Dr Pierpont's peer reviewed work in identifying susceptibility or risk factors for developing wind turbine syndrome / 'noise annoyance'. Whilst Dr Leventhall is critical of some aspects of Dr Pierpont's research, he does state:

Pierpont has made one genuine contribution to the science of environmental noise, by showing that a proportion of those affected have underlying medical conditions, which act to increase their susceptibility.30

2.29 Seventh, Professor Chapman claims that no medical practitioner has come forward with a submission to any committee in Australia about having diagnosed disease caused by a wind farm. Again, Professor Chapman fails to define 'disease'.

Nonetheless, both this committee, and inquiries undertaken by two Senate Standing Committees, have received oral and written evidence from medical practitioners contrary to Professor Chapman's claim.

2.30 Eighth, Professor Chapman claims that there is not a single example of an accredited acoustics, medical or environmental association which has given any credence to direct harmful effects of wind turbines. The committee notes that the semantic distinction between 'direct' and 'indirect' effects is not helpful. Dr Leventhall and the NHMRC describe stress, anxiety and sleep deprivation as 'indirect' effects, but these ailments nonetheless affect residents' health.

2.31 Finally, Professor Chapman queries why there has never been a complainant that has succeeded in a common-law suit for negligence against a wind farm operator.

This statement is simply incorrect. The committee is aware of court judgements against wind farm operators, operators making out of court settlements or withdrawing from proceedings, injunctions or shutdown orders being granted against operators, and properties adjacent to wind turbines being purchased by operators to avoid future conflict. The committee also reiterates its earlier point that contractual non-disclosure clauses have discouraged legal action by victims.

EMAIL FROM MR. GEORGE O CONNOR, STATKRAFT

From: George O'Connor <George.O'Connor@statkraft.com>
Sent: Sunday 21 September 2025 21:28
To: Tina McNabola <tina.mcnabola@colmquinnbmw.ie>; John Lowry <John.Lowry@statkraft.com>
Subject: Re: Email addresses & response to topics raised at Lumville September 5th meeting
Importance: High

Hi Tina,

I am writing to follow up on recent correspondence regarding the Ballinla Wind Farm project.

Firstly, I must express disappointment that, despite the previous request by John, the contact details for Mary have still not been provided.

Response: The applicant is not entitled to get contact details of names & when they are given a specific contact route.

Timely access to relevant contacts is essential for effective communication and transparency.

Please find attached the full text of the memo provided following the meeting on 5 September, addressing the key technical and community topics discussed. We appreciate your engagement and the concerns you have raised. Community input plays a vital role in shaping responsible and sustainable energy infrastructure, and we are committed to maintaining open and transparent dialogue throughout this process.

This response has been prepared by our technical and environmental team, addressing the topics raised.

Key topics covered include:

- Geotechnical and Hydrogeological Considerations
- Wake Effects, Noise and Turbine Parameters
- Aviation Lighting
- Geological context and fault mapping
- Groundwater protection and local well considerations
- Vibration impacts and receptor distances
- Grid route

· Traffic
· Community Engagement
· Human Health and Wellbeing

We trust that the enclosed information will provide clarity and reassurance regarding the robustness of the proposed development and the measures in place to safeguard environmental and community interests.

Geotechnical and Hydrogeological Considerations

· A detailed peat stability assessment has been completed for the site, including all proposed infrastructure such as access tracks, turbine bases, and the grid connection corridor. The assessment concluded that there is no risk of peat instability across the development footprint.

The NW/SE trending fault identified on GSI maps lies within the same geological unit and represents a change in bedding orientation, not a lithological or structural boundary of concern. This type of faulting is common in sedimentary terrains and does not pose a geotechnical risk to the development. The peat stability and foundation design assessments have accounted for this feature.

Response: A geological fault creates a conduit for surface water to drain into limestone conduits & interfere with the existing drinking water wells surrounding the site. It also creates the potential for infrasound generation.

Volumetric assessments are typically undertaken for developments that involve significant groundwater abstraction or discharge such as quarries and landfills. Wind energy developments do not fall into this category and are not considered a risk to groundwater resources under EPA or Geological Survey Ireland (GSI) guidance.

Response: Use of lubricating oils, blade delamination & blade cleaning chemicals in addition to the dead insect body detritus create a major impact in relation to groundwater contamination.

The site is underlain by locally important aquifers with moderate productivity and is not located within a Groundwater Source Protection Zone. While some local wells may be used for domestic or agricultural abstraction, many are unregistered and typically serve low-yield private use. Assessment carried out to date confirm no significant groundwater vulnerability, and no karst features or high-yield aquifers are present.

Response: No assessments of these local wells have been provided.

The proposed development has been designed to maintain the existing hydrogeological regime, with embedded controls including sustainable drainage systems (SuDS) to mirror existing runoff and infiltration, no groundwater abstraction or discharge, localised dewatering where required. The proposed wind farm will not alter groundwater flow or yield.

Wake Effects, Noise and Turbine Parameters

· While we are unable to provide proprietary modelling software, the understanding of wake effects is well-established in peer-reviewed literature. Wake effects, characterised by reduced wind speed and increased turbulence, are typically confined to short distances downwind of turbines. According to Astolfi et al. (2023), wake-induced power losses and turbulence intensity diminish significantly beyond 10 rotor diameters.

Response: We attach all of the publications (15no.) found for Astolfi in 2023 & can find no reference to wake induced power losses & turbulence intensity that diminish beyond 10 rotor diameters:

On the Use of Blockchain for the Operation and Management of EV Charging Infrastructures
Conference Paper- November 2023-2023 Asia Meeting on Environment and Electrical Engineering (EEE-AM)
Marco Pasetti, Salvatore Dello Iacono, Davide Astolfi, Antony Vasile

Wind Power Applications of eXplainable Artificial Intelligence Techniques
Conference Paper- October 2023- 2023 AEIT International Annual Conference (AEIT)
Davide Astolfi, Fabrizio De Caro, Alfredo Vaccaro

Recent Advances in the Use of eXplainable Artificial Intelligence Techniques for Wind Turbine Systems Condition Monitoring
Article- August 2023- Electronics
Davide Astolfi, Fabrizio De Caro, Alfredo Vaccaro

Characterizing the Wake Effects on Wind Power Generator Operation by Data-Driven Techniques
Article- August 2023- Energies
Davide Astolfi, Fabrizio De Caro, Alfredo Vaccaro

Enhancing Wind Turbine Power Curve Monitoring with eXplainable Artificial Intelligence Techniques
Conference Paper- July 2023- IEEE EUROCON 2023- 20th International Conference on Smart Technologies
Davide Astolfi, Fabrizio De Caro, Alfredo Vaccaro

Towards the Electrical Self-Sufficiency of a University Campus: Techno-Economic Case Studies
Conference Paper- July 2023- IEEE EUROCON 2023- 20th International Conference on Smart Technologies
Alessandro Ciocia, Valeria Cocina, Giovanni Grosso, [...], F. Spertino

Experimental Assessment of Data-driven Methods for Detecting Wind Power Ramps
Conference Paper- June 2023- 2023 International Conference on Clean Electrical Power (ICCEP)
Fabrizio De Caro, Davide Astolfi, Alfredo Vaccaro

Experimental Analysis Of The Effect Of Static Yaw Error On Wind Turbine Nacelle Anemometer Measurements
Conference Paper- June 2023- 2023 IEEE International Conference on Environment and Electrical Engineering and 2023 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe)
Davide Astolfi, Linyue Gao, Ravi Kumar Pandit, Jiarong Hong

Condition Monitoring of Wind Turbine Systems by Explainable Artificial Intelligence Techniques
Article- June 2023- Sensors
Davide Astolfi, Fabrizio De Caro, Alfredo Vaccaro

Data-driven characterization of performance trends in ageing wind turbines
May 2023- Journal of Physics Conference Series
Alessandro Murgia, Henrique Cabral, Elena Tsiporkova, [...], Ludovico Terzi

Diagnosis of wind turbine systematic yaw error through nacelle anemometer measurement analysis
Article- May 2023- Sustainable Energy Grids and Networks
Davide Astolfi, Ravi Kumar Pandit, Andrea Lombardi, Ludovico Terzi

Wind Turbine Drivetrain Condition Monitoring through SCADA-Collected Temperature Data: Discussion of Selected Recent Papers
April 2023- Energies
Davide Astolfi

A Review of Predictive Techniques Used to Support Decision Making for Maintenance Operations of Wind Turbines
February 2023- Energies
Ravi Kumar Pandit, Davide Astolfi, Isidro Sergio Durazo-Cardenas

Advanced Methods for Wind Turbine Performance Analysis Based on SCADA Data and CFD Simulations
Article- January 2023- Energies
Francesco Castellani, Ravi Kumar Pandit, Francesco Natili, [...], Davide Astolfi

Discussion on the Suitability of SCADA-Based Condition Monitoring for Wind Turbine Fault Diagnosis through Temperature Data Analysis
January 2023- Energies
Alessandro Murgia. Robbert Verbeke, Elena Tsiporkova, [...], Davide Astolfi

Peer-reviewed studies using large-eddy simulations and field measurements consistently show that wake-induced changes in near-surface microclimate, such as soil temperature, are localised, minor, and typically less than 0.4°C in magnitude (comparable in magnitude with the natural variability) which are not considered ecologically or agriculturally significant.

Response: No peer reviewed studies have been provided in the application. However, it seems that the applicant accepts a 0.4C reduction in temperature over a distance of 10 rotor diameters (1.62km) & does not include consent from landowners & householders for this drop in temperature plus associated crop losses.

The proposed turbines for the Ballinla Wind Farm are expected to have a tip height of 185m, with rotor diameters in the region of 160m, comprising blades of around 80m in length. Ground clearance will typically be in the range of 25 to 30m, depending on final design. Operational parameters for turbines of this scale generally include cut-in wind speeds of 3–4 m/s, rated output at around 12–13 m/s, and cut-out speeds between 22–25 m/s. Turbine weights vary significantly depending on manufacturer and model, and final specifications will be determined based on commercial availability and procurement at the time of construction. All selected turbines will comply with relevant Irish and EU standards for safety, noise, and environmental performance. These turbines are designed to operate safely across a wide range of wind conditions and are equipped with automatic shutdown protocols in extreme weather.

Response: The Derryadd Windfarm Sweetman v An Bord Pleanála ([2021] IEHC 390) High Court decision requires Plans & Particulars for the proposed development to be submitted with the application. An envelope of products is not permissible.

Nordex Wind Turbines Operable in USA 2024, All smaller than Ballinla proposal with lower impact on visual landscape.

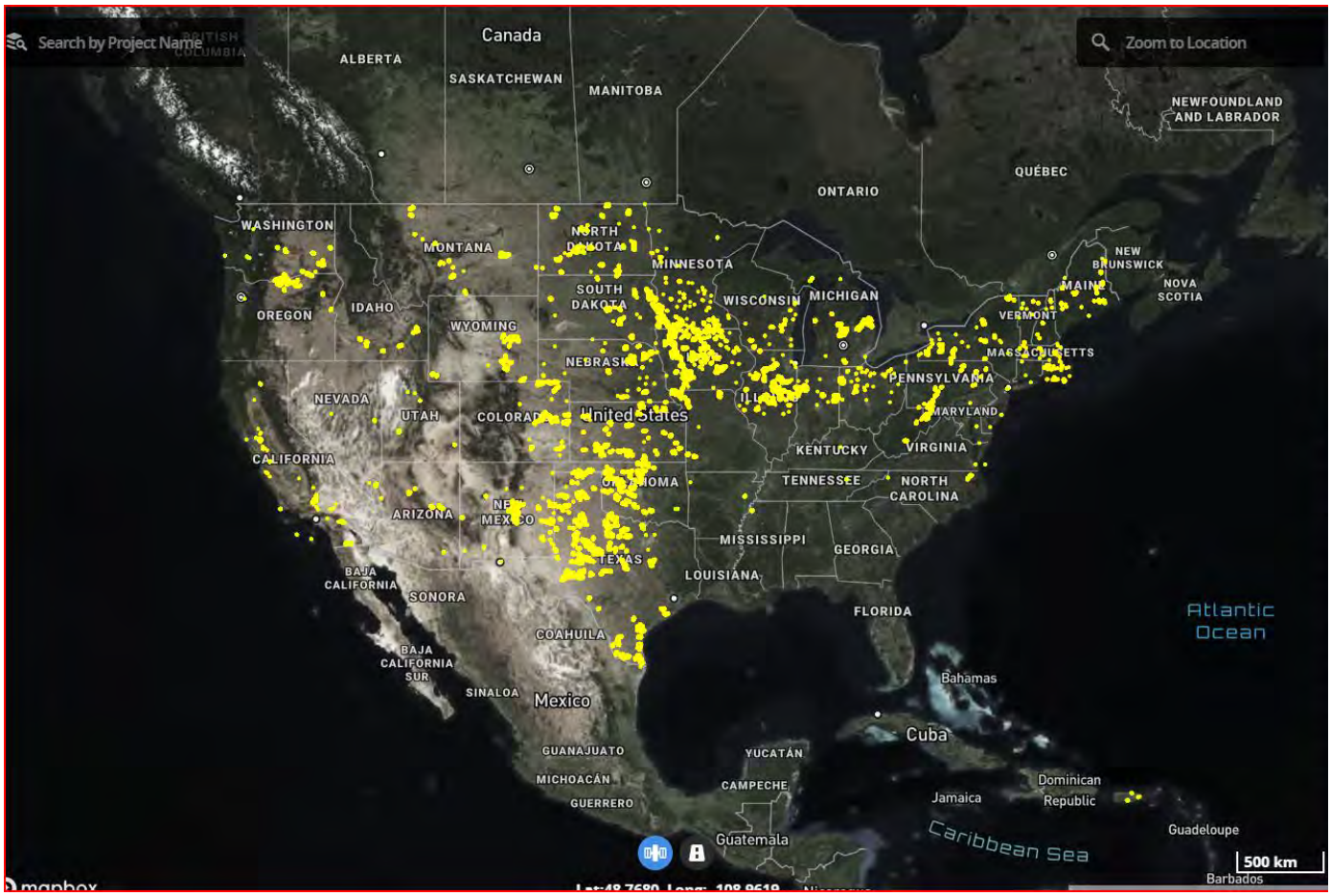
U.S. Energy Information Administration, 1000 Independence Ave., SW, Washington, DC 20585

2024 Form EIA-860 Data- Schedule 3, 'Wind Technology Data' (Operable Units Only)

Predominant Turbine Manufacturer	No of Turbines	Predominant Turbine Model Number	Design Wind Speed (mph)	Wind Quality Class	Turbine Hub Height (Feet)	Operating Year	State	Summer Capacity (MW)	Winter Capacity (MW)	Operating Month
Nordex	63	N149/4.0-4.5	12.0	3	354.3	2021	Tx	351.8	351.8	2
Nordex	74	N149/4.0-4.5	16.7	3	354.3	2024	Tx	350.2	350,2	8
Nordex	79	N149/4.0-4.5	18.6	2	489.0	2022	Tx	302.4	302.4	1
Nordex	38	N149/4.0-4.5	27.0	2	344.0	2021	Tx	298.8	298.8	1
Nordex	38	N149/4.0-4.5	21.5	2	351.0	2021	Tx	297.6	297.6	12
Nordex	62	N155/4.5	19.0	2	345.0	2024	Tx	200.0	200.0	12
Nordex	32	N149/4.0-4.5	17.5	2	324.0	2023	Tx	196.8	196.8	10
Nordex	42	N155/4800	17.4	2	354.0	2003	Tx	182.4	182.4	7
Nordex	71	N149/4.0-4.5	12.3	2	354.3	2021	Tx	182.4	182.4	12
Nordex	30	N149/4.0-4.5	20.6	2	351.0	2021	Tx	153.6	153.6	5
Nordex	12	N117/3000	16.6	2	305.1	2021	Tx	124.0	124.0	7
Nordex	20	N100/2500	17.9	2	263.0	2015	Tx	107.5	107.5	12
Nordex	17	N117/2400	13.5	3	298.6	2012	Tx	81.6	81.6	12

Nordex	16	N100/2500	19.0	2	328.1	2012	Tx	75.0	75.0	3
Nordex	15	N90/2500	15.0	1	262.4	2009	Tx	62.5	62.5	8
Nordex	41	N117/2400	13.7	3	299.0	2014	Tx	50.4	50.4	12
Nordex	37	N100/2500	19.0	2	328.0	2012	Tx	50.0	50.0	8
Nordex	21	N117/3000	17.9	2	298.6	2018	Tx	48	48.0	10
Nordex	34	N100/2500	19.0	2	328.0	2011	Tx	40.8	40.8	12
Nordex	16	N90/2500	19.0	2	262.0	2011	Tx	40.0	40.0	12
Nordex	8	N100/2500	17.3	2	328.0	2014	Tx	40.0	40.0	8
Nordex	43	N100/2500	19.0	2	328.0	2012	Tx	34.0	34.0	10
Nordex	25	N100/2500	19.0	2	262.4	2012	Tx	30.0	30.0	11
Nordex	12	N100/2500	17.7	2	328.1	2015	Tx	30.0	30.0	12
Nordex	16	N100/2500	17.2	2	262.0	2011	Tx	22.5	22.5	12
Nordex	9	N100/2500	17.2	2	262.0	2011	Tx	22.5	22.5	12
Nordex	9	N100/2500	16.5	2	272.0	2010	Tx	20.0	20.0	11
Nordex	4	N90/2500	19.0	2	262.0	2011	Tx	10.0	10.0	8
Nordex	1	N54/1000	19.0	2	229.0	2012	Tx	1.0	1.0	10

Note the operating months above & not consistent power. The following numbers indicate that the windfarms in the USA are mainly in the unpopulated west. Using data from these States is not referrable to Ireland.



We also note that the Strategic Infrastructure Development (SID) designation is determined by the installed rated capacity of the overall wind farm and has undergone a pre-application consultation with An Coimisiún Pleanála, who have formally determined that the project qualifies as SID under Section 37A of the Planning and Development Act 2000 (as amended), based on its scale, strategic importance, and contribution to national renewable energy targets.

Response: This is an incorrect statement. SID is determined by the installed output >50Mw & not installed rated capacity.

Aviation Lighting

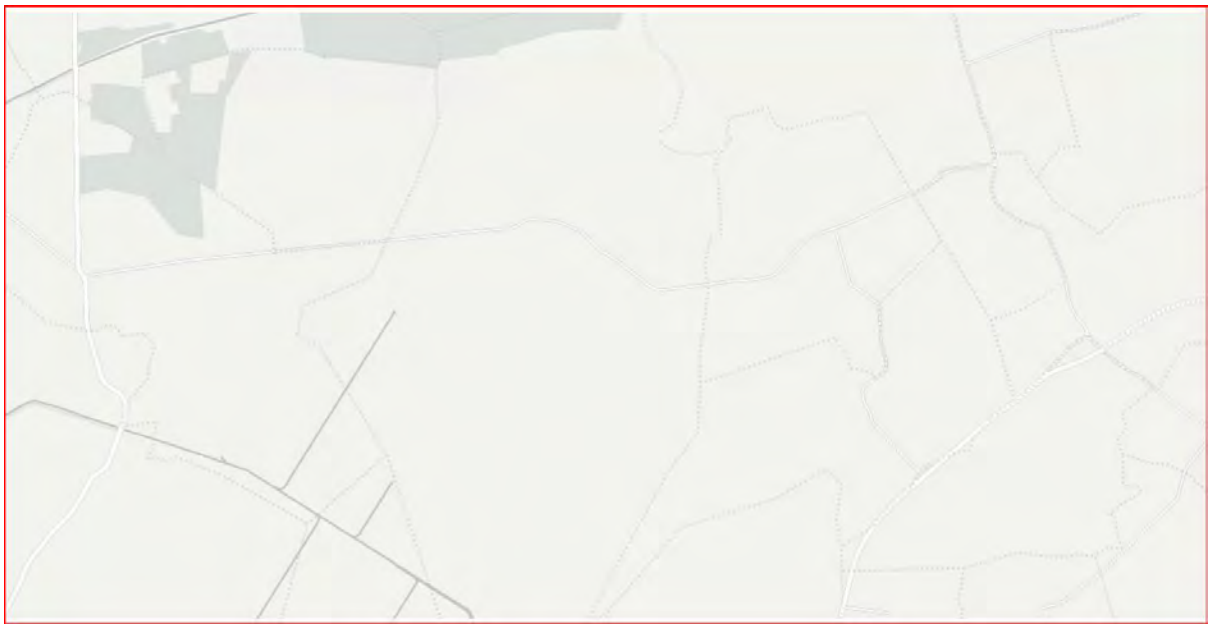
Where required by the Irish Aviation Authority, turbines will be fitted with medium-intensity fixed red obstacle lights (2000 candelas). These lights will be equipped with baffles to direct light skyward, significantly reducing visibility from ground level and mitigating light pollution concerns.

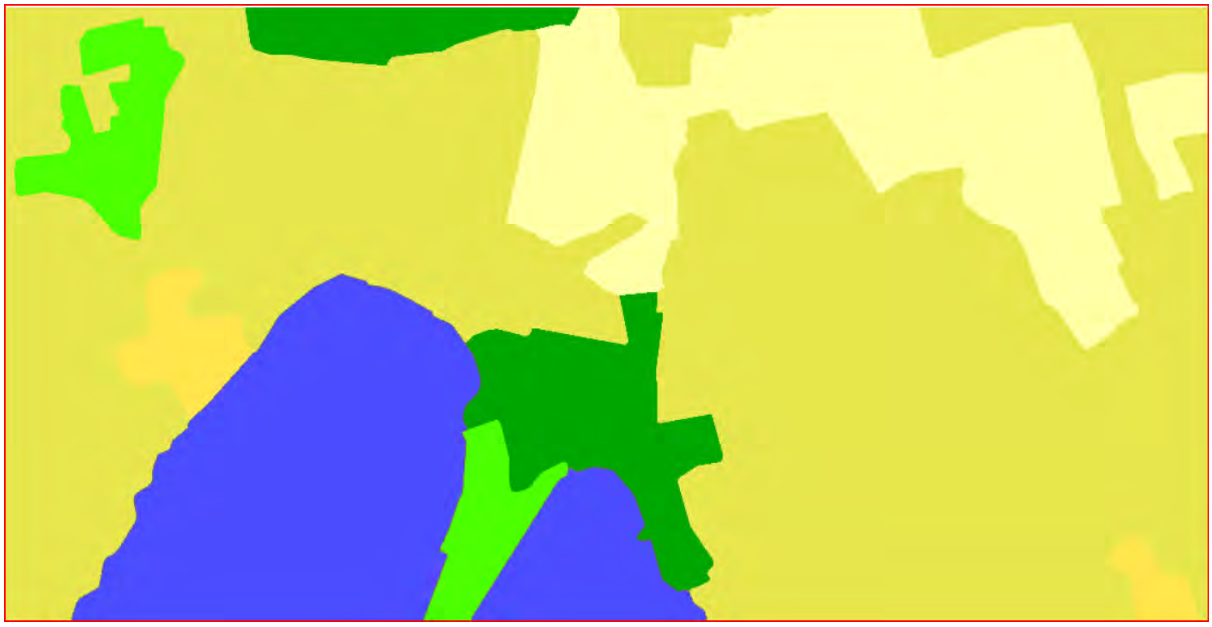
Vibration Impacts

Vibration effects from wind turbines are not expected to pose any risk to nearby receptors or to soil stability. All residential receptors are located well beyond the range at which ground-borne vibration could be perceptible. Vibration energy from turbine foundations dissipates rapidly with distance and becomes negligible at typical setback ranges.

The site is predominantly underlain by peat, a soft and damp material known for its natural ability to absorb and attenuate vibration. This significantly limits the transmission of vibration through the ground. Additionally, the site's generally flat topography reduces the potential for vibration to interact with slope dynamics or cause instability.

Response: The site is not predominantly underlain by peat. The Corine Maps below, indicate Pasture Lands & Agriculture & the Fault line runs across these lands.





Legend
Corine Land Cover 2018 LAEA - raster100
LABEL3
Continuous urban fabric
Discontinuous urban fabric
Industrial or commercial units
Road and rail networks and associated land
Port areas
Airports
Mineral extraction sites
Dump sites
Construction sites
Green urban areas
Sport and leisure facilities
Non-irrigated arable land
Permanently irrigated land
Rice fields
Vineyards
Fruit trees and berry plantations
Olive groves
Pastures
Annual crops associated with permanent crops
Complex cultivation patterns
Land principally occupied by agriculture, with sign
Agro-forestry areas
Broad-leaved forest
Coniferous forest
Legend
Broad-leaved forest
Coniferous forest
Mixed forest
Natural grasslands
Moors and heathland
Sclerophyllous vegetation
Transitional woodland-shrub
Beaches, dunes, sands
Bare rocks
Sparsely vegetated areas
Burnt areas
Glaciers and perpetual snow
Inland marshes
Peat bogs
Salt marshes
Salines
Intertidal flats
Water courses
Water bodies
Coastal lagoons
Estuaries
Sea and ocean
NODATA

Foundation design and construction methods will be tailored to local ground conditions, including peat depth and composition, ensuring that turbine loads are safely distributed. Taken together, the combination of distance, soil characteristics and terrain confirms that vibration will not pose a risk to soil stability or residential amenity.

Response: These designs should be part of the application.

Grid Route

· The proposed underground grid connection from the Ballinla Wind Farm to the Philipstown Substation is subject to a separate consenting process, which will be progressed in accordance with statutory requirements. However, the route and associated works have been fully considered within the Environmental Impact Assessment Report (EIAR) to ensure transparency and cumulative impact assessment.

Response: The proposed route is not under the control of the applicant. Yet it is coloured red on application.

The proposed grid route is primarily located within existing public roads, minimising land disturbance and avoiding sensitive environmental or residential areas. As a statutory undertaker, we are authorised to lay electrical cables within public roads without requiring third-party landowner consent. This is consistent with established legal precedent, including the Crimins case, which addressed similar issues. We appreciate your interest and will continue to engage transparently throughout the planning process.

Response: Statkraft are not a statutory undertaker & are not authorised to lay electrical cables within public roads without requiring third party landowner consent. Nor are they allowed to install passing bays. This is an incorrect interpretation of the High Court decision in relation to Dromada Windfarm (ROI) Limited, Plaintiff and Denis Cremins, Defendant [2023] IEHC 417 [Record No. 2021/3588P] (Reference No. 12.5)

This case concerns an issue in relation to high voltage cables servicing the plaintiff's windfarm which have been laid in the grass verge alongside a public road which abuts the defendant's land. The plaintiff now accepts that the cables are in fact laid on ground which is the property of the defendant. Put at its simplest, the main issue this Court has to decide is whether orders should be made preventing the defendant from interfering with the cables, and allowing them to remain in situ – in which case the plaintiff accepts that the defendant would be entitled to monetary compensation for what is in effect a trespass on his land – or whether the court should order the plaintiff to remove the cables, which the plaintiff submits would result in it incurring a wholly disproportionate loss in circumstances where it alleges that the cables do not interfere with the defendant's present use of the land in any material way.

The plaintiff is a company incorporated in the State and is part of the SSE group of companies. The plaintiff is one hundred percent owned by SSE Renewables Wind Farms (Ireland) Limited which is one hundred percent owned by SSE Renewables Holdings Limited. That company is in turn a subsidiary of SSE plc. The court was told in evidence that SSE entities operate 26 windfarms in Ireland.

The defendant is a farmer and, together with his wife Sheila Cremins, is the registered owner of lands comprised in folio 3305F County Limerick ('the lands'). The defendant acquired the lands in or around 2006.

The plaintiff is the operator of Dromada Windfarm ('the windfarm'), which comprises of 19 turbines and ancillary developments located at lands at Clash South, Athea, County Limerick. Planning permission was obtained for the windfarm in 2004, but on the basis that twenty-three wind turbines would be erected, along with the substation, including a control building, the construction and upgrading of site entrances, site tracks and associated works. Permission was subject to 17 conditions.

When planning permission was obtained, it was on the basis that three of the 23 permitted turbines would be constructed on lands now owned by the defendant and the defendant's wife, pursuant to a lease arrangement. In that regard, the plaintiff's predecessor in title had entered into an option agreement ('the option agreement') with the previous owners of the lands for the construction of part of the windfarm on their lands, and those lands were included in the planning application on that basis.

Conclusions

The defendant is the victim of trespass and deserves to be compensated.

The connection remains subject to approval from EirGrid, and all works will be carried out in compliance with their technical and operational standards.

Response: The technical & operational standards are not included with this application.

Traffic

· Although automatic traffic counters have not yet been deployed for the proposed development, the Traffic and Transport chapter of the EIAR presents a comprehensive analysis based on baseline traffic volumes sourced from Transport Infrastructure Ireland (TII), projected construction traffic flows, and volume-to-capacity ratios for regional and local roads.

Response: TII data only relates to National Roads & not to out of capacity RESTRICTED Regional & Local roads. In other words, they are guessing traffic numbers.

This assessment concludes that no significant traffic impacts are anticipated during either the construction or operational phases of the development. All roads evaluated are expected to continue functioning within acceptable capacity thresholds, even at peak construction times.

Response: The EIAR assessment is incompetent & determines that the application should be refused.

To further mitigate any temporary disruption, a Traffic Management Plan (TMP) will be implemented, including road condition monitoring and close coordination with Offaly County Council.

Response: An applicant cannot be granted approval based on a future wish list.

Community Engagement

· Our community engagement for the Ballinla Wind Farm has been extensive, transparent and inclusive, as detailed in the Community Engagement Report (Appendix 01-2 of the EIAR).

To date, we have held 175 face-to-face meetings with residents and 12 meetings with community groups, distributed 756 project booklets and 189 planning notification letters, and launched both a dedicated website and a virtual consultation room to facilitate accessible dialogue.

Importantly, feedback received through these channels directly influenced the project design, including a reduction in turbine numbers from 10 to 7.

This approach aligns with the Code of Practice for Wind Energy Development in Ireland (2016) and reflects our commitment to meaningful, responsive engagement with the local community.

Property Valuation

· Research on Wind Turbines and House Prices along the West of Ireland concluded that any impacts “attenuate over time, becoming insignificant beyond 10 years post connection”.

Response: Note – no reference. The historical nature of windfarms involved far smaller scale developments to the current proposal. These large turbines are only developed in the past 2-years. A statement of “insignificance” after 10-years is unproven, but relevant in that the applicant recognises a property loss.

It is also worth noting the limitations of this report in that it looked at just over 64,000 listings, only 225 of which are within 1 km of a turbine, between 2016 and 2021.

For comparison, a recent 2024 study in the United States looked at 300 million house sales from 1997 to 2020 of which 250,000 transactions are within 1.5 km of a turbine.

Response: Note – no reference. The historical nature of windfarms involved far smaller scale developments to the current proposal. These large turbines are only developed in the past 2-years with very few 162m turbines in the USA.

We assume the following reference:

Reference 1.4: The visual effect of wind turbines on property values is small and diminishing in space and time. Wei Guoa, Leonie Wenzc, and Maximilian Auffhammere. Edited by Geoffrey Heal, Columbia University, New York, NY; received June 3, 2023; accepted January 10, 2024. 121 (13) e2309372121.
https://doi.org/10.1073/pnas.2309372121

Results Property Value Impacts.

We find that having at least one wind turbine in a home's viewshed (10 km radius) reduces the sales price of such a property on average by 1.12%.

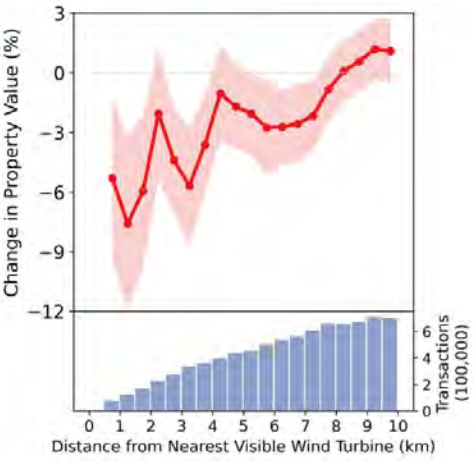


Fig. 2. Effect of wind turbine visibility on property value by distance. The effect of wind turbine visibility on property values for different distance bins. Each distance bin represents a 500-m range, determined by the distance from the nearest visible wind turbine. Red dots indicate estimated coefficients, as obtained by interacting the coefficient of interest from the difference-in-difference model (interaction between post-treatment status and treatment assignment) with distance bin indicators. Shaded areas represent 95% CIs constructed using two-way clustered SEs at the census tract and year level. Bars in the *Lower* panel show the number of transactions within each distance bin, corresponding to the right y-axis.

The impact of visual disamenity created by wind turbines may also vary depending on the distance from the nearestvisible turbine. To test how the effect varies by distance, we re-run the baseline specification with the indicators of interest interacted with 500-m (_ 0.3-mile) distance bin indicators for the proximity of the closest wind turbine. The effect of wind turbine visibility decreases as distance increases (Fig. 2). The effect is largest in immediate proximity of wind turbines—with the visual disamenity reducing property values by up to 8% within a neighborhood range of 1.5 km (_ 0.9 miles). Even though this number is economically large, there are two noteworthy caveats. First, the CI is sizable including reductions in property value between 3 and 13%. Second, the number of properties within this distance bin is small. Nationally, there are fewer than 250,000 transactions within 1.5 km of the nearest wind turbine, as opposed to approximately 8.5 million transactions within 10 km.

Moreover, we find that properties within 10 km from wind turbines are 1.16 to 1.7% lower in sales price than those 10 to 50 km away. These gaps are not driven by differences in the housing characteristics of properties located in different communities. Therefore, the cross-sectional difference in property value between visible and non-visible areas as well as between proximate and distant areas indicates a potential selection effect that is consistent with the siting of wind turbines in places with lower property values.

We investigate whether the visual impact of wind turbines varies with the intensity of visibility using two measures: The number of wind turbines in view and the intensity classified by whether there are more than 20 turbines in sight. We find that the capitalization of the visual disamenity increases with the treatment intensity, with every

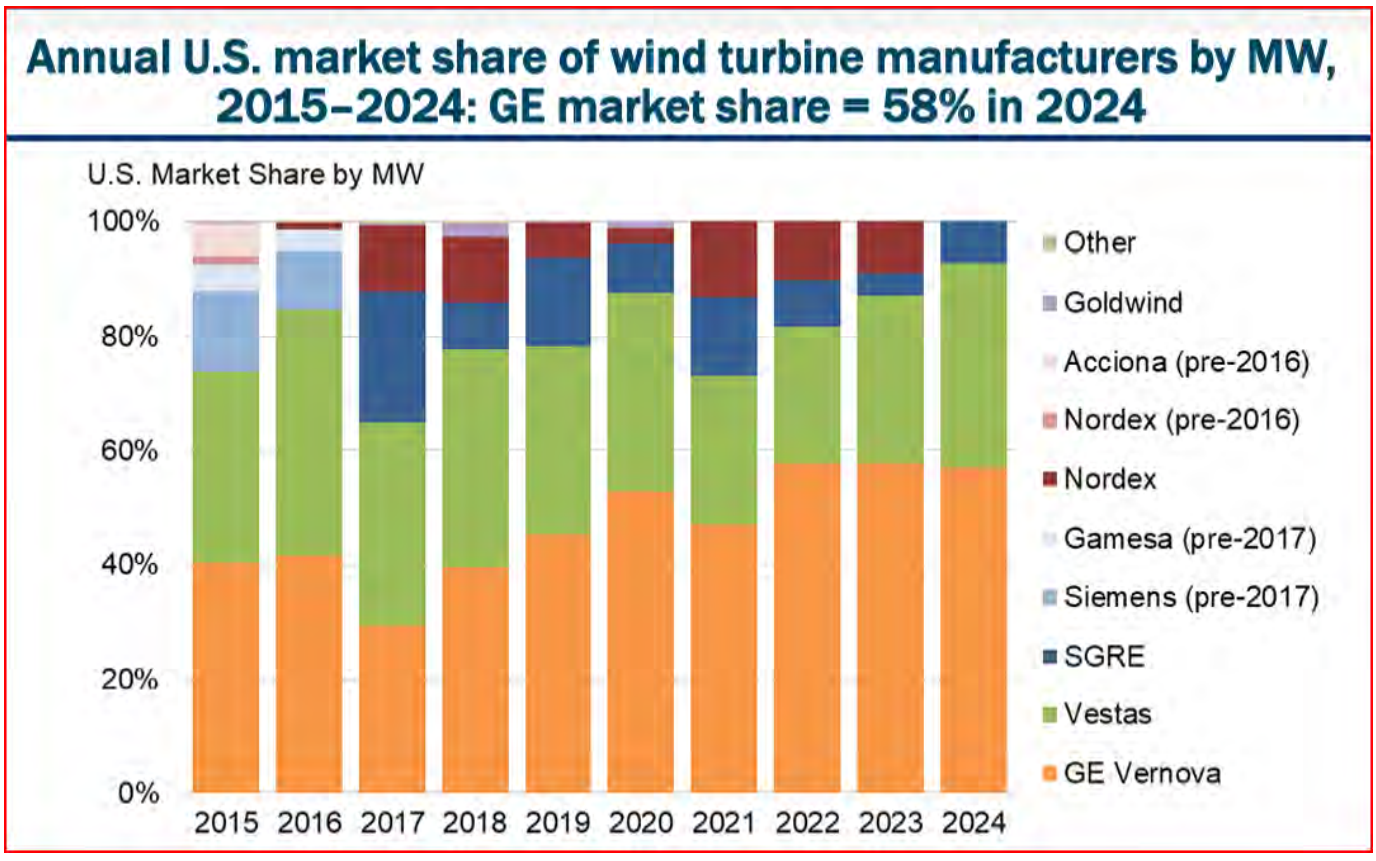
additional 10 wind turbines in view reducing the property value by an additional 0.2% [Table 1, column (2)]. Furthermore, wind farms with more than 20 turbines reduce the property value in visible areas by an average of 2.48%, whereas those with less than 20 turbines have a reduction effect of only 1.02% on visible areas [Table 1, column (3)]. These findings suggest that the density of wind turbines in view plays a role in driving the magnitude of the visual disamenity valuation.

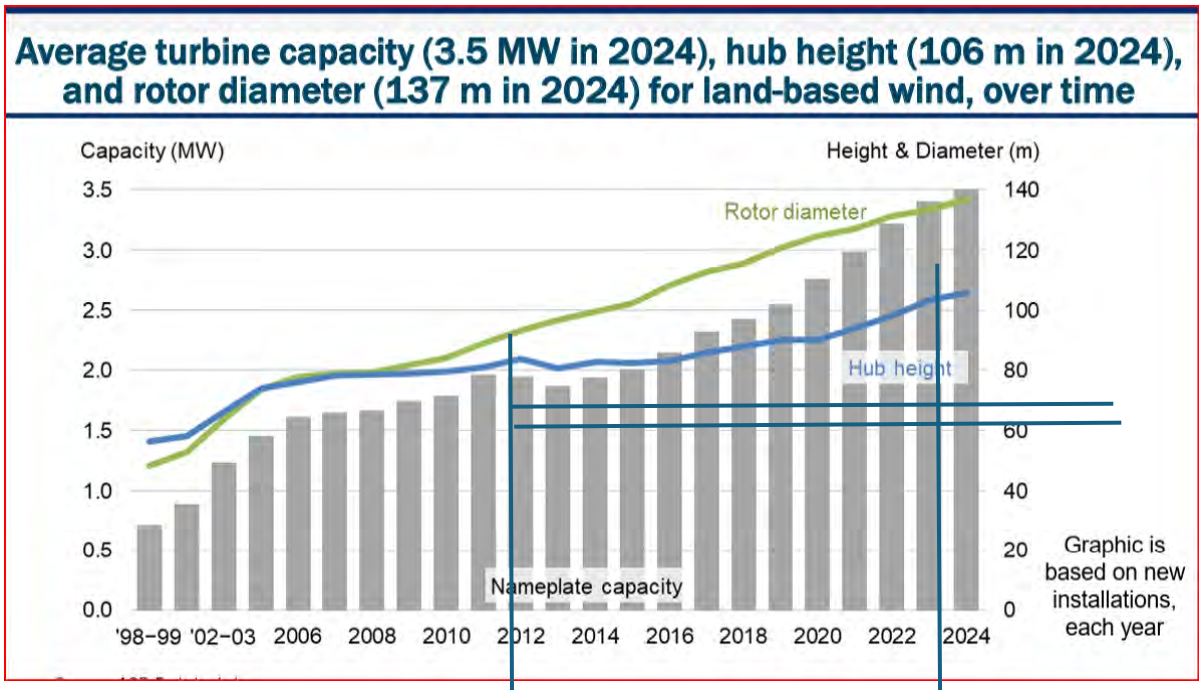
The findings indicate that wind turbines have a negative effect on property value in locations where they are visible. On average, across the whole sample, house prices decrease by up to 8% after the construction of a wind turbine within viewshed and close neighborhood range from the property, with the effect decaying as the distance increases. The average effect falls to a 1% reduction for houses within 10 km of visible wind turbines. It also diminishes over time—both in terms of more recent installations having a smaller disamenity effect and in the sense that the reduction in value a property experiences peaks 3 y after the installation and then becomes smaller the more years pass. These findings are consistent with a cognitive model where people get used to new structures in their environment over time.

The reduction in property values resulting from wind turbine installations raises questions about how this might affect siting decisions for future wind farms. This paper highlights the externality of wind power developments as they are capitalized in the housing markets. These estimates could also serve as a future basis for calculating compensation to local homeowners for placing a new wind turbine within their viewshed."

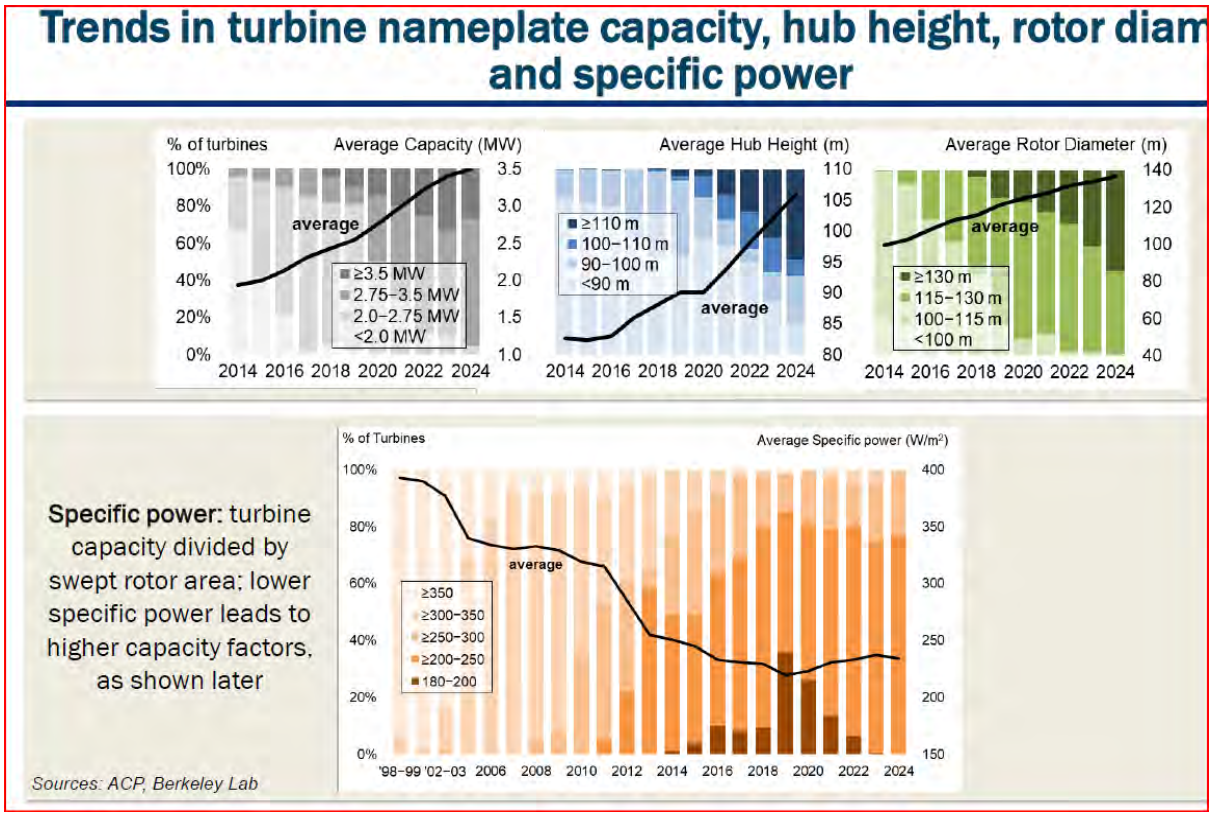
Reference Number 1.5: Commercial wind turbines and residential home values: New evidence from the universe of land-based wind projects in the United States, Eric J. Brunner, Ben Hoen, Joe Rand, David Schwegman. Energy Policy Volume 185, **February 2024, 113837.** https://doi.org/10.1016/j.enpol.2023.113837

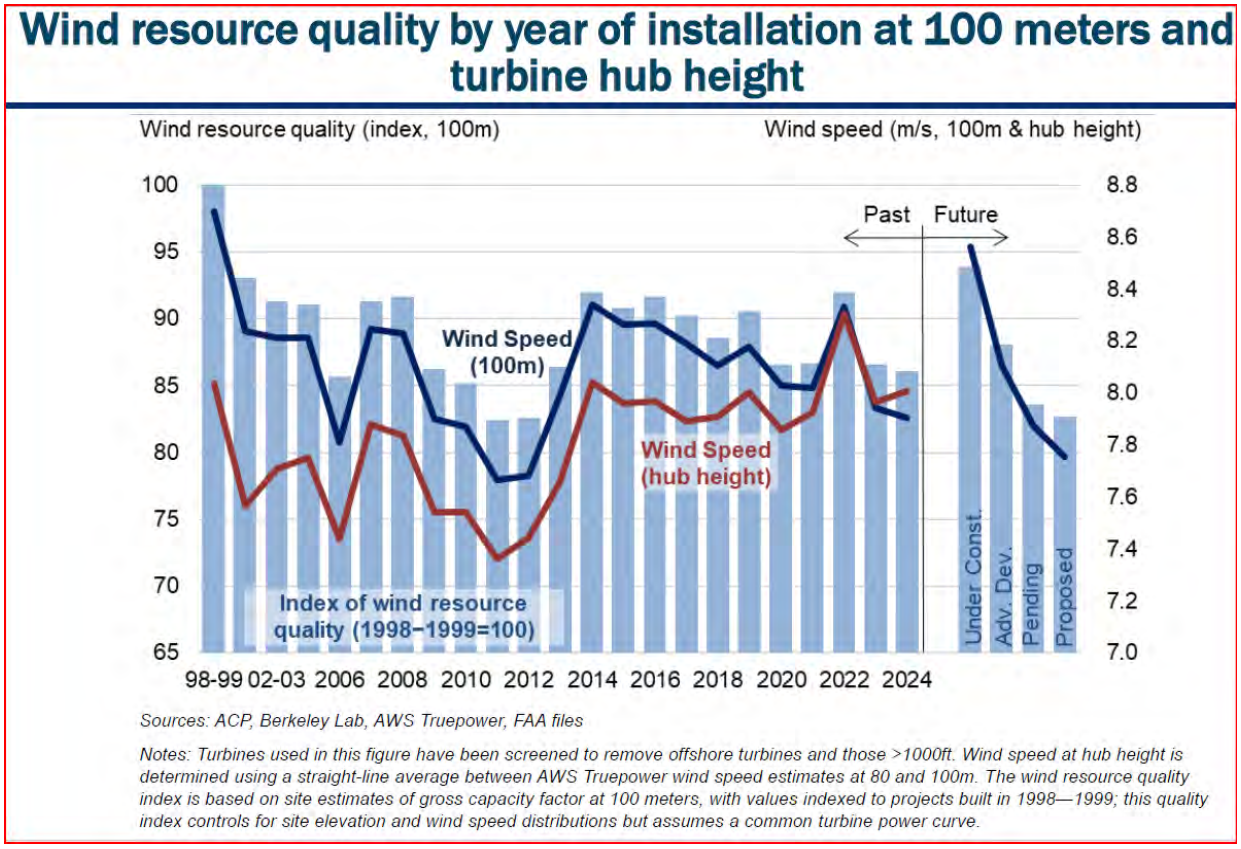
We examine the impact of proximity to land-based commercial wind turbines on residential home values in the United States using data on the universe of commercial wind turbines and residential property transactions from 2005 to 2020. Using event study and difference-in-differences identification strategies we find that, on average, homes located within 1 mile of a commercial wind turbine experience approximately an 11% decline in value following the announcement of a new commercial wind energy project, relative to counterfactual homes located 3 to 5 miles away.





Note wind turbines in 2010 had a Capacity of 2Mw, Hub height of 80m & Rotor diameter of 85m. The height to the tip of the wind turbine would have been 80+42.5=122.5m. The present application is for a 7.2Mw capacity with a tip height of 185m. These are not comparable.





Note future wind speed between 7.0 & 8.6m/s with c8m/s for pending applications.

Closer to home a 2016 study in Scotland looked at more than 500,000 property sales between 1990 and 2014. Both of these studies, which are far more comprehensive and carried out over a much longer time, found little to no evidence of a negative impact on property prices.

Response: Note – no reference. The historical nature of windfarms involved far smaller scale developments to the current proposal. These large turbines are only developed in the past 2-years. A statement of no negative impact on property prices is without proof.

Human Health and Wellbeing

· We can confirm that the assessment was carried out in accordance with relevant national and international guidance, including the 2018 World Health Organization (WHO) Environmental Noise Guidelines for the European Region and the Health Service Executive (HSE) Position Paper on Wind Turbines and Public Health (2017). These documents were explicitly referenced and considered in the preparation of the Population and Human Health chapter of the Environmental Impact Assessment Report (EIAR).

The Ballinla Wind Farm has been assessed using best practice guidance, including the 2006 Wind Energy Development Guidelines, ETSU-R-97, and the Institute of Acoustics Good Practice Guide (IOA GPG). The noise criteria adopted for this project are robust and conservative:

Daytime noise limits: 40 dB LA90,10min in quiet environments or 45 dB LA90,10min where background noise exceeds 30 dB.

Response: Ballinla is a low noise rural location that is affected from recently erected windfarms surrounding the present proposal. As a result of the effect of these windfarms on baseline noise, this application tries to justify higher noise emissions.

Night-time noise limits: 43 dB LA90,10min or 5 dB above background, whichever is higher.

The “37 dB challenge” referenced in the Gibbot Hill High Court case is acknowledged; however, it is important to note that the Ballinla Wind Farm has adopted stricter limits than those applied in that case, with predicted noise levels at all receptors remaining below 43 dB LA90,10min, even at rated wind speeds.

Response: It seems that the applicant thinks that a 43dBa level is stricter than a 37dBa level.

The Gibbot Hill case centred on a single fixed threshold of 37 dB LAeq, applied without differentiation between daytime and nighttime conditions or consideration of background noise levels. In contrast, the Ballinla Wind Farm assessment applies dual thresholds; 40 dB LA90,10min during daytime and 43 dB LA90,10min at night, or 5 dB above background noise, whichever is higher. This approach is not only more protective of residential amenity, but also responsive to local acoustic conditions, ensuring that turbine noise remains below perceptible levels in quieter environments.

The EIAR confirms that no significant noise effects are anticipated during either the construction or operational phases. The turbine model used for assessment includes serrated trailing-edge blades to reduce aerodynamic noise, and all predictions incorporate a 2 dB uncertainty margin to ensure compliance.

Response: In the absence of the noise model this confirmation has zero relevance or applicability.

The project commits to post-commissioning noise monitoring in line with IOA GPG Supplementary Guidance Note 5. This will include:

Measurement of turbine noise at representative noise-sensitive locations (NSLs)
Verification against planning conditions and noise criteria
Assessment of tonal characteristics and amplitude modulation, if any
Should any exceedance or complaint arise, the operator will implement corrective actions, including curtailment or low-noise operational modes. These measures will be managed via the wind farm’s SCADA system and verified through follow-up monitoring.

We acknowledge the concern regarding sleep disturbance and recognise the personal impact described. However, recent research has examined this issue in depth and consistently finds that infrasound generated by wind turbines is well below the threshold of human perception and diminishes rapidly with distance. Studies show that external noise levels from turbines measured up to 46 dBA pose no risk to sleep quality, whether through audible sound, infrasound, or low-frequency components. These findings are supported by controlled trials and acoustic modelling, reinforcing that turbine-related noise at these levels does not disrupt human sleep. It is noted that the Ballinla Wind Farm has adopted more conservative noise limits, with maximum nighttime levels set at 43 dB LA90,10min or 5 dB above background, providing an additional margin of protection for residential amenity.

Response: Recent research without references has no relevance to this application.

Regarding a request for access to commercially sensitive data that requires licensed software, I must reiterate that such requests cannot be accommodated—even under a Non-Disclosure Agreement. This policy stands irrespective of whether all contact details for attendees at the 5 September meeting are provided. The data in question is protected for both commercial and regulatory reasons, and access is strictly limited to ensure compliance with statutory and contractual obligations.

Response: The applicant is obliged to provide the lacunae for the proposed development. The noise & wake model should include the input parameters for the proposal. In the absence of this information, the development must be refused.

The use of Windpro Software Model programming or similar & the failure to provide the background data used invalidates this application. The neighbouring residents have to be informed of the underlying assumptions used in the design.

Reference 1.6: Windpro Manual: 8a.1.1 Offshore Vs Onshore optimization Manual

The New Optimizer in windPRO covers both onshore and offshore optimization. For offshore layouts the geometry is not fixed, for this functionality the user is referred to as the Classical windPRO optimizer. The key differences between onshore and offshore optimizations lie in the setup of the wake decay constant for the annual energy production (AEP) calculation and in the model for calculating the cost of building the wind farm (if costs are included in the objective). Hence, for pure optimizations of AEP there is no difference in the way that the Optimizer operates. However, the performance will of course be guided by the user-provided information such as WTG area and resource, which typically have distinct characteristics offshore and will be reflected in the resulting optimization solutions. A feature that is particularly useful for offshore applications is the integration of cost surfaces. This feature allows to better integrate costs that change over space into the cost analysis. Further details of onshore and offshore cost models are given in section 8a.4.2.

8a.1.2 The GUI tree-structure and its levels: Site>WTG>Size>Run

A flexible graphical user interface (GUI) has been developed for the New Optimizer to accommodate several different scenarios of use (see section 8a.2 for a description of the scenarios). This flexible GUI is represented by a tree located on the left side of the Optimizer window. The tree will be gradually built-up by the user with the required input information and with the different optimization scenarios run by the user. A lot of information needs to be defined and setup prior to running the optimizations. This setup of pre-defined data and pre-calculated information is a prerequisite for gaining sufficiently fast, yet accurate, optimization results. Building the tree, setting up and preparing the optimization, different information and decisions must be defined and entered.

8a.1.2.1 Site

The Site level is the fundamental level of the optimization, but there can be multiple Sites in the tree to allow studying the effect of different basic assumptions. In the Site, the following information and settings must be defined:

Site Climate/Resources- here the pre-calculated wind resource across the site must be defined by selecting an ‘rsf’ or ‘siteres’ file. Ideally, the resource has a grid resolution of 0.5 times the turbine rotor diameter or less as this leads to a good balance between resolution and performance.

Objective – this is the choice of what the user wants to optimize: AEP (annual energy production), LCOE (cost of electricity) or NPV (profit of project). These are described in detail in section 8a.4. For each choice of objective several associated decisions are required. For instance, Wake Decay constant in the PARK calculation (all objectives), setting up a Cost Model (LCOE and NPV) including cost map configurations, or setting the expectation for the future average Electricity Price.

Constraints- The particular requirements for the site must be defined and ALWAYS requires definition of a WTG Area. This defines the limits of the site area or sub-areas where turbine placement is allowed, any requirements for minimum and maximum turbine numbers or capacity in each sub-area. It also defines exclusion zones and set-back buffers as well as minimal spacing requirements for turbines in each sub-area. Logically, the WTG area must be fully covered by the defined site climate/resource data, which is checked with maximum accuracy upon clicking Coverage Check, which also allows a visual inspection on a map. In addition to this the spacing or interturbine Distance defined in the WTG area may be activated or deactivated. Finally, constraints on turbine component Lifetime, turbine noise at noise sensitive areas, and Wake constraints for new and existing WTGs may be activated (see section 8a.5 for further details).

Connection points – Objectives which require cost calculation (LCOE and NPV) may include known connection points for external grid and road connection. These points must be pre-defined as Control points and selected here.

Existing WTGs – If there are known turbines in the area from other projects which will create wakes on this project they must be defined as existing WTGs and selected here. Their wake effect on the new turbines will be included and the additional wake that they might experience can be considered.

Noise sensitive areas – If noise constraint is activated one or more noise sensitive area (NSA) points must be selected here.

8a.1.2.2 WTG

At the WTG level the required data must be defined for the objective and constraints selected on the Site level. All new turbines in optimizations in this branch of the tree will use the selected turbine and data.

WTG & Mode- Any optimization requires the selection of a turbine model from windPRO's WTG catalogue, a Hub height, and a Turbine Configuration for that turbine model. For traditional power curve data the appropriate power curve is selected, which is the basis for the AEP and wake loss calculations. From windPRO 4.2 onward, the Turbine Configuration can be selected instead that contains the available operation modes with the pairings of power curves with noise curves and load response files. One mode must be selected for the optimization from the list of available modes. It remains an option to use the Power Matrix format, too.

The noise and the load data from the Turbine Configuration or the Power Matrix are used for constraint validations if the site is set up to account for those constraints.

Lifetime/Loads – If lifetime constraint is activated the turbine Design Standard and Design Class must be defined as well as the Load Response Model for use in the calculation of loads and lifetime.

Noise Data – When noise constraint has been activated, the noise data must be selected from the Noise curves provided in the WTG catalogue. When a Turbine Configuration or a Power Matrix is selected, the noise data is retrieved from those via the selected mode.

Use individual WTG cost model- When multiple WTG types are defined for the same Site, it might be relevant to define different cost models for each WTG type individually. In that case this option must be activated and the cost model for the current WTG type defined here. This will override the cost model selected on the Site level

Introduction 5 Figure 6:

8a.1.2.3 Size (and 'Add Sizes & Runs' button)

The Size level has no setting up on the window to the right. Instead, it is created in a single step together with at least one Run at it its sub-level (child). This is done via the Add Sizes & Runs button (see green highlight in Figure 6).

Once the Sizes and Runs have been created this window shows an overview of all the runs for this size. In this regard a run is simply an optimization for the park size in question and subject to optimization settings.

The benefit from adding Sizes & Runs in a single step is mainly efficiency, so that more park sizes can be created at once with identical optimization settings without further effort.

Define Park size(s)- Here the user can define the park sizes of interest. Note that ALL sizes from minimum through to maximum will be created once the button Create & queue runs is pressed after which a separate optimization will be run for each size. It is therefore recommended to limit the range of sizes such that it results in a reasonable number of optimizations. The table above the size selection summarizes the requirements for minimum and maximum turbine numbers in the WTG area. Limits on capacity are automatically converted to turbine numbers given the selected WTG. Alternatives, to defining a range of sizes are either to define a User layout where the user must select the initial positions for the optimization or Fill max which will seek to fill the maximum number of turbine units (see section 8a.3 for further details).

Run setup for each Size – This setup defines the optimization strategy for each created optimization run. Default is Smart with the alternatives Random and Custom. The latter unlocks the lower section of the window unleashing the full flexibility of the optimization solution (see section 8a.3 for details). The Realizations setting available for Random simply defines how many times to repeat the experiment of starting an optimization run from a random initial layout. Setting realizations to 5, for example, will yield five different random runs for each size.

When setup is done in the Setup & Run window the optimizations can either be put in the queue directly by pressing Create & queue runs or be parked for now to be run later by pressing Create & park runs.

8a.1.2.4 Run

The deepest level of the GUI tree is the Run level. At this level each optimization run is presented and when they are completed a resulting optimized layout can be created in the windPRO object list and map window by pressing Realize Final Layout. Through the course of the optimization the positions of WTGs at the current step of the optimization run are visible and updated in the Layout plot. Similarly, the Steps list will show the current and history of the Objective. Alternatively, the Wake loss (available for all objective) or AEP, Wake loss or Cost1 are plotted (only available for LCOE and NPV objectives. This information is also available in the Convergence plot. At the top of the view is a detailed summary of the settings for the run, including a Status indication whether it is running, done or failed.

Details of constraints and/or individual turbine production and wake loss information may be viewed via the buttons Show AEP/Wake and Show Constraints to the lower left of the Optimizer window.

The current status of a run is indicated in the Status line in the Summary when the run is selected in the tree. The status is also in the tree itself on the level of the run and via the icons shown to the left on that line. The legend for these icons and a summary status of all current runs within the tree are shown just below the tree.

8a.1.3 Copy-pasting of levels in GUI structure

As a new feature of windPRO 4.2., it is now possible via a right click on the respective level to copy and paste all levels of the tree-structure, be it a Site, WTG, Size, or Run level. It is both possible to select the level and all children, or only the right-clicked level. This enables faster setups for comparing different WTG types or different run configurations. For example, optimization results from site setup with a desired lifetime of 20 years can be compared to a site with 30 years in just three clicks: Copy site with all children, paste all, start all parked runs.

8a.2 Which decision to optimize?

Many important decisions need to be taken when developing a wind farm. Several of these decisions can benefit from an optimization approach but may not fit well into a traditional optimization setup. In some of the cases the variables on which the decisions are based on (the objective) such as AEP, or financial metrics as cost-of-energy (COE) may not be suitable or sufficiently sensitive to the decisions in question. One such example is the size of a wind farm. The relation between the number of WTGs in the farm and the associated AEP, is simply an increase with the number of WTGs. COE on the other hand typically decreases smoothly with the number of WTGs. This makes AEP and COE unsuitable for determining the optimal size of a wind farm on their own [1]. To accommodate these additional and important decisions in the optimization setup, but not directly in the actual algorithmic optimization process, the decision of these variables is supported by the structure of the GUI. The main use-scenarios are described in the following and includes the following key decisions in wind farm development:

- Design of a layout
- Number of WTGs in the park
- Choice of turbine model
- Fulfillment of constraints

Section 8a.1.2 has described how to establish the tree with a Site, WTG and one or more optimization runs and the settings and inputs needed at each level of the GUI tree. All these settings are done on the Setup & Run tab (cf. Figure 8), which basically is the action mode of the Optimizer, where optimizations can be added and setup and details can be viewed.

To compare multiple finalized optimizations the Optimizer has a ‘comparison mode’ which is available via the Compare tab (cf. Figure 10). In compare mode, the GUI allows for easy comparison across results for different WTGs, sizes and runs mainly showing the results and some overall settings. Once in compare mode (i.e. on the Compare tab) the GUI tree will behave slightly differently as it will start highlighting the runs which are being compared in mustard color (cf. Figure 11). The highlight shows the level selected by the user below which runs will be compared.

When a site is selected results will be compared for WTGs defined for that site. For each WTG the best run across all sizes will be chosen and highlighted in mustard color. When selecting a WTG all sizes below that level will be compared, for each size the best run will be chosen if there is more than one run. Selecting a size will simply compare all runs for that size. At the current stage it is not possible to compare across sites, as they may have different objectives and constraints which cannot easily be compared.

8a.2.1 Design of layout (given park size)

Designing a layout with a single fixed number of WTGs is the basic and simplest mode of use for the Optimizer. Just one optimization needs to be set up and run once the data and settings on the Site and WTG levels have been defined. The flexibility of the GUI tree helps to compare different strategies for the optimization, described in further detail in section 8a.3. Such strategies could include the default, which is called Smart, a user defined initial layout (via User Layout), or perhaps relying more on stochasticity by including random runs. In the last case, several random runs can be started via Realizations. Once a single run has been added for the park size in question more runs can be added by selecting the size in the tree and pressing the button Add Runs, which in this case has replaced the Add Sizes & Runs button (shown when the WTG level is selected). If, on the other hand, a particular run in the tree is selected, then the button renames to Clone Run – this will allow to use the result of that run at starting point for another run. This can be useful for continuing an optimization or doing an optimization with multiple stages. The three variants of the 'Add…' button are shown in Figure 12.

An example of a size with several runs is demonstrated in Figure 13 showing the view on Setup & Run tab. Figure 14 shows the view on the Compare tab, which is more focused on comparing the objective for the final layout across the runs.

8a.2.2 Number of WTGs (park size)

The New Optimizer can be used to analyze parks with different sizes, but it does not optimize for the number of turbines since the objectives are not well suited to optimize the park size: If the objective is to maximize the AEP, it is generally best to place as many wind turbines as possible into the park. In such case the Fill max option can be used. On the contrary, if the objective is to minimize the costs, it would be optimal to place none. In practice, the problem is often to find the wind turbine positions that are optimal for the specified objective with a given park size, and it is more useful to analyse different set-ups per park size and for different park sizes. To analyze the park size, simply set the appropriate range of sizes from min to max in the Add Sizes & Runs setup as shown in Figure 15. Then choose the preferred setup of the runs which will be created for each size (see section 8a.1.2.3 for further details). The Optimizer uses parallelization so several runs will start and run simultaneously to speed-up performance.

Once completed, the results can be visualized and analyzed on the Compare tab and by selecting the relevant WTG in the tree.

In some cases, the runs for the largest park sizes will fail before all turbines could be placed by the start model. This can indicate the maximum number of turbines which is possible to place, but care must be taken as several factors influence this outcome. One thing is making sure that the grid resolution is not too coarse, generally around 0.5 RD ensures good performance. Another possibility is that the default start model (Smart) places turbines according to the objective – but that the maximum is determined by a constraint, hence placement may not be ideal regarding minimizing constraint exceedance. Section 8a.2.4 describes a procedure that improves chances of finding a valid layout in such cases.

8a.2.3 Choice of turbine model

To analyze the choice of WTG model, simply add all the relevant WTG models to the Site. In such cases setting the maximum allowed capacity of the grid in the WTG area is beneficial as this will automatically influence the maximum number of turbines for each model, given its capacity. It may also be relevant to set individual cost models for each WTG if detailed cost information is available. However, this is not required as the default cost model will automatically account for the difference in rotor size and generator capacity of each WTG type.

The results across the WTGs may be compared on the Compare tab by selecting the relevant site in the tree. If there are more sizes and runs for each WTG the best run (with regard to the selected objective) is chosen to represent each WTG type.

8a.2.4 Fulfillment of constraints (spacing, noise, lifetime, wake)

In some cases, the optimization is more driven by the constraints (noise or loads) than by the objective (AEP, LCOE or NPV). This does not mean that the objective is irrelevant, but rather that the design space is very difficult to navigate in for the Optimizer because large parts are invalid due to the constraints. In some cases, this may lead to runs failing for particular sizes because the start model cannot generate a valid layout, i.e. place all turbines without violating the constraints. If this happens it can be beneficial to add several runs with the Random run setup for a failed size and with the setting Allow invalid start model activated. This will allow the start model to place all the required turbines but disregard the constraints (except the WTG area). The step model will then seek to minimize the constraint exceedance first, and if that succeeds then optimize the objective function.

8a.3 Optimization algorithm

The wind farm optimization problem is a difficult problem mainly due to the occurrence of several local minima and so-called non-linearity and interaction in the objective functions, chiefly arising from the turbine wake interaction. If one turbine is moved the optimum position for all other turbines in the park may change or they may exceed a constraint they did not before. These effects may be accentuated by too coarse a resource grid and too coarse a directional resolution in the wake model or simply by multi-directional wind roses. When constraints are included, these may also prevent otherwise beneficial layout changes and effectively split the solution space into many smaller un-connected “islands” (in a high dimensional sense), which are extremely difficult to navigate for an optimization algorithm. The supported objectives and constraints are described in section 0.

The structure of the New Optimizer reflects the structure of the underlying solution approach, which is a classical iterative search, but with many built-in smart features that improve its performance and efficiency. In this framework, an optimization needs a Start model, an initial ‘first guess’ and then a Step model that subsequently seeks to make iterative, incremental improvements to further improve and optimize the Start model. As the final optimal model is not known a priori, one or more Stop criteria are needed to decide when to halt the search of the Step model. This could be once a maximum time or a maximum number of fruitless attempts to take a new step improvement have been tried.

The better the initial Start model the more focused the iterative Step model can perform its search. In fact, the wind farm optimization problem is so complex that with many turbines it is very difficult for an iterative solution to find a good optimum. Increasing the likelihood of ending up in an only modestly good local optimum. In this sense the old saying “Well begun is half done” is extremely pertinent and the reason for the development of the Smart Start models described in section 8a.3.1.

Figure 20 shows the basic options available for setting up optimization runs. The Optimizer includes multiple options both for the Start model, Step model and Stop criteria and is quite flexible in this sense. However, the basic options shown represent the main recommended combinations of Start and Step models.

The full flexibility is available when choosing the Custom option where all the Start, Step and Stop options become available. These options are summarized in the bullet points below including the two additional options, Seed and Realization, which are explained in their respective parentheses.

- Custom
  - Start: Fill; Manual; Resource Greedy; Random; Smart
  - Step: Random, Local; Random, Regional; Random, Global
- Resolution: Discrete (Limit to grid points), Continuous
  - Stop: Max runtime, Max fruitless tries, (exhausted neighborhood)
  - Stochastic (use of random numbers)
  - Seed (to ensure reproducibility of stochastic methods)

o Realizations (how many runs to generate for a stochastic method)
The last listed Stop criterion, exhausted neighborhood, is in parentheses as it is never selectable for the enduser and always applied when the optimization runs with the Discrete resolution setting, where turbine positions are limited to the grid points in the resource grid. This Resolution setting with options Discrete or Continuous is a property of the step model as it is referred to as Limit to grid points in the basic options setup (i.e. not Custom).

To keep the GUI user-friendly, we have pre-defined combinations of Start model and Step model (cf. Figure 20) that are known to perform well together. Above all the Smart option which is the default option will perform the best in the majority of cases. The pre-defined (default) combinations are listed below indicating the Start and Step models

• User Layout o Start: Manual (i.e., user defined)
o Step: Random, Regional
• Fill max o Start: Fill
o Step: Random, Local
• Best location subset
o Start: Fill
o Step: Random, Local
• Smart
o Start: Manual (i.e., user defined)
o Step: None
• Random
o Start: Random
o Step: Random, Regional
The following sections describe the Start, Step and Stop options in further detail.

8a.3.1 Start model

The purpose of the Start model is to define the initial guess of the optimization solution and to make that guess as good as possible. As described earlier, for complex optimization problems “well begun really is half done”, and most likely much more than just half done. A poor starting model will be more likely to end up in modest local optimal solutions. All the start models operate strictly on the resource grid. If this grid is excessively coarse relative to the rotor diameter of the turbine model, that is to say >1RD, the performance of the Start models may deteriorate, in particular the more advanced ones like the Smart Start model. The optimal trade-off between speed and resolution lies around 0.5RD for the resource grid spacing relative to the turbine rotor diameter.

Unless the Allow invalid start model is activated the Start model will respect all activated constraints. The option can only be activated for the Random start model. See section 8a.2.4 for further information.

The Smart Start model picks the optimal position (approximately) for each new WTG it places, regarding the actual chosen objective and the effects of already-placed turbines. If stochastic is activated, a measure of randomness is added in the placement of each individual turbine.

The Random Start model is fully stochastic and picks the positions at random across the entire grid. More than one Realization is recommended for this model, typically 7-8 or more, which simply means doing several similar runs with different sets of random numbers. This model can be beneficial particularly if the optimization is strongly influenced by restrictive constraints. A fixed Seed may be set to exactly reproduce random numbers as this seed is used both for the start and step models to ensure full consistency. A fixed seed cannot be used with multiple realizations.

The Resource Greedy option is mainly included for historic reasons and for comparisons with the Classical windPRO Optimizer. It picks each turbine position according to the best available resource position disregarding wake effects and any objective function. This option performs well for sites with strong resource variation (e.g. a ridge) using the AEP objective.

The Fill Start model will simply disregard the resource and start filling turbines from one corner only respecting the constraints until the required number have been placed. If selected via the Fill max option, the filling will continue until no more turbines can be placed due to the constraints. The Fill algorithm has been improved in 4.2.

The Manual Start model is defined by the user who selects the turbine's starting positions.

The Best location subset model allows the user to identify the optimal subset of locations from a defined set of turbine locations, which can be useful in repowering decision making. This model requires an additional configuration since the set of turbines must be defined from which the best subset is selected from. Note that only WTGs that are positioned within the defined WTG area are available for that selection.

8a.3.2 Step model

The Step model iteratively seeks to improve the Start model until a Stop criterion is met. All the Step models are stochastic, which means that they rely on random numbers. This means that both a turbine is selected at random and that a new position for that turbine is selected at random. The main difference between the Step models is the pool of positions from which these new positions are drawn.

The Random, Local Step model assumes that the current layout and turbine positions are relatively close to the optimum. The assumption is typically valid for Smart Start models and Manual user defined Start models. The local step model draws random positions from a local area around the turbine.

The Random, Regional Step model draws the random positions from a relatively large region around the turbine, expecting improvements to be found further away, and the optimum position is not in the direct neighborhood.

The Random, Global Step model draws new positions from the entire domain. It is not utilized in any of the standard options as convergence is inefficient. However, as a first broad search phase it can be useful followed by a Random, Regional step model initiated via a Clone run, for example.

When grid spacing is finer than the expected optimal trade-off at around 0.5D, the default option is Limit to grid points (Discrete). When grid spacing exceeds 0.5D, the default option is Continuous, which will allow turbines to move away from grid points and prevent local optima due to a grid that is too coarse which is important. The drawback is that the most natural Stop criterion cannot be used as will be described in the next section.

The main difference between the local, regional, and global set-up is the areas around the turbines considered for steps. In a local step, the local area is 5D at the start of the optimization run and becomes iteratively smaller until it reaches 1D at the end of the run in the discrete case or 0.5D in the continuous case. The distance that defines the regional area is a square root of the vertical and horizontal distance of the whole WTG area, but at least 5D in case of small WTG areas, at the start of the optimization run. It also ends up at 1D in the discrete case and 0.5D in the continuous case. In the global step, the whole area is constantly considered during the run.

8a.3.3 Stop criteria

The purpose of the Stop criteria is to detect if an optimization is converged or so close to being converged that further improvement will be insignificant. Another purpose is to give the user a chance to set a maximum waiting time (with the risk of stopping prematurely far from an optimum).

Max runtime is the maximum time Step model is allowed to run. When the time is up the optimization is stopped. The time to generate the starting model is not included in the timing.

Max fruitless tries simply defines the maximum number of unsuccessful attempts to take a step which accepted before stopping. Both invalid steps (i.e., failed constraints) and steps without improved objective values are counted.

Exhausted neighborhood is an option hidden from the user which is the most efficient stopping criterion. It can only be used for runs with the resolution set to Limit to grid points (Discrete). It is a memory that tests if all possible positions in the search neighborhood for all turbines have been tried in vain – and if so, the current layout is by

definition an optimum and the run is stopped. For continuous runs the search neighborhood is always infinite no matter how small it is, and this Stop criterion cannot be employed.

8a.3.4 Objective & Constraints

Put simply, the Objective of an optimization is what we seek to optimize. The design variables are the degrees of freedom given to the Optimizer, which are allowed to be modified to find the best possible objective. In this Optimizer only the turbine positions, their X and Y coordinates are explicit design variables. The number of turbines and the turbine models are implicit design variables which the user can analyze and optimize via the flexible structure of the GUI-tree. The choice of objective may differ for different users, the supported objectives are described in next section.

Constraints are known limitations which must be fulfilled for a solution to be accepted, hence, we call a solution which fulfills all constraints Valid. A solution where at least one constraint is violated is Invalid (and will not be accepted).

8a.4 Objectives

An optimization needs a quantity that must be optimized, the Objective, given a set of design variables that may be varied. For some objectives optimization implies maximization, which is the case when wind farm production (AEP) or project profit is the objective. For other objectives optimization implies minimization, which is the case for cost-of-energy optimization.

8a.4.1 AEP

AEP is simply the Annual Energy Production including wake losses. The AEP calculation is based on the resource data in the selected .rsf or .siteres file, containing sector-wise Weibull parameters (A and k) and frequencies (f). Wake effects are calculated using the PARK2 wake model and the user-defined wake decay constant. Wind farm layout optimizations using AEP as the objective have a drawback, particularly if the available WTG area is large: The optimization may lead to very spread-out layouts that would incur excessive costs for building roads and grid connection. This is the main motivation for choosing other objectives, in particular, objectives which include the costs of building the wind farm.

8a.4.2 Costs

Costs are not included as an objective on its own in the New Optimizer, at least not directly. However, the estimation of costs is an important input to financial objectives such as cost-of-energy (COE) or profit (NPV), to account for the balance between the created value (i.e., AEP) and the expected costs required to realize that potential. Costs in the New Optimizer are estimated using the windPRO Cost tool. This tool estimates costs using parameterized formulas fitted to a large amount of real historic costs and based on extensive literature reviews. As an example, turbine costs scale with generator capacity (MW), specific capacity (MW/m2), rotor size (m2) and hub height (m) via an elaborate regression expression. The cost tool comes with six predefined cost models, three price levels ‘high’, ‘mid’ and ‘low’ for onshore and offshore, respectively.

In the cost tool, the costs are divided into four main categories as listed below.

- Devex: development expenditure
- Capex: capital expenditure
- Opex: operational expenditure
- Abex: abandonment expenditure

Development expenditures (Devex) quantify the cost associated with developing the project, getting permissions to build the wind farm etc. Capital expenditures (Capex) represent the main investment of building the wind farm. Operational expenditures (Opex) represent the costs of keeping the wind farm running through its lifetime, and abandonment expenditures (Abex) quantify the estimated amount of money to eventually remove the wind park. Capex is the only cost category which depends on the actual design of the layout via the costs for the internal grid connection between the turbines (and roads for onshore).

When costs vary over space, cost maps can be imported to account for that via the Add cost map button. These costs are functionally handled as other costs but instead of fix input parameters the cost values are retrieved from the cost map.

For each cost a Cost Index may be defined to account for expected future trends in the price development. This index should exclude the effect of the general baseline inflation.

In Figure 25 please note the possibility to insert adjustments to the baseline costs via entries in the table column Cost function value. It is via values in this column that the high and low alternative cost models are defined, by an increase or decrease of these factors.

In the Optimizer the wind farm is assumed to be built and put into operation the year after the current year, which for 2024 would be 2025. Devex is assumed to occur the year before the installation, i.e. the current year. When the reference year defined in the cost tool deviates from the year that a cost occurs the price index (if set) will be used to adjust the costs accordingly. The default cost index is zero through the lifetime.

Note that the total cost values shown in the optimizer are not discounted only index corrected (if set by the user) and summed over the lifetime.

For the grid (offshore and onshore) and road connection costs (onshore only) an additional sub-optimization is solved for finding the shortest possible way to connect the turbines in the layout. Either to each other or to any of the Connection points if defined for the Site. The resulting inter-connection distance is what enters the cost calculation. The solution to this sub-optimization relies on graph theory and the optimization problem is referred to as the minimum spanning tree. The connections of the minimum spanning tree are visualized in the Layout plot for each run as the black connection lines between the WTGs (and connection points, if any).

As a final remark it is important to stress that the cost model is deliberately kept relatively simple with a minimum of assumptions which are calibrated against actual project costs. Hence, the user does not need, in fact cannot, set a large range of particular cost items such as the cost of crossing a stream or railway. Although that degree of flexibility might appear beneficial, if the input quantities are not known the values will be associated with a very large uncertainty, as will the resulting overall cost estimates. The current cost tool seeks to strike an ideal balance between accuracy and detail/flexibility, but with a preference for accuracy over detail. In the end what is important is getting the right order of magnitude of costs as input to the financial objectives.

8a.5 Constraints

The following sections describe the constraints supported by the New Optimizer. The supported constraints are shown in Figure 27. Note that including Lifetime or Noise constraints are subject to additional windPRO license requirements as they draw on calculation functionality in the LOAD RESPONSE and DECIBEL modules, respectively.

8a.5.1 Area & distance (sub-areas)

Defining a WTG area object is a prerequisite for all optimizations. The WTG area object serves the purpose to define the area limitations for turbine placement. A site may be split into arbitrarily many sub-areas and each sub-area may have individual limitations on minimum and maximum numbers of turbines or installed capacities. Sub-areas may also have individual requirements for turbine spacing typically defined as an elliptical constraint in terms of rotor diameters oriented along the prevalent wind direction. The Optimizer will always adhere to the areal requirements defined in the selected WTG area, whereas minimum requirements for inter-turbine distances must be separately activated via the Distance constraint. Even if no distance constraint is activated the Optimizer will not accept a turbine spacing below 1D. Some tips and considerations to the WTG area import are available in section 8a.6.2, and detailed information about the WTG area object is available at Appendix 8 OPTIMIZE Classic in section 8.0.1.5.

8a.5.2 Wake loss

The maximum wake loss constraint (cf. Figure 27) allows to define maximum wake losses for both new WTG and existing WTG objects; the maximum wake losses can be specified independently from each other.

8a.5.3 Noise

The noise constraint requires an activated license for the DECIBEL module. The calculation is a stripped-down version of the ISO 9613-2 standard. The noise constraint is defined for a single wind speed selected in the Model settings for the noise requirement (Figure 28). Noise sensitive areas must be selected on the Site level (Figure 29) and WTG source noise data on the WTG level (Figure 30).

8a.5.4 Component Lifetime (loads)

The lifetime constraint requires an active license for the LOAD RESPONSE module and sets a constraint on required minimum lifetimes for selected turbine components for each WTG position. The calculation of lifetimes and activation of the lifetime constraint requires a resource file including all the siting parameters for fatigue calculation, i.e., a .siteres file. Such a file may be calculated using the RESOURCE calculation in windPRO drawing upon the IEC61400-1 ed. 4 calculation functionality in SITE COMPLIANCE, or can be downloaded from the free online GASP dataset. The calculation options are a stripped-down version of LOAD RESPONSE as can been from the Model settings in Figure 31.

The lifetime calculation also requires the setup of the wind turbine Design Standard and Class as well as selection of the Load Response Model which can be either a generic model or a specific model provided by a manufacturer. For the response model, a set of sensors must be selected for the constraint, here it is recommended to focus on the key components such as blade root and tower bottom, and perhaps low speed shaft (LDD).

8a.6 Practical recommendations

8a.6.1 Run setting recommendations

As default setting, we reommend:

• Interval — this allows a specific number of WTG's to be placed.
• Smart start — this algorithm excels to maximize the objective when there are not many constraining conditions, e.g. limited space.
For sites where it is difficult to allocate the desired number of turbines and only distance constraints are activated, we recommend:
• Fill Max — this places as many WTG as possible.
For sites where it is difficult to allocate the desired number of turbines and constraints in addition to distance constraints are activated, we recommend:
• Interval
• Random + Allow invalid start model — this allows a specific number of WTG's to be placed when there are multiple constraining factors that complicate to place the desired number of turbines (it is often helpful to increase the run time when both random and allow invalid start model options are selected).
For sites with fix locations for WTGs and an optimal subset of WTGs shall be selected, e.g. for Repowering, we recommend:
• Best location subset
For large sites, high resolution resource data or many turbines that leave to long computation times, we recommend

Limit to grid points — This often yields a good starting point in much shorter time, and the solutions can then be further optimized in a consequent step, e.g. using Manual start 6) For layouts where a good layout has already been found and it shall be refined, we recommend:

Manual start 8a.6.2 WTG Area import

A convenient approach is to import pre-defined WTG Areas (cf. Figure 33: WTG area Import from file.) as shapefile format (.shp). Each feature of the shapefile a WTG area is handled separately for which properties can be defined, e.g., whether the area is an exclusion zone or a WTG area, the minimum and maximum number of WTGs to be

placed, the minimum distance between WTG (cf. Figure 33). Moreover, a buffer zone can be specified (cf. Figure 34) for the optimization.

8a.6.3 Example projects

Three sample projects are provided to show the range of utilities of the optimizer tool: a sample on-shore project, a sample off-shore project, and a sample project for the new noise curtailment optimizer.

The onshore sample project Aparados da Serra.w42p provides a variety of optimization scenarios. These include runs with AEP, LCOE and NPV objectives, runs with different constraints and on different WTG area structures. Lastly, it shows a performance comparison for different turbine types and a performance comparison for different optimization configurations.

The offshore sample Cost model offshore.w42p showcases the new option of including cost maps in the cost set-up that can be used to represent a whole variety of costs, e.g., bathymetry-based costs, soil structure foundation costs, or travel costs.

The noise curtailment Curtailment optimizer demo project.w42p shows how a non-compliant wind farm layout can be made compliant with noise regulations while still obtaining the maximum possible energy yield from optimal curtailment strategies.

Kind Regards
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Reference Number 1.7: Environmental Impact of Wind Farms. Bošnjakovi´c, M.; Hrka´c, F.; Stoi´c, M.; Hradovi, I. Environments 2024, 11, 257. https://doi.org/ 10.3390/environments11110257

Toxicity

The toxicity of substances to humans can be expressed in different ways and is often expressed in CTUh (Comparative toxic unit for human). Onshore wind farms have an average of around 3.9 CTUh/TWh.

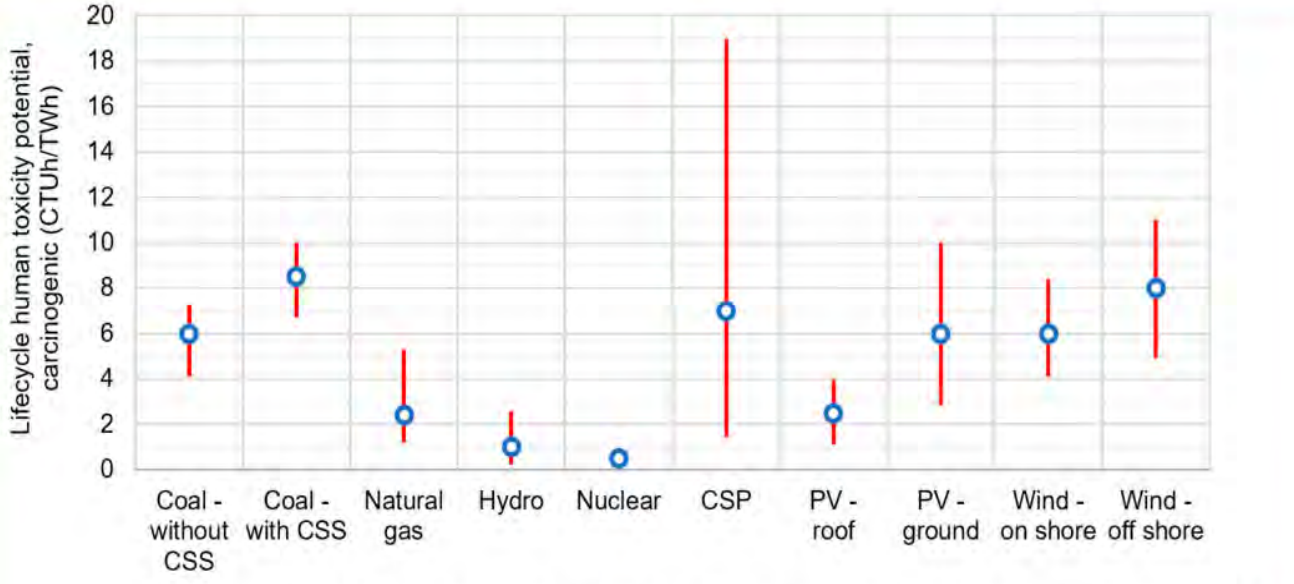

Figure 4. Lifecycle human toxicity potential, carcinogenic. The red line represents the range and the circle represents the median.

Danger of Ice Flying off the Blades

Ice build-up on the rotor blades of wind turbines can pose a serious threat to people and objects in the immediate vicinity. It is, therefore, important to assess the dangers associated with ice shards falling and flying from the rotor blades. Icing can also lead to the failure of wind turbines because the structural integrity is impaired. The hazard posed by ice depends on the severity of the icing, the type of icing, the wind, the rotor speed and other environmental conditions. **A piece of ice with a weight of 0.2 kg and a density of 500 kg/m3 falling from a height of 30 to 50 m is considered fatal if the impact has a kinetic energy of more than 40 J.**

Danger of Blade Parts Flying Off

A "blade failure" can have a number of causes and can result in either whole blades or parts of blades being thrown from the turbine. **A total of 537 separate incidents have been recorded. It has been documented that parts of the blades have travelled up to 1.6 km.** *In Germany, parts of the blade penetrated the roofs and walls of nearby buildings. For this reason, a law was passed in Germany (Bavaria) in 2016 requiring a minimum of two kilometers to be kept between dwellings or workplaces and wind turbines, and Ireland is considering a similar measure.*

Impact on Radio Waves and Air Traffic

Offshore wind turbines can interfere with radar systems on board ships and on land as well as radars used to monitor air traffic. Wind farms located near weather radars can cause false echoes that can be misinterpreted as weather phenomena such as precipitation or thunderstorms. The reason for the interference lies in the structure of the turbines, the height of the turbines and the displacement of the rotors, which can reflect radar signals. In addition, telecommunication and data transmission signals can be weakened when wind turbines are in the line of sight (LOS) for radio communications. In general, two types of effects of wind farms on radar systems can occur:

- *Formation of radar shadows behind wind turbines, which can result in lower targets being poorly recognised or not recognised at all. The relatively high frequencies used by the radar are attenuated when the signal passes through the wind farm, i.e., they shorten the range of the radar.*
- *Reflection of the radar beams from the wind turbines can lead to false radar targets (false echoes).*

Radar systems work by recognising weak reflections that are often in motion. In addition, the rotor blades of wind turbines produce false reflections in the direction of the receivers, causing the radar to misinterpret the signals. While the wind farm industry is growing rapidly, they are causing serious interference problems in critical civil and military radio systems, degrading radar detection range and increasing the complexity of air surveillance and navigation missions.

Habitat Destruction

Based on 84 studies of onshore wind farms in 22 countries, (Tolvanen et al). presented data on the average distance of habitat displacement from the edge of wind farms. The predominant height of wind towers in the studies was 50–99 m.

For birds, bats and mammals, habitat displacement accounted for 63%, 72% and 67% of cases, respectively. Cranes, owls and semi-wild reindeer showed consistent habitat displacements of up to 5 km on average. Gallinaceus birds showed movements of up to 5 km on average, but "no movement" was reported in 40 cases. Bats were displaced by an average of up to 1 km in most cases. Waders, birds of prey, sparrows and black-winged stilts moved their habitats by up to 500 m on average.

Furthermore, human-caused forest landscape fragmentation may lead to a rise in the number of predators (Pasanen-Mortensen and Elmhagen, 2015). For instance, infrastructure like buildings and maintenance roads could attract fox activity (Hradsky et al. 2017), so the risk of predation may be higher near wind farms. Grouse are known to be sensitive to human disturbance (Coppes et al 2017). Many grouse species are site-loyal and therefore highly vulnerable if their habitat overlaps with areas that are suitable for wind turbine installation, particularly in the absence of another suitable habitat (Braunisch et al. 2015).

Collision with a Wind Farm

For some bat species, the installation of wind turbines creates new habitats because there are more insects to feed on in the vicinity of the wind turbines. **Direct causes of bat death at wind turbines are well recognised and include barotrauma (Rollins et al. 2012) and collisions with rotating blades (Horn et al. 2008) or a combination of both.**

The potential threats of wind farms to birds are well documented in the literature, for example. Research suggests that mortality rates (although they may be relatively high in certain areas) are highly variable and depend on a number of factors such as the bird species, the size and the location of the wind farm and others. (Barclay et al. 2007) reported a mortality rate of 0.00–9.33 birds per year per turbine and a mortality rate of 0.00–42.7 for bats. The selective shutdown of wind farms along the bird migration route using radar is very effective in reducing collision rates (Tomé et al 2017).

Noise Onshore Wind Farm

Noise pollution has a negative impact on wildlife as it disrupts mechanisms that are crucial for their survival. According to studies, noise can result in the following:

- *Result in physiological trouble, such as genuine hearing loss or persistently elevated stress hormone levels.*
- *Be viewed as a direct danger, which would lead to an increase in predatory behaviour at the expense of foraging or the departure of the afflicted region, which would result in the loss of habitat.*
- *Distract attention during foraging and reduce foraging efficiency.*
- *Interfere with animal communication by reducing the distance from which the signal can be perceived and lowering the quantity of information that can be taken out of the signal, such as the sound of a predator or approaching potential prey.*
- *Influence the reproductive process. Taubmann et al. reported that noise disturbs grouse up to a distance of 865m. Increasing turbine noise, turbine visibility, and turbine shadow during the breeding season reduced the likelihood of selecting a breeding site.*

The roles that these processes play in determining the effects of noise pollution on different species are not mutually exclusive. Different species respond differently to noise as they have different sensitivities to noise. In general, noise pollution alters animal communities. The effects of noise can contribute to the reduction in biodiversity and also threaten the sustainability of local ecosystems.

The Effects of Vibrations from Wind Turbines on the Ecological System

The impact of vibrations is one of the aspects to be considered when analysing the impact of wind turbines on the environment. Vibrations are mechanical oscillations that can be caused by the operation of the wind farm and its components. In this chapter, the effects of vibrations on the environment are analysed, taking into account the possible consequences for living beings, structures and the surrounding space.

The source of vibrations in wind farms is the rotating parts of the turbines, such as rotor blades and generators. The rotation of these parts generates periodic vibrations that are transmitted to the ground via the foundations of the wind farm. These vibrations can have a negative impact on the animals in the surrounding area, especially on their sensitive acoustic perception. A study by Estefania Velilla and colleagues from 2021 shows how vibrations from wind farms affect the abundance of earthworms in the soil. The relative intensity of vibrations in the soil was measured and the results showed a decrease in the number of earthworms near the wind turbines, which is considered a negative impact on soil organisms. A decrease in earthworms was found in a radius of about 200 m around the wind turbines, where the noise level decreased by an average of 23 ± 7dB. Earthworms are considered important engineers of the ecosystem, and interference with their abundance, survival and reproduction can indirectly affect important processes such as water filtration, nutrient cycling and carbon sequestration. In addition, the vibrational noise generated by the wind turbine can mask the vibrational signs of approaching moles, making earthworms in noisy areas more vulnerable to predation (Dominoni et al. 2020).

Wind farms generate noise that can have harmful effects on humans and animals, especially in the vicinity of the wind farm. Problems noted in humans include insomnia, headaches and the like. For animals, there is a wide range of potential impacts: from possible hearing damage to interference in foraging, predator marking, habitat abandonment and more. The moving rotor blades of the wind farm can pose a risk of collision and death for birds and bats.

Reference Number 1.8: Guidance on biodiversity Cumulative Impact Assessment for wind and solar developments and associated infrastructure 2024: Leon Bennun, Claire Fletcher, Aonghais Cook, David Wilson, Ben Jobson, Rachel Asante-Owusu, Annie Dakmejian, Qiulin Liu. IUCN, Gland, Switzerland and The Biodiversity Consultancy, Cambridge, UK. ISBN: 978-2-8317-2317-4 (PDF). DOI: https://doi.org/10.2305/EHGE6100

Annex III-C Onshore wind

For onshore wind developments, cumulative impacts are most likely to arise from collision risk and displacement, and habitat loss/fragmentation (see Annex III-E for impacts related to associated infrastructure). Biodiversity for which cumulative impacts are likely to result in the strongest negative population-level effects include:

- *Raptors and other large soaring birds rely on updrafts for long distance flights, have low manoeuvrability, and potentially have a restricted forward field of view (e.g. Portugal & Murn, 2012). These species are most at risk from collision with turbines and as they typically have long generation times and relatively small populations, cumulative impacts have a potentially greater effect (AWWI, 2021);*

- *Migratory soaring birds, especially those where any part of their migratory route is constrained by topographic features (e.g. places where there are bottlenecks due to species optimising use of orographic or thermal uplift, or minimising long water crossings), may experience high levels of mortality because a larger proportion of the population could encounter multiple wind farms (Cabrera-Cruz et al., 2020; Thaxter et al., 201740), in addition to risks from other human activities;*

- *Some bat groups: migratory tree-roosting species and open-air foraging species are known to be at highest risk of collision with onshore wind turbines because of several factors, including (but not limited to) their foraging height, fast flight speed, commuting flight behaviour across open landscapes, and exploration or attraction with wind turbines (Aronson, 2022; AWWI, 2021; Guest et al., 2022; MacEwan et al., 2020; Thaxter et al., 2017); In contrast, little is known about the risk to fruit and nectar feeding bats (plant-visiting bats) because most studies to date have been in the northern temperate zone, where there are few plant-visiting bat species, and because they have a wide range of characteristics different to insectivorous bats (but see: Cabrera-Cruz et al., 2020; Aronson, 2022).*

- *Restricted-range species, habitat specialists: Those species, which either have small overall ranges, or are specialised to a particular habitat or topographic feature, may experience the greatest effect from cumulative impacts because multiple onshore wind developments have the potential to cover a large portion of the species' range; and*

- *Natural habitats and other high biodiversity value areas: as for solar developments, utility scale wind power projects can individually and cumulatively cover large areas, causing potentially significant habitat loss, degradation and fragmentation, and barrier effects. Key receptors include protected areas, KBAs, or areas of particular importance to threatened or declining species and ecosystems.*

Annex III-E Associated infrastructure

Wind, both onshore and offshore, and solar developments can have a variety of associated infrastructure, which may also represent significant risk to biodiversity, and it is important that this risk is considered as an integral part of any project. Overhead transmission and distribution lines are required to connect all project types with the energy grid: for onshore projects, these connect directly to the project substation, while for offshore projects, these connect with a substation at the subsea cable landfall site. All transmission lines present potentially significant risks to bird species and at the cumulative level, these impacts may have large population-level effects. The energy transition will require extensive construction of new transmission and distribution lines, potentially involving habitat clearance of variable widths along the powerline corridor. The scale of the collision impact associated with powerlines is potentially much larger than that associated with wind farms. Collision and electrocution kill hundreds of thousands to millions of birds every year (Bernardino et al., 2018; Erickson et al., 2005), with the potential for population-level impacts (Bernardino et al., 2018; Burnside et al., 2015; Lopez-Lopez et al., 2011; Travers 2023), including contributing to imminent species extinction risk (Uddin et al., 2021). Species with high wing loading are at higher risk of collision with transmission lines because of their lower manoeuvrability (e.g. bustards, cranes, pelicans, storks, geese, swans, eagles, and vultures) (Janss, 2000). Raptors and other large perching birds, along with fruit bats, are at greatest risk

of electrocution at distribution line poles due to their large wingspan, which means they can inadvertently create a short circuit (e.g. Martin Martin et al., 2022; Shaw et al., 2018; Tella et al., 2020).

Land clearance for access roads, temporary construction areas, and permanent on-site facilities can also impact biodiversity, both directly through destruction of natural habitats and species mortality, or indirectly by induced access for humans to otherwise inaccessible areas.

In the United States, temporary loss has been estimated at 2.8 ha for a 2.5 MW turbine in forest (Voigt, 2023) and at 0.7±}0.6 ha per MW for generic temporary impacts and ~0.2 ha per MW for permanent infrastructure (Denholm et al., 2009).

Annex III-A Key potential cumulative impacts on biodiversity from wind, solar, and transmission infrastructure

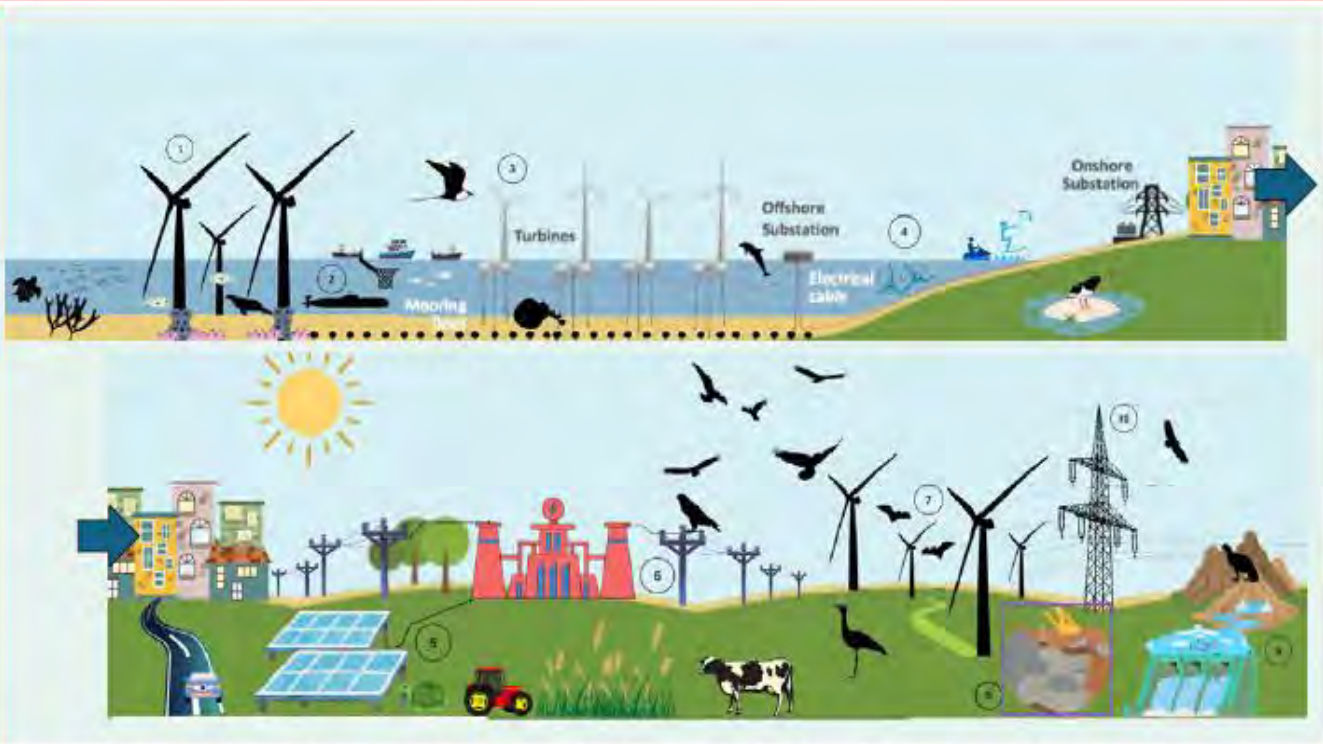

Figure 12 **Key potential cumulative impacts on biodiversity from wind and solar and transmission infrastructure** *Source: TBC*

Key

1) Fixed offshore wind farms can have cumulative and even ecosystem-level impacts to the composition of the seabed, marine species assemblages, nutrient flows and ocean circulation.
2) In addition to other marine activities like fishing, sports, and military activity, wind energy can add additional construction noise and disturbance to marine ecosystems.
3) Collision and displacement of seabirds is a major impact of increasing offshore wind energy, with floating wind farms now expanding to areas that were previously technically unfeasible.
4) Subsea cables from offshore wind will have a terrestrial impact and combine with other forms of nearshore energy like tidal power.
5) Solar power has a cumulative impact on land use, in addition to other requirements like agriculture, protected areas, real estate and transport infrastructure.
6) Associated renewable energy infrastructure expands the number of distribution and transmission lines needed, incurring greater electrocution risks, especially across vulnerable and migratory species' ranges.
7) Onshore wind energy infrastructure incurs greater collision risks, especially across vulnerable and migratory species' ranges.
8) Expansion of renewable energy has an implication for mining with increased demand for rare earth minerals and metals.
9) Other forms of renewable energy like hydropower will have an impact on freshwater environments and can add cumulative impacts to the water requirements of solar energy for cleaning and cooling panels.
10) Associated renewable energy infrastructure expands the number of distribution and transmission lines needed, incurring greater electrocution risks, especially across vulnerable and migratory species' ranges.

Volume 2 - Main EIAR

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Appendix 01-1 Stakeholder Consultation List.pdf
Appendix 01-2 Community Engagement Report.pdf
Appendix 01-3_EIAR Scoping Report.pdf

Chapter 02 Project Description.pdf
The Offaly WES states the following regarding wind farm development in areas Open for Consideration for Wind Energy Developments:
"These areas are open for consideration for wind energy development as these areas are characterised by low housing densities, do not conflict with European or National designated sites and have the ability by virtue of their landscape characteristics to absorb wind farm developments. Notwithstanding this designation, wind farm developments in these areas will be evaluated on a case-by-case basis subject to criteria listed in Development Management Standard 109 contained in Chapter 13 of Volume 1 of this County Development Plan and the Section 28 Wind Energy Development Guidelines".

The WES states that the site is in Area 1 (area generally north of Rhode). The area is described as follows: *"This area is characterised by significant tracts of peatlands and improved agricultural land to the north of the village and large landholdings. In addition, there exists a precedent of windfarm and renewable energy projects being deemed suitable while there exists both good wind speeds and electricity infrastructure in the area. There is sensitivity in relation to views of Croghan Hill to the north and west which can be mitigated by suitable layout minimising visual conflict or compromising this focal feature in the area by considering the clustering of turbines and adequate separation of turbines from the vista of Croghan Hill from Rhode village".*
Response: Site is South-East of Rhode & not north of Rhode.

Additional temporary works will be required to facilitate the delivery of the turbine components along the public road network. These are outlined in the Turbine Delivery Report (Appendix 2-2). A road opening licence will be sought and agreed with the relevant local authority for any works required within the public road network.

2.3.1 Proposed Wind Farm Layout Wind Turbines

Table 2-1: Proposed Turbine Dimensions and Co-ordinates

Turbine Ref. No.	Hub Height	Blade Length	Turbine tip height (m)	Grid Co-ordinates (ITM)	
T1	104	79.35	185	655751 (X)	731543 (Y)
T2	104	79.35	185	656181 (X)	731802 (Y)
T3	104	79.35	185	656655 (X)	731460 (Y)
T4	104	79.35	185	656053 (X)	729897 (Y)
T5	104	79.35	185	656718 (X)	729689 (Y)
T6	104	79.35	185	656060 (X)	729191 (Y)
T7	104	79.35	185	655818 (X)	728575 (Y)

2.3.7 Site Access

Primary access to the Proposed Wind Farm will be provided from the local public road (L5010), which links the L5006 in the east and the R400 to the west. (refer to Figure 2-6). There will be two site entrances, one each to facilitate the northern and southern sections of the site.
Haul roads to the Proposed Development will utilise the local and regional road network. There will be no access to the Proposed Wind Farm for deliveries on the L5006 from the north. This is to reduce impact on the road network at the Trimblestown Bridge which is a narrow blind humpback bridge over the Grand Canal.
Entrance Point 2 on the L-5010 will serve the northern portion of the site and internal tracks to T1, T2, T3 and the substation. Entrance Point 1 will be created on the same L-5010 local road and will serve the southern portion of the site and internal tracks to T4, T5, T6 and T7. These site access points will facilitate turbine deliveries, construction

materials, aggregates, operations and maintenance vehicles. These will be permanent access points, however they will be scaled back, landscaped, fenced and gated as the wind farm enters the operational phase.

2.3.8 Turbine Delivery

All turbine components for the Proposed Development will arrive at one of Irelands deepwater ports, such as Bellview in Co. Waterford. From here, the components will travel via the national road and motorway network to Junction 5 (Kilbeggan/Tullamore) on the M6. Components will travel south on the N52 towards Tullamore. Due to vertical and horizontal alignment constraints the turbine blades and tower sections will take different routes from the N52/L2025 roundabout near Tullamore to Ballinagar village. A description of both proposed routes is provided below, and an overview of the proposed section is shown in Figure 2-7.

Turbine Blades

- Exit M6 at Junction 5.
- M6/N52 roundabout, exit traveling south.
- N52/R443 roundabout, exit travelling southeast on N52.
- N52/L2025 roundabout, exit travelling east on L2025.
- Continue east along L2025 through Cappincur, Clonmore and Toberleheen.
- L2025/R402 junction at Ballinagar, exit travelling northeast on R402.
- Continue northeast along R402 through Knockballyboy and Derrygowley.
- R402 junction at Daingean, continue east on R402.
- Continue east along R402 through Ballyhugh/Springfield, Killeenmore and Bogtown.
- R402/Local Road at Ballyfore, exit travelling north on local road.
- Local road junction 3-point turn to turn the blade vehicle west on L5010 towards Leitrim townland.
- Site entrances located approximately 2km and 2.7km along the L5010 to the south and north shoulders of the road respectively.

Turbine Tower Sections

- Exit M6 at Junction 5.
- M6/N52 roundabout, exit traveling south.
- N52/R443 roundabout, exit travelling southeast on N52.
- N52/L2025 roundabout, exit travelling south on N52.
- N52/R420 roundabout, exit travelling southeast on R420.
- Continue southeast along R420 through Meelaghans.
- R420/R402 junction at Ballina, exit travelling northeast on R420.
- Continue northeast along R402 through Ballymooney.
- L2025/R402 junction at Ballinagar, exit travelling northeast on R402.
- Continue northeast along R402 through Knockballyboy and Derrygowley.
- R402 junction at Daingean, continue east on R402.
- Continue east along R402 through Ballyhugh/Springfield, Killeenmore and Bogtown.
- R402/Local Road at Ballyfore, exit travelling north on local road.
- Local road junction 3-point turn to turn the blade vehicle west on L5010 towards Leitrim townland.
- Site entrances located approximately 2km and 2.7km along the L5010 to the south and north shoulders of the road respectively.

The delivery of turbine components to the Proposed Development will require temporary works on sections of the public road network along the delivery route including hedge or tree cutting, relocation of powerlines/poles, lampposts, signage and temporary local road widening. Such works will be temporary for the delivery of turbine components. There are three locations where works will be required within private lands, and these are included in the planning application boundary. Hedge/tree cutting and local road widening are assessed where applicable in the relevant chapters of this EIAR.

No mention of route for delivery of c400t Nacelle & corresponding bridge, culvert, gas pipeline, underground watermains & road strength assessments.

2.3.9 Traffic Management

All reasonable efforts will be made to minimise the impact of the works on local residences and users of the public road networks. A Traffic Management Plan (TMP) outlining the required traffic management procedures to be implemented on the public roads during the construction of the Proposed Development and delivery of the wind turbine components is included as Appendix 15. In the event ABP decides to grant approval for the Proposed Development, the final TMP will address the requirements of any relevant planning conditions, including any additional mitigation measures which are conditioned by the consenting authority. The TMP will be updated prior to construction of the Proposed Development to ensure all necessary controls are in place. All suppliers and contractors coming to and working on the Proposed Development site will be made aware of the TMP and measures to be implemented.

2.3.19 Cumulation with Other Existing and/or Approved Planned Developments

The Proposed Development, consisting of all elements, including the wind farm, substation, underground grid connection and turbine delivery route have been assessed as a whole. The Proposed Development was considered in combination with other plans and planned developments that could result in cumulative effects. including:

- Offaly County Wind Energy Strategy (2021- 2027).
- Offaly County Development Plan 2021-2027.

Any developments under these plans will first have to be consented under planning and development legislation. Significant cumulative impacts are not predicted with the plans listed above, as each plan has a range of environmental and natural heritage policy safeguards in place. Furthermore, this Proposed Project has been developed in view of achieving the objectives of these plans. Therefore, the development of this Proposed Development in combination with the scope of works required to achieve the objectives of these plans will not result in cumulative effects.

In terms of the Proposed Development, the zoning in the county development plan relates to wind energy development and there is no other contradictory zoning for other Proposed Development types or infrastructure. In terms of the Offaly County Wind Energy Strategy, the area where the Proposed Development is to be located is deemed 'Open for consideration for Wind Energy development'.

Table 2-6: Summary of Approximate Aggregate and Steel Quantities

Item	Unit	Quantity
Imported stone for turbine bases	m3	10738
Imported stone for turbine hardstand	m3	28816
Imported stone for access tracks	m3	4654
Imported stone for substation area	m3	16843
Imported stone for temporary compound	m3	3781
Imported stone for independent power producer	m3	19899
Imported stoner for external cable route	m3	2943
Imported stone for internal cable route	m3	121
Total volume of imported aggregate required	**m3**	**87795**
Concrete for turbine Bases	m3	8482
Concrete for substation	m3	73
Concrete for lidar unit	m3	3
Concrete for independent power producer	m3	327
Concrete for external cable route	m3	2864
Concrete for internal cable route	m3	1852
Total volume concrete required	**m3**	**13601**
Reinforced steel for turbine bases	tonnes	1272
Reinforced steel for substation	tonnes	9
Reinforced steel for IPP	tonnes	41
Reinforced steel for lidar unit	tonnes	0
Total volume of imported steel reinforcement required	**tonnes**	**1323**

4.4 Site Entrances

Primary access to the Proposed Development will be provided from the local public road linkage (L5010) between the L-5006 in the east and the R400 to the west (refer to Figure 4-2). There will be two site entrances, one each to facilitate the northern and southern sections of the Proposed Wind Farm.

Entrance Point 1 will be created on the L-5010 local road and will serve the southern portion of the Proposed Wind Farm and internal tracks to T4, T5, T6 and T7.

Entrance Point 2 on the L-5010 will serve the northern portion of the Proposed Wind Farm and internal tracks to T1, T2, T3 and the substation. These site access points will facilitate turbine deliveries, construction materials, aggregates, operations and maintenance vehicles. These will be permanent access points, however they will be scaled back, landscaped, fenced and gated as the Proposed Development enters the operational phase.

4.6.3.2 Construction Phase Monitoring

Continuous Field Monitoring During the construction phase of the project, a surface water monitoring schedule, finalised prior to construction, will be followed. In summary, it is recommended that weekly field monitoring of surface water quality chemistry will be carried out at identified surface water quality monitoring locations 5, 6 and 10 in Figure 4-4, or others as required.
The following parameters will be measured:

- pH (field measured).
- Electrical Conductivity (field measured).
- Temperature (field measured).
- Dissolved Oxygen (field measured).
- Total Dissolved Solids (TDS).
- Turbidity (field measured).

Monthly Laboratory Analysis

The analytical determinants of the monitoring programme (including limits of detection and frequency of analysis) will be as per S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations and European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009.
The likely suite of determinants will include:

- pH.
- Total Petroleum Hydrocarbons (TPH).
- Temperature.
- Total Phosphorus.
- Chloride.
- Nitrate.
- Nitrite.
- Total Nitrogen.
- Orthophosphate.
- Ammonia N.
- Biochemical Oxygen Demand.
- Total Suspended Solids.

Monitoring for blade cleaning chemicals plus insect detritus & other constituents of the blades is not included.

Visual Monitoring

Periodic visual observations at each of the monitoring points will be recorded with specific reference to flow, stream substrate and water colour. Photos will be taken to support visual observation, and inspection sheets including visual observation results and photographic records will be kept on site. Visual observations will also be completed after major rainfall events along with photographs which will be collected and assessed by the ECoW.
What does periodic mean?

The elements which will be included in the visual checklist are as follows:

• Appropriate periodic visual inspection of all watercourses which drain the proposed development by the ECoW or a suitably qualified and competent person delegated by the ECoW.
• All elements of drainage system will be monitored including settlement ponds, check dams, interceptor drains etc. Corrective action will be carried out if there is a visual indication of discoloration, oily sheen, odour or litter.
• Event based visual inspections by the ECoW as follows:
• Following a high intensity localised rainfall event (10mm/hr).
• Heavy rainfall within a day (25mm in a 24 hour period).
• Higher than monthly rainfall within a week period.
• A record of all visual inspections will be included in the Construction Environmental Management Plan (CEMP) and maintained site
Will these results be made continuously available to the local community online?

4.7 Traffic Management

A detailed Traffic Management Plan (TMP) has been prepared and is included in Appendix 15 of the EIAR. The TMP will be updated at the construction stage (or the update commenced during planning compliance stage) to ensure controls are in place for all users of the site. It will be necessary to engage with the Roads and Transportation section of Offaly County Council and with An Garda Siochána and to establish traffic volumes and local road usage at the time.

The purpose of developing and implementing an agreed TMP for the construction phase works is to minimise the impact of the works on local residences and users of the public road networks.

4.9 Wind Turbines

4.9.1 Wind Turbine Locations

Turbines have been located to minimise the volume of excavated spoil and to achieve as close as possible to a balance of cut and fill of the underlying strata at each turbine location. This was achieved by orientating the turbine base and crane hardstanding area with its long axis parallel to the ground contours as much as possible while taking account of access criteria for delivery of turbine components. Table 4-3 gives the location of each of the proposed turbines.

The location of these turbine locations ignores the local community. The Manufacturers Model for Noise & Wake was requested from the representatives of Statkraft [Mr. G. O'Connor & Mr. J. Lowry] on the 5/9/2025 & we were informed that's its content was confidential & not available. This information is part of the lacunae for this application & must be made available.

Table 4-3: Turbine Locations

Turbine Ref. No.	Hub Height	Blade Length	Turbine tip height (m)	Grid Co-ordinates (ITM)	
T1	104	79.35	185	655751 (X)	731543 (Y)
T2	104	79.35	185	656181 (X)	731802 (Y)
T3	104	79.35	185	656655 (X)	731460 (Y)
T4	104	79.35	185	656053 (X)	729897 (Y)
T5	104	79.35	185	656718 (X)	729689 (Y)
T6	104	79.35	185	656060 (X)	729191 (Y)
T7	104	79.35	185	655818 (X)	728575 (Y)

4.11.2 Wind Farm 110kV Substation

The proposed 110kV wind farm substation compound will occupy an area of approximately 10,500m2 and will comprise an outdoor electrical yard and two single storey buildings (one for EirGrid and one for the wind farm operator). The substation will connect via underground cable circuits to accommodate a grid connection. The proposed 110kV substation will be made up of 1 No. Control Building, 1 No. IPP MV Switch room, Transformer compound and Busbar compound. The control building works will consist of foundation works, block work, roofing, low voltage electrical fit out, cladding and building finishing works. The transformer, gantry and structural steelwork

will be installed in the transformer compound. Two cable sealing ends will be installed to incorporate the radial underground circuits in and out of the station. The busbar compound structural steelwork will be erected, with lightning masts also installed. Substation electrical equipment will be installed once the control building and compound is complete. Fencing will be erected around the compound for security/protection. Permanent access tracks will also be installed to allow traffic in and out of the proposed substation compound, access track to loop in interface mast structures and internal access track for compound use.
No noise data was provided for this substation.

4.11.3 External Grid Connection

A 110kV underground cable associated with the Proposed Grid Connection within a single trench extending approximately 8km from the proposed onsite substation to the Philipstown Substation.
To cross sensitive features such as the Leitrim watercourse and the Bord na Móna rail track, Horizontal Directional Drilling (HDD) will be employed. This trenchless method involves drilling beneath obstacles using a guided rig and bentonite fluid to support the bore. Launch and receiving pits will be constructed at either end of the crossing, with careful environmental protection and fluid containment measures in place.
Where land drains or existing underground services are encountered, the trench will either pass over or under them depending on available cover. A minimum clearance of 300mm is required between the ducting and any existing service.
Additionally, joint bays and communication chambers will be installed approximately every 500–1,000m along the route to connect cable segments. These chambers will be precast or cast in situ, with excavation areas protected against runoff and sediment loss. Once installed on a prepared base, the chambers will be backfilled and sealed, ensuring continuity and durability of the grid connection infrastructure.
In the absence of alternative option evaluations, this cannot be approved.

4.12 Turbine Delivery Route

All turbine components for the proposed development will arrive at one of Irelands deepwater ports, such as Bellview in Co. Waterford. From here, the components will travel via the national road and motorway network to Junction 5 (Kilbeggan/Tullamore) on the M6. Components will travel south on the N52 towards Tullamore. Due to vertical and horizontal alignment constraints the turbine blades and tower sections will take different routes from the N52/L2025 roundabout near Tullamore to Ballinagar village. An overview of the proposed section is shown in Figure 4-7. Route B uses a local road (L2025) in order to get through Ballinagar, to reduce impact on the local road, this route will be used to transport the blades, which are the long abnormal load items. The more numerous shorter loads (such as the tower elements) will use Route A along the proposed TDR, which maximises the use of regional roads.
The Turbine Delivery Assessment Report is available in Appendix 2-2 of the EIAR.
The delivery of turbine components to the proposed development will require temporary works on sections of the public road network along the delivery route including hedge or tree cutting, relocation of powerlines/poles, lamp posts, signage and temporary local road widening. Such works will be temporary for the delivery of turbine components. There are three locations where works will be required within private lands and these are included in the planning application boundary.

EMP 7: Construction Traffic Management

Purpose: To describe measures for the management of all traffic, including construction traffic and oversized loads, for the minimisation of disturbance and nuisance to the local community.
Scope: All Site Construction Areas, approach roads to the site and internal access track traffic.
Procedure: All traffic management and road signage will be in accordance with the Department of Transport (DoT) Traffic Signs Manual Chapter 8: Temporary Traffic Measures and Signs for Road Works. in agreement with Laois County Council and Offaly County Council.
In consultation with Offaly County Council's Roads Department, vehicle passing bays will be provided along the L5010, prior to the commencement of the proposed site construction, to facilitate two-way vehicle traffic movements
This is not acceptable & involves trespass. The passing bays should be identified & landowner consents included with this application.

A Traffic Management Plan (TMP) outlining the required traffic management procedures to be implemented on the public roads during the construction of the proposed development is included as Appendix 3 in EIAR Volume 3. The Traffic Management Plan will be updated, as appropriate, following the proposed project detailed design/tendering stage, and submitted for the approval of Offaly County Council, prior to construction.

The Proposed Grid Connection will require a Road Opening License (ROL) prior to the commencement of any grid connection works on the public road. The road surface of the public roads will be reinstated to the standards set out by the Department of Transport (DoT) Guidelines on the Opening, Backfilling and Reinstatement of Trenches on Public Roads (April 2017).
All road permanent reinstatement works will be in accordance with the requirements of Offaly County Council.
No construction delivery vehicles would access the site via the northern section of the L5006 and its Trimblestown Bridge on the Grand Canal.

A construction wheel wash facility will be provided at the construction compound to wash truck tyres leaving the construction site.

Appendix 02-2 Turbine Delivery Route Assessment Report.pdf

2. Turbine Delivery Route Assessment

2.1 Delivery Route Overview

The Proposed Wind Energy Development is located in a rural area of east county Offaly. The site is approximately 4km west of the Edenderry town boundary and 24km east of Tullamore. The wind energy development consists of 7 No. WTGs with a maximum blade tip height of 185m. MWP have been requested to provide a study on the viability of delivering components for this class of turbine to the proposed development. WTG blade and Tower Section deliveries are the most onerous factor for component deliveries in terms of swept paths and cleared area requirements. A blade delivery vehicle incorporating a blade length of 80m and a tower delivery vehicle with a 45.5m long and 4.6m ø tower section have been considered as the design vehicles to assess the proposed component delivery route for Ballinla Wind Farm. The components for each WTG are expected to be delivered in approximately 10 No. deliveries (approximately 70 No. deliveries in total). Due to their abnormal size, the blades, nacelle, drive train and cylindrical steel tower sections will be delivered at night to avoid disruption to daytime traffic. The components are expected to be delivered by sea to a port and transported to site along the national, regional and local road network. The oversize and overweight components will require pilot vehicles and Garda escort from port to site.

2.2 Proposed Delivery Route

All WTG components for the Proposed Development will arrive at one of Irelands deepwater ports, such as Bellview in Co. Waterford. From here, the components will travel via the national road and motorway network to Junction 5 (Kilbeggan/Tullamore) on the M6. Components will travel south on the N52 towards Tullamore. Due to vertical and horizontal alignment constraints the WTG blades and tower sections will take different routes from the N52/L2025 roundabout near Tullamore to Ballinagar village. A description of the section, both proposed routes, is provided below, and an overview of the proposed section is shown in

Turbine Blades

- Exit M6 at Junction 5
- M6/N52 roundabout, exit traveling south
- N52/R443 roundabout, exit travelling southeast on N52
- N52/L2025 roundabout, exit travelling east on L2025
- Continue east along L2025 through Cappincur, Clonmore and Toberleheen
- L2025/R402 junction at Ballinagar, exit travelling northeast on R402
- Continue northeast along R402 through Knockballyboy and Derrygowley
- R402 junction at Daingean, continue east on R402
- Continue east along R402 through Ballyhugh/Springfield, Killeenmore and Bogtown.
- Three-point turning manoeuvre to be completed at the R402/L5006 junction at Ballyfore. Exit travelling north on local road
- Three-point turning manoeuvre to be completed at the L5006/L5010 junction. Exit to the west on L5010 towards Leitrim townland

• Site entrances located approximately 2km and 2.7km along the L5010 to the south and north shoulders of the road respectively.

Turbine Tower Sections

• Exit M6 at Junction 5
• M6/N52 roundabout, exit traveling south
• N52/R443 roundabout, exit travelling southeast on N52
• N52/L2025 roundabout, exit travelling south on N52
• N52/R420 roundabout, exit travelling southeast on R420
• Continue southeast along R420 through Meelaghans
• R420/R402 junction at Ballina, exit travelling northeast on R420
• Continue northeast along R402 through Ballymooney
• L2025/R402 junction at Ballinagar, exit travelling northeast on R402
• Continue northeast along R402 through Knockballyboy and Derrygowley
• R402 junction at Daingean, continue east on R402
• Continue east along R402 through Ballyhugh/Springfield, Killeenmore and Bogtown
• Three-point turning manoeuvre to be completed at the R402/L5006 junction at Ballyfore. Exit travelling north on local road
• Three-point turning manoeuvre to be completed at the L5006/L5010 junction. Exit to the west on L5010 towards Leitrim townland
• Site entrances located approximately 2km and 2.7km along the L5010 to the south and north shoulders of the road respectively.

2.3 Swept Path Analysis

A vehicle swept path analysis (SPA) of an 80m blade on a vehicle with an overall length of 93m (truck and blade) was completed using Autodesk ® Vehicle Tracking software.
Analysing aerial photography, topographical survey, GIS and information from site visits for the proposed route highlighted pinch points that required a vehicle tracking model.

The Autodesk model was developed for the 80m blade with a 11.7m overhang on a Scania R500 truck and bogie trailer (dolly blade clamp), see Figure 2-2, in assessing the route from M6 Junction 5 (Kilbeggan/Tullamore) to the site entrances. An additional Autodesk model was developed for a tower section, see Figure 2-3 to assess the delivery route. In both cases, the type of trailer modelled are available from heavy haulage / turbine transport companies.

An automatic steering principle within the software was used where possible but otherwise a manual override system is used with a conservative maximum steering angle of 30° to help alter the path of the bogie past constraints at pinch points. The Swept Path Analysis output is illustrated in the drawings included in Appendix 1. This shows the extents of the wheel swept path, vehicle body swept path and blade swept path as the delivery truck manoeuvres around each pinch point. This information highlights areas that require widening or clearance along the route. See Table 3-1 for an overview of works required to public roads along the turbine delivery route. The images within the table are extracts from the Autodesk model, the coloured lines represent different elements of the delivery vehicle.
• Cyan – Vehicle outline
• Red – Wheelbase footprint (truck & trailer)
• Green – Load footprint (tower/blade)

Ref #	Location Drawing Number	Swept Path Drawing Number	Description of Location	Description of Enabling Works	Street view photo of site location
7	23882-MWP-HR-00-DR-C-1100	23882-MWP-HR-00-DR-C-0007	East of Tullamore on L2025 between Clonmore and Toberleheen	• Trees and hedgerows to be trimmed • Telegraph stay wire to be relocated • Blade oversails hedgeline on southern side of the road.	
8	23882-MWP-HR-00-DR-C-1100	23882-MWP-HR-00-DR-C-0008	East of Tullamore on L2025 within Toberleheen		
9	23882-MWP-HR-00-DR-C-1100	23882-MWP-HR-00-DR-C-0009	East of Toberleheen on L2025 approaching Ballinagar village	• Trees to be trimmed • Traffic signs to be removed • Blade vehicle to overrun onto footpath (wedges or similar required to transition to footpath)	
17	23882-MWP-HR-00-DR-C-1101	23882-MWP-HR-00-DR-C-0017	Existing Ballyfore north along local road towards Ballinla	• Trees and vegetation require trimming	
18	23882-MWP-HR-00-DR-C-1101	23882-MWP-HR-00-DR-C-0018	Existing Ballyfore and entering Ballinla, before Ballinla local road junction	• Trees and vegetation to be trimmed back • Pole to be relocated	

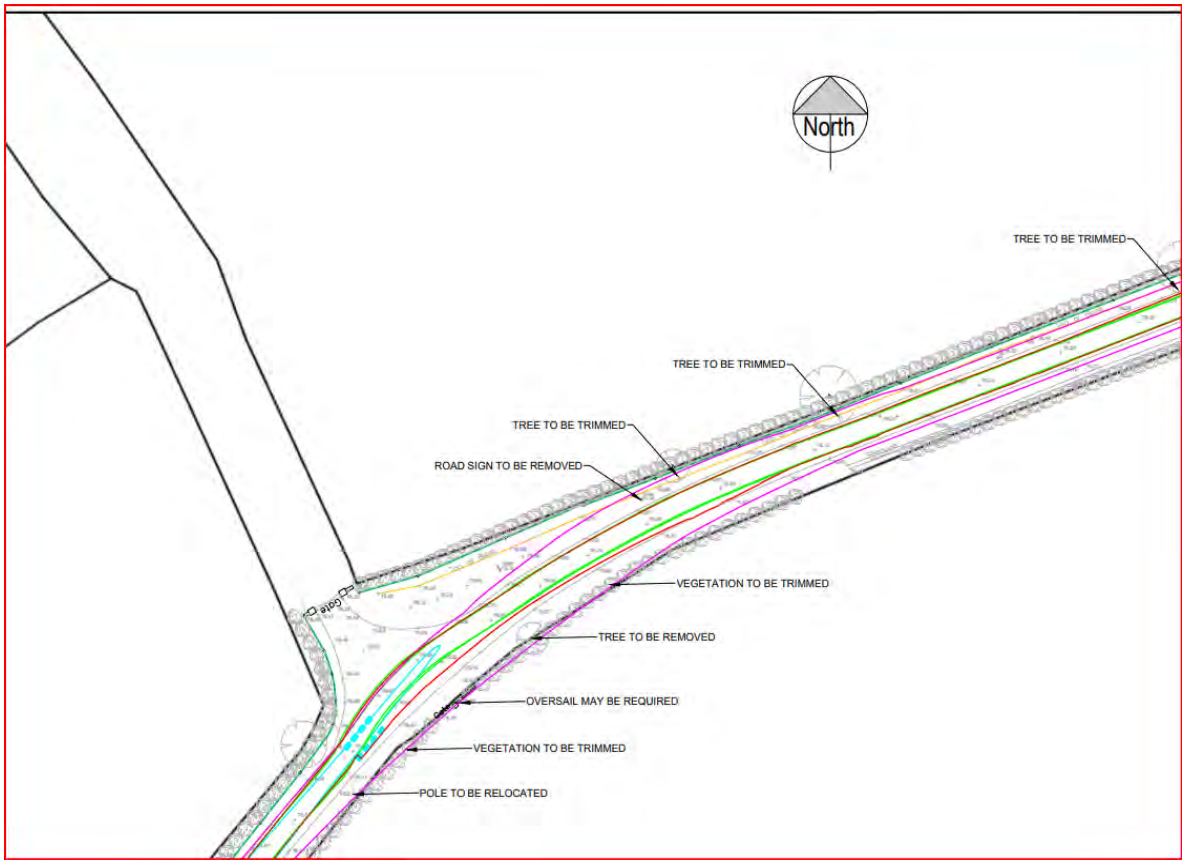
20	23882-MWP-HR-00-DR-C-1101	23882-MWP-HR-00-DR-C-0020	Entering Lumville west along local road L5010 towards Leitrim	• Tree and vegetation to be trimmed	
21	23882-MWP-HR-00-DR-C-1101	23882-MWP-HR-00-DR-C-0021	Centre of Lumville west along local road L5010 before local junction	• Tree and vegetation to be trimmed • Sections of the road verge to be widened and surfaced	
22	23882-MWP-HR-00-DR-C-1101	23882-MWP-HR-00-DR-C-0022	Centre of Lumville west along local road after local junction	• Trees and vegetation to be trimmed • Potential for blade to oversail gate and gate posts. • Pole to be relocated	
				• Sections of the road requires widening and surfacing	
23	23882-MWP-HR-00-DR-C-1101	23882-MWP-HR-00-DR-C-0023	Exiting Lumville west along local road L5010 towards Leitrim	• Trees and hedges require trimming • Sections of the road verge requires widening and surfacing	
24	23882-MWP-HR-00-DR-C-1101	23882-MWP-HR-00-DR-C-0024	Entering Leitrim west along local road L5010, site entrance to the south	• Trees and Vegetation to be trimmed • Pole to be relocated • Section of the road requires widening and surfacing	
25	23882-MWP-HR-00-DR-C-1101	23882-MWP-HR-00-DR-C-0025	Centre Leitrim northwest along local road L5010 towards site entrance	• Trees and Vegetation to be trimmed • 4 No. poles to be removed • Sections of the road requires widening and surfacing • Diversion/piping of existing roadside drainage required at widened areas.	
26	23882-MWP-HR-00-DR-C-1101	23882-MWP-HR-00-DR-C-0026	Centre Leitrim northwest along local road L5010, site entrance to the north	• Trees and vegetation to be pruned • Low parapet wall to be removed • Hedgerow to be removed • Pole to be removed	

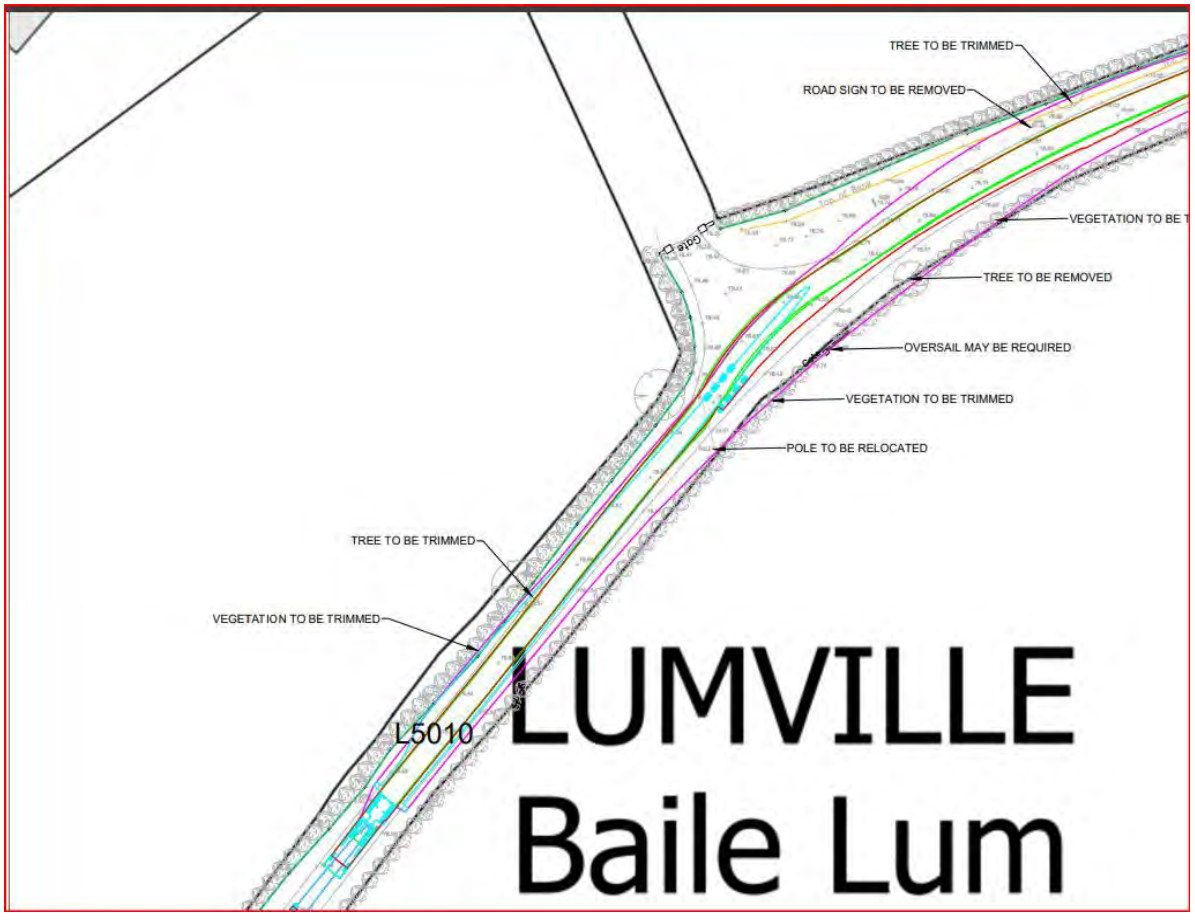
No permission exists for trees & vegetation to be trimmed, no permission for road widening, no permission for oversailing, no permission to lay cables. Note width of Regional Road in photographs & absence of 0.5m hard shoulder. Thus Type 2 or Type 3 AADT capacities do not apply.

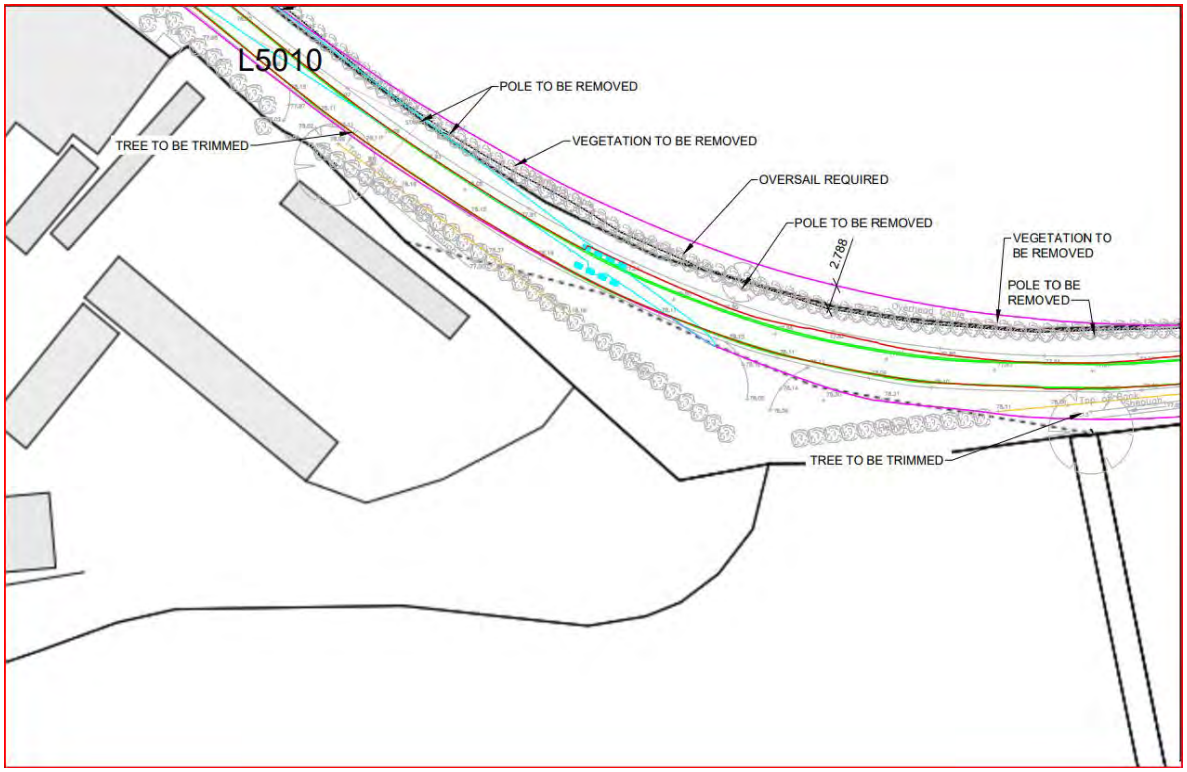
3. Recommendations and Conclusions

The swept path analysis of the proposed WTG component delivery route has identified areas where component overrun requires works to be completed prior to deliveries occurring. These works have been detailed in the

drawings appended to this report. Prior to commencement of any works and delivery of turbine components to site, a permit for moving abnormal loads to the wind farm site will be sought from An Garda Síochána and the local councils along the selected haulage route. A detailed transportation plan with a breakdown of the timing of deliveries will be established at construction stage.






L5010
POLE TO BE REMOVED
TREE TO BE TRIMMED
VEGETATION TO BE REMOVED
OVERSAIL REQUIRED
POLE TO BE REMOVED
2.788
VEGETATION TO BE REMOVED
POLE TO BE REMOVED
TREE TO BE TRIMMED

3.2 Local Access Routes

The components for the seven turbines will be delivered by cargo ships from a preferred port. The components for each turbine will be delivered in separate loads, some of which are abnormal in terms of their width and length. The components will be transported a preferred port to the site along the National, Regional and Local road network. The delivery of turbine components to the Proposed Development will require temporary works on sections of the public road network along the delivery route including hedge or tree cutting, relocation of powerlines/poles, lampposts, signage and temporary local road widening. **Such works are temporary for the delivery of turbine components and are not included in the planning application boundary, however there are three nodes along the TDR where works will be required within private lands, and these are included in the planning application boundary.** Private trees & hedges that require cutting require consent.

3.3 Site Entrances

The design criteria governing the north and south site entrances are set out in Transport Infrastructure Ireland (TII) 'DN-GEO-03060: Geometric Design of Junctions (priority junctions, direct accesses, roundabouts, grade separated and compact grade separated junctions)' and 'DN-GEO-03031: Rural Road Link Design'. The location where the required sightlines are measured from along the centre of the minor approach road is setback a distance of 3.0m from the near edge of the major road. This distance is referred to as the 'x-distance'. The required visibility distance along the major road is referred to as the 'y-distance' and is measured to the near edge of the major road in both directions. The 'y-distance' requirement is 90m for both site entrances. Since 7th February 2025, the statutory speed limit on the local roads has been reduced from 80km/h to 60km/h. This applies to both proposed site entrances from the L5010 and requires a stopping sight distance of the order of 90m on the L5010. The sightline distance will be achieved by maintaining a visibility envelope free obstructions such as vegetation. The proposed visibility envelopes for the site entrances are shown in planning drawing 23882- MWP-00-00-DR-C-5004. These improvements will remain in place permanently and will benefit users of the wind farm when exiting the site onto the public road. A photograph of a typical wind farm entrance with sightlines improved is given in Figure 3-2. It is noted that the previous requirement to provide 160m clear sightlines is also possible from both site entrances.

3.5.1 Wind Turbine Locations

The nature of the site is relatively flat topographically. Turbine locations have been selected to allow for a balance of cut and fill of the underlying strata at each location. The turbine locations were chosen considering adjacent stakeholders, land available, ecological constraints, hydrological, spacing and other constraints.

Table 3-1: Spoil Excavation and Construction Material Volumes

Excavations		
Total Excavation Volume	**m^3**	**84,714**
Excavated Material Stored or Reused Onsite	m^3	84,714
Excavated Material Removed from Site	m^3	0*
Imported Material		
Total Volume of Stone Required	**m^3**	**87,795**
Imported Stone	m^3	87,795
Site Won Stone	m^3	0
Concrete for bases (7 @ 1212 m^3 each)	m^3	8,482
Concrete for substation and LiDAR unit foundations	m^3	76
Concrete for cable route	m^3	4,716
Reinforced steel for turbine bases (7 @ 182 tonnes each)	tonnes	1,272

*This material will be reused on site as preference in trackside berms etc. It is, however, included in the table above as material to be removed from site as a precautionary measure.

3.11.4.7 Surface Water Quality and Cementitious Material

It is important to prevent raw cement from entering waterways within and near the Proposed Development. Cement is required as a constituent for concrete. Concrete will be used for construction of the turbine bases, the substation buildings and any culvert crossings.

The primary method of reducing the potential impact from cementitious material on the hydrology of the Proposed Development is the selection of ready-mixed concrete as opposed to site batching of concrete. Site batching requires the delivery and storage on site of significant quantities of raw cement. The chemical reactivity of cement is at its most vigorous in the early stages of its activation by water (hydrolysis, typically in the first 15 minutes). In the batching plant water is added to the cement at the correct water/cement ratio to fully activate the cement hydration process.

By removing cement in its raw state from the site the potential for a significant effect from hydrolysis of cement in the surrounding watercourses is eliminated. When ready-mixed concrete is used, the hydrolysis stage of the cement process has already been completed during the batching process and the chemical reaction undergoes a dormancy period during which it enters a plastic state. During this period the concrete is delivered and placed. After approximately 3 hours the cement in the concrete enters a third stage of the chemical process where it hardens, primarily due to the hydration of tricalcium silicate. This process increases in activity for approximately 12 hours and then decreases over the following 20 hours. After approximately 36 hours the concrete is considered to have set.

As part of the curing process the top exposed surface of poured concrete is covered in a curing blanket which eliminates the effect of rain washing down uncured cement from the top surface. Concrete placement for a truck load is typically complete within 3 hours of batching. It is normal for the truck operator to wash out the drum and chutes of the truck on site. This typically requires approximately 250l of water to complete. This concrete washout contains cement that has not fully completed the hydration process and as a result can have an elevated pH level (higher alkalinity).

Concrete truck washouts for the Proposed Development will be limited to washing down chutes only, reducing water volume to approximately 25l. The chute wash down area, which will retain the washout water, will be located within the construction compound and there will be no other chute wash down activity on any other part of the Proposed Development

Washout of concrete truck drums will be carried out at the source quarry. There will be no onsite batching of concrete. Concrete requirements will be met by ready-mix suppliers.

4.2 Site Selection Process

Prior to selection of the site to cater for such development, a detailed screening exercise was undertaken by the Applicant using a number of criteria and stages to assess the potential of a large number of possible sites, on lands under consideration, suitable to accommodate a wind energy development. These included:

- Wind resource.
- Proximity to grid.
- Compliance with planning designation.
- Avoidance of environmental designations.
- Separation distance from dwellings.
- Site accessibility.
- Level of visual impact.

Interrelated to this, the Proposed Wind Farm must, in non-environmental terms, be commercially viable to ensure it will attract the necessary project finance to progress to the construction phase and ultimately deliver renewable electricity to the National Grid which is an objective of National energy policy.

A technical review of potential candidate sites for wind energy development over a wide area in the region was conducted using a desk-based geographical information system (GIS) screening exercise. The first step in the selection process was to examine high level constraints to eliminate areas which were deemed unsuitable for wind turbines. This identified all registered environmental designations, protected views, cultural and heritage sites, and other areas of special sensitivity.

Alternative locations were eliminated in the early stages of the site selection process as the goal for this project was to deliver a large-scale wind farm. The Proposed Development site was the site identified as most suitable to take forward as a potential wind farm location. The following is a summary of the methodology used in the screening process.

The application states compliance with 2006 Wind Energy Guidelines but ignores the separation distances required of 7xrotor diameter in order to get over the 50Mw SID threshold.

4.2.1 Phase 1 Initial Screening

The screening process involved the application of a defined set of spatial and policy-based criteria to the wider study area. These criteria were informed by national and regional planning guidance, including the relevant County Development Plan(s) and associated Renewable Energy Strategies. The objective was to identify lands where wind energy development would be considered acceptable in principle, subject to further environmental and technical assessment. Key considerations during Phase 1 included:

- **Policy Designations:**

Lands were assessed against the zoning and policy designations set out in the County Development Plan. Areas not identified as being at least “open for consideration” for wind energy development were excluded from further analysis.

- **Environmental Constraints:**

Areas subject to statutory environmental designations, such as Natura 2000 sites (Special Areas of Conservation (SAC), Special Protection Areas (SPAs) and Natural Heritage Areas (NHAs)), were excluded to avoid potential significant effects on sensitive ecological receptors.

- **Landscape and Visual Sensitivity:**

While not fully assessed at this stage, areas identified in planning policy as having high landscape sensitivity were noted for further consideration in later phases. The outcome of the Phase 1 screening was the exclusion of large portions of the county where wind energy development would be inconsistent with planning policy or where significant environmental constraints were present. The remaining areas were then carried forward for more detailed Phase 2 assessments, which included technical feasibility, grid connection potential, and environmental sensitivities.

4.2.2 Phase 2 Grid Constraints

Following the initial policy and environmental screening, the remaining candidate areas were assessed in Phase 2 for technical feasibility, with a particular focus on grid connection potential. This stage involved a review of the

existing electricity transmission and distribution infrastructure, including proximity to substations, available capacity on the local network, and the feasibility of connecting to the grid without requiring extensive or cost prohibitive upgrades. Areas located at significant distances from the existing grid or where network capacity was known to be constrained were deprioritized. This screening ensured that only sites with a realistic prospect of timely and cost-effective grid connection were carried forward for more detailed environmental and technical assessment. The consideration of grid constraints at this stage was essential to ensure the viability and deliverability of the Proposed Development.
This assessment of alternatives has not been provided. Cost is not an allowable issue.

4.2.3 Phase 3 Screening

Phase 3 of the screening process involved a detailed evaluation of the short-listed areas identified in earlier phases, with a focus on site-specific environmental sensitivities and technical feasibility. These included the following considerations:

- Amenity, tourist or scenic areas.
- Insufficient development area.
- Lands utilised for other wind farm developments.
- Natura 2000 Sites.
- Natura ecological designations.
- Sensitive habitat/species of bird.
- Land ownership considerations.
- Residential density considerations.
- Potential project scale.
- Sites with impractical/irregular shape/layout/topography.

The application of the above criteria resulted in the discounting of further land areas, leaving reduced areas for further assessment. The site selection process was, by necessity, strategic and desk-based in nature in order to narrow down the areas suitable for a wind farm. This is considered to be a rational and appropriate approach, and its implementation was clearly founded on knowledge and observation. Based on the screening process, the Proposed Development site was the preferred site of scale to take through to the next stage of validation.

4.2.4 Site Validation

The Proposed Development site was further examined under the following headings to confirm its suitability for wind energy development. The main policy, planning and environmental issues considered for the validation of this wind farm site included:

- Alignment with the local development plans and renewable energy strategy.
- Obtainable and economic connection to the National Grid.
- Site specific environmental constraints.
- Consistently high average annual wind speeds.
- Proximity to local communities.
- Site topography.
- Access issues for turbine delivery and construction activities.

The above exercises, based on a number of key environmental, technical and policy-related criteria, determined that the Proposed Development site represented a suitable location for the Proposed Development in County Offaly. The Proposed Development site has satisfied a number of key criteria required for successful wind energy development and these are presented in Table 4-1.

Table 4-1: Summary of Site Suitability Criteria

Suitability Criteria	Proposed Development Site
Wind Resource	The predicted wind speeds at the site vary between 7.9m/sec and 8.1m/sec as shown in Sustainable Energy Ireland's Wind Atlas
Proximity to Grid	Underground cable (UGC) Proposed Grid Connection from the proposed onsite 110kV substation via a route on public road for 8km to the existing Philipstown 110kV substation.
Compliance with Planning Designation	The Offaly County Wind Energy Strategy (WES), part of the Offaly County Development Plan (CDP) 2021-2027, has identified the site as being located in 'Areas Open for Consideration for Wind Energy Development'. All wind turbines are sited within the 'Areas Open for Consideration for Wind Energy Development'. The wind energy development policy from the Offaly County Wind Energy Strategy (WES) states that these areas are open for consideration for wind energy development as these areas are characterised by low housing densities, do not conflict with European or National designated sites and have the ability by virtue of their landscape characteristics to absorb wind farm developments.
Avoidance of Environmental Designations	There are no Natura 2000 sites within the Proposed Wind Farm footprint. The nearest identified site is the Long Derries, Edenderry SAC which is located 7.6km to the west of the study area.
Separation distance from dwellings	Four times the tip height (185m) setback distance of 740m as per the Draft Wind Energy Development Guidelines (2019).
Site Accessibility	Primary access to the Proposed Development site can be achieved the local public road linkage (L5010) between the L-5006 in the east and the R400 to the west.
Level of Visual Impact	Assessment of the capacity to absorb the proposed wind farm development.

Note that the applicant is aware of the predicted wind speeds between 7.9m/s and 8.1m/s & has to relate these to output.

4.3 Design Process

The Proposed Development has been designed to minimise potential environmental effects and to maximise wind potential on site. The design was developed following a step-by-step process in line with the EIA Directive which informed and identified the buildable areas suited to turbines, access tracks and infrastructure, based on avoidance of unsuitable areas and following good practice of mitigation by design.

4.3.1 Identification of Environmental Sensitivities

There are a number of drivers that will ultimately influence how a design layout for a project evolves. For wind farm development, this is usually concerned with location and placement of development components within a limited footprint at the site, which is largely defined by aspects such as noise, set-back from residential dwellings, habitat, access, grid connectivity and ground conditions, including slope, soil and drainage regime.

The EIA process involved the completion of all baseline studies to generate environmental constraints that informed the design for the optimum wind farm layout. These studies were undertaken by the environmental, planning and engineering professionals that made up the wind farm design team. Site visits between 2023 and 2025 have informed the Proposed Development EIAR and planning application. The design process is an iterative process, resulting in the assessment of numerous design iterations (or revised designs) to ensure the identified environmental and engineering constraints are applied to successive layout designs. The design iterations, as reasonable alternatives, and the evolution of the final design, or final alternative are discussed.

Following consultation and baseline assessment of the site, the following key environmental factors were identified:

- Topography.
- Sensitive Habitats.
- Bat Ecology.
- Public Roads and Population Density.
- Ornithology.

• Soils and Geology.
• Hydrology.
• Archaeology.
• LVIA.

Based on the environmental sensitivities identified on site and the potential for significant environmental effects, it is considered that, through appropriate site design and the implementation of targeted mitigation measures, any such effects associated with the proposed development can be either eliminated or effectively mitigated. The design process has been guided by the principles of avoidance and minimization, including the application of buffer zones and setback distances that reflect best practice and site-specific constraints. These measures have been developed in accordance with the design requirements set out in the Wind Energy Development Guidelines, ensuring that the proposed layout aligns with national policy standards. Table 4-2 summarises the physical and environmental constraints which have informed the wind farm design.

Table 4-2: Physical and Environmental Sensitivities Considered

Sensitivity	Design Constraint
Topography	Topography is generally flat, consequently, no topographic constraints identified.
Sensitive Habitats	Infrastructure to avoided ecologically valuable or sensitive habitats to minimise ecological disturbance.
Bat Ecology	Based on the SNH buffer formula and proposed turbine dimensions, the following habitat management and/or felling distances were calculated for each of the turbines: T1 = 77 m, T2 = 89 m, T3 = 77 m, T4 = 83 m, T5 = 91 m. A modified buffer around turbines T6 and T7 will be required to ensure the stream and bordering tree lines, found in the southwest of the site, are retained.
Public Roads	Apply a minimum distance of height of the turbine to the tip of the blade plus 10%. from proposed turbine locations to public roads as recommended in the Draft Wind Energy Development Guidelines (2019).
Ornithology	Turbine locations to be selected to avoid key flight paths, foraging areas, and proximity to sensitive bird habitats.
Soils and Geology	Areas with high peat slide risk or poor constructability to be avoided.
Hydrology	Turbines to be sited at least 50m from EPA registered watercourses.
Archaeology	A minimum 20m buffer was maintained around recorded archaeological features, based on professional judgement and site-specific assessments.
LVIA	Turbines to be sited in a way that minimises their visual intrusion and respects the character of the surrounding landscape through the appropriate identification of Zones of Theoretical Visibility (ZTV) within 20km of the Proposed Development.
Noise Sensitive Receptors	Adopt relevant separation distances between turbines and identified noise sensitive receptors.

4.3.1.1 Topography

There are no steep slopes within the footprint of the Proposed Development. The site is described as being flat land. The topography of the area is flat with **elevations ranging between 69.5m to 78.6m above Ordnance Datum (AOD).**

4.3.1.2 Sensitive Habitats

The project has been designed to minimise the footprint of the Proposed Development within sensitive habitats. This has been achieved in collaboration with engineering constraints, for example by taking account of habitat value from ecological site visits and survey work and areas potentially impacted. The project design has followed the basic

principles outlined below to reduce and where possible eliminate the potential for significant effects on ecological receptors:

• Avoidance/minimisation of turbine array and wind farm infrastructure at sensitive habitats (e.g. hardstanding areas designed to the minimum size necessary to minimise habitat loss).

• Avoidance of wildlife refuge sites (e.g. waterbodies) insofar as possible.

• The Proposed Grid Connection route and internal access tracks were selected to utilise existing built infrastructure for the majority of their lengths where possible (i.e. cables to be laid within public road and existing tracks).

4.3.1.3 Bat Ecology

For low risk sites, such as the Proposed Development, a Bats and Onshore Wind Turbines: Survey Assessment and Mitigation (2021) document prepared jointly by Scottish Natural Heritage, Natural England, Natural Resources Wales, Renewable UK, Scottish Power Renewables, Ecotricity Ltd, the University of Exeter and the Bat Conservation Trust (BCT) with input from other key stakeholders, recommends a buffer distance of 50m between a turbine blade tip and the nearest woodland. This buffer creates a clearance setback of 50m between the arc of the blade's sweep and the forest edge which could be used by bats without risk of collision with the turbine blades. Based on the SNH buffer formula and proposed turbine dimensions, the following habitat management and/or felling distances were calculated for each of the turbines: T1 = 77 m, T2 = 89 m, T3 = 77 m, T4 = 83 m, T5 = 91 m. A modified buffer around turbines T6 and T7 was assessed as the best option to ensure ecological pathways at the Leitrim stream, found in the southwest of the site, are retained. Further details in relation to the calculation and buffers is provided in Chapter 6 Biodiversity and the Bat Survey Report (Appendix 6-2, Volume III).

4.3.1.4 Public Roads and Population Density

The Wind Energy Development Guidelines (2006) outlines the below in relation to turbine proximity to public roads and railways: 'Although wind turbines erected in accordance with standard engineering practice are stable structures, best practice indicates that it is advisable to achieve a safety set back from National and Regional roads and railways of a distance equal to the height of the turbine and blade.' As outlined in the Draft Wind Energy Development Guidelines (2019): 'it is advisable to achieve a safety set back from National and Regional roads and railways of a distance equal to the height of the turbine to the tip of the blade plus 10%.' The Proposed Development achieves the above setback, as outlined in draft guidelines

As per the Turbine Delivery Route Assessment (Appendix 2C), the delivery route to the Proposed Development is feasible for all turbine components related to the Proposed Development. A review of the 2022 Census of Population shows that the recorded population density surrounding the Proposed Development varies, with the populations increasing when closer to the towns of Edenderry and Rhode. Further details in relation to population density are included in Chapter 5 Population and Human Health.

"All turbine components" include the nacelle with a weight of c400tonnes. No structural assessment was provided for roads, bridges, culverts or underground services to carry such a weight.

4.3.1.5 Ornithology

As advised by a qualified Ornithologist and in line with best practice, should any protected species, be recorded breeding within the given distances of the works area, specific buffer zones depending on the species will be established around the expected location of the nest. All works will be restricted within the zone until it can be demonstrated by an ornithologist that the species has completed the breeding cycle in the identified area. See Chapter 7 Ornithology for additional information.

4.3.1.6 Soils and Geology

According to Geological Survey of Ireland (GSI) mapping, **the Proposed Wind Farm is primarily underlain cutover peat with localised areas of limestone derived till**. According to GSI mapping, the bedrock beneath the Proposed Wind Farm is limestone of the Edenderry Oolite Member. Given the site's generally flat topography and lack of significant slope gradients, the risk of peat instability or landslide is considered to be low, however areas of deep peat will be avoided where feasible.

4.3.1.7 Archaeology

There are no known archaeological sites or monuments within the boundary of the Proposed Wind Farm. Several Recorded Monuments and Places (RMP) are located in the vicinity, recorded heritage assets in the immediate site vicinity are comprised of enclosures, ring forts and crop circles with several recorded sites and monuments in the wider surrounds. A minimum 20m buffer will be applied to all recorded heritage assets and any potential features identified onsite.

4.3.1.8 Public Consultation

Feedback received through public consultation with local residents, as well as engagement with statutory bodies including ABP and OCC, has played a significant role in shaping the design of the Proposed Wind Farm. Concerns raised by the local community, ABP and OCC were carefully considered and addressed through iterative design revisions, including the repositioning of turbines and setback distances.
A summary of the organisations/groups consulted and the consultation that happened is provided in Chapter 1 Introduction. The issues raised were subsequently considered in the EIA process.

4.3.2 Constraint Mapping and Buildable

Area Once the key sensitive environmental concerns were identified, separation distances to constraints were applied using GIS. Constraint mapping was generated, which identified the most and least environmentally sensitive, or constrained, areas within the site. This approach highlights potentially significant environmental impacts early on in the design process in order that they can be avoided, and if that is not possible, impacts reduced or mitigated. It also limits the area for development within the study site thereby limiting the number of turbines and associated infrastructure.
The constraint mapping documented and visually communicated the environmental concerns (e.g. sensitive habitat, water features) to the wind farm design team, thereby highlighting the optimum locations (areas with few or no constraints) for wind farm infrastructure. Constraint mapping was also cognisant of relevant consultation concerns. Figures 4-3 and 4-4 outline the watercourse and habitat constraints.

4.3.3 Preliminary Planning Stage Design

Following identification of all the environmental, technical and engineering constraints for the site, a preliminary layout that fit within the remaining unconstrained areas was developed. The layout included the preliminary internal access track network and provisional locations for the electrical substation compound, permanent meteorological mast, borrow pit and deposition areas. The technical design criterion for the layout was to maximise the annual energy yield, while maintaining the required separation distances between turbines. The preliminary design layout was then used as a basis for a more detailed site assessment on which the final detailed design would be developed (refer also to Chapter 3 Civil Engineering).

4.3.3.1 Position of Turbines

A range of alternative wind farm layouts and configurations were considered through an iterative design process to identify the most suitable layout for the site. This process involved a comparative assessment of the potential environmental effects associated with each design option, enabling the selection of a layout that balances technical feasibility with environmental sensitivity. The consideration of reasonable alternatives is a core requirement of the EIA process, and in this case, alternative turbine arrangements and development scales were fully explored. The final layout was informed by detailed analysis of habitat mapping, hydrological features, biodiversity constraints, peat depth data, and proximity to residential receptors, ensuring that the selected design represents the optimum solution with the least potential for environmental impact.
This information was refused by Statkraft representatives.

4.3.4 Detailed Planning Stage Design

The detailed design of the proposed wind farm was guided by a principle of mitigation through avoidance, alongside a strong emphasis on maximising the use of existing infrastructure. Where possible, turbines, access tracks, and the substation were positioned to minimise environmental impact and reduce the need for new ground disturbance. However, relocating individual components was often complex, as adjustments to one element—such as a turbine or access road—necessitated corresponding changes to others **in order to maintain required separation distances**, comply with technical constraints, and respect environmental buffers and setbacks. Over the course of the design process, the initial layout underwent five iterations, each informed by engineering, environmental, technical, and landowner considerations. While the geographic extent of these changes was

relatively limited due to site constraints, they required significant coordination and input from the multidisciplinary design team to ensure that the final layout achieved a balance between technical feasibility and environmental sensitivity.

The layout submitted does not comply with 2006 Wind Guideline separation distances as from their own grid coordinates.

4.4 Alternatives Considered

This section outlines the main reasonable alternatives examined and considered during the project design process and indicates the main environmental reasons for choosing the development as proposed. A comparison of the environmental effects on the alternative considered is also provided. The alternatives considered include the following:

- Reasonable Alternative Wind Farm Layout and Turbine Scale.
- Reasonable Alternative Proposed Grid Connection Methodologies.
- Reasonable Alternative Construction Methodologies.

4.4.1 Alternative Wind Farm Layout and Turbine Scale

In total there were five layout iterations considered, to determining the optimum layout with minimal environmental impact. The final design layout was primarily influenced by physical and environmental sensitivities. The iterations are listed in Table 4-3 which outlines the design improvement as the layout, size and scale evolved. As outlined in the European Commission's 2017 Guidance, alternatives provide an opportunity to change the design in order to minimise the project's significant effects on the environment. Preventative action is the most effective way to avoid potential negative environmental effects, and this avoidance has been achieved through the design process and the consideration of alternatives and through the review of the project design to minimise environmental effects.

Table 4-3: Design Evolution and Iterations

Iteration	Description of Iteration	Reason for change	Design Improvement
1	Ten turbine layout, with three turbines adjacent to the Grand Canal. The three turbines ranged from 120-300m distance to the canal. Two locations identified for the substation.	N/A	N/A
2	Ten turbine layout. Movement of one turbine from the southern section to the northern section adjacent to the canal. Substation moves to final location now proposed.	Landowner considerations	Design maximises available land.
3	Movement of one turbine from 120m to 200m from the canal.	Potential visual impact from the high amenity area of the Grand Canal.	Reduced landscape and visual impacts on the Grand Canal high amenity area.
4	Eight turbine layout. Removal of two turbines from northern cluster and introduced 500m buffer to the Grand Canal.	Potential visual impact from the high amenity area of the Grand Canal.	Reduced landscape and visual impacts on the Grand Canal high amenity area and residential receptors.
5	Seven turbine layout. Removal of a turbine from the northern cluster.	Potential visual impact from the high amenity area of the Grand Canal. Landowner considerations	Reduced landscape and visual impacts on the Grand Canal high amenity area and residential receptors.

The final layout represents the most appropriate design for the site conditions, following an iterative approach of design optimisation by the engineering and environmental members of the project team. This approach took account of all emerging baseline environmental information during the EIA process, and therefore, the optimum

wind farm layout for the development is proposed. Table 4-4 outlines a comparison of site conditions and environmental effects in relation to the design improvements from initial to final design.
The separation distances at 7 times the diameter require 1,134m & not 500 – 600m distances

Table 4-4: Comparison of Environmental Effects

Environmental Factor	Initial Design	Final Design
Population and Human Health	10 turbine layout	7 turbine layout, reduced impact all-round.
Biodiversity	Larger area across site	Reduced development footprint

Environmental Factor	Initial Design	Final Design
Air and Climate	Large scale project	Project scale reduced, short term construction negative impacts reduced, long term climate positive impacts reduced.
Landscape and Visual	10 turbine layout	7 turbines layout. Reduced landscape and visual effect
Water	10 turbine layout	7 turbine layout, reduced impact all-round.
Land and Soil	10 turbine layout	7 turbine layout, reduced impact all-round.
Noise	10 turbine layout	7 turbine layout, reduced impact all-round.
Cultural Heritage	10 turbine layout	7 turbine layout, reduced impact all-round.

4.4.2 Proposed Grid Connection and Substation

The Proposed Grid Connection from the proposed onsite 110kV substation is located via a route on public road for 8km to the existing Philipstown 110kV substation. A 110kV underground cable (UGC) Proposed Grid Connection will be trenched into the road or the verge of the public road. The Proposed Grid Connection will travel from the proposed Ballinla Wind Farm 110kV substation along the access tracks for approximately 0.5km to the L5010. On the L5010 the UGC will then travels east for approximately 2km to the L5006. On the L5006 the UGC will progress south on the L5006 for approximately 5km before joining the R401 south for approximately 1km where it will link into the newly constructed Philipstown 110kV substation. The Proposed Grid Connection route was chosen for the following reasons:

• Utilisation of existing access track and public road infrastructure thereby minimising the requirement for new access track infrastructure associated with the connection.
• Low impact on biodiversity as a result of utilising access track and public roads for the majority of the connection.

The proposed 110kV electrical substation and compound will comprise an outdoor electrical yard and two single storey buildings (one for EirGrid and one for the wind farm operator). The EirGrid building will contain a control room, storeroom, office/canteen and a toilet. The wind farm operator building (or IPP substation building) will contain a storeroom, communications room, control room, staff room, office, switchgear room and a toilet. The substation location was chosen for the following reasons: • Landowner considerations.
• Reduced impact on residential receptors
• EirGrid required separation distances from the 110kV substation to the turbines
No alternative design provided.

4.5 Do Nothing Scenario

In the 'Do-Nothing' scenario, the site would remain in its current state, comprising a mix of managed agricultural land, forestry, and natural vegetation. Over time, the site would continue to evolve through routine land management practices, including potential commercial forestry operations such as clear-felling and replanting.

No wind energy infrastructure would be developed, and the site's potential to contribute to Ireland's renewable energy generation targets would remain unrealised. Ireland is legally committed to achieving a 51% reduction in greenhouse gas emissions by 2030 (relative to 2018 levels) and to reaching net-zero emissions by 2050, as set out in the Climate Action and Low Carbon Development (Amendment) Act 2021.

The Climate Action Plan 2024 & 2025 and the National Energy and Climate Plan (NECP) 2021–2030 both identify onshore wind as a cornerstone of Ireland's renewable energy strategy, with a target of 9 GW of installed onshore wind capacity by 2030. In the absence of the Proposed Development, Ireland would continue to rely on imported fossil fuels to meet growing electricity demand. This would undermine national efforts to decarbonise the energy sector, increase exposure to volatile global energy markets, and weaken energy security
Furthermore, the 'Do-Nothing' alternative would represent a missed opportunity to harness the significant wind energy resource available at the site. It would fail to contribute to national and EU renewable energy targets, delay progress toward climate neutrality, and forgo the associated socio-economic benefits, including local investment, community funding, and job creation. Given the urgency of Ireland's climate commitments and the strategic importance of onshore wind energy, the 'Do-Nothing' scenario is not considered a viable or sustainable alternative.

4.6 Conclusion

The project design process and reasonable alternatives were completed with reference to EIA Directive and EU Guidance Document 2017. The Proposed Development has been designed to minimise potential environmental effects and to maximise wind potential on site. Alternatives examined included alternative land areas, site layouts, alternative Proposed Grid Connections and alternative construction methods. The final site layout (iteration number 5) was determined based on multi-discipline inputs and consideration of topography, biodiversity, land and soils, archaeology, hydrology, landscape, and engineering constraints and assessments.
The development, as proposed, is the preferred option as it results in the least effects on resources and receptors while meeting the project objectives of a large-scale renewable wind energy development.

5. Population and Human Health

5.1 Introduction

This Chapter considers any likely significant effects on population and human health arising from the Proposed Development. A full description of the Proposed Development, development lands and all associated development elements is provided in Chapter 2 Description of the Proposed Development of this EIAR. The Study Area for the purpose of the population and human health assessment focuses on the local receiving human environment in the vicinity of the Proposed Development site. The human environment is examined in terms of population and settlement, economic activity, employment, land use, tourism and amenities.

The chapter has been prepared having regard to information on the local population and land-use and in consideration of any human health impacts via environmental pathways from aspects such as soil, air, water or changes to material assets.

The assessment comprises:

- A description of the existing human environment.
- Prediction and characterisation of effects.
- Evaluation of effect significance.
- Consideration of mitigation measures, where appropriate. Information has been gathered from publicly available sources, including Local Authority Plans (for OCC), the Central Statistics Office (CSO), Fáilte Ireland and the Met Éireann website.

Table 5--1: Issues relevant to Human Environment

Topic Area	Potential Issues
Employment	Will the development affect employment opportunities?
Settlement Patterns	Will the development change settlement patterns?
Land-Use Patterns	Will the development change land use patterns and types of activity?
Baseline Population	Will the development affect the current population?
Demographic trends	Will the development change concentrations of a particular ethic group or influence the movement of human populations?
Human Health	Vectors through which human health impacts could be caused e.g. water, air, soil, discomfort or nuisance?
Amenity	Will the development change site uses, loss of right of way or amenity?

Accordingly, the scope of this assessment is made with respect to these topic areas and considers the effects of the construction, operation and decommissioning of the Proposed Development in terms of how the proposal could affect:

- Land Use Change.
- Population and Settlement.
- Economic Activity and Employment.
- Tourism and Amenities.
- Human Health.

Shadow Flicker is briefly addressed in this chapter, with a full assessment found in Chapter 16 Shadow Flicker. Based on a review of the characteristics of the Proposed Development and according to the EPA guidance, Guidelines on the information to be contained in Environmental Impact Assessment Reports (2022), any potential negative impacts on the local human environment are considered to include the following human health/wellbeing and disturbance concerns:

- Dust emissions from construction activities.
- Noise emissions during the construction and operation.
- Public safety during construction activities and operations.

• Traffic disturbance during construction and operation, and.
• Visual impacts and shadow flicker operation. Each of these concerns have been fully addressed and documented in various chapters of this EIAR as set out in Table 5-2. These assessments were reviewed to inform this study

Table 5-2: Potential Disturbance & Health and Safety issues and Relevant EIAR Chapters

Development Phase	Potential Disturbance/ Health & Safety Issue	Addressed in EIAR Chapter
Construction Phase	Noise emissions and vibration	Chapter 10 Noise
	Dust emissions	Chapter 13 Air and Climate
	Public safety	Chapter 2 Description of the Proposed Development
	Traffic disturbance	Chapter 15 Material Assets – Traffic and Transport and Appendix 15C Traffic and Transport Assessment
Operational Phase	Noise emissions and vibration	Chapter 10 Noise
	Visual effects	Chapter 11 Landscape and Visual
	Air quality effects	Chapter 13 Air and Climate
	Shadow Flicker disturbance	Chapter 16 Shadow Flicker
	Telecommunications interference	Chapter 14 Material Assets – Built Services
	Public safety	Chapter 2 Description of the Proposed Development
Decommissioning	Traffic disturbance	Chapter 15 Material Assets – Traffic and Transport
	Noise emissions and vibration	Chapter 10 Noise

5.2.1.2 Public Consultation

For the purposes of public engagement and consultation, Ballinla Wind Farm Limited set up a dedicated project website www.ballinlawindfarm.ie. Activities of public engagement carried out so far are detailed in Chapter 1 Introduction of this EIAR. The consultation enabled the public to examine many aspects of the project in detail and then revert to the project team with any questions, comments, or suggestions. Refer to the Community Report in Volume III, Appendix 1A.

5.2.1.3 Assessment Criteria

Determination of the significance of an effect will be made in accordance with the terminology outline in the EPA Guidelines on the information to be contained in Environmental Impact Assessment Reports (2002). This assessment criteria are set out in Table 5-3

Table 5-3: Assessment Criteria

Quality of Effects	**Positive**	**A change which improves the quality of the environment.**
	Neutral	No effects or effects that are imperceptible, within normal bounds of variation or within the margin of forecasting error.
	Negative/ adverse	A change which reduces the quality of the environment.
Significance of Effects	**Imperceptible**	An effect capable of measurement but without noticeable consequences.
	Not significant	An effect which causes noticeable changes in the character of the environment but without significant consequences.
	Slight	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities (no direct impact).
	Moderate	An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends (change is noticeable but reversible – site/feature can be integrated into development).
	Significant	An effect which, by its character, magnitude duration or intensity alters a sensitive aspect of the environment
	Very Significant	An effect which, by its character, magnitude duration or intensity alters most of a sensitive aspect of the environment.
	Profound	An impact which obliterates sensitive characteristics. Mitigation would be unlikely to remove adverse effects.
Extent and Context of Effects	**Extent**	Describe the size of the area, the number of sites and the proportion of a population affected by an effect.
	Context	Describe whether the extent, duration or frequency will conform or contrast with established (baseline) conditions (is it the biggest, longest effect ever?)
Probability of Effects	**Likely Effects**	The effects that can reasonably be expected to occur because of the planned project if all mitigation measures are properly implemented.
	Unlikely Effects	The effects that can reasonably be expected not to occur because of the planned project if all mitigation measures are properly implemented.
Duration and frequency of Effects	**Momentary**	Effects lasting from seconds to minutes.
	Brief	Effects lasting less than a day.
	Temporary	Effects lasting less than a year.
	Short-term	Effects lasting one to seven years.
	Medium-term	Effects lasting seven to fifteen years.
	Long-term	Effects lasting fifteen to sixty years.
	Permanent	Effects lasting over sixty years.
	Reversible	Effects that can be undone e.g. through remediation or restoration
	Frequency	How often the effect will occur. (once, rarely, occasionally, frequently, constantly – or hourly, daily, weekly, monthly, annually).
Types of Effects	**Indirect (a.k.a. Secondary or Off-site Effects)**	Impacts which are not a direct result of the project.
	Direct	For example, where an archaeological/heritage feature/site is physically located within the footprint of a proposed development whereby the removal of part or all of the feature or site is thus required.
	Cumulative	The addition of many minor or significant effects, including effects of other projects, to create a larger, more significant effect.
	'Do-Nothing'	The environment as it would be in the future should the subject project not be carried out.
	'Worst-case'	The effects arising from a project in the case where mitigation measures substantially fail.
	Indeterminable	When the full consequences of a change in the environment cannot be described.
	Irreversible	When the character, distinctiveness, diversity or reproductive capacity of an environment is permanently lost.
	Residual	The degree of environmental change that will occur after the proposed mitigation measures have been implemented.
	Synergistic	Where the resultant effect is of greater significance than the sum of its constituents, (e.g. combination of SOx and NOx to produce smog).

5.2.2 Statement of Limitations and Difficulties Encountered

Tourism and amenity effects are interrelated with effects on landscape and visual amenity, archaeology and heritage interests, and transport. Each if these are addressed in other chapters of this EIAR and reference should therefore be made to Chapter 11 Landscape and Visual, Chapter 12 Cultural Heritage, and Chapter 15 Material Assets- Traffic and Transport. While reference is made to these effects where relevant, this chapter does not re-evaluate these assessments. The focus of this assessment is primarily on physical disruption, severance, or exclusion of users' ability to continue existing activities or deterrence of additional further development of amenities and tourism potential.

5.3.1 Study Area

The Study Area for the purpose of this assessment on Population and Human Health primarily focuses on the local receiving human environment in the vicinity of the Proposed Development. These comprises those who reside, work, visit, or use the local road networks. Electoral Divisions (EDs) are the smallest legally defined administrative areas in the State for which Small Area Population Statistics (SAPS) are published from the Census of Population. Therefore, in order to discuss the receiving human environment and other statistics in the vicinity of the Proposed Development site, the Study Area for this assessment has regard to EDs within or located close to the Proposed Development. The extent of the EDs and SAPS considered for the purposes of this assessment are shown in Figures 5-1 and 5-2 and set out in Tables 5-4 and 5-5. Although this chapter predominantly describes the human environment in the vicinity of the Proposed Development, sensitive human receptors in the broader human environment are considered in the other specialised environmental topics, including the following.

- Air Quality and Climate (Chapter 13).
- Noise (Chapter 10).
- Landscape and Visual (Chapter 11).
- Cultural Heritage (Chapter 12).
- Material Assets- Built Services (Chapter 14).
- Material Assets- Traffic and Transport (Chapter 15)

5.3.2 Site Location and Description

The Proposed Development is located in a rural area of east Co. Offaly. The site is approximately 4km west of the Edenderry town boundary and 24km east of Tullamore. Figure 5-3 outlines the location of the Proposed Development with the townlands while Figure 5-4 outlines the layout of the Proposed Development included in the planning application. The area within this red line boundary is approximately 42ha. For EIAR purposes, the Proposed Development includes the Proposed Wind Farm, the Proposed TDR and the Proposed Grid Connection (which will be subject to a separate planning application). The Proposed Ballinla Wind Farm is within the townland of Leitrim in the municipal district of Edenderry, Co. Offaly.

The Proposed Grid Connection will be a linear development within the townlands of Leitrim, Lumville, Ballinla, Clarkeville, Ballyfore Big, Ballyfore Little, Ballyleakin and Ballykilleen, Co. Offaly. The 8km Proposed Grid Connection route is from the Proposed Wind Farm south along public roads to the existing Philipstown 110kV substation to the southeast and adjacent to the Edenderry Power Station. The TDR location is outlined in Appendix 2-2. Temporary works required on the TDR are detailed in that report. Existing land cover at the site consists of agricultural land in the northern section and coniferous commercial forest in the southern section. The northern and southern sections of the Proposed Development are split by the L5010 local road which travels in an east west direction bisecting the Proposed Development. The Grand Canal is located to the north of the Proposed Development. The surrounding land includes agricultural fields, commercial forestry and cutover peatlands.

Note, the alternative for off road or overground were not provided.

5.3.3 Settlement Patterns

Settlement patterns in the greater region are generally small cluster settlements of houses and farmsteads, and linear settlements along local and regional roads. Edenderry is the closest town (population 7,888, CSO, 2022) settlement to the Proposed Development, located c.7km to the east. One other settlement of note is Rhode (population 841, CSO, 2022) which is located c.7.5km northwest of the Proposed Development. Built up areas (BUAs) in the surrounding area of the Proposed Development are shown in Figure 5-5.

5.3.4 Shadow Flicker

The Study Area for the purpose of this assessment on Shadow Flicker primarily focuses on the local receiving human environment and residential properties in the vicinity of the Proposed Development site. In line with best practice, the scope of this assessment extends to a distance of 10 times the maximum rotor diameter, in this case 1.6km. The grid coordinates for both houses & turbines indicate separation distances far greater than those shown on the maps provided. Those grid coordinates are fed into a model to identify noise & shadow flicker. Thus any assessments produced are based on incorrect data.

5.3.5 Population Density

The 2022 Census of Population provides population statistics for Small Area Populations (SAPs) and Electoral Divisions (EDs). A review of this data showed that population density is evenly spread among the SAPs and EDs, with the populations increasing when closer to the built-up areas in the area. These statistics are presented in Table 5-6 and Table 5-7. Housing in the area is cluster or ribbon settlements along local and regional roads.

5.3.6 Population Trends

The available data on population trends for the period 2016 – 2022 indicates that all of the EDs shown in Figure 5-1 of Section 5.2.2, experienced a population increase, as presented in Table 5-8.

Table 5-8: Population Trends

Electoral Division	2016 Population	2022 Population	% Change on Population 2016-2022
Monasteroris ED	806	892	+10.7%
Edenderry Rural ED	816	890	+9.0%
Cappancur ED	1,531	1,701	+11.1%

5.3.7 Public Health

The 2022 Census provided information on the general health profile of the population of each small area. The statistics showed that, overall, the majority of the local population are in 'good' or 'very good' health. Less than 4% in the Study Area were counted as 'bad' or 'very bad' health. A further breakdown is shown in Table 5-9.
Thus, we can assume that the applicant will prepare a baseline health study & monitor it on an annual basis & provide health & life insurances for all those included in the study for the 40-Year life of the development.

Table 5-9: Health Statistics 2022

Area Ref	CSO Small Area	SAP Population	% Good to Very Good Health	%Bad to Very Bad Health
1	A187017001	316	88.3%	2.5%
2	A187035001/01	222	73.4%	1.4%
3	A187035001/02	186	76.9%	3.2%
4	A187035002	482	73.2%	1.7%
5	A187063001	369	85.6%	2.4%
6	A187063002	245	86.1%	1.2%
7	A187063003	278	79.5%	3.2%

The emergence of the Covid-19 virus in Ireland in the early part of 2020 presented a new human health risk and concern amongst the general public across Ireland including the area of the Proposed Development and surrounds. Currently, there are no Covid-19 restrictions in place and the introduction of vaccines have helped society gravitate towards living with Covid-19. The medium to long term effects of the virus on national and local human health, however, is not currently fully known.

5.3.8 Economic Activity

According to the 2022 census employment statistics for the region, the workforce is employed in a diverse range of industries, refer to Table 5-10. The statistics show that the highest level of employment is within the Professional Services category with 27.7% of the Study Area population employed in this sector. Commerce and Trade is the second highest employing sector and employs 20.3% of the Study Area workforce. Other key employment sectors include Manufacturing Industries (13.1%), Other (11%), Building and Construction (6.5%), Agriculture, Forestry and Fishing (7.2%). The 2022 Census Commuter Flow data, Table 5-11, suggests that most workers (73.7%) are travelling

by private vehicles, whereas 4.8% travel via bicycle or on foot. Only 4.6% use public transport, while 7.3% work mainly from home. The remaining commuters did not state their transport to work method.

5.3.9 Land Uses

The land on which the Proposed Wind Farm is located is split as north and south by the local road L5010. The northern section of the Proposed Wind Farm is agricultural land and pastures, with commercial woodland to the north. The southern section of the Proposed Wind Farm is commercial coniferous and mixed woodland. The area is accessible by the L5010, and most residential dwellings are along this route in small ribbon developments. The R402 is southeast of the Proposed Development that provides access to Edenderry. There are three existing windfarms south of the Proposed Development. Cloncreen Wind Farm, which hosts 21 wind turbines, is located c. 2km southeast of the Proposed Development, Mount Lucas Wind Farm is located c. 4km south of the Proposed Development and contains 28 turbines and Cushaling Wind Farm c. 5km southeast with nine turbines. There is a windfarm currently under construction north of the Proposed Development, the Yellow River Wind Farm, c. 4km, which will contain 29 turbines and is due for completion in 2025. The land in the area is generally flat and low lying

There is no recreational land use designated in the area of the Proposed Development. The closest recognised recreational route is the Grand Canal Walkway north of the Proposed Development. The closest school is Ballybryan National school, c. 3.8km north of the Proposed Development. Other education facilities within the vicinity are Scoil Bhríde Primary School Edenderry (c. 6km), Oaklands Community College (c. 6km), Gaelscoil Éadan Doire (c. 6.1km), all located east of the site in Edenderry, and Rhode National School (c. 7.1km), northwest of the Proposed Development. Ballyfore GAA Club is located east of the southern section of the Proposed Development, c. 2km. The nearest town to the Proposed Development is Edenderry, c. 4km east of the Proposed Development. Within the town is a number of retail, commercial, and community facilities. The town is accessed from the Proposed Development via the R402. The town itself is accessible via a number of regional roads, and the M4 Motorway is c. 10km north of the town. The town has several bus routes that service it, the 120, 120C, AI05, 120D and 120X. Tullamore is the closest 'large town' (population 23,494, CSO 2022), which is c. 32km west of the Proposed Development mainly via the R402.

5.3.10 Tourism and Amenities

There are no tourist attractions or amenities within the Proposed Development site. The nearest attraction is the Grand Canal Walkway, c. 500m north of the site. Blundell Castle is located in Edenderry, c. 6.5km to the east of the Proposed Development and is a ruin castle. Carbury Castle and Motte is east of the proposed site c. 15km. Killinthomas Wood is located c. 20km southeast of the site. Lullymore Heritage and Discovery Park is also southeast of the Proposed Development, c. 28km. Coolcarrigan House and Estate is c. 26km to the east of the Proposed Development. The Tullamore Dew Distillery experience is c. 35km west of the proposed site. Mountlucas cycle and walkway is located c. 12.5km south of the site and hosts events such as VHI Parkrun weekly. The Hilltop Farms Alpaca Attraction is c. 20km west of the Proposed Development. The Proposed Development is located away from any major tourist attraction or recreational activity facilities, which ensures that users and visitors to the area are not directly impeded from the greater area during the operational phase. The Proposed Development may be visible during operation from some of these locations, and this is further discussed in Chapter 11 Landscape and Visual.

5.4 Assessment of Effects

5.4.1 Construction Phase

5.4.1.1 Land Use Change

All new development proposals have the potential to affect the local area character and human environment by introducing a new incompatible land use activity which could result in physical disruption, severance or exclusion of user's ability to continue existing activities or the sterilisation of lands thus preventing any additional further land-use potential. During construction, there will be a level of effect on existing land-uses within the development site. Existing agricultural and forestry activities (apart from felling required for the Proposed Development) will cease within the footprint for the duration of the construction works. Public access within the site will also be prohibited during construction, operation and decommissioning, however as the lands are under private ownership public access is not available. Outside of the development footprint, it is not envisioned that land use activities would be adversely affected.

Overall, it is considered that during the construction phase there is likely to be a direct, short-term, slight to moderate, negative and localised effect on land use within the wind farm site and along the Proposed Grid Connection.

5.4.1.2 Population and Settlement

It is envisaged that 60 jobs will be created during the construction phase of the project, a period of 18-24 months. It is expected that the majority of construction personnel will primarily be local to the region. A minor number of key employees involved in the construction, may decide however to temporarily re-locate to the area in the shortmedium term. Any direct and indirect jobs created or supported during the 18 to24 month construction phase will be temporary in nature. Residential dwelling patterns in the area are standalone residential dwellings along the L5010 road. These dwellings may experience some disturbance during the construction phase due to haulage and construction vehicle traffic, and general noise created during the construction phase. However, noise from these sources is predicted to be temporary. All best practice guidelines will be followed during the construction works to minimise the impact on the dwelling in the Proposed Development's receiving area. The 8km grid connection route will follow the road network in the area to the newly constructed Philipstown 110kV substation, located southeast of the Proposed Development, following the L5010 to the L5006 before joining the R401.

The Proposed Grid Connection will have some localised and temporary disruption during its construction to local residents. Chapter 10 Noise and Vibration and Chapter 15 Material Assets – Traffic and Transportation provide further information on these topics. In the absence of any substantive, peer reviewed Irish studies on the effect of wind farms on property values, recent studies from the United States and Scotland are considered.
Refer to Appendices attached that include such Irish references. The effect on the Horse stud farm & Charolais bull breeding farm are not included.

The largest study of the impact of wind farms on property values was carried out in the United States. 'The Impact of Wind Power Projects on Residential Property Values in the United States: A multiSite Hedonic Analysis', December 2009, was carried out by the Lawrence Berkley National Laboratory (LBNL) for the U.S Department of Energy. It concluded that "no evidence was found that home prices surrounding wind facilities are consistently, measurably, and significantly affected by either the view of wind facilities or the distance of the home to those facilities".

The study was updated by Lawrence Berkeley National Laboratory (LBNL) who published a further paper entitled "A Spatial Hedonic Analysis of the Effects of Wind Energy Facilities on Surrounding Property Values in the United States", in August 2013. It concluded that no statistical evidence was found that "home prices near wind turbines were affected in either the post-construction or post announcement/pre-construction periods".

A more recent study published by Climate exchange in October 2016 titled 'Impact of wind Turbines on House Prices in Scotland' concluded that there was "no evidence of a consistent negative effect on house prices". Taking these studies into consideration, it is not anticipated that the Proposed Development will have any detrimental effect on the local property values.
The Proposed Development is deemed likely to have neutral, localised, short-term effects in the area of the Proposed Development with imperceptible significance to population and settlement patterns during the construction phase.

5.4.1.3 Economic Activity and Employment

During the construction phase, it is anticipated that resources and labour will be sourced in the region where possible. Aggregates and concrete supply track construction and foundations will be obtained from local quarries and suppliers operating in the area, which will support the local economy. Local suppliers of other materials and equipment will also be engaged when necessary, extending the economic reach of the Proposed Development into the local economy. It is the intention of the developer to require the main contractor to use local subcontractors, drivers, suppliers and materials where possible. The construction phase is estimated to take between 18 to 24 months, which is envisaged to create 60 direct jobs during this phase. Additional services required in engineering, consultancy, site investigation, surveying, and environmental assessment and monitoring will provide further short-term employment opportunities. It is expected that there will be additional indirect employment opportunities for the many retail and service establishments in the nearby towns and settlements.

Therefore, it is considered the construction stage of the Proposed Development will likely have a direct, shortterm, localised, and positive effect on the employment profile of the study area, and a short-term slight positive effect on local businesses and services in the nearby towns and villages in the study area during the construction stage.

5.4.1.4 Tourism and Activities

While tourism is a major economic driver in Co. Offaly, no significant economic benefits of this industry are directly associated with the Proposed Development. The Proposed Development is not currently used as a forest park or recreation site. There are no picnic facilities near the site or any direct tourist attractions or services at the site. There are important tourist and amenity attractions within the study area of the Proposed Development, as identified in Section 5.3.10. Construction personnel in the area travelling to and from site, and the delivery of supplies and materials will see an increase of vehicle use on the local road network. However, given that the turbines won't be erected until the final phase of construction, the effect of the Proposed Development during the construction phase is considered localised, neutral, short-term and of imperceptible effect on the receiving environment. Further information regarding visual impact in the area and traffic management are found in Chapter 11 Landscape and Visual Impact Assessment and Chapter 15 Material Assets – Traffic and Transportation

5.4.1.5 Human Health

While there is the potential for construction related hazards, serious risks to human health and safety are not envisioned. Should a major accident or natural disaster occur, the potential sources of pollution onsite during both the construction and operational phases are limited. Sources of pollution with the potential to cause significant environmental pollution and associated negative effects on health such as bulk storage of hydrocarbons or chemicals, storage of wastes etc. are limited. There is limited potential for significant natural disasters to occur at the Proposed Development site. Ireland is a geologically stable country with a mild temperate climate. The potential natural disasters that may occur are therefore limited to flooding and fire.

The risk of flooding is addressed in Chapter 08 Water.
It is considered that the risk of significant fire occurring, affecting the wind farm and causing the wind farm to have significant environmental effects is limited.
As described earlier, there are no significant sources of pollution in the wind farm with the potential to cause environmental or health effects. Also, the spacing of the turbines and distance of turbines and substation from any properties limits the potential for effects on human health. Major industrial accidents involving dangerous substances pose a significant threat to humans and the environment. such accidents can give rise to serious injury to people or serious damage to the environment, both on and off the site of the accident.
The Proposed Development is not regulated or connected to or close to any site regulated under the Control of Major Accident Hazards Involving Dangerous Substances Regulations i.e. SEVESO sites and so there are no potential effects from this source. During construction and decommissioning the site will be managed in accordance with the following safety and health regulations and guidelines which will ensure a high standard of safety both for workers on site and the general public.

- Safety, Health & Welfare at Work (Construction) Regulations 2013.
- Safety, Health & Welfare at Work Act 2005.
- Safety, Health & Welfare at Work (General Applications) Regulations 2007 to 2020.
- Irish Wind Energy Association Best Practice Guidelines.

The provision of underground electric cables of the capacity proposed is common practice throughout the country and installation to the required specification does not give rise to any specific health concerns. A Safety and Health Plan covering all aspects of the construction process will be prepared in advance of construction and will comprehensively deal with safety and health related issues.
It is not anticipated that the workings of the turbines will present any danger to the public. There are rigorous safety checks imposed on the turbines during design, construction, commissioning, and operation ensures the risks to humans are negligible. Construction works and new development not only can pose safety risks but can also give rise to potential effects on general amenity affecting health and wellbeing. General amenity relates to the pleasant, amenable qualities of a place as it is used and perceived by the people who reside, frequent, or view it. There are a number of general elements that contribute to, or detract from, the amenity of an area. Disturbances such as noise, dust and traffic are potential factors for the devaluation of amenity.

The potential wellbeing and disturbance effects of the proposed wind farm scheme on the local human environment have been identified as follows:

- Dust emissions from construction activities.
- Noise emissions during the construction and operation.
- Public safety during construction activities and operations.
- Traffic disturbance during construction and operation.
- Visual impacts and shadow flicker operation.

Each of these effects has been fully assessed and are documented in other chapters of the EIAR as set out in Table 5-12. These assessments were reviewed to inform this study, and it is concluded having regard to these environmental factors, under which human health effects might occur, there will be no significant effects on human health as a result of the Proposed Development expected.

Table 5-12: Potential Issues

Development Phase	Potential Nuisance/Health & Safety Issue	Addressed in EIAR Chapter
Construction Phase	Noise emissions and vibration	Chapter 10 Noise
	Dust emissions	Chapter 13 Air and Climate
	Traffic disturbance	Chapter 15 Material Assets - Traffic and Transport
Operational Phase	Noise emissions and vibration	Chapter 10 Noise
	Visual quality effects	Chapter 11 Landscape and Visual
	Air quality effects	Chapter 13 Air and Climate
	Shadow Flicker disturbance	Chapter 16 Shadow Flicker
	Telecommunications interference	Chapter 14 Material Assets - Built Services
	Public safety	Chapter 2 Description of the Proposed Development
Decommissioning	Traffic Disturbance	Chapter 15 Material Assets - Traffic and Transport
	Noise emissions and vibration	Chapter 10 Noise

Traffic and Road Usage

Potential effects on the surrounding road network will arise principally during the construction phase. Peak daily construction traffic is predicted to be 198 HGV movements (99 each way) with the predicted highest peak hourly HGV traffic volumes to be approximately 21 deliveries per hour. Peak construction traffic would principally occur during turbine base pours and therefore arise on seven occasions. Traffic studies carried out for the Proposed Development indicate that while there will be an increase of traffic volume on the local public road network during the construction phase, this increase will be well within the carrying capacity of the local public road network. However, the existence of additional traffic, especially heavy goods vehicle traffic, associated with the construction phase has the potential for local residents and users of these roadways to experience minor disturbances and/or be inconvenienced on encountering site related traffic. There will be a slight, short-term negative effect on traffic over the 18–24-month construction programme with isolated, localised peaks of brief but moderate effects. The Proposed Grid Connection will follow the road network in the area. The 8km route will go from the proposed Ballinla Wind Farm 110kV substation to the under construction Philipstown 110kV substation. The Proposed Grid Connection goes east from Ballinla along the L5010 to the L5006. The route then goes south to meet the R401 before connecting to the Philipstown substation. The works will be brief and appropriate traffic control and management systems will be in place to minimise as far as possible traffic disruption to road users. Once the works are complete, the road will be reinstated. A full assessment of can be found in Chapter 15 Material Assets – Traffic and Transport of this EIAR.

Check reference 3.11.1 Construction Phase where it identifies 440 vehicles per day & not 198

Noise

The construction phase has the potential to generate noise emissions which has the potential to cause disturbance to local noise sensitive areas. The results of the construction noise predictions indicate that noise generated during the construction phase will not exceed the noise limits in the BS5228 Construction Noise Guidelines at any dwelling

location, for the duration of the construction phase. The noise assessment proposes recommendations regarding measures of reducing the amount of noise reaching the noise sensitive areas in accordance with BS5228-1&2 +A1 2014, Code of Practice for the Control of Noise and Vibration on Construction and Open Sites. A full assessment of can be found in Chapter 10 Noise of this EIAR.

Air Quality

There is the potential for temporary adverse effects in terms of dust emissions during the construction phase of the development. Vehicle and fugitive dust emissions would occur primarily during Proposed Development construction. Dust generated during the construction phase is not likely to significantly affect the local air quality. Given the distances to the nearest sensitive receptors, dust levels will not exceed the recommended TA Luft 350mg/m3/day guidelimit. There is, however, the possibility of dust occurring in the vicinity of the site entrances and along the local public road which could affect road users. This is considered a temporary minor adverse effect and mitigation will be implemented. With the effective implementation of standard dust management measures to control and reduce dust, no significant adverse effect, in terms of a community disturbance is likely to occur. A full assessment of can be found in Chapter 13 Air and Climate of this EIAR.

Shadow Flicker

As the turbines will not be commissioned until the end of the construction phase, no construction phase shadow flicker impacts will occur. The potential impacts of shadow flicker are only applicable during the operational phase.

5.4.2 Operational Phase

5.4.2.1 Land Use Change

During operational phase it is considered that the Proposed Development would not constitute significant negative effects in terms of land-use considerations for the following reasons:

- The Proposed Development does not conflict with any planning policies or zoning provisions for this area.
- The Proposed Development will not introduce any activities or features which are otherwise currently unusual to the area. There are therefore no changes to the patterns and types of activity in the area as a result of the proposed project.
- There will be no loss of rights of way or amenities as a result of the Proposed Development.
- In terms of effects to neighbouring lands and land-uses it is considered that the Proposed Development does not pose a significant risk to either existing or future land-uses. All existing land-use practices can co-exist with the development. Once operational, conventional agricultural and forestry activities will continue to take place at the site independent of the wind farm proposal. Only a relatively small area of commercial forestry, approximately 18ha of the forestry resource in the area locally, will be permanently displaced in the footprint of the wind farm infrastructure. This loss of land use would not be significant. In terms of effects to neighbouring lands and land-uses it is considered that the wind farm development does not pose a significant risk to either existing or future land-uses. All existing land-use practices can co-exist with the proposed wind farm. The Proposed Development is likely to have a direct, long-term, neutral, and localised effect on land use.

5.4.2.5 Human Health

During the operational phase, potential electrical risks are associated with turbine transformers, switches and cabling. It is not envisioned that these will however pose any significant risk as these will fully meet health and safety regulations relating to high voltages. The turbines will prevent access to the public through the erection of steel palisade fencing. The extremely low frequency (ELF) and EMF associated with the operation of the proposed cables fully comply with the international guidelines for ELF-EMF set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), a formal advisory agency to the World Health Organisation, as well as the EU guidelines for human exposure to EMF. Accordingly, there will be no operational effect on properties (residential or other uses) as the ICNIRP guidelines will not be exceeded at any distances even directly above the cables. The EirGrid document 'EMF & You: Information about Electric & Magnetic Fields and the electricity transmission system in Ireland' (EirGrid, 2014) provides further practical information on EMF. Blades can potentially fail through damage sustained in severe weather mainly through lightning strike or due to inadequate upkeep and maintenance. This is extremely rare, and the developer undertakes to operate and maintain all plant safely and in good working order on the site. Modern wind turbine design incorporates a failsafe mechanism that comes into play under extreme weather conditions. This mechanism causes the turbines to automatically shut down in periods of excessively high wind-speeds. The separation distances of turbines from public roads and residences are well beyond the turbine

falling over distance that would present a risk of significant accidents. It is not expected that the Proposed Development will result in significant effects resulting in the risk of major accidents and disasters, nor is the project considered vulnerable to risks of major accidents and disasters. Several topics related to human health at the operational phase are discussed in the following subsections.

Traffic and Road Usage

Once operational, the development will for the most part be monitored remotely with only occasional trips generated by maintenance and monitoring personnel. This would generate a relatively low volume of vehicles. Therefore, there will be negligible operational stage traffic impacts associated with the Proposed Development. Hence, the proposed operational phase would have imperceptible to not significant traffic effect.

What does “occasional trips” mean?

Noise

Potential sources of noise during the operation phase of the Proposed Development include mechanical noise from the gearbox or generator, aerodynamic noise from the rotor blades, and noise from the transformers and cooling fans in the substations. Advances in the development of commercial wind turbines has led to mechanical noise being significantly reduced during operation. In relation to aerodynamic noise, noise predictions were undertaken at identified receptor locations closest to the turbines and substations. For the transformers and cooling fans, the noise is generally recognisable as a steady hum which arises from electric and magnetic forces within the transformer. Given the separation distance between the windfarm and the nearest and nearest residential receptors and with adherence to the national guide limits, no significant noise effect on the local population is envisaged. No operational noise impacts will be generated from the underground grid cable.

The noise assessment undertaken demonstrates the noise limits can be achieved at all 3rd party local residential dwellings. It is considered that the effects of noise and vibration during the operation phase will be not significant and long term. Chapter 10 Noise of this EIAR considers the effects of noise emitted for the Proposed Development at operational phase.

The grid coordinates are not accurate & indicate separation distances far greater than shown on maps. The noise assessment does not demonstrate that noise limits can be achieved at all 3rd party local residential dwellings. The proximity of downwind turbines is affected by turbulent air & increased noise occurs. It would seem that the noise data is for singular standalone turbines. The recent High Court Case determined that noise was an issue at 1.1km from a wind turbine. This determination is legally binding & supercedes the 2006 Wind Energy Guidelines.

Shadow Flicker

Shadow flicker is defined as the alternating light intensity produced by a wind turbine as the rotating blade casts shadows on the ground and stationary objects, such as the window of a residence. The HSE position paper (2017) states that, “There is insufficient direct evidence to draw any conclusions on an association between shadow flicker produced by wind farms and health effects. Flashing lights can trigger seizures among people with a rare form of epilepsy called photosensitive epilepsy. The risk of shadow flicker from wind farms triggering a seizure among people with this condition is estimated to be extremely low”. The study area for shadow flicker is 1.62km, which is 10 times the rotor diameter. There was no identified dwelling within 500m of any turbine at the Proposed Development. Of the 141 dwellings within the study area, shadow flicker was assessed to potentially impact 111 during the operational phase. Shadow Flicker Control Modules (SFCM) are a standard element of commercial wind turbine packages which requires the identified dates and times of day of potential occurrence of shadow flicker at dwellings within the shadow flicker study area to be inserted into the SFCM computer program. This software considers factors such as weather conditions, which will then automatically stop each wind turbine at times when shadow flicker could otherwise occur within any of the houses within the study area. Once the conditions for shadow flicker to occur no longer apply (e.g. when the sun has passed the relevant position in the sky or once it has been clouded over), the wind turbine is restarted. With the implementation of the SFCM in the Proposed Development, the effects of shadow flicker will change from negative to neutral and the significance of the effects will be imperceptible, with the probability of the effect occurring being unlikely. A full assessment of shadow flicker is found in Chapter 16 of this EIAR.

As the grid coordinates are incorrect, this analysis is unreliable.

Air Quality

The Proposed Development will make a positive contribution to air quality once operational, displacing greenhouse gas emissions which would otherwise be emitted by fossil fuel powered electricity. Chapter 13 Air and Climate of

this EIAR presents a full assessment on the effects of air quality from the Proposed Development. The operational phase will have significantly less impact on air quality, with lower vehicle and dust emissions when compared to the construction phase. Emissions will arise from maintenance vehicles (light goods vehicles) estimated at 1-2 visits per month. The additional traffic generated during the operational phase will be negligible therefore the overall potential impact from dust and vehicle emissions during the operational phase will be longterm, imperceptible and have a positive impact on air quality, with a reduction of electricity generation from fossil fuel sources. Over the 35-year lifespan of the Proposed Development, approximately 1.6 million tonnes of CO2 will be offset.

5.4.2.6 Climate Change

The proposed wind farm project will facilitate decarbonisation objectives at local and national levels as set out in the 2023 National Climate Action Plan and the 2021- 2027 Offaly County Development Plan which states that Offaly County Council will facilitate and support the development of renewable energy sources which will aid in achieving national targets and a reduction in fossil fuel dependency and greenhouse gas emissions.
The project is estimated to offset approximately 1.6 million tonnes of CO2 during its 35-year operational lifespan. The payback from emissions generated during the construction of the Proposed Development is estimated to be 1.7 years, with total losses approximately 86,911 tonnes of CO2. The remaining 33.3 years of operation of the Proposed Development will see a positive offset of emissions, and will therefore have a long-term, direct, slight, positive and extensive effect on climate change. A full assessment of climate change effects and impacts related to the Proposed Development is found in Chapter 13 of this EIAR.
This assessment does not include the Wake reduction in vegetation growth from a 3^0 Centigrade temperature drop.

5.4.2.7 Visual Elements

A landscape and visual impact assessment was carried out in relation to the Proposed Development. A total of 29 viewpoints were used to determine the visual presence of the proposed wind farm. From these viewpoints photomontages were prepared and an assessment completed. **The turbine structures and their proposed position in a relatively flat, low-lying area, will have a visual consequence that is unavoidable**. However, the extent of intrusion will vary in degree and significance according to viewing distance, the numbers and parts of turbines visible, the number of viewers affected and of course public perception. Chapter 11 of the EIAR sets out the potential landscape and visual impacts of the Proposed Development and describes the setting of the Proposed Development Site in relation to tourism features. The assessment concludes that there will be no significant effects as a result of the Proposed Development. The visual impact assessment also assessed the cumulative effect of the Proposed Development along with other planned or operating wind turbines in the area. The cumulative effect was not considered significant owing to the limited number of turbines and compact layout.

5.4.4 Do Nothing

An alternative to the Proposed Development of the Proposed Ballinla Wind Farm is to leave the site as it is currently being utilised for agricultural and forestry purposes. There will be no changes to the baseline environment of the site and existing activities such as agricultural activities and periodic tree felling will continue. There will be no increases in local employment and the economic benefit via the community benefit fund will not be realised. The potential emissions from the construction phase will not be created and there will be no noise, shadow flicker or visual effects which are associated with wind farms. However, the local, regional and national benefits which accompany the Proposed Development associated with the replacement of fossil fuels with renewable energy will be lost.

5.7 Conclusion

This chapter has assessed the potential effects on population and human health on the Proposed Development, and it is not anticipated to have any significant effects on population, employment, economic activity, tourism, land use and human health. The assessment considered the existing baseline environmental conditions of the Proposed Development which included the demographics and socioeconomics in the electoral divisions. In addition, potential effects during the construction phases, operational phase and decommissioning phase were considered as well as cumulative and residual effects. Finally, where effects were unavoidable but manageable, mitigation measures are to be implemented where relevant. Regarding the local population and settlement patterns, no significant impacts are considered to occur due to the Proposed Development. Personnel will be recruited from the local area where possible for construction, operation and decommissioning phases. There may be some experienced employees that may temporarily relocate during the phase of the lifespan relevant to their experience, but this impact is negligible,

and overall, no negative effects are associated with the Proposed Development regarding population and settlement patterns. As mentioned regarding employment in the preceding paragraph, workers needed for the phase of the Proposed Development will be sourced locally, having a direct and positive impact in the area. Indirect positive impacts during the construction and decommissioning phase will affect the smaller towns, with an increase in business, particularly for food and beverage operators being utilised by construction personnel. The Proposed Development has been designed to keep land take to a minimal, reducing the impact on land use in the vicinity, and no negative effects are considered in relation to land use and social considerations related to the Proposed Development. There will be no severance, loss of rights of way or amenities as a result of the Proposed Development. It was concluded that while there would be no significant effect on tourism infrastructure in the vicinity of the Proposed Development. Health and Safety guidelines will be followed throughout construction to ensure no serious accidents occur.
There is no public access available to the area of the Proposed Development, and it will be closed to the public throughout its lifespan.
Shadow flicker impacts during the operation phase have also been considered with the potential effect on nearby sensitive receptors, and it was concluded that there are likely to be no significant impacts on human health and safety related to the Proposed Development.
A similar conclusion can be considered for Climate, as the project over its lifespan will offset approximately 1.6 million CO2 and is considered to also have a positive effect on climate overall. The main disturbance during the construction phase of the Proposed Development will be the generation of additional traffic on the local road networks which may present noise and safety implications as a concern.

The disturbances associated with additional traffic volumes will however be confined to the construction phase of the Proposed Development and will not be a concern once works are complete. The construction phase will be managed so that effects to the human environment and local residents are managed. Mitigation measures outlined in the relevant Chapters 10 and 15 will be implemented and therefore, no significant negative effects on the local human environment are expected.
The operational phase of the Proposed Development is not expected to present any adverse effects on the human environment. The production of electricity by wind energy is environmentally friendly and reduces national dependency on fossil fuel production and its use in electricity generation. This reduction in demand for electricity from fossil fuel resources has a positive long-term effect on human health.
Noise effects are not considered to be significant. The noise assessment demonstrates that the proposed wind farm will operate within the recommended noise limit criteria in the Draft Revised Wind Energy Development Guidelines (2019) for all noise sensitive receptors surrounding the development and thus will not cause an adverse effect on the quality of life of local residents and the existing relatively tranquil environment in which they live.
Consideration of the recent High Court noise case is ignored.

The shadow flicker assessment demonstrates that while there may be potential for a number of dwellings to experience shadow flicker effects within the shadow flicker study area of 1.62km, the operational mitigation measures, SFCM, will be implemented to ensure that shadow flicker will be eliminated at all residential receptors. Cumulative effects were considered in relation to proposed, consented and constructed projects located nearby the Proposed Development.
No significant in-combination impacts were identified in relation to population and human health. Once mitigation measures set out throughout this EIAR are implemented, it is unlikely that significant negative impacts to population and human health will occur as a result of development of the Proposed Development. **This is also similar to residual effects, with no significant residual effects to the population and human health associated with the Proposed Development.**
The key issues to be examined in this regard include population, human health, employment and economic activity, land use, residential amenity (including visual amenity, shadow flicker, noise and traffic), community facilities and services, tourism, property values and health and safety & these have not been considered properly. The report states that when considering the amenity of residents in the context of a proposed windfarm, there are three main potential impacts of relevance:
1) Shadow Flicker,
2) Noise, and
3) Visual Amenity.

6.2.4.2 Field Surveys

Habitats and Flora Habitat surveys were undertaken on the 14th of June 2023 and on the 26th of January 2024, with a re-examination of the habitats undertaken during non-volant mammal surveying undertaken on the 22nd and 23rd of February 2024. Habitats were mapped according to the classification scheme outlined in the Heritage Council publication 'A Guide to Habitats in Ireland' (Fossitt, 2000) and following the guidelines contained in 'Best Practice Guidance for Habitat Survey and Mapping' (Smith et al., 2011). Habitat surveys and mapping were considered when identifying ecological constraints during the early design stages of the Proposed Development. Higher value habitats were avoided from the developable area of the Proposed Development where possible. In conjunction with the habitat surveys, botanical surveys were completed within the Study Area and included a 'look-see' search methodology (NRA, 2009) within habitat features likely to support protected species. This aimed to confirm the presence of plant species considered to be rare in both a national and local context (Scannell and Synnott, 1987), but with particular emphasis on the following:

- The plant species listed in Annex II of the EU Habitats Directive.
- Flora Protection Order species (FPO) (2022).
- Flora species listed in the Irish Red List for Vascular Plants (Wyse Jackson et al., 2016). Plant nomenclature for vascular plants followed 'Webb's An Irish Flora' (John Parnell and Tom Curtis Eight Edition). Classification of mosses and liverworts followed 'Mosses and Liverworts of Britain and Ireland: a field guide' (Atherton et al., 2010). During habitat and flora surveys of the Study Area, any invasive plant species were recorded, with a focus on those species listed under the Third Schedule of the European Communities Regulations 2011 (S.I. 477 of 2011). Any infestations encountered were recorded with regard to species, location and extent of infestation, and a photographic record made.

The Study Area refers to a broad geographical area within which habitats and biodiversity have been identified and assessed. This area comprises land and natural features, including areas outside the immediate Proposed Development footprint, and is used to determine baseline data collection and to ensure all ecological aspects are considered. The Proposed Development boundary refers to the areas within which construction and operational phase activities associated with the proposed wind energy development will take place. This boundary is confined to the immediate Proposed Development footprint and includes turbine hardstands, substation, access tracks and other ancillary infrastructure. The Proposed Development boundary represents the physical limits within which works will take occur and any potential impacts to biodiversity will be assessed with respect to this defined area.

Non-Volant Mammals

The scope of the non-volant mammal (land-based mammals that cannot fly) surveys were informed by the initial ecological surveys carried out across the Study Area on the 14th of June 2023 and the 26th of January 2024, as well as by species previously recorded in the 10km square N52 and N53 hectads encompassing the Study Area. Surveys to document non-volant mammals onsite were undertaken on the 22nd and 23rd of February 2024. The surveys targeted species protected under the Wildlife Acts 1976 to 2021, as amended, species listed in Annex II, Annex IV and Annex V of the Habitats Directive, and Irish Red Listed species (Marnell et al. 2019).

Particular focus was given to protected species such as Badger (Meles meles), Irish hare (Lepus timidus hibernicus), Pine marten (Martes martes), and Otter (Lutra lutra) in consideration of the type of habitat features present within the Study Area and the species records listed by the NBDC for hectad N52 and N53. These surveys involved a comprehensive search for all mammal activity in the form of prints, scat, resting/breeding places, feeding signs, mammal trails and direct observations. These surveys had regard to 'Animal Tracks and Signs' (Bang and Dahlstrom, 2004) and 'Ecological Surveying Techniques for Protected Flora and Fauna' (NRA, 2009). Badger surveys were carried out on the 22nd of February 2024, which confirmed three setts were located in the northwest of the site. The location of these setts are shown in Section 6.3.7.1.2. Surveying for badgers followed methodology in 'Surveying for Badgers: Good Practice Guidelines' (Scottish Badgers, 2018).

Otter surveys were carried out with a particular focus given to watercourses within the Study Area. Surveys of existing stream crossings were completed as part of the mammal surveys conducted on the 22nd and 23rd of February 2024. Survey methodology had regard to 'Monitoring the Otter Lutra lutra' (Chanin, 2003a) and 'Ecology of the European Otter' by Chanin (2003b). Otter signs searched for included spraints, footprints, tracks, couches, and holts.

Pine marten surveys were completed as part of the overall non-volant mammal surveys on the 22nd and 23rd of February, 2024. Surveys for this species primarily focused on the conifer plantation and woodland areas present within the Study Area. Any evidence of pine marten activity in the form of scat, prints and resting/breeding places

was recorded. Two trail cams were deployed within the site on the 22nd of February and were collected on the 9th of March 2024. Trail cams were deployed under licence (licence no. 227/2023).

Bats

Field surveys were carried out to identify and investigate potential bat roosting features at the Proposed Wind Farm, along the proposed grid route at points of interest, and along the proposed turbine delivery route. All structures with potential to host roosting bats were inspected visually from ground-level. Roosting features' potential is described according to Collins (2023). In addition, bat activity at the proposed wind farm was investigated using a combination of active and passive bat detector surveys.

A number of surveying methodologies were undertaken to inform the assessment of likely effects of the Proposed Development on bats, including:

- Bat foraging and commuting habitat suitability survey.
- Preliminary Roost Assessment (PRA).
- Nighttime Bat Walkover survey (NBW).
- Passive Automated Bat survey (PAB). Details of the methodologies of these surveys are detailed in Appendix 6-2 Ballinla Bat Survey Report. Preliminary Roost Assessment surveys were undertaken on the 23rd of April, 2024, nighttime bat walkover surveys were conducted on the 23rd of April, 14th of May, 16th of June and 8th of August, the 3rd of September and the 12th of September. The ground-level static surveys were undertaken over the course of the 2023-2024 bat season. PAB surveys deployed static units for the summer and autumn seasons of 2023 and for the spring, summer, and autumn seasons in 2024 for ten consecutive nights within each season. Initial PAB surveys across the summer and autumn 2023 seasons determined the majority of bat activity across the site is within the northern section which is possibly influenced by the Grand Canal which may be a valuable commuting and foraging resource for bats in the Proposed Development site. The PRA survey was conducted on the 23rd of April 2024, by a licenced MWP bat surveyor to inspect any buildings, structures and trees which could support roosting bats. PAB survey efforts were initially undertaken to capture data on the extent of bat activity within the site. Consequently, static detectors were deployed across areas in an attempt to capture as much habitat representation across the Proposed Development site as possible. A daytime walkover survey of farmland in the centre-west of the Study Area was undertaken on January 28th , 2025, to determine presence of potential roost features and general habitat suitability of this area.

Freshwater Aquatic Survey

As part of the aquatic survey report (see Appendix 6-1), biotic indices (Q rating system and Ephemera, Plecoptera, Tricoptera Index (EPT)) were used to assess water quality from ten identified watercourses which comprise EPA registered water bodies and identified field drains (see Figure 6-1). These indices use species richness and relative abundance to determine biological water quality. Results from indices indicate watercourses in the receiving environment are largely degraded due to excessive siltation and enrichment. Unsatisfactory ecological conditions were recorded at all locations.

The Study Area was defined as fluvial habitats (watercourses) potentially affected by the Proposed Development, including within the Proposed Development site, and those downstream, within the receiving environment. Survey sites were selected on waterbodies within and downstream of the Proposed Development. It is noted that there was once a standing waterbody in a field to the northeast of the site. This waterbody, which appeared to be a semi-natural pond, based on historical aerial imagery has been infilled and is mapped in the habitat map as spoil and bare ground (ED2). The field surveys comprised an evaluation of aquatic habitats, fish assessments and biotic assessment using aquatic macroinvertebrates, as well as onsite physico-chemical water quality measurements. Water quality affects the viability and quality of salmonid habitat so is useful in assessing habitats for aquatic organisms, including trout (Salmo trutta) and salmon (S. salar). To this end biological sampling and water quality indices were used to evaluate watercourses at selected locations. This field work was carried out on the 14th and 15th June (biological sampling) and 2nd and 3rd August (electric fishing carried out under licence) during 2023. A survey was also undertaken on 26th January when water levels were higher to determine if any waterbodies within the Proposed Development site drained to the north.

Statement of Limitations and Difficulties

Encountered Limitations to methodologies, procedures, equipment and knowledge can arise during the course of an ecological assessment. Some limitations may be foreseen and can be accounted for while others may not be apparent until the actual assessment has taken place. The Study Area contains areas of dense conifer mixed forestry plantation in the south of the site. Due to the inaccessibility of these areas, the internal forestry area could not be

fully surveyed. However, clearings and the outskirts of the plantations were accessible for surveys. A trail camera became dislodged after having been deployed outside of a potential badger sett. This location has been identified as a badger sett using the precautionary principle and due to the presence of recent activity by way of latrines and fresh digging in the vicinity of the suspected sett. The necessary protection measures outlined in Guidelines for the Treatment of Badgers Prior to the Construction of National Roads Schemes (NRA, 2005. 2009) will be applied in this case.

6.3.6 Rare and Protected Flora within the Study Area

6.3.6.1 Desk Study

The desktop study included a review of data held by the NBDC for the hectads N52 and N53. The search targeted plant species listed under the EU Habitats Directive, Flora Protection Order species (FPO) (2022), and species listed in the Irish Red List (Wyse Jackson, et al. 2016) within the hectads N52 and N53 which encompasses the Study Area. Species records are listed in Table 6-5.

Table 6-5: Documented Records of Protected Flora Species within Hectads N52 and N53

Name	Record Date	Designations and Status	Habitat Requirements (Curtis and McGough, 1988)[14,15]
Alder Buckthorn (*Frangula alnus*)	2010	Red List: Vulnerable	Wet soils, heaths, open woodland, river banks and bogs.
Basil Thyme (*Clinopodium acinos*)	1921	Red List: Endangered	Exposed esker ridges, in arable fields, on gravel, and on sandy soils.
Blue Fleabane (*Erigeron acer*)	2022	Red List: Endangered	Eskers, in dry grassland, sandy pastures and on walls - especially on calcium-rich substrates.
Fir Clubmoss (Huperzia selago)	2022	Habitats Directive [92/42/EEC] Annex V	Acidic, nutrient-poor upland heaths, moorlands, bogs, rocks.
Pyrola rotundifolia subsp. rotundifolia	2022	Red List: Endangered	Wet bogs, damp hollows in dunes, in fens, woods and on damp rock ledges.
Round-leaved Wintergreen (*Pyrola rotundifolia*)	2019	Red List: Endangered	Wet bogs, damp hollows in dunes, in fens, woods and on damp rock ledges.
Slender Tufted-sedge (*Carex acuta*)	2001	Red List: Near threatened	Ponds, lakes and marshes on mostly basic or weakly acid substrates.

6.3.6.2 Field Survey

The Study Area is dominated by conifer plantation and intensively managed agricultural grasslands in the north, with the southern area of the site being characterised by mixed conifer broadleaved woodlands and recently clearfelled areas.

No rare or protected flora species, including any of those listed in Table 6-5 above, were recorded during ecological surveys undertaken in the Study Area. While the lack of evidence of a protected species does not necessarily preclude its presence at the site either at this current time or in the future, the highly altered habitats in the area within the Study Area considered in combination with the species' habitat requirements as described by Curtis and McGough, 1988, indicate a lack of suitable habitat within the Study Area for any of the species to occur.

6.3.7 Protected Fauna within the Study Area

6.3.7.1 Non-volant mammals

Desk study Records of protected fauna were retrieved from the NBDC database for hectads N52 and N53 which encompasses the Study Area and information received from the NPWS data request for rare and protected species were reviewed. These records are listed in Table 6-7.

Table 6-6: Records of Protected Non-Volant Mammals from Hectads N52 and N53

Common Name	Species Name	Level of Protection	Hectad	Record Origin
Badger	*Meles meles*	Wildlife Act, 1976 (and Wildlife (Amendment) Act, 2000)	N52/ N53	NBDC
Eurasian Pygmy Shrew	*Sorex minutus*	Wildlife Act, 1976 (and Wildlife (Amendment) Act, 2000)	N52/ N53	NBDC
Eurasian Red Squirrel	*Sciurus vulgaris*	Wildlife Act, 1976 (and Wildlife (Amendment) Act, 2000)	N52/ N53	NBDC
European Otter	*Lutra lutra*	Wildlife Act, 1976 (and Wildlife (Amendment) Act, 2000). EU Habitats Directive (92/43/EEC) Annex II, Annex IV	N52/ N53	NBDC
Hedgehog	*Erinaceus europaeus*	Wildlife Act, 1976 (and Wildlife (Amendment) Act, 2000)	N52/ N53	NBDC
Pine marten	*Martes martes*	EU Habitats Directive (92/43/EEC) Annex V	N52/ N53	NBDC
Irish Hare	*Lepus timidus* subsp. *hibernicus*	Wildlife Act, 1976 (and Wildlife (Amendment) Act, 2000). EU Habitats Directive (92/43/EEC) Annex V	N52/N53	NBDC
Stoat	*Mustela erminea*	Wildlife Act, 1976 (and Wildlife (Amendment) Act, 2000)	N53	NBDC

6.3.7.1.2 Field Surveys

No visual observation of badger was made within the Study Area however signs of badger activity were frequently recorded throughout the Study Area during site visits. Evidence of badger activity in the form of scats and latrines were recorded throughout the Study Area, predominantly in the northwestern area comprised of conifer woodland and broadleaved woodland in areas located outside the Proposed Development boundary. Badger setts, three in total, were recorded in the vicinity of the Proposed Development site and were again focussed in the northwest of the Study Area within conifer forestry (Figure 6-6). These setts comprised a main sett in the northeast of the conifer woodland habitat with an annex sett located approximately 120m directly to the south of this. A third sett, a subsidiary sett, was identified approximately 1km west of these two setts in the far northwest of the Study Area. These sites displayed varying levels of badger activity when visited in February and September 2024. None of these setts are within 30m or 50m of any proposed turbine location or access track. The closest turbine (T2) is located c. 152.2m south of the nearest sett. The setts were revisited on the 12th of September 2024, which found badger setts at location 1 and 2, refer to Figure 6-6, were both recently in use by badgers, whilst the subsidiary sett in the far northwest at location 3, was determined to not be actively in use due to infilling of the sett entrance, no evidence of entrance having been in recent use, as well as a lack of prints or latrines located close by. During the daytime bat walkover undertaken on 28th of January 2025, an attempted sett was observed at the western extent of the Study Area in the centre of the site. The attempted sett was shallow and infilled with debris and measured approximately 35cm x 35m (length x height). This attempted sett is located approximately 380m from the nearest proposed infrastructure footprint and will not be removed as part of the Proposed Development.

Trail cams deployed to monitor a sett failed to capture active badger activity on video, however photographic stills were captured of a small mammal believed to be American mink (Neovison vison), an invasive mammal species and

not protected under legislation. No evidence of otter was found on the site, though there was instance of likely otter scat recorded along the banks of the Leitrim river in the south of the Study Area. No otter holts, couches or slides were found along this watercourse, though species may likely be using aquatic corridor for foraging purposes. Irish hare were present in vegetated areas and were noted in the northeast of the Study Area on the fringes of mixed woodland and in the centre of the site amongst the clear felled conifer plantation. No additional non-volant mammal species were identified during surveying of the site.

6.3.7.2 Bats

6.3.7.2.1 Desk Study

With regard to the Study Area, the Bat Habitat Suitability Index (BHSI) rating was determined for all Irish bat species. Bat habitat suitability for all bat species within the Study Area is 29.11 for hectad N53 and 23.78 for hectad N52, respectively, ratings which are considered very low. The highest rating value for any individual species was 48.

Table 6-7: Bat Habitat Suitability Index (BHSI) for the Study Area and surrounds (NBDC, 2024)

Species		Suitability Index Rating (N52/N53)	
		N52	N53
All Bats		23.78	29.11
Lesser Horseshoe bat	*Rhinolophus hipposideros*		
Nathusius' pipistrelle	*Pipistrellus nathusii*	2	5
Daubenton's bat	*Myotis daubentonii*	31	35
Natterer's bat	*Myotis nattereri*	25	34
Whiskered bat	*Myotis mystacinus*	13	16
Common pipistrelle	*Pipistrellus pipistrellus*	40	48
Leisler's bat	*Nyctalus leisleri*	36	45
Soprano pipistrelle	*Pipistrellus pygmaeus*	38	44
Brown long-eared bat	*Plecotus auritus*	29	35

6.3.7.2.2 Field Study

Overall, the PRA undertaken on the Study Area determined the area was considered to be of 'negligible' value to bats. In the north of the Study Area, the PAB surveys indicated activity was predominantly focussed on the Grand Canal flowing west to east, located outside the planning boundary for the Proposed Development. Nighttime walkover surveys in the south of the Study Area, indicated activity in the south was focussed along the watercourse which exits the Study Area to the south. PAB surveys determined that soprano pipistrelle had the highest number of passes recorded at 46.91% across both years. Common pipistrelle was the second most frequently recorded species at 34.53%. Overall bat activity in the south was relatively low and limited to common pipistrelle, soprano pipistrelle, Leisler's bats and Myotis spp. More details on these PRA and PAB bat surveys can be found in Appendix 6-2 – Ballinla Bat Report. Separately from surveying undertaken as part of the bat report, a daytime walkover survey was undertaken on the 28th of February 2025. This survey identified three potential roost features between three trees along a mature treeline of approximately twelve ash trees (Fraxinus excelsior) in the centre-west of the Study Area. At the time of surveying, livestock consisting of bullocks were located in the area where the ash treeline occurs, with the ground at the treeline showing disturbance from trampling highlighting their activity in this area of farmland. These trees were considered to be in relatively poor condition with dead branches and tree material present on the ground at time of surveying. The first potential roost feature (PRF) consisted of lifting bark on the trunk of the tree located at a height of c. 1.8 m, whilst the remaining two features consisted of fluting and/or wounding at approximately 1 m height. All trees were approximately 1.4 m in diameter and all PRFs faced north with the latter two being susceptible to water infiltration which indicated they may not be suitable as shelter for bats. Where the lifting bark PRF occurred, this feature was notably small and whilst it could be used by individual bats, in consideration of the isolated nature of the ash trees and their poor health, all the PRFs were considered to be of 'Low' habitat suitability. Therefore, in accordance with Collins (2023) guidance, no further survey for these trees was considered necessary.

6.3.7.3 Invertebrates Desk Study

NBDC records from the hectads N52 and N53 overlapping the Study Area indicate documented records for butterflies, and moths (Lepidoptera), beetles (Coleoptera) and bees (Hymenoptera). Species of note, including the legislative protection and/or conservation status of these species, are listed in Table 6-8.

Table 6-8: Documented Records of Terrestrial Macro-Invertebrate within N52 and N53 Encompassing the Study Area

Common Name	Species Name	Hectad	Level of Protection/Conservation Status[20]
Dark Green Fritillary	*Argynnis aglaja*	N52	None/'Vulnerable'
Dingy Skipper	*Erynnis tages*	N52/ N53	None/'Near Threatened'
Large Red-Tailed Bumble Bee	*Bombus (Melanobombus) lapidarius*	N52/ N53	None/'Near Threatened'
Marsh Fritillary	*Euphydryas aurinia*	N52/ N53	Annex II/'Vulnerable'
Small Heath	*Coenonympha pamphilus*	N52/ N53	None/'Near Threatened'
Wall butterfly	*Lasiommata megera*	N52/ N53	None/'Endangered'
Large Red-Tailed Bumble Bee	*Bombus (Melanobombus) lapidarius*	N52/ N53	None/'Near Threatened'

6.3.7.3.2 Field Study

No protected and/or threatened species, including those listed in Table 6-8, were recorded during ecological surveys completed in the Study Area. A number of other species of butterfly and bee were noted during surveys, including the small tortoiseshell butterfly, the peacock butterfly, speckled wood, meadow brown, ringlet, silverwashed fritillary, orange tip, painted lady, small heath, green-veined white, common carder bee, and white tailed bee species. None of these species are considered threatened or vulnerable and are not afforded legal protection in Ireland. Regarding Q values: Site 1, Site 7 and Site 12 were rated Q3-4 'Moderate' status, Site 6 was rated 'Poor' status whilst the remaining sites were unsuitable for Q-rating due to unsuitable habitat present for surveying. With regard to EPT index, water quality varied between 0 at site 1 to 7 at Sites 1, 3, 4, 8, 9, and 11. Results of the EPT index indicated degraded water quality. Biological water quality results and interpretations at study sites on watercourses potentially affected by the Proposed Development are detailed in Table 6-9. Water quality was Unsatisfactory (Moderate or Poor status) across the Study Area which may be due to the substrate siltation causing reduced biological diversity and thus reduced biological water quality across the Study Area. High and persistent sediment loads may affect invertebrate assemblages and abundances, with Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa exhibiting the greatest negative response to increased sediment

6.3.7.4 Freshwater Aquatic species Desk Study

In order to collate information on aquatic species and to identify features of aquatic ecological importance within the Study Area, a desk-top study was undertaken. Details of records of aquatic macroinvertebrates, fish, and amphibians are detailed in the Aquatic Ecology and Fish report, which can be found in Appendix 6-1. Aquatic species recorded in the N52 and N53 hectads are listed in the table below. The influence of the Boyne catchment to the north of the Proposed Development site is likely driving the presence of lamprey and salmon in N53. Though white-clawed crayfish has been recorded in N52 and N53, EPA biological sampling did not return records for the species in 2022.

Table 6-10: Documented records of freshwater aquatic species within N52 and N53 encompassing the Study Area

Common Name	Species Name	Level of Protection	Hectad	Record Origin
Brook lamprey	*Meles meles*	Wildlife Act, 1976 (and Wildlife (Amendment) Act, 2000)	N52/ N53	NBDC
Atlantic salmon	*Salmo salar*	Wildlife Act, 1976 (and Wildlife (Amendment) Act, 2000). EU Habitats Directive (92/43/EEC) Annex II, Annex IV	N52/N53	NBDC
White-clawed crayfish	*Austropotamobius pallipes*	Wildlife Act, 1976 (and Wildlife (Amendment) Act, 2000). EU Habitats Directive (92/43/EEC) Annex II, Annex V	N52/N53	NBDC

6.3.7.4.2 Field Study

As part of the aquatic baseline surveys, extensive surveying of the watercourses within the site was undertaken. Surveying found that the Leitrim River within the site is not utilised by spawning salmonids due to its small size and slow flowing watercourse. Despite brown trout being found in the Leitrim River itself, those found were deemed to have spawned in the Esker River located downstream. Other species found in the watercourses draining the Study Area included three-spined stickleback (36), brown trout (15), minnow (41), pike (2), dace (4), perch (1), and brook lamprey (1). Salmonids were absent from all sites with the exception of Site 10 (Leitrim River) and 12 (Esker stream) due to a lack of habitat suitability but also partly due to water quality, with these two features being interrelated in small channels draining the site. Overall, the biological water quality is considered to be largely compromised within the Study Area which suggests an unstable aquatic ecosystem in smaller channels within the site attributed to loss of soils to streams and associated enrichment relating to agriculture and coniferous forestry, albeit to a lesser degree. Though a single brook lamprey was recorded during electrofishing efforts on the Leitrim River, the aquatic report concluded that migratory lamprey species such as sea and river lamprey are highly unlikely to occur in watercourses within the Study Area.

6.3.7.5 Reptiles & Amphibians

6.3.7.5.1 Desk Study

Common frog (Rana temporaria) has been recorded previously in hectads N52 and N53, encompassing the Study Area. Smooth newt (Lissotriton vulgaris) has been recorded previously in hectad N53. Both species are protected under the Wildlife Act, 1976 (and Wildlife (Amendment) Act, 2000) and Common frog is also listed under Annex V of the EU Habitats Directive.

Table 6-11: Records of Protected Reptile/Amphibian Species Recorded in N52 and N53

Common Name	Species Name	Level of Protection	Hectad	Record Origin
Common frog	*Rana temporaria*	Wildlife Act, 1976 (and Wildlife (Amendment) Act, 2000). EU Habitats Directive (92/43/EEC) Annex V	N52/ N53	NBDC
Smooth newt	*Lissotriton vulgaris*	Wildlife Act, 1976 (and Wildlife (Amendment) Act, 2000)	N52	NBDC

6.3.7.5.2 Field Study

Some suitable breeding habitat for frog was identified within the Study Area. tadpoles were identified at one location in a drainage ditch in the northern extent of the site in June 2023. However, there was evidence of failed frog spawning at the site when surveyed in February 2024. No Smooth newt nor its habitat was identified during any site surveys.

Ecological Receptor	Legislative Protection	Ecological Value	Rationale	Important Ecological Receptor
Eurasian Pygmy Shrew (*Sorex minutus*)	Wildlife Acts, 1976 to 2021, as amended	Local importance (higher value)	The species is protected under national legislation. Not recorded during ecological surveys but suitable habitat occurs. Precautionary principal.	**Yes**
Eurasian Red Squirrel (*Sciurus vulgaris*)	Wildlife Acts, 1976 to 2021, as amended	Local importance (higher value)	The species is protected under national legislation. Not recorded during ecological surveys but suitable habitat occurs. Precautionary principal.	**Yes**
European Otter (*Lutra lutra*)	Wildlife Acts, 1976 to 2021, as amended. Annex II, Annex IV of the EU Habitats Directive (92/43/EEC)	Local importance (higher value)	The species is protected under national and European legislation. Evidence of the species (scat) found near watercourse on site during surveying. No evidence of holt on watercourse. may use area for commuting	**Yes**
Hedgehog (*Erinaceus europaeus*)	Wildlife Acts, 1976 to 2021, as amended	Local importance (higher value)	This species was not recorded on site during ecological surveying. however, suitable habitat exists and there are desktop records in the greater area. This species is protected under national legislation.	**Yes**
Pine marten (*Martes martes*)	Annex V Habitats Directive, Wildlife Acts, 1976 to 2021, as amended	Local importance (higher level)	Species not identified during surveying though area contains suitable resting and breeding habitat for the species	**Yes**
Irish Hare (*Lepus timidus hibernicus*)	Annex V Habitats Directive, Wildlife Acts, 1976 to 2021, as amended	Local importance (higher value)	National legal protection, observed during surveying, particularly in the northern areas of the Study Area. Consequently, site was considered to contain suitable resting and breeding habitat for the species.	**Yes**
Irish stoat (*Mustela erminea hibernica*)	Wildlife Acts, 1976 to 2021, as amended	Local importance (higher level)	The species is protected under national legislation. Suitable resting and breeding habitat occurs.	**Yes**
Bats				
Lesser Horseshoe bat (*Rhinolophus hipposideros*)	Wildlife Acts, 1976 to 2021, as amended. Annex II and Annex IV of the EU Habitats Directive (92/43/EEC)	Local importance (lower level)	None detected during survey efforts across 2023 and 2024 survey seasons. No records within 10km of the site and the BHSI rating for this species is 0 throughout the site	No
Nathusius' pipistrelle (*Pipistrellus nathusii*)	Wildlife Acts, 1976 to 2021, as amended. Annex IV of the EU Habitats Directive (92/43/EEC)	Local importance (higher level)	Species identified during surveying	**Yes**
Daubenton's bat (*Myotis daubentonii*)	Wildlife Acts, 1976 to 2021, as amended. Annex IV of the EU Habitats Directive (92/43/EEC)	Local importance (higher level)	Species potentially identified during surveying	**Yes**

Ecological Receptor	Legislative Protection	Ecological Value	Rationale	Important Ecological Receptor
Natterer's bat (*Myotis nattereri*)	Wildlife Acts, 1976 to 2021, as amended. Annex IV of the EU Habitats Directive (92/43/EEC)	Local importance (higher level)	Species potentially identified during surveying	**Yes**
Whiskered bat (*Myotis mystocinus*)	Wildlife Acts, 1976 to 2021, as amended. Annex IV of the EU Habitats Directive (92/43/EEC)	Local importance (higher level)	Species potentially identified during surveying	**Yes**
Common pipistrelle (*Pipistrellus pipistrellus*)	Wildlife Acts, 1976 to 2021, as amended. Annex IV of the EU Habitats Directive (92/43/EEC)	Local importance (higher level)	Species identified during surveying	**Yes**
Leisler's bat (*Nyctalus leisleri*)	Wildlife Acts, 1976 to 2021, as amended. Annex IV of the EU Habitats Directive (92/43/EEC)	Local importance (higher level)	Species identified during surveying	**Yes**
Soprano pipistrelle (*Pipistrellus pygamaeus*)	Wildlife Acts, 1976 to 2021, as amended. Annex IV of the EU Habitats Directive (92/43/EEC)	Local importance (higher level)	Species identified during surveying	**Yes**
Brown long-eared bat (*Plecotus auritus*)	Wildlife Acts, 1976 to 2021, as amended. Annex IV of the EU Habitats Directive (92/43/EEC)	Local importance (higher level)	Species identified during surveying	**Yes**
Terrestrial Macro-Invertebrates				
Marsh Fritillary (*Euphydras aurinia*)	Annex II of the Habitats Directive (92/43/EEC)	Local importance (lower value)	No suitable habitat composed of devil's bit scabious (*Succisa pratensis*) was identified during field surveys. Unlikely to occur	No
Other terrestrial macro-invertebrates (bees, butterflies etc.,)	N/a	Local importance (higher value)	The terrestrial insect population in semi-natural terrestrial habitats is important at the lower level of ecosystem food chains, for example, essential for sustenance of bats.	**Yes**
Aquatic Species				
White-clawed crayfish (*Austropotamobius pallipes*)	Wildlife Acts, 1976 to 2021, as amended. Annex II and Annex V of the Habitats Directive (92/43/EEC)	Local importance (lower value)	Though NBDC reports records of the species in the River Deel once supported crayfish but was decimated in 2017, likely due to the introduction of crayfish plague. Not recorded during EPA sampling in 2020.	No
Brook Lamprey (*Lampetra planeri*)	Annex II of the Habitats Directive (92/43/EEC)	Local importance (higher value)	Common species in most fluvial habitats with suitable spawning and nursery habitats. One brook lamprey identified during surveying, however unlikely to be spawning in area	**Yes**
Atlantic Salmon (*Salmo salar*)	Annex II, Annex V of the Habitats Directive (92/43/EEC)	Local importance (lower value)	Overall evaluation of the salmon habitat at aquatic survey sites was considered unsuitable and	No

Ecological Receptor	Legislative Protection	Ecological Value	Rationale	Important Ecological Receptor
			marginal for all sites (1-11) other than site 12. Site 12 (Leitrim River) was considered to be suboptimal for early life stages and spawning adult salmon. Due to the morphological characteristics of the Leitrim River.	
Freshwater Pearl Mussel (*Margaritifera Margaritifera*)	Wildlife Acts, 1976 to 2021, as amended. Annex II, Annex IV of the Habitats Directive (92/43/EEC)	Local importance (lower value)	No habitat for the species exists within the site. Aquatic surveys found no evidence of the suitable habitat or presence of species in watercourses.	No
Other fish species (e.g., Brown trout (*Salmo trutta*), minnow (*Phoxinus phoxinus*), three spined stickleback, stone loach (*Barbatula barbatula*), dace (*Leuciscus leuciscus*), perch (*Perca fluviatilis*), and pike (*Esox lucius*)	N/a	Local importance (higher value)	These species were recorded during electrical fishing in watercourses draining the Study Area	**Yes**
Reptiles & Amphibians				
Common Frog (*Rana temporaria*)	Wildlife Acts, 1976 to 2021, as amended	Local importance (higher value)	Drainage ditches located throughout the site provide spawning habitat for frog. Tadpoles were identified at one drainage ditch location in June 2023, though no evidence of successful spawning in February 2024. It is considered likely that frogs spawn in other drainage ditches within the Study Area.	**Yes**
Smooth Newt (*Lissotriton vulgaris*)	Wildlife Acts, 1976 to 2021, as amended	Local importance (lower value)	Neither species nor pond habitat were identified within the Study Area.	No

6.4 Assessment of Impacts and Effects

Wind farm developments are projects that may potentially impact on the natural environment (habitats, flora, fauna, water quality, and aquatic ecology). For wind farm projects, the construction phase has the potential to have the most significant effect on biodiversity. This section will identify in detail the potential ecological impacts of the construction, operational, and decommissioning phases of the Proposed Development on the receiving natural environment. The potential impacts of the Proposed Development were considered and assessed to ensure that all effects on IEFs are adequately addressed, and no significant residual effects are likely to remain following the implementation of mitigation measures.

6.4.1.3 Bats

Wind turbines and associated infrastructure present four main potential construction phase impacts to bats, namely:

- Collision mortality, barotrauma and other injuries.
- Loss or damage to commuting and foraging habitat.

• Loss of, or damage to, roosts.
• Displacement of individuals or populations.

Whilst the Study Area is predominantly composed of intensive agricultural grasslands and dense conifer plantations with a general lack of roosting opportunities, the foraging and commuting habitat is suitable with good connectivity to the surrounding habitats. Pasture-based agriculture will continue in undeveloped areas in the Study Area post-construction and the impact of foraging habitat loss to bats is likely to be not significant. Whilst linear habitat features such as hedgerows and treelines are common features in the wider landscape, the loss of these commuting habitats will potentially displace some bats in the immediate environs of the Proposed Development and marginally reduce habitat connectivity. It should be noted that, in the context of wind farm development, it is preferrable to reduce habitat connectivity in the immediate locality of turbines to reduce the potential for collision and barotrauma to occur. No bat roosts were confirmed within the Proposed Development area with the assessments as outlined in the bat report (see Appendix 6-2 – Ballinla Bat Survey Report) determining the site was of 'negligible' potential for roosting bats. Bat activity surveys across the site determined that the majority of activity was found to be within the northern section of the Proposed Development Study Area, likely driven by the Grand Canal which borders the site to the north, as well as the presence of relatively higher number of linear habitats in the north of the site such as hedgerows and treelines. Comparatively, the southern section of the Study Area is dominated by relatively dense conifer plantation-mixed broadleaf woodland which is not conducive to favourable bat habitat. Most bat activity in the south, albeit low activity, was recorded in areas relatively clear of trees such as along the river watercourse and in areas of scrub.
No significant potential tree roost locations suitable to support roosting bats were noted along the grid route. Trees proposed for removal within the wind farm site are considered to be of low suitability. Trees located along the proposed turbine delivery route are also considered to be of low suitability for bat roosts.
Construction phase lighting has the potential to attract certain bat species and displace others, however this will be temporary in nature, relatively localised around the site compound, and limited to standard construction hours which are mostly during daylight hours. Overall, the potential effects on bats during the construction phase of the Proposed Development are considered to be slight negative.
Details of the construction phase impacts can be found in Appendix 6-2- Ballinla Bat Survey Report, the results of which are summarised in Table 6-17.

6.4.2 Operational Phase

6.4.2.1 Habitats and Flora

During the operational phase of the Proposed Development, significant effects on habitats and flora are not anticipated. No additional habitat loss is required as part of the operational phase. Fuel and/or oil spills are unlikely to occur due to the limited use of plant and machinery that will be required during the operational phase. In the unlikely event that a spill was to occur the significance of any potential effects will be ameliorated by the inherent limiting effects of the small volumes and the fact that any dispersal plume will not percolate through the soil beyond the immediate footprint of the spill area. During reinstatement, bare areas at the site, including felled areas around turbines will be re-vegetated, reducing the potential for encroachment of invasive and ruderal species, and also reducing any potential for increased run off from the site. During the operation of a wind farm, any medium and long-term impacts are typically associated with the permanent site infrastructure such as access tracks, turbine bases, and hard stands (Natural England, 2010) which, in the case of the Proposed Development, are sited primarily in agricultural grassland and forestry plantation habitats. While impacts during the operational phase may be lower in magnitude, the Proposed Development is likely to operate for up to 35 years. Impacts associated with the operational phase include sediment release and chemical pollution, alteration of surface water flows by new drainage systems as well as localised disruption of flow paths near turbine stands and water table lowering near drainage ditches. Alteration of flow pathways can alter erosion potential downstream due to changes in runoff patterns and/or changes in sediment supply. Regarding habitats with potential to support mammals, the area of conifer plantation with pockets of broadleaved woodland in the northern section of the Study Area has been avoided by design due to the presence of badger of setts in this area. Other habitats with lower relative ecological value and higher proportional representation within the Proposed Development site were chosen as alternative. Consequently, the potential effects on terrestrial habitats and flora, identified as IEFs in Table 6-13 above, during the operation phase of the Proposed Development, in the absence of mitigation, are assessed as long-term, imperceptible, negative effects. The potential effects on aquatic habitats, comprising 'Depositing/lowland rivers

(FW2)' and 'Drainage ditches (FW4)' during the operational phase of the Proposed Development, in the absence of mitigation, are assessed as long-term, slight negative effects.

6.4.2.2 Non-Volant Mammals

No significant disturbance and/or displacement impacts are expected to affect protected mammals selected as IEFs, detailed in Section 6.4.1.2, Table 6-13 above. Once the construction phase of the Proposed Development has been completed, any individuals of protected non-volant mammal species (badger, otter, pine marten, Irish hare, Irish stoat, hedgehog, pygmy shrew or red squirrel) that may have been temporarily displaced owing to construction activity are expected to utilise the habitats within and adjacent to the Proposed Development site within a short period of time. During the operational phase, there may be some slight disturbance owing to noise and human activity arising from periodic maintenance. however, it is considered that the level of operational traffic, human presence and ongoing maintenance will not significantly exceed existing noise levels at the site, given the level of agricultural and other activity within/surrounding the Study Area.

There is some potential for minor excavations associated with drainage, access track and cable maintenance. however, these will be small in scale and infrequent in comparison to the construction phase. Maintenance works on turbines will be carried out from the tracks and hardstands. Some erosion of soil will continue into the operation phase, however, as vegetation becomes established and equilibrium is achieved, erosion rates will reduce to pre-construction levels, lowering the risk of effects on species such as otter. Operational phase effects which may arise as a result of potential disturbance/displacement impacts on nonvolant mammals identified as IEFs (badger, otter, hedgehog, pygmy shrew, red squirrel, Irish hare, Irish stoat, pine marten), in the absence of mitigation, are assessed as long term, slight to imperceptible negative effects.

6.4.2.3 Bats

The primary impact to bats associated with the operational phase of the Proposed Development is considered to be injury/mortality caused by potential collision with operational turbine blades and/or barotrauma (damage to internal tissues caused by rapid changes in air pressure as a result of moving turbine blades) (Mathews et al., 2016). Several operational phase impacts are presented by wind turbines and associated infrastructure namely injury and/or mortality due to collision with turbine blades and/or barotrauma, and from the displacement and/or disturbance of foraging, commuting, or roosting bats. The susceptibility of bat species likely to be at risk of impacts from wind turbines is partly associated with the likelihood of different species flying at rotor blade height. Bat activity at the site was considered to be low across all seasons for all species. Though there is little published evidence regarding bat fatalities at wind farms in an Irish context, species of bats which may be considered to be at greater risk include Leisler's bat which are relatively larger, higher flying, and forage independently of linear habitat features such as treelines and hedgerows. However, decreased connectivity to proposed turbine locations is considered desirable to reduce risk of injury and/or fatality as a result of collision with wind turbines and/or their blades. A licenced senior bat ecologist from MWP carried out an assessment of collision risk scheme provided in NatureScot (2021) and the assessment is considered to represent the best available information for use in an Irish context. Species are categorised into 'Low', 'Medium', and 'High' risk based on flight characteristics and foraging behaviour as well as fatality rates in the UK, whilst relative abundance was determined according to a scheme for rarity of bat species in Wray et al., 2010, using best available population data from recent Article 17 reports (NPWS, 2019). The estimation is presented in Table 6-21

Table 6-21: Estimation of Irish bat species' Population Vulnerability to Wind Energy Development

Relative Abundance	Collision-Risk		
	Low	Medium	High
Common (100,000 plus)			Common Pipistrelle Soprano Pipistrelle
Rarer (10,000 – 100,000)	Daubenton's Bat Brown Long-eared Bat Lesser Horse-shoe Bat		Leisler's Bat
Rarest (under 10,000)	Natterer's Bat Whiskered Bat		Nathusius Pipistrelle

Population vulnerability: yellow = low, orange = medium, red = high.

NatureScot (2021) recommends a two-stage process in determining risks to bats from wind farms projects. The first stage assesses risk based on habitats present and development related features including the number of proposed

turbines and size, as well as proximity to other wind farm developments. The second stage assesses risk for high-collision species (see Table 6-22) considering species vulnerability and results of bat activity.
In relation to stage one, a habitat site risk of 'Low' was considered appropriate due to a lack of roost features within the site, low-quality foraging habitat and the site being relatively isolated. In consideration of developmentrelated features, the Proposed Development is considered to be in the 'Medium' category considering the seven turbines proposed, with other wind farms located within 10km. This category uses the number of turbines, turbine height and proximity to other wind developments as the descriptors to define project size. Although the 185m blade tip height of the turbines indicates their classification as a 'Large' project, the number of turbines proposed (7) and proximity to other wind developments also requires consideration and as a result the category of 'Medium' was considered by the assessor to be a more appropriate project size category. Based on the initial risk assessment the Proposed Development is considered to be 'Medium Risk' to bats and a site risk score of 3 is applicable.
In relation to stage two, 'high collision-risk' species are assessed with regards to their activity level within the site in each monitoring period and in doing so identifies projects of greatest concern in terms of collision risk. The 'high collision-risk' species are Leisler's bat, Common pipistrelle, Soprano pipistrelle and Nathusius' bat.
Leisler's bat is a common species in Ireland and is considered high-risk due to their foraging behaviour and flight characteristics. Their minimum population range in Ireland is estimated at between 63,000 to 113,000 and they were recorded across all seasons during activity surveys. In the context of the proposed wind farm, their activity levels are considered 'Low' across the surveying seasons. Soprano pipistrelle is also considered a 'high collision risk' species due to their foraging ecology and flight characteristics. Activity levels for this species is considered to be 'Low' across all survey seasons.
Common pipistrelle is another widespread species in Ireland and is considered high-risk due to their foraging behaviour and flight characteristics. Activity levels for this species was considered to be 'Low' across all survey seasons. The fourth 'high collision risk' species Nathusius' pipistrelle is a slightly less agile, albeit fast, flyer compared to other pipistrelle species. Like the other species considered, Nathusius' pipistrelle is of high collision risk due to their foraging behaviour and flight characteristics. This bat species was only recorded during 2024 surveying efforts with low numbers of registrations, thus yielding a 'Low' activity category for this species. Table 6-22 gives the result of the assessment, with scoring being a product of multiplying site risk and the activity category for high collision species. The overall assessment results are categorised as follows: Low (green): 0 – 4, Medium (amber): 5 – 12, High (red): 15 – 25.

Table 6-22: Overall Collision Risk Assessment of Relevant (High-Risk) Bat Species

	Species	Site Risk Level	Activity Category	Overall Assessment
Summer 2023	Leisler's Bat	3	Low (1)	3
	Common Pipistrelle	3	Low (1)	3
	Soprano Pipistrelle	3	Low (1)	3
Spring 2023	Leisler's Bat	3	Low (1)	3
	Common Pipistrelle	3	Low (1)	3
	Soprano Pipistrelle	3	Low (1)	3
Spring 2024	Leisler's Bat	3	Low (1)	3
	Common Pipistrelle	3	Low (1)	3
	Soprano Pipistrelle	3	Low (1)	3
	Nathusius' Pipistrelle	3	Low (1)	3
Summer 2024	Leisler's Bat	3	Low (1)	3
	Common Pipistrelle	3	Low (1)	3
	Soprano Pipistrelle	3	Low (1)	3
	Nathusius' Pipistrelle	3	Low (1)	3
Autumn 2024	Leisler's Bat	3	Low (1)	3
	Common Pipistrelle	3	Low (1)	3
	Soprano Pipistrelle	3	Low (1)	3
	Nathusius' Pipistrelle	3	Low (1)	3

Overall collision risk assessment: Low (green), medium (amber), high (red) (following SNH, 2019).

The overall risk assessment pertains to high-risk species, and per NatureScot (2021), there is no requirement to assess for low-risk species (see Table 6-21). Low-risk species recorded at the site included Brown Long-eared bat,

Natterer's bat, Whiskered bat, and Daubenton's bat. Overall, activity levels for these species were 'Low' and no significant related risk is likely in consideration of their low potential vulnerability to wind energy developments. Lesser horseshoe bat was not recorded during any of the surveys.

The effect of potential impacts to bats during the operational phase of the proposed wind farm development is considered to be slight negative at a local level in the absence of mitigation. For more details refer to Appendix 6-2 – Ballinla Bat Survey Report. The results of the assessment of operational effects are detailed in Table 6-23.

Table 6-23: Operational Stage Potential Effects to Important Ecological Feature Bat Species Without Mitigation

Important Ecological Feature	Description of Unmitigated Impact	Significance of Unmitigated Effects (NRA 2009 & EPA 2022)
Common pipistrelle (*Pipistrellus pipistrellus*) **Soprano pipistrelle (*Pipistrellus pygmaeus*)**	Injury/mortality due to collision/barotrauma associated with rotating turbine blades.	Injury/mortality due to collision/barotrauma during the operational phase is assessed as **long-term, slight negative effects**.
Leisler's bat (*Nyctalus leisleri*) **Nathusius' bat (*Pipistrellus nathusii*)**	Disturbance/displacement of foraging/commuting bats due to loss of relevant habitat, increased lighting.	Disturbance/displacement during the operational phase is assessed as **long-term, slight negative effects.**
Daubenton's bat (*Myotis daubentoniid*) **Brown long-eared bat (*Plecotus auritus*)**	In consideration of these species' flight characteristics and foraging behaviour, they are considered to be at low risk of injury/mortality due to collision with turbine and/or its blades.	Injury/mortality due to collision/barotrauma during the operational phase is assessed as **long-term, insignificant negative effects**.
Whiskered bat (*Myotis mystacinus*) ***Myotis* spp.**	Disturbance/displacement of foraging/commuting bats due to loss of relevant habitat, increased lighting.	Disturbance/displacement during the operational phase is assessed as **long-term, slight negative effects.**

6.4.2.4 Terrestrial Macro-Invertebrates

With regard to other macro-invertebrates, once the construction phase has been completed, other than those initially displaced by the construction of the development would utilise the habitats within and adjacent to the Proposed Development boundary Proposed Development within a short period of time. Disturbance and/or displacement effect on terrestrial macro-invertebrates during the operational phase are assessed as long-term, insignificant, negative effects.

6.4.2.5 Freshwater Aquatic Species

Once the construction phase is completed the source element of the source-pathway-receptor pathway will be significantly reduced. Whilst there is some potential for minor excavations associated with drainage, access track and cable maintenance, however these will be small in scale and infrequent in comparison to the construction phase. Maintenance works on turbines will be carried out from the tracks and hardstands. Some erosion will continue into the initial operational phase, however as vegetation becomes established and equilibrium is achieved, erosion rates will reduce to pre-construction levels, with the risk of water quality impacts and related effects returning to pre-construction conditions.

The effects on fish species during the operational phase are assessed as long-term, insignificant negative effects. With regard to aquatic macro-invertebrates. the majority of species recorded on site during aquatic surveying were pollution tolerant species with low diversity between communities. Low diversity reflects the current fluvial condition within the onsite waterbodies, some of which are degraded from anthropogenic pressures such as agriculture and forestry. Any disturbance and/or displacement effects on aquatic macroinvertebrates during the operational phased are assessed as long-term, neutral effects.

6.4.2.6 Reptiles & Amphibians

Though common frog (Rana temporaria) utilises the site for breeding and foraging, it is expected that any frogs that may have been temporarily affected due to the construction activity would utilise aquatic habitats within and downstream of the Proposed Development site within a short period of time. The disturbance and/or displacement effects on common frog during the operational phase are assessed as longterm, neutral effect.

6.4.2.7 Water Quality

Biological water quality results are suggestive of an unstable ecosystem in some channels with the most likely influencer of water quality being enrichment from soil loss to streams. The Q-values scored the biological water quality as Moderate or Poor at all sites whilst downstream EPA monitoring sites were also rated as Moderate in 2020 with improvements at Clonbulloge, downstream of the confluence with the River Figile located approximately 10km downstream of the Study Area. Based on the results of aquatic surveys, it is concluded that the main water quality problems in the study are related to agriculture and to a lesser degree coniferous forestry, with some albeit reducing legacy effects of peat harvesting practices in the past. The operational phase does not pose potential significant effects to water quality directly, however indirect effects may arise as a result of the operational phase which may affect water quality. In general, drainage and changes to morphology could comprise a potential risk to water quality during the operational phase of a wind farm development in the absence of appropriate design and mitigation. Consequently, any impact likely to occur as a result of the operational phase to water quality is assessed as being likely short-term, imperceptible negative effect at a local level

6.4.4 Cumulative Effects

A cumulative effect arises from incremental changes caused by other past, present, or reasonably foreseeable activities interacting synergistically with the impacts generated by the Proposed Development in a manner that has the potential to cause effects on the receiving environment. The activities, pressures and projects identified as plausible sources of impacts to be assessed for their potential to generate cumulative effects are listed in Table 6-24, as are the characterisations of cumulative effects. The assessment and rationales supporting the individual characterisations of other ongoing activities in the broader environs are provided in Sections 6.4.4.2.1 to 6.4.4.2.4, inclusive, below. In each case the Confidence Level of the Prediction is Near certain

Table 6-24: Characteristics of Cumulative Effects for Proposed Development

Other Activities	Characterisation of Effect			Confidence level
	Quality	Significance	Duration	
Agriculture	Negative	Moderate	Short term	Near certain
Peat Extraction	Neutral	Imperceptible	Short term	Near certain
Forestry	Negative	Slight	Short term	Near certain
Wind Farm Development	Neutral	Slight	Long-term	Near certain
Solar Farm Development	Neutral	Imperceptible	Long-term	Near certain
Plans (minor)	Neutral	Imperceptible	Long-term	Near certain

6.4.4.1 Plans

The Proposed Grid Connection for the Proposed Development and Proposed TDR has also been assessed as part of this EIA and is therefore not considered cumulatively. The Proposed Development was considered in combination with other plans and projects that could result in cumulative effects including:

- Offaly County Wind Energy Strategy (2021- 2027).
- Offaly County Development Plan 2021-2027.

Any development under these plans will firstly have to be consented under planning and development legislation. Significant cumulative impacts are not predicted with the plans listed above, as each plan has a range of environmental and natural heritage policy safeguards in place. Furthermore, this Proposed Development has been developed in view of achieving the objectives of these plans. Therefore, development of the Proposed Development in combination with the scope of works required to achieve the objectives of these plans will not result in cumulative effects. In terms of the Proposed Development, the zoning in the development plans relates to wind energy development and there is no other contradictory zoning for other project types or infrastructure. In terms of the Offaly County WES, the area where the Proposed Development is to be located is deemed 'Open for consideration for Wind Energy development' in principle. The material for the cumulative assessment was gathered

through a search of relevant County Councils' Online Planning Registers, the ABPs website and the EIA Portal. A review of applications for the preceding 5 years was carried out during the EIA process. The search focused on the townlands common to the development area. All other wind farm developments were considered within 15km of the site for cumulative impact on biodiversity. Finally, recent planning applications that are pending a decision from the planning authority, which were accompanied by an EIAR, were also considered. The projects in the surrounding areas mostly relate to small scale development including agricultural sheds and shed extensions, dwelling houses, and extensions to dwelling houses, attic conversions, domestic wastewater treatment systems, installation of photovoltaic for domestic purposes, garages, demolitions, and retention permission applications etc.
Such minor domestic and agricultural development will not introduce cumulative effects. These minor projects are either under the threshold for EIA or excluded from the list of projects requiring EIA and due to the nature and scale of these applications would not introduce complex or significant issues. Therefore, they are not considered in the cumulative assessment. The most relevant applications relate to the expansion of Ballinla Farm within the subject site. The remaining developments are ancillary applications for the nearby wind farms or Edenderry Power Station.

6.5 Mitigation and Monitoring Measures

6.5.1 Mitigation by Design

Site design was carried out with cognisance to ecological features to minimise the impact of the Proposed Development on biodiversity and other environmental receptors. Consultation between the design team (project manager, project engineers, and project ecologists) and the Applicant was conducted on a regular basis during the design phase in order to formulate a project design which would avoid, prevent, and/or minimise any significant adverse environmental effects, in so much as was practicably possible. A considerable effort was spent by the project ecologists and engineers on avoiding or minimising ecological effects and this has been constraint led throughout the design process. The Proposed Development has been designed wherein the footprint avoids relatively ecologically valuable habitats. This has been achieved in collaboration with engineering constraints, for example by taking account of habitat value, the location of badger setts, and areas potentially impacted by the Proposed Development. During the construction phase, there is potential for increased sedimentation to surface waters via runoff which may lead to potential contamination of immediate and downstream watercourses without the implementation of appropriate mitigation. Consequently, the need to keep clean water clean (i.e., runoff from adjacent ground upslope of the permitted development footprint) and manage all other runoff and water for construction is fundamental. In consideration of these requirements and in order to safeguard water quality from any potential increased sediment as a result of the wind-farm development, a specific drainage system has been designed. The system is designed to ensure it will largely mimic the existing drainage regime across the site and will not deteriorate water quality. A Water Quality Management System has been prepared to control erosion and prevent sediment runoff during the construction phase of the Proposed Development. The implementation of sediment and erosion control measures will ensure the construction and early-post construction phases of the Proposed Development will not create adverse effects on the aquatic environment including effects to water quality. Furthermore, a site-specific Surface Water Management Plan (SWMP) has been designed for the Proposed Development to avoid impacts to water quality both in immediate and downstream surface waters.
In the north of the Proposed Development site, within the areas to be managed for bats as per the SNH guidance at T1, T2, and T3, linear hedgerow habitats within the zones will be retained with hedgerows being kept short, c. 1m to 1.5m in height, as opposed to being lost entirely. This was considered a better option when considering the relative openness of the surrounding landscape. Retaining these linear features at these turbines should limit bats being drawn towards turbines. The retention of these linear features should create a shield effect and draw incoming bats away from the turbine hardstand. The length of these retained habitats is approximately 700m in length.
Where there will be unavoidable removal of hedgerow and treeline habitat, these areas of losses will be reinstated within the proposed site. A linear length of approximately 1km for hedgerow has been designed alongside the Proposed Development with a further minimum 0.76ha of additional potential enhancement and/or creation area provided (see Figure 6-8 and drawing number 23882-MWP-00-00-DR-C-5426 landscaping plan). These areas will be rewilded or fully reinstated with native trees and shrub species and will be composed of at least 75% whitethorn and 25% of other native species in keeping with ideal hedgerow creation (NBDC, 2009). Some of the habitat creation area will be managed with shallow routing species as collector cable and grid connection cable will require a 3m buffer zone from trees. South of T5 a forested area bordering a naturalised land drain classed as a lowland depositing river will be removed in order to accommodate the bat buffer felling zone around the turbine. Where conifer trees will be removed from the bank of the watercourse due to overlap with felling zone, these areas will not be replanted with improved species in order to minimise drawing in of bats towards the turbines during the

operational phase. The riparian zone along the Leitrim stream will be preserved even if it does occur within the bat buffer zone. This is specific to T6 and T7 in the south. The keeping of the riparian zone on the Leitrim Stream is seen as beneficial in preserving a potential bat corridor on the stream. Habitat reinstatement will commence at the construction stage. The success of any habitat reinstatement measures will be monitored by the project ecologist/ECoW throughout the construction phase and continue into the operational phase. Existing internal treelines and hedgerows within the Proposed Development site, where possible and appropriate, will be retained and improved comprising the planting up of large gaps and openings with native shrubs and tree species. Reinforcing these linear features vegetatively will also deter livestock from breaking though features which can reduced connectivity

6.5.2.2.2 Protection of Fauna- Bats

A stringent post-construction monitoring programme shall be performed to assess any changes in bat activity patterns and help inform any potential mitigation in the form of turbine curtailment. Monitoring will be completed annually for three years after construction. During this time period, casualty searches and acoustic monitoring will take place alongside one another. Acoustic surveys can be used to continue to assess bat activity and behaviour following construction of turbines to assess any significant decrease or indeed increases in bat activity. Passive Automated Bat surveys (PAB) shall be conducted each year for three years over 10 nights in each of spring (April to May), summer (June to midAugust) and autumn (mid-August to October). The methodologies for these surveys are the same as those described in Appendix 6-2 Ballinla Bat Survey Report. The PAB surveys can be accompanied with nighttime bat activity walkover surveys with the use of thermal imaging cameras as necessary to provide more detailed information on bat activity in the vicinity of turbines. Systematic searches for bat casualties on the ground below wind turbines are currently the only effective means of monitoring bat fatalities. Searches should be undertaken as early as possible in the morning during high-risk periods. Data from the pre-application activity surveys show that the highest level of activity was recorded in the summer, as such it is concluded that this period is deemed to be of the highest risk for bats currently using the site. Suitably trained dogs with handlers are significantly more efficient and faster than humans in locating carcasses and should preferably be used to achieve more robust results. The number of turbines surveyed should be proportional to the size of the site. As the site is deemed to be large (greater than five turbines), turbines can be selected at random, except where there is evidence to suggest an elevated risk at a particular turbine location (at present there is no evidence to suggest this is the case).

A limitation to conducting carcass searching is lack of access to the land beneath the turbine. As such it is essential that access is secured through liaising with the turbine operator and that land-use is conducive to performing a search. Systematic searches will be conducted within a 100m x 100m grid centred on the turbine, they will be conducted in at least two search periods, which is typically in the summer and autumn periods. Data must be obtained from the turbine operators on whether or not the target turbine(s) were operational on the night prior to the search, with the surveying procedure adjusted as necessary if the turbines were either non-operational or were not rotating because of a lack of wind. Once all surveys have been conducted across the bat active season (spring, summer and autumn), data shall be compiled into an annual bat monitoring report, outlining the findings and implications for the wind farm operation, including any mitigation measures.

Table 6-26: Summary Table of Effects

IEF	Impact (Pre-mitigation)		Mitigation Measures	Residual Effect (Post-Mitigation)
	Construction	Operational		
Otter (*Lutra lutra*)	No habitat loss effects on otter predicted. Direct disturbance and/or displacement effects during the construction phase are assessed as **Likely Short-term, Slight Negative Effects.** Indirect disturbance and/or displacement effects during the construction phase are assessed as **Likely Temporary to Short-term, Slight Negative Effects.**	Potential operational effects to otter are, in the absence of mitigation, assessed as being **Likely, Long term, Slight to Imperceptible, Negative effects**	CEMP Best Practices and Site Management Pre-construction surveys	**Short-term, Likely Slight Negative Effect.**
Badger (*Meles meles*)	Habitat loss effects on badger (loss of potential foraging habitat) assessed as a **Likely Short-term Slight Negative Effect.**	Potential operational effects to badger are, in the absence of mitigation, assessed as being **Likely, Long term, Slight to Imperceptible, Negative effects**	Implementation of CEMP, Pre-construction surveys	**Short-term, Likely Slight Negative Effect.**

	Direct disturbance and/or displacement effects during the construction phase are assessed as **Likely Short-term Slight Negative Effects.**			
Eurasian Pygmy shrew (*Sorex minutus*)	Habitat loss effects on red squirrel are assessed as **Likely Short-term Slight Negative Effects.** Direct disturbance and/or displacement effects during the construction phase are assessed as **Likely Short-term Slight Negative Effects.**	Potential operational effects to pygmy shrew are, in the absence of mitigation, assessed as being **Likely, Long term, Slight to Imperceptible, Negative effects**	Pre vegetation clearance check	**Short-term, Likely Slight Negative Effect.**
Eurasian red squirrel (*Sciurus vulgaris*)	Habitat loss effects on red squirrel are assessed as **Likely Short-term Slight Negative Effects.** Direct disturbance and/or displacement effects during the construction phase are assessed as **Likely Short-term Slight Negative Effects.**	Potential operational effects to red squirrel are, in the absence of mitigation, assessed as being **Likely, Long term, Slight to Imperceptible, Negative effects**	Any felling of forestry should be limited to avoid the January – March period when young are in dreys	**Short-term, Likely Slight Negative Effect.**
Pine marten (*Martes martes*)	Habitat loss effects on red squirrel are assessed as **Likely Short-term Slight Negative Effects.** Direct disturbance and/or displacement effects during the construction phase are assessed as **Likely Short-term Slight Negative Effects.**	Potential operational effects to pine marten are, in the absence of mitigation, assessed as being **Likely, Long term, Slight to Imperceptible, Negative effects**	Pre-vegetation clearance check Limit felling to avoid March to April period when young may be in dens	**Short-term, Likely Slight Negative Effect.**
Irish hare (*Lepus timidus hibernicus*)	Habitat loss effects on red squirrel are assessed as **Likely Short-term Slight Negative Effects.** Direct disturbance and/or displacement effects during the construction phase are assessed as **Likely Short-term Slight Negative Effects.**	Potential operational effects to Irish hare are, in the absence of mitigation, assessed as being **Likely, Long term, Slight to Imperceptible, Negative effects**	Pre-vegetation clearance check	**Short-term, Likely Slight Negative Effect.**
Irish stoat (*Mustela erminea Hibernica*)	Habitat loss effects on red squirrel are assessed as **Likely Short-term Slight Negative Effects.** Direct disturbance and/or displacement effects during the construction phase are assessed as **Likely Short-term Slight Negative Effects.**	Potential operational effects to Irish stoat are, in the absence of mitigation, assessed as being **Likely, Long term, Slight to Imperceptible, Negative effects**	Pre vegetation clearance check Limit vegetation removal to avoid bird-nesting period (March – August) where possible	**Short-term, Likely Slight Negative Effect.**
Common pipistrelle (*Pipistrellus pipistrellus*) Soprano pipistrelle	Habitat loss/vegetation removal (potential foraging/ commuting habitat) effects on bat species are assessed as **Likely, Permanent, Slight, Negative Effects**.	Injury/mortality due to collision/barotrauma during the operational phase is assessed as **long-term, slight negative effects**.	Up to 92 m buffer at all turbines, Turbine lighting Implementation of CEMP, Best Practices and Site Management	**Long-term, Likely Slight Negative Effect.**

Leisler's bat Nathusius' bat	Disturbance and/or displacement effects on bat species during the construction phase are assessed as **Likely, Short-term, Slight Negative, Effects.**	Disturbance/displacement during the operational phase is assessed as **long-term, slight negative effects.**		
Daubenton's bat Brown long-eared bat Whiskered bat Myotis spp.	Habitat loss/vegetation removal (potential foraging/ commuting habitat) effects on bat species are assessed as **Likely, Permanent, Slight, Negative Effects.** Disturbance and/or displacement effects on bat species during the construction phase are assessed as **Likely, Short-term, Slight Negative, Effects.**	Injury/mortality due to collision/barotrauma during the operational phase is assessed as **long-term, insignificant negative effects.** Disturbance/displacement during the operational phase is assessed as **long-term, slight negative effects.**	Up to 92 m buffer at all turbines, Turbine lighting Implementation of CEMP, Best Practices and Site Management	**Long-term, Likely Slight Negative Effect.**
Terrestrial macro-invertebrates	Habitat loss/alteration effects on other terrestrial macro-invertebrate species are assessed as **Temporary to Permanent, Slight to Moderate Negative effects.**	Disturbance and/or displacement effect on terrestrial macro-invertebrates during the operational phase are assessed as **Long-term, Insignificant, Negative Effects.**	None required	**Long-term, Likely Slight Negative Effect**
Brook lamprey (*Lampetra planeri*)	Disturbance/displacement effects on brook lamprey are assessed as **Temporary to Short-term, Likely Slight to Moderate Negative effects.**	The effects on fish species during the operational phase are assessed as **Long-term, Insignificant Negative effects.**	Implementation of CEMP, Best Practice and Site Management, Site-specific drainage system design	**Long-term, Likely Slight Negative Effect.**
Other fish species	Disturbance/displacement effects on brook lamprey are assessed as **Temporary to Short-term, Likely Slight Negative effects.**	The effects on fish species during the operational phase are assessed as **Long-term, Insignificant Negative effects.**	Implementation of CEMP, Best Practice and Site Management, Site-specific drainage system design	**Long-term, Likely Slight Negative Effect.**
Common frog (*Rana temporaria*)	Direct disturbance and/or displacement effects during the construction phase are assessed as **Short-term Slight Negative Effects.** Indirect disturbance and/or displacement effects during the construction phase are assessed as **Temporary to Short-term, Slight Negative Effects.**	The disturbance and/or displacement effects on common frog during the operational phase are assessed as **Long-term, Neutral effect.**	Pre-construction checks with the possibility of translocation to nearby suitable aquatic habitat if required	**Long-term, Likely Slight Negative Effect**

6.7 Conclusion

Provided that the proposed wind farm development is constructed and operated in accordance with the design, best practice and mitigation measures proposed, significant residual effects on biodiversity are not likely on any Important Ecological Feature (IEF). The application of mitigation and protection measures throughout the construction and operational phases will ensure that no significant residual effects are likely to arise from the Proposed Development, either alone or in combination with other plans or projects. The following mitigation measures are considered for the project (see Table 6-27).

Appendix 06-1 Aquatic Ecology & Fish Report.pdf

Appendix 06-2 Ballinla Bat Survey Report.pdf

Table 7: Level of potential vulnerability of populations of British bat species (Adapted from Wray et al., 2010)

	Low collision risk	Medium collision risk	High collision risk
Common species	Brown long-eared **Low vulnerability**	n/a	Common pipistrelle Soprano pipistrelle **Medium vulnerability**
Rarer species	Daubenton's Natterer's Whiskered Lesser horseshoe **Low vulnerability**	n/a	Nathusius' pipistrelle Leisler's **High vulnerability**

6. Results
6.1 Desk Study
6.1.1 NPWS Database & NBDC database

Following review of data from NPWS's database for records of lesser horseshoe bat (LHB) roosts in the area, 16 there are no known LHB roosts within 10 km of the development site with the closest found over 100 km to the west. In addition, the NBDC on-line database for all Irish bat species was checked for records within a 10km radius of the site, the following table provides a summary of these results.

Table 8: Summary of bat data for all Irish bat species within a 10km radius of the site.

Species	Number of Records	Year (most recent)	Location (closest)	Record type
Brown long-eared bat	5	2009	2 km northeast	In flight
Common pipistrelle	15	2019	1.5 km northeast	In flight
Daubenton's bat	10	2018	1 km north	In flight
Leisler's bat	5	2019	1.5 km northeast	In flight
Natterer's bat	1	2009	1.5 km northeast	In flight
Soprano pipistrelle	14	2019	1.5 km northeast	In flight

6.1.2 Bat Habitat Suitability Index (BHSI)

A review of the NBDC's Bat Habitat Suitability Index available on-line determined that the for the area encompassed within the Proposed Development site, and also including the lands extending away from the proposed development site, the BHSI rating is split between the northern section of the site and the southern section of the site. For the northern part of the site the BHSI has been assigned for 'all bats' is 29.11 out of 100, and for the southern part 23.78 out of 100, based on the analysis of the habitat and landscape associations of Irish bats compiled in Lundy et al. (2011). The maximum rating given for any individual species is 48, with a minimum rating of 0 (see Table 9 below). On the basis of the BHSI ratings assigned for all bats and for individual species, the Proposed Development site and surrounding land is considered to be of relatively low overall value for bats. The marginally higher rating in the northern part of the site could be attributed to the mix of hedgerows, woodland and agricultural land use within the site and the Grand Canal found north of the site boundary and there being more low-quality bat habitat in the form of plantation woodland found to the south.

Table 9: BHSI Rating for 2.5 km grid square encompassing and extending away from the proposed development site (adapted from NBDC on-line)

Common name	Scientific name	BHSI Rating
All Bats	-	**North – 29.11** **South – 23.78**
Brown long-eared bat	*Plecotus auritus*	North - 35 South - 29
Common pipistrelle	*Pipistrellus pipistrellus*	North - 48 South - 40
Daubenton's bat	*Myotis daubentonii*	North - 35 South - 31
Leisler's bat	*Nyctalus leisleri*	North - 45 South - 36
Lesser Horseshoe bat	*Rhinolophus hipposideros*	North - 0 South - 0
Nathusius's pipistrelle	*Pipistrellus nathusii*	North - 5 South - 2
Natterer's bat	*Myotis nattereri*	North - 34 South - 25
Soprano pipistrelle	*Pipistrellus pygmaeus*	North - 44 South - 38
Whiskered bat	*Myotis mystacinus*	North - 16 South - 13

6.2 Bat Foraging and Commuting Habitat Suitability Survey

The site overall is dominated mostly by a mix of agricultural land with boundary hedgerows and trees lines and coniferous woodland, with all the agricultural land found in the northern portion of the site. The southern section of the site is mostly dominated by coniferous woodland with some scrubby areas and the Leitrim stream. The Grand Canal is found approximately 500m north of the Proposed Development and this feature coupled, with the boundary hedgerows and tree lines, provide high commuting and foraging potential with links to the wider landscape. The coniferous plantation woodland that dominates the south provides very little in the way of suitable commuting and foraging potential. The woodlands are dense with scarce ground flora and thus supports very little in terms of bat's insect prey. These woodlands are also prone to periodical felling, and it is only within areas of scrub regrowth that provide more insect activity, where there is more, albeit limited, foraging potential. There is also the Leitrim stream in the south of the Proposed Development with low commuting and foraging potential.

6.3 Preliminary Roost Assessment

Buildings found on site consisted of agricultural farm buildings such as metal built barns, storage sheds and cattle sheds. A single brick building was also present on site (farm shop). These buildings were well maintained with no apparent gaps or crevice's present. The metal-built buildings, many of which had open access, did not provide suitable features in which roosting bats could utilize. The single brick building on site had tight fitting concrete roof tile with no gaps or missing tiles enabling access. In addition to the buildings on site all trees were subjected to ground level assessments for roosting bats and no potential roosting features were observed. With a lack of suitable roosting features found across all buildings and trees, the site overall was considered to be of 'negligible' value for roosting bats.

6.4 Nighttime Bat Walkover Survey (NBW)

Data collected from the initial static detectors deployed in the summer and autumn of 2023 indicated a high level of bat activity was recorded at detectors placed along the Leitrim stream. Also, high level of bat activity was recorded at detectors placed in close proximity to the Grand Canal north of the northern boundary of the site. Due to design changes and a greater area of land availability for potential mitigation to the north of site, further NBW surveys were not considered here. It should also be noted that desk study results, a preliminary walkover and knowledge of bat ecology indicated that the canal itself would provide high potential for commuting and foraging bats and it was expected that higher levels of activity would be found here. However, as initial survey data suggested that the Leitrim stream found in the south of site was being used by a high number of bats, NBW surveys were undertaken across the full survey season to supplement this data and enable in depth analysis of bat activity. The NBW surveys allowed for a visual assessment of bat activity to understand the amount of bats that were using the stream it's surrounds and how they were using the landscape in this area of site. A total of six nighttime bat walkovers were conducted in 2024 along a predetermined transect route (Figure 4), as discussed in Section 5.5 above. These surveys met the minimum survey requirements in line with Colins (2023). The results are summarised in Table 10, Table 11 and Table 12 below.

Date & time	Weather at Start	Weather at End	Results
Date: 23rd April 2024 **Start time:** 20:41 **End time:** 22:41 **Sunset:** 21:01	**Temp:** 14.2°C **Humidity:** 50% **Moon phase:** Waning Cresent **Wind:** Light breeze **Cloud:** 0% cloud cover **Precipitation:** Dry	**Temp:** 10.6 °C **Humidity:** 59% **Wind:** Light breeze **Cloud:** 0% cloud cover **Precipitation:** Dry	No bats were observed from stopping points 1 to 3. A single Leisler's (L) pass was recorded at 21:25 at stopping point 4 (SP4). Another L pass was heard again at SP4 at 21:30. Two common pipistrelle (CP) passes were heard at 21:27 and 21:30 at SP4. Soprano pipistrelle (SP) passes were heard at 21:32, 21:33, 21:34, 21:36 and 21:37 between stopping points 4 and 5. A single CP pass was heard at 21:38 at SP5 and a single L pass was heard at 21:40 at SP5. SP passes were seen and heard at 21:40, 21:43 and 21:34. During these passes two individual SP were seen commuting south. SP and CP were heard at 21:47 and 21:49 between stopping points 5 and 6. CP passes were heard at 21:50, 21:51, and 21:52 at SP6 and heard again at 21:52 between stopping points 6 and 7. SP passes were heard at 21:56 and 21:57 between stopping points 6 and 7. A single CP call was heard at 21:58 at SP7. L passes were heard at 21:59, 22:00 and 22:01 at SP7. A single *Myotis*.spp (MYO) call was heard at 22:04 at SP7.
Date 14th May 2024 **Start time:** 21:02 **End time:** 23:02 **Sunset:** 21:17	**Temp:** 13.9 °C **Humidity:** 83% **Moon phase:** Waxing Cresent **Wind:** Light breeze **Cloud:**70% cloud cover **Precipitation**: Dry	**Temp:** 13.3°C **Humidity:** 75% **Wind:** Light breeze **Cloud:** 90% cloud cover **Precipitation:** Dry	No bats were observed from stopping points 1 to 4. A single L pass was recorded at 22:05 at SP5 and a single CP pass was recorded at 22:07. CP passes were heard at 22:14 and 22:16 at SP6. A single CP call was heard between stopping points 6 and 7. CP was heard again at SP7 at 22:22, 22:24, and 22:26. SP passes were heard at 22:22 and 22:27 also at SP7. A single CP pass was recorded at 22:29 between stopping points 7 and 8. Single SP and CP passes were heard at SP8 at 20:30 and 20:33 respectively. A single CP pass was heard at 20:36 between stopping points 8 and 9 and two SP passes were heard at 22:36 and 22:37 also between stopping points 8 and 9. A single MYO pass was recorded at 22:38 also between stopping points 8 and 9. A single L pass was heard at 22:39 at SP9. A single CP pass was heard at 22:39 at SP9. SP passes were heard at 22:42 and 22:44 at SP9. Single SP and CP passes were heard at 22:45 between stopping points 9 and 10. No further bat passes were recorded at SP10.

Summary

23/04/2024 – Minimal activity across the survey period with common pipistrelle, soprano pipistrelle, *Myotis*.spp and Leisler's all recorded. Where soprano pipistrelle was seen and heard, they were seen commuting along the Leitrim stream heading southward. No bats were recorded at the first 3 stopping points and no further calls were heard after stopping point 7.

14/05/2024 – Minimal activity across the survey period with common pipistrelle, soprano pipistrelle, Leisler's, and a single *Myotis*.spp call all recorded. All bats were heard and not seen across the survey.

Table 11: Summary of Nighttime Bat Walkover survey results (summer 2024)

Date & time	Weather at Start	Weather at End	Results
Date: 16th June 2024 Start time: 21:26 End time: 23:26 Sunset: 21:46	Temp: 19 °C Humidity: 57% Moon phase: Waxing gibbous Wind: Light breeze Cloud: 10% cloud cover Precipitation: Dry	Temp: 16.9 °C Humidity: 69% Wind: Light breeze Cloud: 50% cloud cover Precipitation: Dry	No bats were observed from stopping points 1 to 3. A single L pass was heard at 22:38 at SP4. Two SP calls were recorded at 22:39 and 22:40 at SP4. A single SP call was heard at 22:45 at SP5. A single SP call was heard between stopping points 6 and 7. CP calls were heard at 22:52 and 22:55 at SP7 and then again at 22:56 between stopping points 7 and 8. SP was recorded at 22:58, 22:59 and 23:00 at SP8. SP was then heard again at 23:02 and 23:03 between stopping points 8 and 9. A single MYO pass was heard at 23:08 at SP9. SP passes were heard at 23:05, 23:07 and 23:08 at SP9. SP was then heard again between stopping points 9 and 10 at 23:11. Two CP calls were heard at 23:14 and 23:15 at SP10. A single SP call was heard at 23:17 at SP10.
Date: 8th August 2024 Start time: 20:51 End time: 22:51 Sunset:21:11	Temp: 17.4 °C Humidity: 69% Moon phase: Waxing crescent Wind: Moderate breeze Cloud: 100% cloud cover Precipitation: Drizzle	Temp: 15.6°C Humidity: 68% Wind: Strong breeze Cloud: 100% cloud cover Precipitation: Dry	No bats were observed from stopping points 1 to 2. L was seen and not heard at 21:36 at SP3. L was then heard again at the same stopping point at 21:44. SP was seen feeding along the Leitrim stream at 21:42 at SP3. SP was seen overhead feeding along the Leitrim stream at 21:50, 21:51, 21:53 and 21:54 at SP4. During these passes only one individual bat was observed and was suspected that each pass was the same individual. A single L was heard and not seen at 22:00 at SP5. A single SP was seen feeding overhead at 22:01 at SP5. A single L pass was heard and not seen at SP6 at 22:21. CP was heard and not seen at 22:21, 22:23 and 21:27 at SP6. L was heard at 22:28 and 22:29 and CP was recorded at 22:31 between stopping points 6 and 7. SP was heard only at 22:32 and 22:33 at SP7. A single L call was heard at 22:33 at SP7. SP was heard feeding at 22:35 between stopping points 7 and 8. SP was recorded at 22:42 and heard feeding at 22:43 between stopping points 8 and 9. CP was heard feeding at 22:47 at SP9. CP was then heard again at 22:55 and 22:56 at SP10.

Summary

16/06/2024 – Low amount of activity across the survey period with no bats seen, just heard echolocating. Species heard included common pipistrelle, soprano pipistrelle, and single calls for both *Myotis*.spp and Leisler's.

08/08/2024 – More general activity was recorded than previous surveys but still found to be at a low level. Species recorded were common pipistrelle, soprano pipistrelle and Leisler's. Feeding was visually observed along the Leitrim stream and overhead on two separate occasions by soprano pipistrelle (21:42 and 22:01). Feeding buzzes were recorded on five occasions but no bats were seen... No bats were recorded between stopping points 1 to 2 and none were recorded at stopping point 8.

Table 12: Summary of Nighttime Bat Walkover survey results (autumn 2024)

Date & time	Weather at Start	Weather at End	Results
Date: 3rd Sept 2024 Start time: 19:53 End time: 21:53 Sunset: 20:13	Temp: 15.3 °C Humidity: 61% Moon phase: Waxing Cresent Wind: None Cloud: 90% cloud cover Precipitation: Dry	Temp: 12.2 °C Humidity: 67% Wind: Light breeze Cloud: 100% cloud cover Precipitation: Dry	No bats were observed from stopping points 1 to 3. SP was seen overhead commuting from a southerly direction and then headed west at 20:43 at SP4. SP was then seen feeding overhead along the Leitrim stream at 20:48 and 20:49 between stopping points 4 and 5. It is suspected that this was the same individual. SP was heard and not seen at 20:50 at SP5. SP was then heard again feeding at 20:56 at the same stop point. CP was heard feeding at 20:54 and then a call was also heard at 20:59 at SP5. A very distant SP call was heard at 21:03 at SP6. A single SP call was heard at 21:20 at SP8. CP was heard at 21:33, feeding, between stopping points 8 and 9 and then a call was heard at 21:36 between stopping points 8 and 9. SP calls were heard at 21:33, 21:34, and 21:35 between stopping points 8 and 9. A single SP feeding buzz was heard at 21:37 at SP9. CP was heard at 21:44 and 21:45 with SP also heard at 21:45, all between stopping points 9 and 10. Two SP calls were heard at 21:50 and 21:51 at SP10.
Date: 12th Sept 2024 Start time: 19:31 End time: 21:31 Sunset: 19:51	Temp: 13 °C Humidity: 69% Moon phase: Full moon Wind: Light breeze Cloud: 70% cloud cover Precipitation: Dry	Temp: 10.8°C Humidity: 88% Wind: Light breeze Cloud: 100% cloud cover Precipitation: Dry	No bats were observed from stopping points 1 to 5. A single SP call was recorded at 20:49 at SP5. A single SP call was heard at 20:55 and a single CP call was heard at 20:56 both at SP6. A single CP call was heard at 20:59 between stopping points 6 and 7. CP calls were heard at 21:03 and 21:04 at SP7. A single SP call was heard at 21:17 between stopping points 8 and 9. A single SP call was heard at 21:26 at SP9.

Summary

03/09/2024 – Low amount of activity across the survey period with only common and soprano pipistrelle being recorded. Soprano pipistrelle was observed visually overhead on three separate occasions (20:43, 20:48 and 20:49). Feeding buzzes were also recorded and bat passes recorded but individual not seen on three occasions No bats were recorded between stopping points 1 to 3 and none were recorded at stopping point 7.

12/09/2024 – Very little activity across the survey period with only common and soprano pipistrelle being recorded. No bats were seen and were only heard. No bats were recorded between stopping points 1 to 4 and none were recorded at stopping points 8 and 10.

Table 13: Percentage of total bat calls recorded, categorised by species and with corresponding BHSI Ratings for the site.

Species	% of total of all bat calls recorded (2023 & 2024)	BHSI Rating (out of 100)
Soprano pipistrelle	46.91	North - 44 South - 38
Common pipistrelle	34.53	North - 48 South - 40
Leisler's bat	14.82	North - 45 South - 36
Myotis specie	1.25	North - 28 South – 23[17]
Brown long-eared bat	1.08	North - 35 South - 29
Nathusius' pipistrelle	0.06	North - 5 South - 2

Table 14: Number of bat passes of each species recorded at each sampling point during the summer 2023 survey

Sampling point	*Myotis* spp.	Leisler's bat	Nathusius' pipistrelle	Common pipistrelle	Soprano pipistrelle	Brown long-eared bat	Lesser horseshoe	NoID	Total	%
2	57	61	0	2,914	3,086	38	0	203	6,359	27.48
8	196	52	0	1,564	3,251	4	0	128	5,195	22.45
12	51	64	0	1,064	2,530	5	0	66	3,780	16.33
11	23	50	0	441	2,237	3	0	91	2,845	12.29
7	27	72	0	412	634	6	0	37	1,188	5.13
5	1	94	0	739	330	9	0	4	1,177	5.09
1	6	48	0	520	121	15	0	48	758	3.28
4	1	128	0	258	298	33	0	14	732	3.16
10	3	46	0	28	381	0	0	11	469	2.03
3	0	87	0	100	121	3	0	29	340	1.47
9	0	37	0	71	46	0	0	147	301	1.3
6	0	0	0	0	0	0	0	0	0	0
Total	**365**	**739**	**0**	**8,111**	**13,035**	**116**	**0**	**778**	**23,144**	
%	**1.58**	**3.19**	**0**	**35.05**	**56.32**	**0.50**	**0**	**3.36**		

Table 17: Number of bat passes of each species recorded at each sampling point during the autumn 2023 survey

Sampling point	*Myotis* spp.	Leisler's bat	Nathusius' pipistrelle	Common pipistrelle	Soprano pipistrelle	Brown long-eared bat	Lesser horseshoe	NoID	Total	%
2	30	12	0	787	3,496	9	0	57	4391	35.82
8	159	15	0	763	3,254	1	0	27	4,219	34.42
6	9	42	0	841	217	12	0	223	1,344	10.96
3	5	8	0	263	472	1	0	7	756	6.17
4	6	26	0	261	284	8	0	23	608	4.96
9	63	5	0	203	46	0	0	39	356	2.90
11	7	3	0	30	227	0	0	6	273	2.23
7	17	22	0	16	54	1	0	10	120	0.98
1	4	3	0	28	44	3	0	23	105	0.86
5	4	21	0	17	33	2	0	3	80	0.65
10	0	1	0	0	1	4	0	0	6	0.05
TOTAL	**304**	**158**	**0**	**3,209**	**8,128**	**41**	**0**	**418**	**12,258**	
%	**2.48**	**1.29**	**0**	**26.18**	**66.31**	**0.33**	**0**	**3.41**		

Table 20: Seasonal and annual totals for 2023 by sampling point

SP	1	2	3	4	5	6	7	8	9	10	11	12	Total	%
Summer	758	6,359	340	732	1,177		1,188	5,195	301	469	2,845	3,780	23,144	65.37
Autumn	105	4,391	756	608	80	1,344	120	4,219	356	6	273		12,258	34.63
Total	863	10,750	1,096	1,340	1,257	1,344	1,308	9,414	657	475	3,118	3,780	35,402	
%	2.44	30.37	3.1	3.79	3.55	3.8	3.69	26.59	1.86	1.34	8.81	10.68		

Table 21: Number of bat passes of each species recorded at each sampling point during the spring 2024 survey

Sampling point	*Myotis* spp.	Leisler's bat	Nathusius' pipistrelle	Common pipistrelle	Soprano pipistrelle	Brown long-eared bat	Lesser Horseshoe	NoID	Total	%
2	131	1359	6	1107	2944	7	0	4	5558	30.74
8	28	1329	0	203	1115	10	0	3	2688	14.87
11	11	1002	5	225	493	0	0	0	1736	9.60
7	35	942	0	299	445	3	0	1	1725	9.54
3	2	372	2	713	626	1	0	0	1716	9.49
4	11	382	10	799	419	54	0	8	1683	9.31
10	46	535	12	248	578	2	0	0	1421	7.86
6	2	572	3	168	125	11	0	2	883	4.88
9	9	267	2	42	39	1	0	0	360	1.99
5	0	34	0	83	192	0	0	0	309	1.71
1	0	0	0	0	0	0	0	0	0	0.00
Total	**275**	**6,794**	**40**	**3,887**	**6,976**	**89**	**0**	**18**	**18,079**	
%	**1.52**	**37.58**	**0.22**	**21.50**	**38.59**	**0.49**	**0.00**	**0.10**		

Table 24: Number of bat passes of each species recorded at each sampling point during the summer 2024 survey

Sampling point	*Myotis* spp.	Leisler's bat	Nathusius' pipistrelle	Common pipistrelle	Soprano pipistrelle	Brown long-eared bat	Lesser Horseshoe	NoID	Total	%
2	19	86	1	3908	2902	16	0	0	6932	24.42
4	13	1764	2	2445	1087	109	0	1	5421	19.10
1	14	108	1	2584	826	27	0	0	3560	12.54
3	22	901	0	1388	1048	88	0	0	3447	12.14
7	30	58	0	517	2606	4	0	1	3216	11.33
5	2	708	1	636	678	19	0	48	2092	7.37
10	32	191	0	447	992	12	0	0	1674	5.90
6	2	294	0	653	394	18	0	0	1361	4.79
8	19	46	0	70	463	10	0	1	609	2.15
9	0	36	1	18	17	0	0	0	72	0.25
Total	**153**	**4,192**	**6**	**12,666**	**11,013**	**303**	**0**	**51**	**28,384**	
%	**0.54**	**14.77**	**0.02**	**44.62**	**38.80**	**1.07**	**0.00**	**0.18**		

Table 27: Number of bat passes of each species recorded at each sampling point during the autumn 2024 survey

Sampling point	*Myotis* spp.	Leisler's bat	Nathusius' pipistrelle	Common pipistrelle	Soprano pipistrelle	Brown long-eared bat	Lesser horseshoe	NoID	Total	%
3	5	343	0	1,543	2,293	14	0	0	4,198	30.27
8	20	56	1	2,073	858	10	0	0	3,018	21.76
2	34	555	1	780	659	166	0	21	2,216	15.98
4	1	876	1	138	261	32	0	2	1,311	9.45
5	27	135	12	293	658	56	0	2	1,183	8.53
6	16	149	0	131	569	187	0	1	1,053	7.59
1	0	112	0	223	454	13	0	0	802	5.78
7	0	78	0	1	4	4	0	0	87	0.63
Total	**103**	**2,304**	**15**	**5,182**	**5,756**	**482**	**0**	**26**	**13,868**	
%	**0.74**	**16.61**	**0.11**	**37.37**	**41.51**	**3.48**	**0.00**	**0.19**		

Table 30: Seasonal and annual totals for 2024 by sampling point

SP	1	2	3	4	5	6	7	8	9	10	11	Total	%
Spring	0	5,558	1,716	1,683	309	883	1,725	2,688	360	1,421	1,736	18,079	29.97
Summer	3,560	6,932	3,447	5,421	2,092	1,361	3,216	609	72	1,674		28,384	47.05
Autumn	802	2,216	4,198	1,311	1,183	1,053	87	3,018				13,868	22.99
Total	4,362	14,706	9,361	8,415	3,584	3,297	5,028	6,315	432	3,095	1,736	60,331	
%	7.23	24.38	15.52	13.95	5.94	5.46	8.33	10.47	0.72	5.13	2.88		

7. Discussion

7.1 Value of the Site for Foraging and Commuting Bats

The Proposed Development site is dominated mostly by a mix of agricultural land (mostly bordered with hedgerows and treelines) and coniferous woodland, furthermore the site is adjacent to the Grand Canal which is found approximately 500m north of the Proposed Development. This canal, coupled with the agricultural hedgerows and treelines, provide high potential for foraging and commuting bats. The coniferous plantation woodland that dominates the south provides very little in the way of suitable commuting and foraging potential and is also subject to periodic felling. The Leitrim stream in the southern section of the Proposed Development was deemed to have low commuting and foraging potential for bats. Results from the NBW surveys and PAB data indicate that the majority of all bat activity found across the site is within the northern section. Initial project designs included more turbines located closer to the Grand Canal. As such sampling points 1, 2, 3 and 4 were chosen to provide a representative sample of bat activity at or close to these initial proposed turbine locations. Data gathered from these sampling points generally were all found to have the highest levels of bat activity, with sampling point 2 recording the highest level of activity for any sampling point across both the 2023 and 2024 survey periods. Due to a number of factors across multiple disciplines, including the high levels of bat activity found in this area and its close distance to the important commuting and foraging feature of the canal, it was recommended to reduce the number of turbines and move the turbines further from the Grand Canal, to ensure this feature and its surrounding area

remained protected from any potential impacts caused by the proposed turbines. Also, within the northern portion of the site there are a number of hedgerows and tree lines marking out agricultural field boundaries, with high commuting potential for bats. Size, quality and structure of said hedgerows varies across the site as does their connectivity to one another. The aforementioned features, qualities and data gathered show that the northern section of site is of more value to foraging and commuting bats than the south. The BHSI was split across site between the northern section and southern section, with the area to the north scoring higher. This score is influenced by habitat features such as the Grand Canal and hedgerows in the area that provide valuable commuting and foraging resources for local bats. In addition, the majority of the closest bat records in the area were located along a stretch of the Grand Canal to the northeast from the site. As designs changed, a number of turbines were dropped from the project and turbines were located further away from the Grand Canal. It can be seen from the ratings listed in Table 9 in Section 6.1.2, not only is the overall BHSI rating for all bat species (29.11 for the north and 23.78 for the south) very low, but the highest rating value for any individual species is also no higher than 48 and only two other species have ratings above 40. Less activity was recorded in the south generally, with some initial high levels of activity found close to the Leitrim stream. As such, NBW surveys were conducted along the Leitrim stream to the south, to gather more information on the numbers of bats and how they are using the landscape to support the initial data collected from the static detectors. Data gathered highlighted the stream is used at a low activity level, by low numbers of individual bats for foraging and commuting purposes. The NBW transect route was extended to cover a greater area of the southern section of site. Overall, this area of the site had very little activity recorded during the NBW surveys with most activity found along the stream already mentioned and within areas of successional scrub, where tree felling has occurred. This southern area of the site is mostly dominated by conifer plantation woodland, which is not conducive bat habitat, and the areas of dense coniferous woodland were found to have very little activity recorded during NBW and PAB surveys. With regard to species composition: common and soprano pipistrelle bats constitute the most frequently recorded species, and the combined totals of their bat passes comprise 81.44% of the total of all passes recorded over the 2023 and 2024 survey periods. Leisler's bats comprise 14.82%; unidentified bats 1.35%; species from the genus Myotis comprise 1.25%; brown long-eared bat, 1.08% and, Nathusius pipistrelle comprise 0.06%. All species recorded on site are considered to have a Favourable Conservation status.

Nightly and Hourly Bat Passes

The nightly and hourly averages of the bat passes recorded at each sampling point during each season, of each species, and bat passes to which a species or genus could not be attributed, are listed in Appendix 2. As mentioned in Section 6.5 an individual bat can be the source of more than one, or even many, calls recorded by the static detectors and that the number of calls recorded is likely to be greater than the number of bats that generated them. High nightly bat passes were recorded for common and soprano pipistrelle in summer 2023 at sampling points, 2, 5, 7, 8, 11 and 12. When looking at hourly passes for the same species in the same survey period, moderate passes per hour for the same species were recorded at sampling points 2, 8, 11 (soprano pipistrelle only) and 12. Only once were passes in excess of 30 an hour and this was for soprano pipistrelle at sampling point 2, the remainder are less than 20 passes per hour. For all other species recorded in the summer 2023 survey season passes per hour never rose above 2. During the autumn 2023 survey season high nightly bat passes were recorded for common and soprano pipistrelle at sampling points 2 and 8 with high nightly passes also recorded for common pipistrelle only at sampling point 6. However, the majority of hourly passes in the autumn survey period were found to be less than 9 per hour for all species except soprano pipistrelle. Soprano pipistrelle passes only exceeded 30 passes twice at sampling point 2 and 8 with 34 and 32 passes an hour recorded respectively. Nightly bat passes recorded in the spring of 2024 highlighted high nightly passes for common and soprano pipistrelle as well as Leisler's bat on occasion at 8 of the 11 sampling points however, when looking at hourly passes for the same species in the same time period the vast majority of hourly passes for all species at all sampling points were found to be less than 10 an hour. The only time 20 passes an hour was exceeded was at sampling point 2 for soprano pipistrelle. A similar data set was recorded in the summer season of 2024 with high nightly passes for common and soprano pipistrelle recorded as well as Leisler's bat on occasion at 8 of the 11 sampling points. When looking at the hourly passes for the summer 2024 survey season again the vast majority of hourly passes for all species at all sampling points were less than 10. In the northern part of the site the hourly passes for common and soprano pipistrelle only exceeded 25 an hour once at sampling point 2, and only exceeded 25 an hour in the south once at sampling point 7 for soprano pipistrelle. Nightly bat passes recorded in the autumn of 2024 indicated high numbers of passes for soprano pipistrelle at 5 of the 11 sampling points, 3 for common pipistrelle and 2 for Leisler's bat. Hourly passes recorded for the same period showed moderate level of passes for common and soprano pipistrelle at sampling points 2 and 8

and never rose above 23 an hour, the remainder of hourly passes for all species at all sampling points never exceeded 9 an hour. Overall hourly passes across the site over the whole combined 2023 and 2024 survey period were at low levels, supporting the analysis that highlights how poor the site is generally for foraging and commuting bats. Overall, it is considered that the site consists of low value foraging and commuting habitat for bats in the southern section and low to moderate value foraging and commuting habitat in the north section of the proposed development site. It is considered that it is highly unlikely that Proposed Wind Farm area is within the core foraging ranges of any bat species, as individual species forage over relatively limited ranges that do not exceed kilometres in the single-digit range. The levels of activity recorded during 2023 and 2024 survey periods are low and reflective of the normal patterns that pertain to the site. It is therefore concluded that the Proposed Development does not pose a significant risk to bat species.

7.2 Value of the Site for Roosting bats

The preliminary survey of the buildings and trees found within the red line boundary and immediate surrounds was undertaken to identify any actual or potential bat roosts which could be either directly or indirectly be impacted by proposed works. No confirmed roosts, bats, or evidence of bats was found during the survey. Buildings found on site consisted of agricultural farm buildings which included metal-built barns, storage sheds and cattle sheds and a brick-built farm shop. These buildings were well maintained with no apparent gaps or crevice's present, nor were there any other potential roosting features (PRFs) found. All trees found on site were also subjected to ground level assessments for roosting bats and no potential roosting features were found. Additionally, data from the desk study shows that there are no known roosts within close proximity to the proposed wind farm location. With a lack of suitable roosting features found across the site for all buildings and trees, the site is considered to be of 'negligible' potential for roosting bats.

9. Conclusion

Residual effects on bats have been assessed as not significant provided best practice methodologies and guidance, as outlined above in Section 8, are employed. Provided that the proposed project is constructed and operated in accordance with the design, and any proposed lighting is in line with the Bat Conservation Trust 2023 'Guidance Note 08/23' are adhered to, significant effects on bat species are not anticipated at any geographical scale. Current proposals in line with the aforementioned will ensure that no significant residual ecological effects, either alone or cumulatively with other plans or projects, will arise on bats from the project.

The following target species were recorded during VP surveys and/or hen harrier roost watches:

• Black-Headed Gull

Bird Sensitivity Mapping to Wind Energy Development - Guidance Document 2015
10.8 Sensitivity to development of wind energy
Adult annual survival of this species is high compared to other species at 90% (Prévot-Julliard et al. 1998), thus exposing individuals to the potential effects of collision mortality across numerous years (Garthe & Hüppop 2004). Contrary to this, Winkelman (1992) found no disturbance of Black-headed Gull feeding and roosting by the presence of operational wind farms. In fact, previous studies have found increases in populations of this species around wind energy installations (Winkelman 1989), possibly through ecological release of resources due to reduced competition. Further, the flight height of Black-headed Gulls below 15 m has been shown to reduce their susceptibility to collision with operating wind turbine rotors (Still et al. 1996). Despite this, measurements at Zeebrugge in Belgium (Everaert et al. 2002) found that Herring, Lesser Black-backed and Black-headed Gulls all exhibited significantly higher mortality by collision than other species present. This report also showed a significant reduction in flights of Black-headed Gulls between the rotor heights of turbines present (36-85 m). Furthermore, the risk of collision was found to be significantly higher at night than during the day (Everaert 2002).

• Buzard

• Common Gull

• Cormorant

• Great Black-backed Gull

• Golden Plover

A wintering golden plover population is present in the area in which the proposed development is located. Large flocks were observed, and flocks of up to 1,000 individuals were observed within the flight activity study area. The majority of activity was concentrated in agricultural land to the east of the northern section of the Proposed Development, and to the east of the southern section around Esker Bog Rathlumber. A flock of 1,500 golden plover was also observed at hinterland survey site HVP8 at Rathvilla Quarry Ponds to the southeast of the proposed development

Bird Sensitivity Mapping to Wind Energy Development - Guidance Document 2015
Collision risk
There are few documented cases of Golden Plover colliding fatally with wind turbines. A review of the European literature found two recorded casualties of Golden Plover as a result of collision with wind turbines in Germany since 1989, with a further casualty in both Sweden and the Netherlands (Hötker et al., 2004). This relatively low incidence of recorded cases of collision in the (limited) published studies does not necessarily mean that Golden Plover are unaffected by collision with wind turbines. There are aspects of Golden Plover behaviour that indicate they may be at increased risk of collision both when performing breeding display flights, which occur at turbine height (30-100m, Cramp & Simmons, 1983; 15-100m, Byrkjedal & Thompson, 1998), and during foraging flights. Adults sometimes forage away from the nesting territory and can make foraging flights at night (Parr, 1980, Whittingham et al., 2000, Pearce-Higgins & Yalden, 2003), which may increase their susceptibility to collision. Foraging usually occurs away from the moorland nesting habitat during incubation, but on the moorland once broods are present (Whittingham et al., 2000). Radio-tracking of European Golden Plovers at night in the UK (Pearce-Higgins & Yalden, 2003) and Germany (Ketzenberg & Exo, 1997), and observational studies in the UK (Gillings et al., 2005) have shown that different feeding locations are used at night compared with day-time. Observations of flight reactions to wind turbines in Schleswig-Holstein indicated that waders reacted at 200-500m from the turbines by increasing flight height or changing direction to fly over or around the turbines (Koop, 1997). Two of three reviewed studies found that wind farms can have a barrier effect for Golden Plover (Hötker et al., 2004). Golden Plovers are manoeuvrable but generally fastflying waders that often occur in large flocks outside the breeding season. It is to be expected that, generally, in conditions of good flight and sight, they will be at low risk of collision. However, in poor flying conditions that hamper manoeuvrability, or when in large flight formations, they

are at increased risk of collision and the cumulative effect of large wind clusters or multiple wind clusters is of particular concern.

• Grey Heron

• Greylag Goose

• Hen Harrier
Hen harrier activity was limited to wintering birds, with the majority of records noting foraging birds. There were three records of casual/opportunistic roosting in wooded habitats near the proposed development; however, no habitual or group roosting indicative of an established hen harrier winter roost was observed.
Bird Sensitivity Mapping to Wind Energy Development - Guidance Document 2015
6.8 Sensitivity to development of wind energy
In general, highly sensitive raptors (such as Hen Harriers) are regarded as being threatened by wind energy development through disturbance displacement and collision (Langston & Pullan 2003). However, limited research exists on the direct effects of wind energy infrastructure on populations of this species, particularly in an Irish context. In terms of collision, the common flight height of Hen Harriers while feeding has been measured at a mean of 10-20 m above the ground, largely ruling out the possibility of collision with active turbines. One study revealed that between 60 – 80% of a Hen Harrier's flight was less than 2 m (Whitfield & Madders 2006). This species may be at greater risk, however, during display flights and inexperienced fledgling flight (Madders 2004). A recent assessment of the effects of a wind farm on an existing population of breeding Hen Harriers reported regular flights at close proximity to turbine bases, some of which were at rotor height (Madden & Porter 2007). This same report revealed that, although reductions in flight activity around turbines were observed during the construction phase, the activity of bird populations quickly returned to pre-construction levels. Aside from collision risk, turbine avoidance by Hen Harriers observed at one wind farm installation extended to within 250 m of turbines (PearceHiggins et al. 2009). Though this study found a halving of flight activity within 500 m of a wind energy array, it found no significant modification in flight height near turbines, although this study also predicted a 52% reduction in breeding population within 500 m of a wind energy array. Madden and Porter thus posit that Hen Harriers will continue to use wind farm sites post-construction, at least in the short-term (Madden & Porter 2007). Further, a recent assessment of Scottish bird populations and their sensitivity to wind energy development found that over 10% of estimated Hen Harrier range already overlaps with existing wind energy installations (Bright et al. 2008). Having said this, in an Irish context, concern has been expressed surrounding the wide ranging behaviour of Hen Harriers, potentially resulting in overlap of more than one wind farm (Percival 2003)

• Kestrel

• Lapwing The local lapwing population observed during surveys includes both wintering birds and a smaller number of resident birds/summer visitors.
Bird Sensitivity Mapping to Wind Energy Development - Guidance Document 2015
3.8 Sensitivity to development of wind energy
Several studies of wind energy infrastructure and its impact on bird populations have found no discernible impact on populations of breeding Lapwings, either through collision, disturbance displacement or avoidance (Winkelman 1992; Ketzenberg et al. 2002; Pearce-Higgins et al. 2009). Indeed, Langston et al. (2003) found that Lapwing nesting occurred slightly closer to turbines than predicted through spatial modelling, possibly as a result of the creation of preferred areas of shorter vegetation. Furthermore, for this species, no difference was found between the impacts of wind energy infrastructure during construction versus during conventional operation (Pearce-Higgins et al. 2012). Disturbance of Lapwing breeding populations has been recorded in several studies, up to a distance of 350 m, though the majority of instances were at much closer proximity, resulting in a mean of 108 m (Hötker et al. 2006), while Pearce-Higgins et al. (2009) found no significant relationship between distance to wind farms and changes on occurrence. Conversely, significant impacts of wind energy installations on non-breeding populations of Lapwings have been identified through a meta-analysis of existing literature (Hötker et al. 2006). Indeed, of several species studied in relation to wind energy impacts, turbine height was most strongly correlated with minimum distance disturbance of non-breeding Lapwings (Hötker et al. 2006). Thus, though breeding Lapwings may not be directly impacted by wind energy infrastructure, changes in land use around these sites – including reduced grazing leading

to longer and more uniform vegetation – may affect the breeding success of this species (a factor likely to exacerbate this species' current decline).

• Lesser Black-backed Gull

• Little Egret

• Little Grebe

• Mallard

• Mute Swan

• Redshank
Bird Sensitivity Mapping to Wind Energy Development - Guidance Document 2015
5.8 Sensitivity to development of wind energy
In general, breeding waders were identified by an EU assessment of wind energy impacts as being particularly susceptible to disturbance displacement and barriers to movement (European Commission 2011). Given the high site fidelity of Redshanks (Thompson & Hale 1989) disturbance to breeding sites is likely to affect breeding success. Furthermore, the continually decreasing availability of suitable habitat for this species (Suddaby et al. 2010; Lauder & Donaghy 2008), particularly machair, makes any impacts on remaining habitat concerning. Specific to infrastructure associated with wind energy, negative effects on the density of breeding Redshanks were observed within 200 m of operational turbines, even though changes in agricultural land-use post-construction may have rendered areas around the base of turbines more favourable for Redshank (Langston & Pullan 2003). Conversely, a study on similar disturbance effects around Dutch wind farms (Winkelman 1992) found no effect on Redshank populations. It was thought that this species is so long-lived and faithful to breeding sites that disturbance effects are lower. Similarly, though in other studies a strong response of this species to recreational disturbance was recorded at 1km (Yalden & Yalden 1989), this did not have an effect on breeding densities until much closer to wind energy infrastructure and may be compensated for by the aforementioned changes in land use. A metaanalysis of wind energy studies revealed that the minimum distance this species was recorded in relation to turbines was a mean of 183 m (Hötker et al. 2006). It was further found that Redshanks were less affected by smaller wind turbines than by taller installations. In this study, there was a strong correlation found between increased wind turbine height and observed minimum distance to these (Hötker et al. 2006). For Redshanks, collisions with operational turbines were not numerous, especially in relation to other at-risk species such as Terns and Gulls (Hötker et al. 2006; Everaert 2002; Percival 2003). In some cases, this was estimated at 0.7 collisions per turbine annually, a figure much lower than other exposed species (Percival 2003)

• Peregrine
Collision Risk
Bird Sensitivity Mapping to Wind Energy Development - Guidance Document 2015
A Peregrine was amongst the victims of 55 birds to be killed by 23 operational wind turbines in the course of a year in Zeebrugge, Belgium (Everaert et al., 2002). After correction for biases it was estimated at least 531 birds had collided in total (although most of these were gulls, Everaert et al., 2002). A review of European literature found two recorded Peregrine fatalities as a result of collision with wind turbines, both of these in Belgium (Hötker et al., 2004). There appears to be a low risk of collision with wind turbines for Peregrine. However, the speed attained by hunting Peregrines and the possibility of focus on the pursuit rather than the bird's surroundings (e.g. Madders & Whitfield, 2006) must predispose them to collision risk. Mapping Peregrine Falcons

• Short-eared Owl
Bird Sensitivity Mapping to Wind Energy Development - Guidance Document 2015
7.8 Sensitivity to development of wind energy
In general, owls have been identified as being at particular risk of collision as a result of wind energy development (Langston & Pullan 2003). Specifically, their large size and nocturnal or crepuscular hunting behaviour puts them at greater risk of collision than other species (EURAPMON 2008). However, hunting flight height is generally low, in the region of 2m. Partially as a consequence of this, collision with vehicles on busy roads at night is an increasing threat

to this species. In addition, removal of suitable hunting habitat or secondary disturbances to prey species may also adversely affect this species survival.

• Snipe Snipe were recorded during surveys, and observations of drumming birds indicate this species breeds on the cutover bogs to the east and west of the proposed development

.

• Sparrowhawk

• Whooper Swan The detection of nocturnal whooper swan flight calls is indicative of some migratory movements through the area in which the Proposed Development is located, while observations from visual surveys confirm the presence of a dispersed and mobile wintering population in the region. Whooper swans were occasionally observed flying over the Proposed Development. Flocks of whooper swan were noted grazing in agricultural land near T3 on two dates in the same week during winter 2022-23 surveys, and other groups were seen roosting/grazing on Esker Bog (west of proposed development) during winter 2023-24 surveys. These were isolated observations of casual roosting and grazing; however, no habitual grazing or roosting sites were observed in the vicinity of the Proposed Development.

Bird Sensitivity Mapping to Wind Energy Development - Guidance Document 2015

14.8 Sensitivity to development of wind energy In general, this species has been identified as being at particular risk of disturbance displacement and collision as a result of wind energy development (Langston & Pullan 2003). In particular, exclusion from habitat around wind turbines has been identified (Larsen & Clausen 2002), in some cases up to 300 m from wind energy installations (Percival 2003). Observations of swan nonbreeding activity from 8 European studies have given a mean minimum distance of 150 m from the base of wind turbines (Hötker et al. 2006), while other studies have shown a reduction of 1-2.5% in available habitat through disturbance displacement (Larsen & Clausen 1998). Whooper Swans have the highest recorded migratory flight height of any species of bird, at up to 8km above sea level (Elkins 1983). However, while moving between roosting and feeding sites, most flocks travel at between 5 and 30 m, putting this species at a much higher risk of collision with medium and large turbines, especially when the size and reduced manoeuvrability of this species is considered (Larsen & Clausen 2002). Though Whooper Swans can avoid turbines and have been known to habituate to these (especially resident birds) their risk of collision is much greater than that of other species. In addition to collisions with turbines themselves, swans have a high observed collision rate with overhead power lines, which may be associated with these installations (Langston & Pullan 2003). Despite this, observed collision rates for Whooper Swans have remained low around the wind 81 Bird Sensitivity Mapping to Wind Energy Development - Guidance Document energy installations of Europe (Hötker et al. 2006). It is therefore claimed that Whooper Swans are most susceptible to collision with medium sized turbines (10 – 50 m blade height) in the low light conditions of mornings and evenings during winter (Larsen & Clausen 2002). There may also be seasonal variation in this exposure, as flight times have been shown to vary across over-wintering periods (Larsen & Clausen 2002).

• Kingfisher (recorded during hinterland surveys on one occasion) Kingfisher was recorded on one occasion during hinterland surveys to the north of TR18 (c. 4.2km west of the Proposed Development), confirming the presence of this species in the wider area. There is no potentially suitable kingfisher nesting or foraging habitat within the Proposed Development.

• Ringed Plover (recorded during breeding wader surveys on one occasion) Ringed plover was recorded as potentially breeding in the surrounding hinterland during summer 2021 breeding wader surveys, which extended to the surrounding hinterland. Indications of breeding were recorded at Site 2 (4.7km west of Proposed Development).

• Woodcock (recorded during breeding wader/woodcock surveys) Woodcock were recorded in woodland beside the Grand Canal to the north-west of T1 during summer 2021, and breeding behaviour (display flights) were noted near T4 during summer 2022 surveys.

Towards a better understanding of avian collision in wind energy facilities using automatic detection systems Charlène Gémard, Olivier Duriez, Olivier Chappe, Gwénaël Duclos,Aurélien Besnard, Journal of Applied Ecology, 2025;62:1437–1448.

3.2 Sensitivity

Birds seemed to approach closer to turbines when humidity, nebulosity and temperature were high and when rotor speed and wind speed were low. Birds flew closer to turbines in the late morning (approx. 5h after sunrise) and in

April and October. Birds may have approached closer to turbines when visibility was high, although the large confidence interval indicates a lack of extreme values. Medium-sized species, individuals in transit flight and individuals detected by 3D systems approached significantly closer to turbines than large species, individuals foraging and birds detected by 2D systems, respectively). We observed a significant site effect (F = 12.06; edf = 3.86; p < 0.001) with a random intercept estimated at 0.12 (95% CI = 0.05–0.28), but the curve interpretation is difficult due to the width of the confidence interval.
Birds spent more time within the risk zone when humidity was high (>75%), visibility low (<10 km), wind speed and temperature moderate (approx. 5–7 m/s, 15°C–25°C) and rotor speed low (<5 rpm). The duration of the intrusion was also longer at the end of the day and between March and June. Individuals of medium species and/or with foraging flights spent more time within the risk zone than individuals of large species and/or in transit. We observed no significant differences between the detection system types and a significant site effect (F = 711.94; edf = 3.71; p < 0.001) with a random intercept estimated at 0.63 (95% CI = 0.29– 1.35), but the curve interpretation is difficult due to the width of the confidence interval.

DISCUSSION
The aim of this study was to propose, as proof-of- concept, a novel utilization of data from automatic detection systems to investigate environmental factors that may enhance the risk of bird-turbine collisions.
Our results are largely consistent with results obtained with other methods, confirming that detection system data have a great potential to improve our understanding of bird collision causes in wind energy facilities. Our results suggest a phenological response of exposure and sensitivity, both the highest during migration periods.
Weather conditions that influence the visual perception of turbines by birds (low visibility and high nebulosity) and flight behaviour (temperature, wind speed) might increase bird sensitivity to collision.
However, data from detection systems have certain limitations that may have affected our results, notably the diversity of flight heights and behaviours of the species studied, as discussed hereafter.
As expected, exposure and sensitivity to collision varied with bird phenology (Balmori-de la Puente & Balmori, 2023; Barrios & Rodriguez, 2004). Exposure peaks were observed in spring (March to May) and autumn (October). These well-documented periods of high activity, which correspond to pre-and post-nuptial migration peaks in central Europe (Newton, 2023), also correspond to peaks of abundance and fatalities in wind energy facilities (Schuster et al., 2015).
However, the intrusion duration peak suggests that sensitivity in our study was still high after the first exposure peak. It may represent the frequent use of the wind energy facilities by resident birds for their daily activities, such as foraging. Contrary to residents, migrant birds flying through are more numerous but do not intensely use this area (Marques et al., 2014). Consequently, their area use is reflected in exposure rather than sensitivity. This non-synchronicity of exposure and sensitivity peaks is consistent with previous studies that examined the lack of relationship between bird abundances (exposure) and fatality rates (Aschwanden et al., 2018; de Lucas et al., 2008). This result highlights the importance of examining both exposure and sensitivity, and how they vary, when assessing a risk.
Our results suggest that exposure and sensitivity were low in winter and at temperatures below 10°C, while we would have expected the opposite, based on bird use of thermal updrafts. Thermal updrafts generated by high temperatures are weak in winter, constraining raptors to fly at lower heights by using orographic uplifts (updraft airflows due to ground relief), increasing the proportion of flight at rotor height (de Lucas et al., 2008; Péron et al., 2017), and thus bird sensitivity. However, results from de Lucas et al. (2008), reporting that raptor fatalities were more frequent in winter, may not be comparable to ours. They focused on two wind energy facilities located in mountainous areas, with different avifauna than ours and with landscape characteristics more conducive to generating orographic lifts than open lands that made up the majority of our study sites.

Results may indicate that birds came closer to turbines at moderate wind speed (5–10 m/s), which is consistent with Linderet al. (2022). However, other studies reported an increased sensitivity in raptors at high wind speeds (Lanzone et al., 2012) and conversely, at low wind speeds (de Lucas et al., 2008). The lack of consensus on the effect of wind speed and temperature on bird sensitivity may be explained by species effects, as each species has its own specific behaviour and flight height depending on its use of thermals and orographic lift to minimize energy expenditure. For example, raptors that typically fly low (e.g. harriers Circus sp.and buzzards Buteo buteo) may fly higher (in the risk zone) at high temperature, whereas species that typically fly high (e.g. shorttoed eagles Circaetus gallicus and golden eagles Aquila chrysaetos) would fly at relatively lower heights (in the risk zone) at high temperature(Lanzone et al., 2012; Schaub, 2024). Here, we used two large species classes based on bird wingspan (medium/large) and

two flight types (transit/foraging) to address the detection systems' technical characteristics. Using such large classes can lead to over simplification and mixing of species with completely different ecologies and behaviours, resulting in opposite trends for certain factors (here, wind speed and temperature). In addition, wind direction influences birds' flight behaviour nearby turbines (Santos et al., 2022) but is scarcely included in collision risk assessment. Our results may indicate that large species and foraging individuals detected by detection systems exhibited higher exposure compared to medium- sized species and individuals in transit.

We would have expected the medium species to be more numerous and more abundant and consequently more exposed than large species. This result may be an artefact of the detection system characteristics, as some systems are unable to detect species below a certain wingspan threshold and/or are configured to focus on large species of interest, such as raptors with conservation issues only (Gradolewski et al., 2021). Here, 3D systems detected more birds than 2D systems, suggesting that their detection abilities might be superior, which supports the bias hypothesis. However, we can-not exclude a potential confounding effect of local abundance due to the small number of wind energy facilities equipped with each type of detection system in our study. Improving the detection capabilities of detection systems would allow us to study species that we currently excluded from our analysis, such as nocturnal and small species, despite the nonnegligible number of fatalities they represent in wind energy facilities (Aschwanden et al., 2018; Erickson et al., 2014; Nilsson et al., 2023). Because Passerines have a low wing aspect ratio, they alternate flapping and gliding phases in a bounding flight. These types of flights are less impacted by weather conditions than soaring flights that rely on weather-induced thermals and orographic lifts (Shamoun-Baraneset al., 2006), suggesting that the weather- dependent response of sensitivity would be different in these species. Therefore, including small and/or nocturnal species in the assessment of collision risk should be a priority to provide relevant recommendations fora wide range of bird species. Results, suggest that sensitivity was higher in large species than in medium-sized species. This disparity may be related to the behavioural tendencies of large species to have lower manoeuvrability when soaring and to use sinuous flights, which usually imply longer flight durations and less vigilance (Linder et al., 2022; Sassiet al., 2024).

Moreover, large raptors, as ground predators using the wind energy facilities studied here to hunt terrestrial prey, tend to focus on the ground rather than ahead or above them when foraging, due to their visual field shape (Potier et al., 2018).The results suggest enhanced exposure and sensitivity in low visibility, high humidity and high nebulosity, which may be related to the birds' visual perception of turbines. Most species have a poor perception of achromatic contrasts (Blary et al., 2024), even lower under conditions that reduce the contrast between the turbines and their background. Although our study has few unique observations of nebulosity, Aschwanden et al. (2018) found similar results and attributed two thirds of observed fatalities to poor visibility and high nebulosity.

In addition, some species are not able to discriminate rotary motion at curtailment speed (2–3 rpm) and may perceive turbines as stationary (Blary et al., 2023), which may explain the increased sensitivity we observed at very low rotor speeds. This result is unlikely to be an artefact of curtailment triggered by bird intrusion, as curtailment is typically triggered for certain species of interest only, usually raptors (Gradolewski et al., 2021), whereas we considered all detected species. To reduce bird sensitivity to collision, the two recommendations based on bird visual perception and our results are an increased contrast between turbines and their environmental background and/or a full turbine shutdown (Blaryet al., 2023; May et al., 2020).

Our results suggest that sensitivity was high at medium windspeeds and at low rotor speeds. It may seem contradictory, but we suggest two explanations. First, turbines must be stopped regularly, regardless of wind speed, for current mitigation measures including automated and passive curtailments (complete shutdown for several days, for instance, during sensitive periods of the annual cycle of birds or agriculture operations) and for scheduled shutdowns for maintenance. Furthermore, wind speed alone is not sufficient to achieve high rotor speed; wind direction must also be considered. Second, our results are not contradictory but complementary, as wind speed may influence bird flight behaviour, whereas rotor speed may influence the bird's visual perception of turbines. This comprehensive study reveals phenological and meteorological effects on bird exposure and sensitivity to collision in wind energy facilities, yet also contains numerous results that are challenging to explain with no clear biological mechanisms, probably due to the considerable heterogeneity of the data sources and the ecology and behaviour of the pooled monitored bird species. Some aspects remain unexplored, notably the site effect, due to a lack of data from a sufficient number of wind energy facilities with heterogeneous landscape contexts. Here, exposure may have been higher in wind energy facilities installed a few years ago, but sensitivity might be higher in recent facilities,

although no conclusions can be confidently drawn from these results. Land cover and topography have not been included in the analyses in spite of their known influence on bird phenology and flight behaviour by shaping resource availability, orographic lifts and thermals. They are also related to weather conditions and land cover and consequently to the visual perception of turbines in their background(Marques et al., 2014). Site effect and interspecific variability should be the focus of future research to obtain a more detailed understanding of bird collision risk in wind energy facilities, with the endgame of identifying high- risk situations in which mitigation measures must be increased.
Using data from automatic detection systems has the potential to provide management recommendations to reduce the risk of bird collisions at wind energy facilities. At a local scale, analysing data collected over one or more years at a facility—similar to the approach proposed here—would highlight specific periods and situations of high (or low) risk within the focal area that may allow for the improvement of detection system settings or curtailment strategies. At a global scale, analysing data from multiple facilities worldwide, across different landscape contexts, would highlight environmental factors that influence bird exposure and sensitivity. Hence, current mitigation strategies could be improved, for example, by avoiding the installation of new facilities in particularly sensitive areas or by adapting detection system settings based on proven effectiveness in similar environments, pending further refinement from local data. Ultimately, the combination of local and global data would create a more comprehensive bird collision risk mitigation strategy, ensuring that both immediate and long-term solutions are in place to bridge bird conservation and turbine productivity.

Response: Using Bird Collision data from 2003 is not acceptable. Windturbines have increased in size since that period & up-to-date models are available.

7.2.6.3.1 Vantage Point Surveys

Additional Whooper Swan Survey Effort Additional VP survey effort was completed during winter 2023/24 and autumn/winter 2024 (see Volume 3 of the EIAR, Appendices 7-1 and 7-2 for survey schedule). The methodology used for these surveys was the same as detailed in Section 7.2.6.3, except that watches were timed to take in the dawn and dusk periods to ensure periods with potentially higher levels of whooper swan activity were covered. The surveys were undertaken from the same VPs, detailed in Figure 7-1. All surveys were conducted during suitable weather conditions.

7.2.6.9 Nocturnal Migration Audio Surveys

In parallel with visual surveys, acoustic monitoring via autonomous recording units (ARUs) and was carried out to monitor nocturnal whooper swan activity, including nocturnal migration. When used in conjunction with visual surveys, ARUs are useful in pinpointing the time of arrival or departure of migratory birds, which can contribute to more robust definition of key periods for migratory activity.
The recording devices used to complete NocMig surveys were Audiomoth passive recording devices. These devices were programmed to record continuously, starting half an hour before sunset and finishing half an hour after dawn.

The deployment periods covered/number of nights recorded are detailed in Table 7-9 and Table 7-10. Audio recorder locations are shown in Figure 7-10. Since the length of device operation is dictated by battery life and other factors, and regular download of data from devices is necessary, regular visits to change batteries, copy data and confirm continued functioning of devices were undertaken. Audio monitoring was not constant, with short intervals of downtime due to low battery levels and required card changes, in addition to scheduling constraints associated with normal working days. However, survey effort was high, covering the majority of key migration periods across multiple locations at the Proposed Wind Farm and therefore comprises a robust sampling effort and baseline data.

7.2.6.4 Hen Harrier Roost Surveys

The methodology used to survey for hen harrier roosting activity adhered to the Irish Hen Harrier Winter Survey (IHHWS) (O'Donoghue, 2019) and Hardey et al. (2013). Potentially suitable areas of hen harrier roosting habitat were identified based on a desktop study and field observations gathered during the previous two years of surveys. These 'target areas' comprised of scrub and scrub/open woodland mosaic are shown in Figure 7-4. Four experienced observers were stationed at four separate VPs overlooking the two target areas suitable for hen harrier roosting at Ballinla. For each target area, two surveyors simultaneously conducted VP surveys starting three hours prior to dusk and continuing until observations were no longer feasible in the dark per IHHWS guidelines

(O'Donoghue, 2019). IHHWS guidelines state that surveyors must be present at least 40 minutes before dusk, and as such the survey effort exceeds that required by IHHWS guidelines. Surveyors recorded all hen harrier flight lines and searched for potential roosting behaviour. Flight durations were recorded in the following height bands: 0-15m, 15-30m, 30-100m, 100-200m and >200m. These height bands encompass the height band occupied by the proposed turbine blade sweep (23m – 185m). Other additional non-target species were also recorded where observed. The same surveyors covered the same locations for the entire survey period to prevent inter-observer variability. The locations of the hen harrier VPs and viewsheds are shown in Figure 7-4.

7.2.6.5 Hinterland Surveys

The methodology used for wetland sites during the winter hinterland surveys followed I-WeBS (Irish Wetland Bird Survey) methodology (Lewis et al., 2019), whereby each location was surveyed for the duration necessary to identify and obtain a count for all target species present. The same approach was adapted for non-wetland sites. A hinterland survey for raptors was conducted in accordance with Raptors: a field guide to survey and monitoring (Hardey et al. 2013) to assess hen harrier and other raptor activity over the winter and breeding periods in the greater surroundings. The hinterland survey also encompassed searches for hen harrier breeding and roosting sites within 2km of the Proposed Development, fulfilling the requirement set out in SNH Guidance (2017). The surveys were carried out in suitable habitats for birds (woodland, wetland, peatland, etc) in the area surrounding the Proposed Wind Farm. A total of 12 hinterland VPs (HVPs) and 12 hinterland transects within 6km of the Proposed Development across summer 2021 and winter 2021/22 were surveyed (per SNH, 2017). Eight sites were surveyed across both seasons. There were ten hinterland sites surveyed in the summer season and six in winter. Surveys carried out between April 2022 and March 2023 focused on eight hinterland sites within c. 5km of the Proposed Development. See Appendices 7-1, 7-2 and 7-7 for a full list of hinterland sites and a detailed schedule of surveys and Figure 7-5 and Figure 7-6 for the location of HVPs and hinterland transects. These sites were chosen as they had suitable habitat for target species such as raptors, geese, swans, waterbirds and waders

7.2.6.6 Breeding Bird Surveys

For general breeding birds the method utilised was based on the existing British Trust for Ornithology (BTO) Breeding Bird Survey (BBS or CBS. Bibby et al. 2000). The study area for this survey comprised four [c. 1km] transects which were selected and centred on different habitats present within the Proposed Development study area (see Figure 7-7). Birds were counted over two visits, each timed to coincide with the early part of the breeding season (April to mid-May 2022) and later part of the season (mid-May to June 2022). Surveyors recorded all birds seen or heard as they walked methodically along the transect routes. Birds were noted in three distance categories, measured at right angles to the transect line (within 25m, between 25m to 100m and over 100m from the transect line) and those seen in flight only. Recording birds in distance bands gives a measure of bird detectability and allows relative population densities to be estimated if required (BTO, 2018). The summer breeding bird transect schedule is detailed in Table 7-3, with survey details including weather and start/finish times indicated:

7.2.6.7 Winter Bird Surveys

Over the winter season, general bird transect surveys were carried out along the same transects as the breeding bird surveys over three rounds, with one visit to each transect per round. Surveyors recorded all birds seen or heard as they walked methodically along the transect routes. Birds were noted in three distance categories, measured at right angles to the transect line (within 25m, between 25m to 100m and over 100m from the transect line) and those seen in flight only. Recording birds in distance bands gives a measure of bird detectability and allows relative population densities to be estimated if required (BTO, 2018). The winter transect survey details are available in Table 7-4 The results are presented Appendices 7-1, 7-2 and 7-5. An additional transect, TR5, was surveyed during winter 2024-25 due to the inclusion of a new site access route within the Proposed Wind Farm (see Table 7-4 and Figure 7-7).

7.2.6.8 Breeding Wader Surveys

Survey transects to assess the presence of breeding wader populations were completed during the months of May, June and July 2021 and April-June 2022. A number of methods were combined from published literature including Bibby et al, (2000), Gilbert et al, (1998), O'Brien & Wilson (2011) and SNH (2017) to estimate numbers of target species breeding within this envelope. Methods utilised were grouped into two categories. those for breeding lapwing Vanellus vanellus and those for other species such as curlew Numenius arquata, common snipe Gallinago gallinago, redshank Tringa totanus, woodcock Scolopax rusticola, common sandpiper Actitis hypoleucos and ringed

plover Charadrius hiaticula. For each species, a pre-defined matrix of suitable habitats was created and used to select target habitats for survey as shown in Table 7-5.

Table 7-5: Target Species and Associated Suitable Breeding Habitat

Target Species	Suitable Breeding Habitat
Lapwing	Lowland wet grassland, arable farmland, cutover bog with pools and wet grassland
Snipe	Wet pastures, marsh, bogs (intact and cutover) and fens
Redshank	Bog
Curlew	Bog
Common Sandpiper	Streams/rivers in bog
Woodcock	Woodland, bog woodland
Ringed Plover	Cutover bog, milled peat with exposed gravel

Table 7-6: Count Units for each Wading Species

Species	Unit
Lapwing	Incubating Bird
Common Snipe	Drumming or Chipping Bird
Redshank	Alarming Bird
Woodcock	Displaying Male
Ringed Plover	Presence or Absence/Fledged Young late in season
Common Sandpiper	Presence or Absence/Fledged young late in season
Curlew	Territorial Activity

7.3.1.2 Avifauna

A desktop study on the avifauna covering the lands overlapping the Proposed Development was conducted. A summary of the desktop study findings is included below. The Proposed Development is situated within 10km grid squares N53 and N52. Examination of the NBDC Biodiversity Maps website indicates the following: Excepting historical records for four species (common coot, 1984. corncrake, 1972. grey partridge, 1991. grey wagtail, 1991 and spotted crake, 1993), a total of 44 bird species are present in historical datasets across both hectads as detailed in Table 7-17.

Information received on 25/03/2024 arising from the NPWS rare/protected species data request noted the following peregrine falcon records from 2002 hectad N53: one unoccupied nest site and hectad N62: one occupied nest site. The NPWS also noted the following records for nesting curlew. hectad N62: one record in 2016 and hectad N63: two records in 2015. Hectads N62 and N63 are located east of the Proposed Development. Birdwatch Ireland's Bird Sensitivity to Wind Energy Mapping Tool which was accessed via the NBDC Biodiversity Maps website, was assessed as a means to predict the sensitivity of birds to wind farm developments within the 10km grid squares N53 and N52 which overlap the site, as per McGuiness et al. (2015). However, no data was available for the wider area in which the Proposed Development is located.

Table 7-17 : Birds of Conservation Interest [1]

Grid Square	Species Name	Date of Last Record	Record Count	Title of Dataset	BoCCI Status	Annex I
N52, N53	Barn Owl (*Tyto alba*)	12/07/2017	2	Birds of Ireland	Red	No
N52, N53	Barn Swallow (*Hirundo rustica*)	19/05/2018	23	Bird Atlas 2007-2011	Amber	No
N52, N53	Black-headed Gull (*Larus ridibundus*)	09/05/2020	5	Birds of Ireland	Amber	No
N52	Common Goldeneye (*Bucephala clangula*)	25/10/2020	2	Birds of Ireland	Red	No
N52, N53	Common Kestrel (*Falco tinnunculus*)	25/10/2020	15	Birds of Ireland	Red	No
N52, N53	Common Kingfisher (*Alcedo atthis*)	31/12/2011	4	Bird Atlas 2007-2011	Amber	Yes
N52, N53	Common Linnet (*Carduelis cannabina*)	13/11/2020	16	Birds of Ireland	Amber	No
N52	Common Redshank (*Tringa totanus*)	25/03/2023	3	Birds of Ireland	Red	No
N52, N53	Common Snipe (*Gallinago gallinago*)	14/04/2023	19	Birds of Ireland	Red	No
N52, N53	Common Starling (*Sturnus vulgaris*)	31/12/2011	22	Bird Atlas 2007-2011	Amber	No
N52, N53	Common Swift (*Apus apus*)	31/12/2011	9	Bird Atlas 2007-2011	Red	No
N52, N53	Corn Crake (*Crex crex*)	31/07/1972	1	The First Atlas of Breeding Birds in Britain and Ireland: 1968-1972.	Red	Yes
N52, N53	Eurasian Curlew (*Numenius arquata*)	21/08/2015	5	The Second Atlas of Breeding Birds in Britain and Ireland: 1988-1991	Red	No
N52	Eurasian Marsh Harrier (*Circus aeruginosus*)	01/05/2010	1	Birds of Ireland	Amber	Yes
N52, N53	Eurasian Teal (*Anas crecca*)	31/12/2011	3	Bird Atlas 2007-2011	Amber	No
N52, N53	Eurasian Wigeon (Anas penelope)	30/10/2017	1	Birds of Ireland	Amber	No

Grid Square	Species Name	Date of Last Record	Record Count	Title of Dataset	BoCCI Status	Annex I
N52, N53	Eurasian Woodcock (*Scolopax rusticola*)	16/03/2018	5	Birds of Ireland	Red	No
N52, N53	European Golden Plover (*Pluvialis apricaria*)	31/12/2011	3	Bird Atlas 2007-2011	Red	Yes
N52, N53	Great Cormorant (*Phalacrocorax carbo*)	12/03/2022	1	Birds of Ireland	Amber	No
N52, N53	Grey Partridge (*Perdix perdix*)	29/02/1984	2	The First Atlas of Wintering Birds in Britain and Ireland: 1981/82-1983/84.	Red	No
N52, N53	Grey Wagtail (*Motacilla cinerea*)	31/07/1991	1	The First Atlas of Breeding Birds in Britain and Ireland: 1968-1972.	Red	No
N52, N53	Hen Harrier (*Circus cyaneus*)	31/12/2011	3	Bird Atlas 2007-2011	Amber	Yes
N52, N53	House Martin (*Delichon urbicum*)	31/12/2011	10	Bird Atlas 2007-2011	Amber	No
N52, N53	House Sparrow (*Passer domesticus*)	31/12/2011	19	Bird Atlas 2007-2011	Amber	No
N52	Little Egret (*Egretta garzetta*)	25/03/2023	1	Birds of Ireland	Green	Yes
N52, N53	Mallard (*Anas platyrhynchos*)	25/03/2023	15	Birds of Ireland	Amber	No
N52, N53	Merlin (*Falco columbarius*)	31/12/2011	1	The First Atlas of Wintering Birds in Britain and Ireland: 1981/82-1983/84.	Amber	Yes
N52, N53	Mute Swan (*Cygnus olor*)	25/03/2023	7	Birds of Ireland	Amber	No
N52, N53	Northern Lapwing (*Vanellus vanellus*)	25/03/2023	18	Birds of Ireland	Red	No
N52, N53	Northern Wheatear (*Oenanthe oenanthe*)	21/04/2021	3	Birds of Ireland	Amber	No
N52, N53	Peregrine Falcon (*Falco peregrinus*)	13/11/2020	5	Birds of Ireland	Green	Yes
N52	Ringed Plover (*Charadrius hiaticula*)	25/03/2023	3	Birds of Ireland	Amber	No
N52, N53	Sand Martin (*Riparia riparia*)	18/10/2015	2	Bird Atlas 2007-2011	Amber	No
N52, N53	Sky Lark (*Alauda arvensis*)	21/05/2019	23	Birds of Ireland	Amber	No
N52, N53	Spotted Flycatcher (*Muscicapa striata*)	31/12/2011	3	Bird Atlas 2007-2011	Amber	No
N52, N53	Tufted Duck (*Aythya fuligula*)	31/12/2011	2	Bird Atlas 2007-2011	Amber	No
N52	Whinchat (*Saxicola rubetra*)	30/05/2021	2	Birds of Ireland	Red	No
N52, N53	Whooper Swan (*Cygnus cygnus*)	25/03/2023	16	Birds of Ireland	Amber	Yes

Grid Square	Species Name	Date of Last Record	Record Count	Title of Dataset	BoCCI Status	Annex I
N52, N53	Yellowhammer (*Emberiza citrinella*)	04/06/2023	12	Bird Atlas 2007-2011	Red	No
N53	Common Coot (*Fulica atra*)	29/02/1984	1	The First Atlas of Wintering Birds in Britain and Ireland: 1981/82-1983/84.	Amber	No
N53	Common Quail (*Coturnix coturnix*)	31/12/2011	1	Bird Atlas 2007-2011	Red	No
N53	Common Sandpiper (*Actitis hypoleucos*)	31/12/2011	4	Bird Atlas 2007-2011	Amber	No
N53	Lesser Black-backed Gull (*Larus fuscus*)	16/10/2010	1	Birds of Ireland	Amber	No
N53	Spotted Crake (*Porzana porzana*)	02/07/1993	1	Rare birds of Ireland	Amber	Yes

7.3.2.1.1 Buzzard Vantage Point Surveys:

Summer/Breeding Season (Summer 2021, 2022 and April 2024) Buzzards were recorded on 185 occasions across all surveyed breeding seasons. The majority of these recorded Buzzard flights travelling either wholly within or partially within the 500m buffer zone as well as within the rotorswept height band (23-185m). There were records of hunting in the flight activity study area; however, there were no records of confirmed breeding behaviour. There were a total of 117 observations of this green-listed species during the summer 2021 VP surveys. These occurred at every VP across all months of the breeding season. Flight activity was recorded in each of the height bands, with most flight time spent in the 100-200m band. A high proportion of activity also occurred >200m. Flight activity was widely distributed across the entire study area. Buzzards were recorded 55 times during the 2022 breeding season across every VP and all months (AprilSeptember). Six of these observations occurred during spring migration watches from VPs 1-3. Most flight activity was concentrated in/adjacent to the northeast section of the study area. Flight activity was also observed in the northwest and south of the study area. Behaviour observed was typical of buzzards as they were seen soaring, circling and hovering. Hooded crows were seen mobbing buzzards on five occasions from VPs 1 and 3 in April, May and June 2022. One observation from VP 2 on 20th June 2022 recorded a buzzard being mobbed by a peregrine while soaring. Displaying behaviour was observed from VP 1 on 18th April 2022. During the 2024 migration surveys in April, buzzards were observed 12 times from VPs 2, 3 and 4. Six of these obervations occurred within the 500m buffer zone, with typical buzzard behaviour observed as they were seen circling, soaring, hunting and being mobbed by hooded crows on two occasions.

VP Surveys:

Winter Season (Winter 2021/22, 2022/23, 2023/24 & 2024/25) Buzzards were recorded 197 times throughout the non-breeding seasons. Buzzards were observed during each season, with typical behaviour such as circling, soaring and hunting noted. During the 2021/22 winter season, there were a total of 43 records of this green-listed raptor species. This included five unmapped static calling records and 38 recorded mapped observations. Observations were noted from all VPs and across every winter month. Flight activity was recorded in every height band with the majority occurring at low heights in the 0-15m band. The behavioural patterns recorded were typical for this species with soaring (seven observations), low flying (four observations) and incidences of mobbing by hooded crows (six observations) observed. Flight activity was primarily concentrated to the northeast and in the mid-west of the study area. During the 2022/23 winter season, a total of 57 observations of this green-listed species were recorded during winter VP surveys. Of these, seven were recorded during autumn migration watches, all seen from at VP 1. Flight activity was predominantly recorded in the 0-15m and 30-100m height bands. The remainder of winter records were observed from VPs 1, 2 and 3 during every month between October 2022 and March 2023. Flight activity occurred in every height band but most frequently between 0-15m. Flight activity was concentrated in/adjacent to the northeast section of the study area. Several records were made in/to the northwest and southern parts of the study area. Activity recorded was typical of buzzards with observations of circling, soaring, hunting, gliding and soaring. Buzzards were mobbed on four occasions by corvids. During the 2023/2024 winter season, there were a total of 78 observations from all VPs and HHVPs (hen harrier watch VPs). Flight activity was recorded in every height band with majority occurring at low heights in the 30- 100m band. There was some activity >200m and also across the remaining bands. Flight activity was concentrated in the southern parts of the study area and the northeastern

section of the study area. Activity recorded was typical of buzzards with observations of circling, soaring, hunting, gliding, soaring and being mobbed by corvids.

During the 2024/25 winter season there was a total of 10 observations from VPs 1 & 3, only one of which traversed the 500m turbine buffer. The majority of flight time was recorded within the 0-15m height band, followed by 30-100m. Flight activity was concentrated in the northeast section of the study area. Winter Transects (Winter 2021/22, 2022/23, 2024/25)

During the 2021/22 Winter Transect Surveys, green-listed buzzard was recorded four times. These were distributed along transect 1 (0-25m and 25-100m distance bands) and along transect 4 (0-25m and flying over/>100m).

During the 2022/23 Winter Transect Surveys, buzzard was recorded seven times. These were distributed along transect 1 (0-25m and 25-100m distance bands) and along transect 4 (0-25m, 25-100m and flying over/>100m distance bands). Two buzzards were seen flying and then perching in trees in the 0-25m distance band along TR5 on 02/12/2024. Hinterland Surveys (2021, 2022, 2023 and 2024)

Buzzards were observed on 29 occasions during the summer of 2021 across every month at hinterland VPs (HVPs) 1, 2, 3 4, 9, 10, 11, 12 and 13. These were primarily observations of single birds. There were 12 records during winter 2021/22 hinterland surveys in every month, excluding November, at HVPs 4, 7, 8 and 12 and along TRs 24 and 25. Display flight activity was noted in a group of five individuals at HVP 7 on February 2nd, 2022. There was also an incidental record noted on February 4th, 2022. In the summer of 2022, buzzard was observed seven times during summer hinterland surveys in April, June, July, August and September. These records were noted at HVPs 7 (4.63km west of study area) and 8 (2.17km southeast of study area) and observed single birds. A juvenile was recorded on one occasion at HVP 8 on September 16th, 2022. During the winter of 2022/23, a total of six records of this species were made during winter hinterland surveys. These occurred at HVPs 7 and 8 during October/November 2022 and in January, February and March 2023. Four of these observations recorded single birds, while two buzzards were seen together on two occasions (at HVP 7 on November 9th and February 3rd).

During the Winter of 2023/24, a total of three buzzard observations were recorded during the hinterland surveys. These occurred at HVPs 7 and 8 during November 2023 and March 2024. Two observations recorded two individuals together (11th November 2023 and 4th of March 2024) while the other observation recorded a single bird. A single record of buzzard was made during winter 2024/25 hinterland surveys, with a pair recorded at HVP7 on 11th October 2024.

7.3.2.1.2 Black-Headed Gull VP Surveys:

Summer/Breeding Season (Summer 2021, 2022 and April 2024) There were no Black-headed gulls observed in the summer season of 2021/22. There were only two Black-Headed Gull observations in breeding season surveys which occurred in 2022. These both occurred from VP 3 on 12th July 2022. The first record noted one gull flying in the 100-200m height band. Three individuals were recorded on the second occasion flying within the following height bands: 0-15m, 15-30m and 30-100m. The flight paths observed traversed the south of the study area over woodland and bog habitat. There were no Black-headed gulls observed in the April 2024.

VP Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25)
There were no Black-headed gulls observed in the winter season of 2021/22. The non-breeding season of 2022/23 was the only survey period where Black-Headed Gulls were recorded. A total of four observations of this amber-listed species were recorded, all from VP 1 on 20th December 2022. Flight activity was recorded predominantly in the 0-15m height band, with a high proportion of time of time also spent between 30-100m. The remaining flight time was distributed across the other height bands (30-100m and 100- 200m). These records were concentrated to the northeast of the study area over farmland. These observations recorded birds circling/searching and then dropping down to land in fields, indicating foraging. There were no Black-headed gulls observed in the winter seasons of 2023/24 or 2024/25. No black-headed gulls were observed during any other surveys.

7.3.2.1.3 Common Gull VP Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25)
Common Gull was not observed during the 2021/22, 2023/24 or 2024/25 Winter VP Surveys. There were two observations of the Common Gull in the 2022/23 non-breeding season surveys. Both were noted from VP 1 on

December 20th. The first record noted four gulls which flew in from the east in the 0-15m and 15- 30m height bands. The second observation recorded six individuals flying in a westerly direction in the 0-15m height band. These flights occurred to the northeast of the study area over agricultural land. There was no flight activity within the 500m buffer. No common gulls were observed during any other surveys.

7.3.2.1.4 Cormorant

VP Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25)
Cormorant was not observed in the winter VP Surveys of 2022/23, 2023/24 or 2024/25. This amber-listed species was recorded on one occasion across the winter 2021/22 season. This observation occurred on the 2nd of November from VP 1 and involved one cormorant in direct flight along the Grand Canal bordering the northern part of the proposed site. Flight activity was recorded in the 0-15m height band (20 seconds) and in the 30-100m band (90 seconds). All flight activity was outside the 500m turbine buffer. No cormorants were observed during any other surveys.

7.3.2.1.5 Great Black-backed Gull

Vantage Point Surveys: Summer/Breeding Season (Summer 2021, 2022 and April 2024)
During summer 2021 VP surveys and early in the breeding season, this green-listed species was recorded a total of five times (during 27th April and 30th April). A total of three observations were recorded from VP 1 and two were recorded from VP 2. Flight activity was predominantly recorded in the 30-100m height band, with less activity noted in the 0-15m and 15-30m height bands. This species was recorded in low numbers with single gulls noted on four the occasions and two individuals sighted together on one occasion (from VP 2).
There were no observations of Great Black-backed Gull in the 2022 Summer season or Migration Survey in April 2024. No great black-backed gulls were observed during any other surveys.

7.3.2.1.6 Golden Plover

Golden Plover were predominantly observed during the winter season, in addition to a small number of records potentially associated with migratory and post-breeding dispersal. Observations indicate the presence of a wintering population in the locality and wider region which utilises agricultural land and bogs.

Vantage Point Surveys: Summer/Breeding Season (Summer 2021, 2022 and April 2024) During the 2021 Summer Surveys, there were no observations of Golden Plover.
During the 2022 Summer Surveys, a total of five observations of this Annex I/red-listed species were recorded. Of these, four were recorded during spring migration VP surveys from VP 1 (5th April 2022). Flight activity of 12-15 birds (three observations) was recorded primarily within the 0-15m height band (137 seconds). Time spent in the remaining height bands was distributed as follows: 15-30m (32s) and 30-100m (86s). These observations involved golden plovers in direct and circular flight predominantly concentrated in/adjacent to the northeast section of the study area. One unmapped static record noted 12 golden plovers in breeding plumage foraging in a field to the south of VP 1 on 5th April 2022. The fifth and final summer season observation of this species occurred on 19th August 2022, from VP 2, where a flock of 46 birds were seen in direct flight moving northwest and skirting the northwestern edge of the study area for 40 seconds in the 30-100m height band. Golden plover activity in August is likely to be indicative of post-breeding dispersal associated with the resident population which breeds in the northwest of the country. During the 2024 April Migration Surveys, one observation was recorded on 9th April 2024. Flight activity of 12 birds was recorded within the 30-100m height band (5 seconds), moving westward to the north of T4.
Vantage Point Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25) During the 2021/22 Winter VP Surveys there were a total of 38 observations. This included 33 visual sightings and five static call records. These records were made from every VP across every winter month. This includes one observation made during an autumn migration survey from VP3. Flight activity was recorded across every height band with the majority occurring in the 30-100m band. Flight time was also recorded across the remaining height bands (0-15m, 15-30m, 100-200m and >200m). Most of the observations were recorded in the north/northeast of the study area. Flock size ranged from eight to 750 individuals. Activity observed included high levels of circling search flight, direct and multidirectional flight. There was also evidence of foraging activity in the flight activity study area. During the 2022/23 Winter VP Surveys, a total of 20 records of this Annex I/red-listed species were made from VPs 1 and 3. Flight paths were primarily recorded in and adjacent to the northeast of the study area. Flight activity was distributed across all height bands with most time spent in the 100-200m, 30-100m and >200m height bands. One

of these observations was noted during an autumn migration survey from VP3 (01/10/2022) and recorded 12 individuals flying in the 0-15m and 30-100m height bands. The smallest number of birds observed together during this season was three, while large flocks of up to 1000 birds were also recorded. The latter large flock of 1000 individuals was seen on three occasions from VP 1 on 15th November 2022. This flock was observed in searching/wheeling flight. Similarly, from VP 1 on 4th November 2022, a group of 500 birds was observed on three occasions. It was first seen rising in a field with lapwing and was later disturbed by a buzzard flying over. The flock returned to the field once the buzzard had departed. A static record of a flock of 55 foraging birds was made on December 20th, 2022 (not mapped). This flock was outside the study area to the east of VP1. During the 2023/24 Winter VP Surveys, there were a total of 16 observations. Flight activity was recorded in every height band with majority occurring at low heights in the 0-15m band. There was some activity in the >200m band. Flight activity was concentrated around Esker Bog Rathlumber and VP1.

During the 2024/25 Winter VP Surveys, there were a total of 14 golden plover observations, four of which intersected the 500m turbine buffer. Flight activity was recorded in every height band and was distributed as follows. Numbers of individuals observed during this period ranged from 3-600. Flight activity was concentrated mainly in the northeast and southeast of the study area.
Winter Transects (Winter 2021/22 and 2022/23) Golden plover were not observed in the 2022/23 Winter Transect Surveys; however, were recorded twice in the Winter Transect Surveys of 2021/22. There was an observation of 10 individuals flying over on 5th of January 2022, and an observation of 1000+ individuals >100m form the transect on 2nd of December 2021. Hinterland Surveys (2021, 2022, 2023 and 2024) Red-listed/Annex I golden plover were recorded three times throughout winter 2021/22 hinterland surveys. The earliest record was made at TR 26 (5th December 2021).
Further records occurred at HVP 4 (5th January 2022) and HVP 8 (10th March 2022). Flock size ranged from 40-1500 individuals. This Annex I/red-listed species was observed on one occasion across all 2022/23 hinterland surveys. This occurred on 14th October 2022, at HVP 8 (southeast of study area) where a flock of 20 individuals was observed on peat hidden among heather. A flock of 80 golden plover were recorded at HVP17 on 1st January 2025. There were no records of golden plover during summer 2021 and 2022 hinterland surveys.

7.3.2.1.7 Grey Heron

Vantage Point Surveys: Summer/Breeding Season (Summer 2021, 2022 and April 2024)
During the 2021 Summer Surveys, this species was observed five times. Three of these occurred from VP 1 (April 27th April and 10th August) and two were recorded from VP 4a (18th May and 12th September). Grey herons were predominantly recorded individually, and two birds were seen together from VP 4a on one occasion. Flight activity was noted in every height band, except for >200m.

During the 2022 Summer Surveys, grey heron was recorded just once. This observation was recorded from VP 2 on 6th June 2022, when an individual was seen flying straight from the northwest corner of the study area moving in a northerly direction in the 30-100m height band.

Vantage Point Surveys: Winter Season (Winter 2021/22)
During the 2021/22 Winter VP Surveys, grey heron individuals were recorded on four occasions (October 2021). This included one migration survey sighting. A total of three observations were noted from VP 2 and one from VP 1.

During the 2022/23, 2023/24 and 2024/25 Winter VP Surveys, grey heron was not observed. Winter Transects (Winter 2021/22 and 2022/23) Grey Heron was not observed in the 2021/22 Winter Transect Surveys. Grey Heron was observed once in the 0-25m distance band in the Winter Transect Surveys 2022/23. Hinterland Surveys (2021, 2022, 2023 and 2024) There were 24 observations of green-listed grey heron during the summer 2021 at HVPs 1, 2, 3, 4, 9, 11, 12, 13 and 19. This species was predominantly found singly or in groups of 2-5 individuals. Grey heron was recorded on five occasions during winter 2021/22 all of which occurred on 5th October 2021. These observations were made

at HVPs 4, 9 ,12 and 13 and were primarily of single birds, along with one record of two individuals together at HVP 9. Grey Heron was not observed in the 2022/23 Hinterland Surveys.

7.3.2.1.8 Greylag Goose

Vantage Point Surveys: Winter Season (Winter 2023/24) During the winter 2023/24 hen harrier roost watch VPs, greylag goose was observed once. A single goose was seen commuting in a south-westerly direction in the 100-200m height band, moving through the 500m buffer near T6. There were no records of greylag goose during any other surveys. 7.3.2.1.9 Hen Harrier Foraging hen harrier were observed during the winter seasons, and casual/opportunistic roosting of individual birds was observed on three occasions. However, surveys established the absence of any communal/habitual roosts in the locality of the Proposed Development. The region in which the Proposed Development is located provides a landscape-scale habitat mosaic which is suitable for wintering hen harrier.

Vantage Point Surveys: Summer/Breeding Season (Summer 2021, 2022 and April 2024) During the 2021, 2022 Summer Surveys and April 2024 Migration Surveys, there were no sightings of Hen Harrier.

Vantage Point Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 & 2024/25)
During the 2021/22 Winter VP Surveys, Hen Harrier was recorded on 12 occasions throughout the winter 2021/22 season. All of these observations were recorded from VP 3 (January, February and March 2022). Hen harriers were always seen alone, and flight activity was consistently recorded at low heights, with the majority occurring in the 0-15m band (3010 seconds). An additional 90 second observation was recorded at 15-30m. The distribution of flight activity was concentrated around the southeast of the study area. Birds were predominantly recorded hunting within the study area, which frequently occurred over bog and farmland. Eight of the observations identified a hunting female, five of which were considered to be the same individual on 12th March. Two observations of females flying into the southern part of the study area during February 2022 are considered to be indicative of roosting due to the timing of the observations (17:05 and 16:25 respectively). These observations both recorded a female hen harrier flying low with the flight path terminating out of sight in trees in recolonising cutover bog south/east of the Proposed Development.

During the 2022/23 Winter VP Surveys, there were three observations of hen harrier, all of which were seen from VP 3 on 14th October, 22nd and 29th December 2022. Flight activity occurred in the 0-15m (490s) and 15-30m (425s) height bands. This activity was concentrated to the south of the study area over recolonising cutover bog and remnant drained raised bog. All observations were of single birds, two of which were males. The first record (14th October 2022) noted a male active in this area for almost one hour. During this period, this bird was observed quartering/hunting and preening. A hen harrier was briefly observed (10s) hunting among birch trees within the 15-30m height band in the same area on 29th December 2022. The hen harrier observed on 22nd October 2022 flew southwest before quartering back to fly northeast along bog/woodland edge, occupying the 15-30m height band. This flight pattern is indicative of hunting behaviour.

During the 2023/24 Winter VP Surveys, there were eight observations of hen harrier, with one observation from VP1 (January), one from HHVP 2 (November), four from VP3 (December, March), one from HHVP3 (December) and one from VP4 (March). Flight activity occurred in the 0-15m (410s) height band and was concentrated to the south of the study area.

Six of the observations identified a female of which three were considered to be the same individual on 4th March. One of these observations was an unconfirmed/potential hen harrier recorded flying into the woodland north of T4 at dusk on 11th December 2023. Identification of this bird was inconclusive due to low light; however, this is assessed as a record of roosting hen harrier on a precautionary basis. Hen harriers were not observed during the 2024/25 winter VP surveys. There were no observations of hen harrier during any other surveys.

7.3.2.1.10 Kestrel

Vantage Point Surveys: Summer/Breeding Season (Summer 2021, 2022 and April 2024)
During the 2021 Summer Surveys, there were a total of 14 kestrel observations. These occurred at every VP throughout all summer months except June. Flight activity was recorded across every height band up to 200m. Time was primarily spent between 30-100m. Observations were predominantly recorded along the edge of the study area with some circling flight patterns in the southeast. All of the observations recorded single birds with one confirmed male sighting (11th May 2021 VP3a). There was also a record of a moulting juvenile on August 10th (VP1).

During the 2022 Summer Surveys, kestrels were again observed on 14 occasions. Of these, two occurred during spring migration watches (both on 9th April 2022). Flight activity occurred in the 15-30m and 30-100m height bands during these records. The remaining records were noted during every month between April-September 2022. Flight activity was again predominantly recorded in the 30-100m height band, followed by 100-200m. Flight paths were scattered across the study area with activity concentrated in pockets in/adjacent to the northeast, south and northwest corners of the study area. Kestrels were seen alone during all summer observations. Three were identified as males. Kestrels were seen hunting/hovering during twelve observations across the whole summer season.
During the 2024 April Migration Surveys, there were five kestrel observations, all of which occurred at VP3 in April (9th & 10th). Flight paths were observed in the south of the study area with four observed within the 500m buffer with circling flight patterns. Three were identified as males and two females and were observed hovering and hunting.

Vantage Point Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25)
During the 2021/22 Winter VP Surveys, there was a total of 19 observations of this red-listed species. These were recorded from every VP and across every month of the winter season. Flight activity was highest at low levels with a total of 4210 seconds recorded in the 0-15m band, followed by 759 seconds in the 30-100m height band. The majority of observations were recorded to the southeast of the study area on the outskirts of the SNH buffer, but records were also distributed across the study area. The flight activity observed followed typical patterns for this species with high levels of hovering and hunting in the study area. There were two observations of kestrels hunting finches. The majority of the records noted single birds with four confirmed male individuals.

During the 2022/23 Winter VP Surveys, there was a total of 29 observations of kestrel. Of these, two were noted during autumn migration watches from VP 3 and VP 4 (September 30th and October 1st, 2022). Activity was primarily recorded in the 100-200m height band. Observations of flight paths were primarily concentrated in pockets in/adjacent to the northeast, northwest and south of the study area. The remaining records between October 2022 and March 2023 were made at every VP. Flight activity for these records occurred predominantly in the 15-30m height band. All kestrels observed were alone and eleven were identified as male. Kestrels observed were mainly engaged in hunting, during both seasons.

During the 2023/24 Winter VP Surveys, there was a total of 65 observations recorded from every VP across every month of the winter season. Flight activity was highest in the 15-30m height band followed by 30-100m. The majority of observations were recorded to the southeast or northeast of the study area on the outskirts of the southeast 500m buffer or within the 500m buffer in the northeast. Hunting and hovering were frequently observed. Kestrels were observed alone, and majority were identified as male.

During the 2024/25 Winter VP Surveys kestrel was observed six times. No flight activity occurred within the 500m buffer. Flight activity was observed in each of these height bands: 0-15m, 15-30m and 30-100m. Winter Transects (Winter 2021/22 and 2022/23) There was one observation of red-listed kestrel within the 25-100m distance band at transect 4 (round 1) in the 2021/22 Winter Transect Survey. There were no observations of kestrel in the 2022/23 Winter Transect Survey. Hinterland Surveys (2021, 2022, 2023 and 2024) A total of five observations of this red-listed species were recorded in summer 2021. These occurred in June 2021 (9th and 30th June) from HVPs 9, 10 and 12. These observations were all of single birds.

During winter 2021/22, this species was observed twice at TR 24, where hunting activity was recorded on one occasion (January 1st 2022). Red-listed kestrel was observed on one occasion during summer 2022 hinterland surveys. This occurred at HVP 7 on 12th July 2022. There was one observation of an individual kestrel during winter 2022/23 hinterland surveys, recorded from HVP 7 on 18th December 2022. Kestrel was observed three times during winter 2023/24 hinterland surveys. These occurred at HVP 8 on 11th November 2023, HVP7 and HVP9 on 4th March 2024.

7.3.2.1.11 Kingfisher
Hinterland Surveys (winter 2021/2022)

There was one incidental record of this amber-listed/Annex I species across hinterland surveys which occurred on 5th December 2021 to the north of TR18 (c. 4.2km west of the Proposed Development). There were no observations of kingfisher during any other surveys.

7.3.2.1.12 Lapwing

Vantage Point Surveys: Summer/Breeding Season (Summer 2021, 2022 and April 2024)
During the 2021 Summer Surveys, lapwing was recorded twice. These both occurred early in the breeding season (30th April) from VP 2 and recorded single birds. Flight activity only occurred within the 30-100m height band for 308 seconds and noted individuals flying over conifer plantation in the northwest of the study area and then continuing over improved agricultural grassland and woodland in a westerly direction. This red-listed species was recorded a total of 30 times during summer 2022 VP surveys. Of these, seven were noted during spring migration watches, all of which were seen from VP 3 (1st April and 5th April 2022). During this period flight activity was observed in the 15-20m and 0-15m height bands. Display behaviour was seen during these spring migration surveys on three occasions on both dates, one of which involved a flock of 12 individuals (1st April 2022). The remaining summer observations were seen from VPs 3 and 4. Flight activity was primarily in the by 15-30m height band, followed by 0-15m. Lapwing were commonly observed alone or in pairs. However, groups of 3-22 were also recorded. The largest flock of 22 birds, made up of juveniles only, was seen from VP3 on 20th June. This species was seen foraging, displaying and commuting on/over peatland, and also occasionally agricultural land. These records were primarily concentrated in the south of the study area.
Display flights were recorded over peatland in the south of the study area on 5th April and 8th May 2022. Display flights over fields were recorded on 1st and 5th April. During the April 2024 Migration Surveys, lapwing was recorded thirteen times. Of these, 12 were seen from VP3 and one from VP4. All observations were in April (9th to 11th). Flight activity was mainly observed in the 15-30m height band. Display flight was observed overlapping the southeast of the 500m buffer on 10th April and potential nesting and foraging behaviour was also observed, including a pair in a stubble field near VP3 (outside the Proposed Development c. 900m outside the 500m buffer.

Although breeding behaviour was observed, surveyors noted any potential breeding attempts would be unlikely be successful for this ground-nesting species due to high predator pressure in the locality (resident foxes, hooded crows and magpies were frequently observed, and pine marten and mink are also likely to be present). No evidence of successful breeding on Esker Bog Rathlumber was recorded.

Vantage Point Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25) A total of 15 observations of this red-listed species were recorded during winter 2021/22 VP surveys. These occurred at VPs 1, 3 and 4. Flight activity was recorded across all height bands with the majority of total flight time spent at 100-200m. Number of individuals per record ranged from single birds to flocks of up to 78 individuals. The flock of 78, observed on 8th November 2021 was recorded circling within the 500m buffer over plantation woodland near T4. This was the only incidence of flight activity in this area during winter 2021/22. the majority of flight activity was focused in the area of Esker Bog Rathlumber to the east of T6. The majority of observations recorded lapwing circling over Esker Bog Rathlumber (recolonising cutover bog to the south/east of the Proposed Development). Flocks in direct flight were also observed in the north of the study area. On two occasions, lapwings were flushed, once by a buzzard and once by a peregrine. Additionally, there were three records where lapwing was heard but not seen. A total of 26 records of this red-listed species were made during 2022/23 winter VP surveys.

These were noted from every VP in October, November, December 2022, and January and March 2023. There was flight activity in every height band but primarily within the 30-100m and 15-30m bands. Flight paths were concentrated in two main pockets, one in/adjacent to the south and one in/adjacent to the northeast of the study area. A static record of a flock of four lapwing foraging with a flock of golden plover was made on December 20th, 2022 (not mapped). This flock was outside the study area to the east of VP1. Lapwing were seen alone or in pairs but more commonly in groups ranging between 3-120 individuals. The largest flocks of 90 and 120 birds were observed from VP 1 (November 15th and December 6th, 2022). Another large flock of 58 individuals was recorded from VP 3 (October 22nd, 2022). The size of other groups ranged from 3-50 birds. There were observations of foraging behaviour, searching, and circling flight patterns across the season. In March 2023 at VPs 3 and 4, display flights and calling birds were recorded (four records from March 17th to 21st).

During the 2023/24 Winter VP Surveys a total of 27 lapwing observations were made. These were noted from every VP in every month. Flight activity was primarily in the 0-15m height band. Flight paths were concentrated in two main pockets, one in the south and one in the northeast of the study area. Lapwing were observed in numbers ranging from 1-200 individuals. The largest flock of 200 individuals was seen from HHVP4 on 20th November. During the 2024/25 Winter VP Survey, lapwing were observed seven times from VPs 1 and 3, with groups of between four to 65 birds recorded. Flight activity occurred in the northeast and south of the study area, with two flights intersecting the southern part of the 500m buffer.

Breeding Wader Surveys (Summer 2021 and 2022/23)

A total of four lapwing observations were recorded in summer 2021, including two sets of pairs at wader site 2 (4.7km west of Proposed Development) and site 4 (3.1km west of Proposed Development), indicative of possible breeding at these locations in the surrounding hinterland. There was also a record of possible breeding noted at site 7 (630m northwest of Proposed Development). Audio recorders detected this species at site 5 (3.1km west of Proposed Development). See Figure 7-8 for breeding wader (2021) survey locations. Lapwing was recorded on three occasions during summer 2022 breeding wader surveys. The earliest was at wader transect W3 in April 2022 and noted adults in display flight over cutover bog for ten minutes. This was recorded as an occupied territory. The second observation noted two adult birds flying to roost at W2 on 9th June 2022. During the third and final observation at TR3, two adult birds flushed and flew up after being disturbed. This observation was recorded as an occupied territory. Breeding Transects (Summer 2021 and 2022) Lapwing was observed within 25m of transect 1 during the early part of the 2021 breeding season. There were two observations of this red-listed species during 2022 breeding transect surveys, one in April and one in June. These both occurred within 25-100m of Transect 4. Lapwing was recorded in low numbers (one to two individuals).

Hinterland Surveys (2021, 2022, 2023 and 2024)

A total of seven observations of this red-listed species was recorded during summer 2021 hinterland surveys. These occurred at HVPs 12 and 9 and TRs 18, 19 and 23 in groups of 2- 4 individuals. This includes observations of two sets of pairs inhabiting flooded cutover bog viewed from TR 18 (May 18th) and TR 19 (June 6th). This species was recorded twice during the winter season at HVP 7 (March 10th and 20th). A total of three observations of this red-listed species were recorded during summer 2022 hinterland surveys. These all occurred at HVP 7 on 8th May 2022, 22nd June 2022 and 1st August 2022. On the first occasion, two pairs were observed defending their nests. The second observation recorded one bird, and five individuals were seen during the final observation. There was one record of this lapwing during winter hinterland surveys. A total of 39 individuals were observed from HVP 7 on 2nd March 2023.

There was one observation of Lapwing during the winter 2023/2024 Hinterland survey on 4th March at HVP7 with 29 individuals observed. There was one observation of Lapwing during the winter 2024/2025 Hinterland survey on 1st January at HVP17 with 200 birds observed.

7.3.2.1.13 Lesser Black-backed Gull

Vantage Point Surveys: Summer/Breeding Season (Summer 2021, 2022 and April 2024) A total of 30 observations of this amber-listed species were recorded during summer 2021 VP surveys. Sightings were recorded at every VP across all summer months. Flight activity was observed in each height band, with the majority recorded between 100-200m. Gulls were commonly observed alone (eleven observations) but flocks of up to 48 individuals were also recorded. Flight activity was widely distributed across the study area with the main flight pattern observed being directional flight. This amber-listed species was recorded on 19 occasions during summer 2022 VP surveys from VPs 1, 2 and 3 in April, May, July, August and September 2022. One static record (not mapped) was made from VP 1 on 25th May 2022. In this instance, three adults and two sub-adults were seen roosting in a field 30m north of VP 1 (inside the study area). For the remainder of records, flight activity occurred predominantly in the 30-100m height band.

This species was recorded primarily to the northeast of the study area. Gulls were sometimes recorded foraging and mostly travelling over agricultural land in this area. There was also some activity to the northwest of the study area and one observation of flight across the south of the study area. This species was observed alone and in pairs but more commonly in groups of 3-17 gulls, primarily moving in direct flight. Two observations on 25th May recorded groups of nine and seven gulls flying in to join gulls roosting north of VP 1. During the April 2024 Migration Surveys there was one observation from VP 4 on 11th April where 22 individuals were observed, mainly in the 30-100m height band as well as the 15-30m height band, flying south, briefly intersecting the 500m buffer.

Vantage Point Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25) There was one observation of this amber-listed species throughout the winter 2021/22 VP survey season. This occurred from VP 1 on 2nd December 2021. Two gulls were observed flying in the 15-30m and 0-15m height bands. Lesser black-backed gull was observed on three occasions during winter VP surveys. The earliest observation occurred from VP 1 on 4th November 2022 and recorded two gulls in direct flight in the 30-100m height band. This species wasn't seen again from VP1 until March 22nd 2023. A gull was seen from VP 4 on 18th November 2022, flying in the 15-20m height band. Two of the records were observed in the northeast corner of the study area, while one noted a gull flying through the middle of the study area in a southeasterly direction. During the 2023/24 Winter VP Surveys there were 11 observations from each of the VPs in October, December and March. Group size ranged from 1-65, with the 65 individuals observed from VP1 on 27th October flying south. Flight activity was observed mainly in the 30-100m flight height band. Lesser black-backed gull was observed once in the 2024/25 winter VP surveys in the northwest of the study area where a flock of 37 was noted loafing on a ploughed field for one hour.

No flight activity was recorded. Hinterland Surveys (2021, 2022, 2023 and 2024) There are no records of this species being observed during the 2021, 2023 and 2024 Hinterland surveys. This amber-listed species was recorded once across all hinterland surveys on 1st August 2022 from HVP 7 (4.63km west of study area) where two individuals were observed.
There were no records of lesser black backed gull during any other surveys.

7.3.2.1.14 Little Egret

Vantage Point Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25)

During the 2021/22 Winter VP Surveys Little Egret was not recorded. During the 2022/23 Winter VP Surveys there were two observations of Annex I species little egret. The first occurred on October 22nd, 2022, from VP 3 and recorded a single bird flying in the 15-30m height band. The second observation similarly recorded one bird from VP 3 flying between 15-30m on 20th December 2022. This flight activity occurred in the south of the study area. During the 2023/24 Winter VP Surveys little egret was observed from HHVP 3 on 11th December 2023 foraging around pools. During the 2024/25 Winter VP Surveys, little egret was not recorded.

Hinterland Surveys (2021, 2022, 2023 and 2024)
There are no records of this species being observed during the 2021, 2023, 2024 Hinterland surveys.
This Annex I species was recorded twice during summer 2022 hinterland surveys. These both occurred at HVP 7 (4.63km west of study area), on 1st August and 10th September 2022. On both occasions one bird was observed.
There were no records of little egret during any other surveys.

7.3.2.1.15 Little Grebe

Vantage Point Surveys: Summer/Breeding Season (Summer 2021, 2022 and April 2024) During the 2021 Summer Surveys, there were no little grebes recorded. There was one observation of this green-listed species during summer 2022 VP surveys. One bird was observed from VP 2 in the northwest of the study area, on 18th August 2022. This individual spent 15 seconds flying in the 30-100m height band in a north-westerly direction; no flight activity was recorded within the 500m turbine buffer.
During the April 2024 Migration Surveys, there were no little grebe observations. Hinterland Surveys (2021, 2022, 2023 and 2024) There are no records of this species being observed during the 2021, 2022 and 2024 Hinterland surveys. There was one observation of little grebe on 11th November 2023, recorded from HVP8 where two individuals were observed in the Winter Hinterland Survey.
There were no records of little grebe during any other surveys.

7.3.2.1.16 Mallard

Vantage Point Surveys: Summer/Breeding Season (Summer 2021, 2022 and April 2024) This amber-listed species was recorded a total of six times during summer 2021 VP surveys. These were noted from VPs 2, 3a and 4 (16th September, 5th and 18th May 2021). Flight activity was predominantly recorded in the 100-200m height band. Small groups of one to three individuals were recorded on four occasions. Additionally, there were two tight flocks recorded, comprising 28 and 66 individuals
A total of 12 records of this amber-listed species were made during summer 2022 VP surveys. Of these, five were observed during spring migration watches (1st and 5th April 2022). During this time, observations were recorded

from VPs 3 and 4. Flight activity was primarily in the 0-15m height band. Flight paths were mainly concentrated in the south and middle/west of the study area. The remaining records were made in April, May, July, August and September from VPs 1, 3 and 4. Flight activity was predominantly in the 15-30m height band. On one occasion from VP 1 (May 25th), three mallards were seen in chasing flight. This species was most commonly seen in small numbers between 1-5 birds, however, a larger flock of 22 individuals was recorded from VP 3 on 6th September 2022. During the April 2024 Migration Surveys, there were 6 observations, five from VP3 and one from VP2. All observations were recorded in April with groups ranging from 1-3 birds. Flight activity was mainly concentrated in the south and middle/west of the study area.

Vantage Point Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25)
A total of 13 records were noted of this amber-listed species during winter 2021/22 VP surveys. This included 12 mapped flightlines and one static calling record. These all occurred at VP 3 across every winter month except December. Flight activity was recorded at every height band except >200m. Number of individuals per record ranged from single individuals to groups of up to 68. Two pairs were recorded in February 2022. There were 15 observations of amber-listed mallard during winter 2022/23 VP surveys. Of these, three observations (including a flock of 23 individuals) were recorded during autumn migration watches from VP 3 over 30th September and 1st October 2022.
Flight activity was recorded in the 15-30m and 30-100m height bands. Activity was predominantly recorded in the south and middle/west of the study area. The largest flock (23 birds) recorded during this season was seen at VP 3 on 30th September 2022, during an autumn migration watch. The remaining observations were recorded in October 2022, February and March 2023 from all VPs. Flight activity was predominantly in the 30-100m and 15- 30m height bands. During this period, mallards were observed in small numbers (between 1-5 individuals) and seen in either direct or chasing flight. During the 2023/24 Winter VP Surveys, there were eight mallard observations from all HHVPs in February and March. Mallards were observed alone or in pairs and flight activity was recorded. There were two individuals in two observations from VP3 on 11th March recorded flying in the 30-100m height band before landing in a drain in the south area of the study area. Flight paths were mainly concentrated in the south and middle/west of the study area. During the 2024/25 Winter VP Surveys, there was one observation of mallard from VP3 outside the 500m buffer in the southeast part of the study area. Flight activity was observed within the 15-30m height band.

Winter Transects (Winter 2021/22 and 2022/23) There were no observations of Mallard in the 2021/22 Winter Transect Survey. Mallards were observed once during the 2022/23 winter transect surveys within the height band of >100m/flying over where a total of eight individuals were observed from Transect 4 on 20th December 2022.
Hinterland Surveys (2021, 2022, 2023 and 2024) There were 22 observations of this amber-listed species during summer 2021 hinterland surveys. These were records of single birds or groups of up to 10 individuals across HVPs 1, 3, 4, 9, 11, 12, and groups of 10 and at both TR18 and TR19.
During the winter season, there were eight mallard records across HVP 1, 7, 8, 9, 11 and 12. These predominantly noted groups between 2-13 individuals. A total of four observations of this amber-listed species were recorded during hinterland surveys. These were recorded from HVP 7 (4.63km west of study area) and HPV 8 (2.17km southeast of study area) on 27th April, 8th May, 11th July and 1st August 2022. These observations recorded mallard groups in numbers between 2-12 birds. The latter largest group was recorded at HVP 7 on August 1st, 2022. Mallard was recorded three times during winter hinterland surveys. These occurred at HVP 8 and HVP 7 on December 18th, 2022, February 10th and March 2nd, 2023. The largest flock recorded was 26 birds at HVP 8 on December 19th, 2022. There are no records of this species being observed during the 2023 and 2024 Hinterland surveys.

7.3.2.1.17 Merlin

Vantage Point Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25)
During the 2021/22 Winter VP Surveys There was a total of two observations of amber-listed/Annex I species merlin. These were recorded at VPs 2 and 3 (3rd November and 5th January respectively). One bird was seen perched on a tree to the northwest of the study area (outside 500m buffer) before dropping out of sight behind houses. The other bird was recorded flying low over the bog in the south of the study area. A total of 13 seconds was spent in the 0-15m height band. During the 2023/24 Winter VP Surveys, there were two merlin observations from VP 1 and 2 in November and January. Both were observed outside of the 500m buffer within the 0-15m (53s), 15-30m(2s) height bands. There were no records of merlin during any other surveys.

7.3.2.1.18 Mute Swan

Vantage Point Surveys: Summer/Breeding Season (Summer 2021, 2022 and April 2024)

This amber-listed species was recorded on two occasions throughout the 2021 breeding season from VPs 2 and 4a (30th April and 6th June respectively). Flight activity was recorded exclusively in the 30-100m height band. One record was of an individual. the other was of a pair. Flight patterns displayed directional flight across the north and centre of the study area. During the 2022 Summer Surveys, Mute Swan was not observed. During the April 2024 Migration Surveys, Mute Swan was not observed. Vantage Point Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25) During the 2021/22 Winter VP Surveys, Mute Swan was not observed. During the 2022/23 Winter VP Surveys, there were four observations of this amber-listed species, all of which were recorded from VPs 1 and 2. One of these observations was made during autumn migration VP watches (27th September 2022) and noted two individuals flying directly from the northeast of the study area to the northwest in the 15-30m height band. The remaining observations noted between 2-4 birds flying together on 16th December 2022, 18th January 2023 and 2nd March 2023. Flight activity was observed in the northwest and northeast corners of the study area. During the 2023/24 and 2024/25 Winter VP Surveys, Mute Swan was not observed.

Winter Transects (Winter 2021/22 and 2022/23) Mute Swan were observed twice during the 2021/22 winter transect surveys within the 0-25m distance band where one individual was noted from transect 1 during round 3 (14th February 2022). Mute Swan were observed twice from transect 1 during the 2022/23 winter transect surveys within the 0-25m distance band. A group of three was seen during round 2 and a pair was seen during round 3.

Hinterland Surveys (2021, 2022, 2023 and 2024)
This amber-listed species was recorded five times during summer 2021 at HVP 12 and TRs 18, 19 and 20. The latter transects run through cutover bog. Breeding activity was recorded along TR 20 where there is extensive wet cutover and areas of open water, on 18th May 2021. A group of ten individuals was recorded along TR 19 on June 5th.

During winter season hinterland surveys, there were eleven observations of mute swans at HVPs 1, 7, 8 and 12. These consisted of single birds and groups of 2-4 individuals. Amber-listed mute swan was observed six times during summer hinterland surveys. These were recorded from HVPs 7 (4.63km west of study area) and 8 (2.17km southeast of study area) in April, May, June, July and September 2022. Most of the observations recorded two individuals together. This included a pair nesting at HVP 8 on May 8th, 2022. A group of five individuals consisting of two adults and three cygnets was observed at HVP 8 on 16th September 2022. A total of 12 observations of this amber-listed species were recorded during winter hinterland surveys. These occurred at HVPs 7 and 8 in every month of the winter 2022/23 season. These observations recorded mute swan in numbers of 1-7 individuals. On 14th October 2022, two adults and five cygnets were recorded at HVP 8. At this same location on November 9th, 2022, two adults and four juveniles were observed. On 17th March 2023, there were two pairs observed at HVP 8.
Mute swan was observed four times during the 2023/24 winter hinterland survey, with records from HVP4 in October 2023, HVP7 in November 2023, HVP8 in January and March 2024. Mute swan was observed four times during the 2024/25 winter hinterland survey, with records from HVP8 in October and November 2024, January 2025 and HVP17 in January 2025.
The observation at HVP 17 which occurred on 1st January 2025, noted a herd of 80 mute swans at Derryarkin near the Yellow River wind farm to the northwest.

7.3.2.1.19 Redshank

Vantage Point Survey: Autumn migration (Winter 2021/22)
There was a single record of redshank, with this species noted calling for 20 seconds near VP3 on 1st October 2022. There was no visual record of this species. Redshank was not recorded during any other surveys.

7.3.2.1.20 Peregrine

Vantage Point Surveys: Summer/Breeding Season (Summer 2021, 2022 and April 2024)

There were two observations of this green-listed/Annex I species throughout summer 2021 VP surveys. These were recorded from VP 4a (18th May and 25th July). Flight activity recorded consisted of one record of a pair and another record of an individual, flying in the 30-100m height band. These records occurred over cutover bog within the

study area, in the central/western sector of the study area. A total of eight observations of this Annex I species were made during summer 2022 VP surveys, all of which occurred at VP 2. Of these, one was recorded during spring migration watches on 5th April 2022. The remaining observations were noted on 6th and 20th June and 7th July 2022. Flight activity occurred predominantly in the 15- 30m and 100-200m height bands. Flight patterns most frequently consisted of soaring and circling. On June 20th, one peregrine was observed diving at a buzzard three times before heading south. Flight activity was concentrated in the northwest corner of the study area. Peregrines were primarily seen alone. However, on 7th July two birds, a juvenile and an adult were seen together and later on the same date two juveniles and one adult were recorded. During the April 2024 Migration Surveys, there was one Peregrine observation on 2nd April from VP 2 in direct flight in a southeasterly direction within the 30-100m and 15-30m height bands.

Vantage Point Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25)
This green-listed/Annex I species was recorded on one occasion during winter 2021/22 VP surveys. This occurred at VP 3 on 8th November and involved one bird flying for 180 seconds between 100-200m altitude. This individual was observed hunting lapwing within the southeast sector of the study area. It is noted this event occurred in an area with a high concentration of lapwing activity. Peregrines were recorded on three occasions during the winter 2022/23 VP surveys, all of which were observed from VP 3. Most flight activity occurred in the 15-30m height band. Two observations were recorded on 22nd October 2022, and the final record was noted on 9th February 2023. These birds were observed flying over the south of the study area. Peregrine were observed alone for all winter records. The same female individual was recorded twice on 22nd October 2022 and was seen hunting low and landing on peat during the second observation. During the 2023/24 Winter VP Surveys, there were seven observations of peregrine In January, November and December from all VPs but predominantly VP2. The majority of flight activity occurred in the 15-30m and 30- 100m height bands. These birds were observed flying mainly in the southeast and northwest of the study area with just 2 observations overlapping the 500m buffer. During the 2024/25 Winter VP Surveys, Peregrine was observed once hunting over bird flocks. This flight activity was observed outside of the 500m buffer near VP1, within the 30-100m height band.

Winter Transects (Winter 2021/22 and 2022/23) There were no observations of Peregrines in the 2021/22 Winter Transect Survey. Annex I peregrine was observed on one occasion during 2022/23 winter transect surveys. This occurred on 19th January 2023, when one bird was observed within 25-100m of Transect 1. Hinterland Surveys (2021, 2022, 2023 and 2024) Annex I /green-listed peregrine falcon was observed on one occasion during winter 2022/21 hinterland surveys. This occurred on 6th June 2021 and recorded single bird at HVP 13. There were no peregrine falcons observed in the remaining 2022, 2023 and 2024 hinterland surveys.

7.3.2.1.21 Ringed Plover

Breeding Wader Surveys (Summer 2021)
This species was recorded as potentially breeding in the surrounding hinterland during summer 2021 breeding wader surveys. Indications of ringed plover breeding were recorded at Site 2 (4.7km west of Proposed Development) as there were a minimum of six ringed plover pairs observed there. Audio recorders also detected this species at site 1 (2.8km southwest of Proposed Development). There were no ringed plover observations during any other surveys.

7.3.2.1.22 Short-eared Owl

Vantage Point Surveys: Winter Season (Winter 2023/24)
This Annex I/Amber-listed species which occurs as a scarce but widespread winter visitor was recorded on four occasions across two rounds of hen harrier roost watch VPs. A short-eared owl was seen hunting from HHVP1 in the 15-30m height band outside the 500m buffer on 30th October 2023 at 17:00. A short-eared owl was then seen hunting in the 0-15m height band at 17:22 near HHVP2 by the second surveyor. This second observation recorded flight activity both inside and outside the 500m buffer. This activity occurred over woodland, cutover bog, high bog and farmland. Based on observed flight patterns and timing of observations, both of these records are likely to have been of the same owl hunting. This species was seen again on 20th November 2023, this time with both observations occurring at HHVP2. The first observation occurred at 17:03, followed by the second at 17:09. Both recorded short-eared owls hunting in the 0-15m height band outside the 500m buffer over cutover bog, high bog and farmland. This activity occurred over woodland, cutover bog, high bog and farmland. Similarly to the observations on 30th October 2023, based on observed flight patterns and timing of observations, both of these

records are likely to have been of the same owl hunting. Short-eared owl was not observed during any other surveys.

7.3.2.1.23 Snipe

Vantage Point Surveys: Summer/Breeding Season (Summer 2021, 2022 and April 2024)
This red-listed species was observed on one occasion during summer 2021 VP surveys. This was recorded late in the breeding season (13th September 2021) from VP 3b and involved one bird flying in the 15-30m height band before landing.
There were two observations of this red-listed species during summer 2022 VP surveys. The first of these occurred on 17th April 2022, at VP 4 when one bird was recorded flying for in the 15-30m height band from the western edge towards the north/centre of the study area. The second observation was noted on 22nd June 2022, from VP 3 and recorded one bird drumming intermittently in the 0-15m height band over farmland to the southeast of the study area. During the 2024 April Migration Surveys, there were no Snipe observations.

Vantage Point Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25)
During the winter 2021/22 season VP surveys, there were eight observations of red-listed snipe. These occurred at VP 3 (28th October, 8th and 10th November and 5th December) and VP 1 (5th January). Time attribute to flight activity was low, with a total of 35 seconds flight time between 15-30m. There was a long observation that recorded eight birds feeding in pools for one hour from VP3 (5th December). Snipe were otherwise seen alone or in flocks of up to 26 individuals. There is suitable cutover bog habitat (Esker Bog Rathlumber) for snipe outside the Proposed Development site in the south of the study area where feeding activity has been observed from VP 3. A total of three records of red-listed snipe were made during winter 2022/23 VP surveys. One of these occurred during autumn migration (30th September) from VP 3 and noted calls only from peatland in the south of the study area (Esker Bog Rathlumber). Another call was heard from the same bog on 4th November from VP 3. On January 5th, 2023, one bird was observed from VP 4 in the 30-100m height band flying across the centre of the study area in an easterly direction.

During the 2023/24 Winter VP Surveys, there were six records of Snipe (four visual records and two records of snipe calling) from HHVPs 1, 2 and 3 across January, February, October, November and December, with numbers ranging from 1-4 individuals observed. The majority of flight time was spent in the 15-30m height band. During the 2024/25 Winter VP Surveys, there were two observations of Snipe from VP 3 and VP 4 in November and December. Both observations were of snipe being flushed and flying for five seconds in the 0-15m height band. One record northwest of T4 bordered the 500m buffer. The other, which involved a snipe being flushed by a dog, occurred in agricultural land outside the 500m buffer to the east of T7.

Breeding Wader Surveys (Summer 2021, 2022) During summer 2021, breeding snipe activity was recorded at sites 1 and 3 located respectively 2.8km south and 4.8km west of the Proposed Development as indicated by drumming birds (minimum 20 birds). This species was also detected through an audio recording at site 5. There was a single observation of this red-listed species during breeding wader surveys. This was on 17th June 2022 at W3 outside the Proposed Development site when one adult was flushed. This observation was recorded as an occupied territory.
Winter Transects (Winter 2021/22 and 2022/23) There were no observations of Snipe in the 2021/22 Winter Transect Survey. Snipe was observed on one occasion during winter transect surveys. This occurred on 18th December 2022 when two birds were noted within 25-100m of Transect 1.
Hinterland Surveys (2021, 2022, 2023 and 2024) This red-listed species was recorded three times during summer 2021 surveys along TRs 19, 20 and 22. Confirmed breeding was noted at TR 20 on 18th May. A flock of approx. 20 individuals was observed at TR 19 (5th June). The record noted along TR 22 was heard only. There were also three observations of snipe during winter 2021/22 hinterland surveys. These were recorded at HVPs 7 and 8, and TR24. This species was recorded four times during summer 2022 hinterland surveys. The records were made at HVPs 7 (4.63km west of study area) and 8 (2.17km southeast of study area) in August, July and September 2022. These were primarily individuals, but a group of four birds was also recorded at HVP 7 on September 10th, 2022. Snipe was observed on three occasions during winter 2022-23 hinterland surveys. These were recorded from HVPs 7 and 8 on 14th October, 9th November 2022 and 5th January 2023. During the first observation, two birds were recorded together. A group of five individuals was seen on the second occasion and the final observation recorded three birds. There were no observations of Snipe in the 2023 or 2024 Hinterland Surveys.

7.3.2.1.24 Sparrowhawk

Vantage Point Surveys: Summer/Breeding Season (Summer 2021, 2022 and April 2024)

This green-listed species was observed on 12 occasions throughout summer 2021 VP surveys. Records were noted at every VP between May and August inclusive. Although flight activity was noted within every height band, the majority of flight time was spent in the 100-200m band. Sparrowhawks were primarily seen alone, however there was one group of three individuals sighted together. The majority of observations were recorded along the edge and on the outskirts of the study area. A total of four observations of this green-listed species were recorded during summer 2022 VP surveys. One of these occurred during spring migration watches from VP 4 and noted one bird soaring for 120 seconds above 200m. The other records were noted from VPs 1, 4 and 3 on 18th April 2022, 11th July 2022 and 3rd August 2022, respectively. During the second of these observations, a sparrowhawk was seen soaring close to five buzzards. Flight activity occurred predominantly in the 30-100m height band and predominantly in the southern section of the study area. One observation (18th April 2022) was to the northeast of the study area. During the April 2024 Migration period (see Appendices 7-3 and 7-4), there was one observation of Sparrowhawk on 11th April from VP4 within the flight height bands of 30-100m and 15-30m. This bird was observed being mobbed by corvids before dropping into the woods. Vantage Point Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25) There was a total of five sightings of this green-listed raptor during winter 2021/22 VP surveys. These occurred at every VP (28th October, 2nd November, 1st December, 4th and 6th February). Flight activity was recorded at low height bands with the majority spent in the 0-15m band. Activity patterns were typical of sparrowhawks with hunting flight by confirmed male individuals observed on three occasions. The majority of observations were recorded outside the 500m buffer. Green-listed sparrowhawk was observed on two occasions during winter VP surveys. One of these was during autumn migration watches (1st October 2022) from VP 4 and recorded one bird flying in the 30-100m height band towards the centre of the study area from the west. The second observation was noted on 4th November 2022 from VP 2 and involved one sparrowhawk seen chasing two jackdaws in the 0-15m height band to the northwest of study area. During the 2023/24 Winter VP Surveys, there were 16 observations of sparrowhawk from all VPS across all months (see Appendices 7-3 and 7-4). Flight activity was mainly distributed in the southeast of the study area with activity in the northern study area also. During the 2024/25 Winter VP Surveys there was one observation from VP 4 of a sparrowhawk being mobbed by hooded crows. Flight activity was recorded within the 30-100m height band.

Winter Transects (Winter 2021/22 and 2022/23) Sparrowhawk was observed once in the 2021/22 winter transect within the 0-25m distance band of Transect 1 (Round 2, 5th January 2022). There were no observations of Sparrowhawk in the 2022/23 Winter Transect Survey. Hinterland Surveys (2021, 2022, 2023 and 2024) This green-listed species was recorded eight times during summer 2021 hinterland surveys. Observations were made at HVPs 2, 3, 4, 9, 12 and 13. Confirmed breeding of this species was noted at HVP 4 on 26th July. There were three records of this species during the winter season at HVPs 7, 11 and TR 24. Display flight activity was noted at HVP 7 on 25th February. During summer 2022 hinterland surveys, there were two records of this green-listed species. The first occurred at HVP 7 (4.63km west of study area) on 8th May 2022 and recorded one individual. The second observation was recorded at HVP 8 (2.17km southeast of study area) on 22nd June 2022 and noted a single bird. There was one observation of this green-listed species during winter 2022/23 hinterland surveys. This was recorded from HVP 7 on 3rd February 2023. There are no records of Sparrowhawk from 2024 Hinterland surveys.

7.3.2.1.25 Whooper Swan

Vantage Point Surveys: Winter Season (Winter 2021/22, 2022/23, 2023/24 and 2024/25) This amber-listed/Annex I species was recorded on two occasions during winter 2021/22 VP surveys. One record (26th October, VP3) flight activity was observed in the 0-15m height band for 25 seconds as three birds flew low between bog pools. The second record involved five birds flying northeast through the northwestern part of the study area, spending total of 58 seconds in the 30-100m flight band. Flight observations during this season indicated directional flight across the northwest (away from area in a northerly direction) and southwest (into the southern part of the study area in a north-westerly direction).

There were seven records of this Annex I species during winter VP surveys. One record was of swans calling but not seen. Whooper swans were observed from VPs 1, 3 and 4. Flight activity occurred primarily in the 15-30m and 30-100m height bands. Most activity occurred in the southern part of the study area over bog and woodland. This species was commonly seen in small numbers (single birds or groups of up to eight). however, larger flocks of 26 and 38 were also observed. These were both seen from VP 4 (16th and 18th November 2022) and were both recorded

grazing on agricultural land in the centre of the northern section of the study area (in fields near T3). Both flocks were present throughout the entire watch period of three hours.

During the 2023/24 Winter VP Surveys, this species was recorded 12 times from VPs 1, 4, HHVP3 and 4 in October, November, December and January. Whooper swans were observed in flight and also on the ground on Esker Bog during this survey period. The flight activity patterns observed indicated flights to and from Esker Bog, and also flights traversing the study area as swans moved between roosting and grazing sites in the wider area (see whooper swan report in Appendix 7-7. During the 2024/25 Winter VP Surveys, this species was recorded twice from VP 3 both observations occurring on 15th November 2024, with 4 individuals being noted overall. Both flights traversed the southern part of the 500m buffer before one proceeded east and the other proceeded southeast towards Cloncreen windfarm. There were also four casual/incidental observations of whooper swan during this season, recorded during audio device deployment visits. These included a group of seven flying east through the 500m buffer towards Esker bog. a group of 11 flying east/then north through the 500m buffer near T3 and calling, and a group of 16 commuting south through the 500m buffer before exiting the buffer and turning west/southwest. The fourth incidental record was a static observation of a herd of 22 swans seen on the central/northern part of Esker Bog on 24th October 2024.

Winter Transects (Winter 2021/22 and 2022/23) There were no observations of Whooper Swan in the 2021/22 Winter Transect Survey. There was one record of Annex I whooper swan during winter 2022/23 transect surveys. This occurred on 12th December 2022 when seven individuals were observed flying over Transect 4. Hinterland Surveys (2021, 2022, 2023 and 2024) A group of 14 whooper swans (Annex I/amber-listed) was recorded once during the winter 2021/22 hinterland survey along TR 24. This Annex I species was recorded four times during winter 2022/23 hinterland surveys. Observations were recorded from HVPs 7 (4.63km west of study area) and 8 (2.17km southeast of study area) in October, November 2022, January and February 2023. Whooper swans were observed in numbers between 2-15 birds. On 14thOctober 2022, at HVP 7, a group of three adults and four juveniles was recorded. The largest flock of 15 individuals was observed at HVP 7 on 3rd February 2023. There were five whooper swan observations in the winter 2023/24 hinterland surveys – fours at HVP16 and one from HVP9. These observations were recorded in November, December 2023 and January 2024. Number of individuals observed ranged from 4-14. During winter 2024/25 hinterland surveys, a total of 10 observations of whooper swan were made. The majority of these were observations swans roosting and/or grazing, with only one record of swans in flight (25th November 2024). These records, which encompass groups ranging from two to 46 swans were distributed throughout the wider area around the Proposed Development site. The site where whooper swans were most frequently observed were HVP9 (Esker Bog) (six records). The highest numbers of swans were recorded at HVP17 at Derryarkin (with herds of 45 and 46 noted on 1st January 2025 and 23rd January 2025 respectively) and HVP 16 (38 swans observed here on 15th January 2025). Audio Surveys (Spring & Autumn 2024)
Audio surveys detected nocturnal whooper swan flight calls during both autumn and spring 2024 (see Appendix 7-7).
Table 7-19 indicates an autumn migration window extending from 9th October to the 25th of November 2024, based on the timing of first and last audio registrations during this period. The first visual record occurred after the first audio registration. Peaks in nocturnal call registrations occurred around early October and from late October to late November 2024. The scattered distribution of registrations, in addition to absence of a habitual roost site in the vicinity of the Proposed Development, indicates the activity recorded is likely to be the dispersed arrival of smaller groups, with no convergence on a roost site near the Proposed Development. For spring 2024, a migration window extending from 8th March to 30th March 2024 is indicated by audio survey results. The last visual observation recorded (10th February 2023) is considered too early to be indicative of migration. The concentration of most registrations around late March (27th to 30th March 2024) indicates a buildup in outward migration during this period. It is possible that groups from the region coalesce to migrate together, and/or leave from various roosts distributed around the region. These patterns of a longer and more dispersed inward migration window and buildup to a concentrated outward migration window are well-known and established patterns. however, the data obtained from audio surveys make these assumptions more robust and allows both spatial and temporal patterns to be defined with higher certainty.
The audio registrations from these surveys cannot be interpreted empirically in terms of numbers or exact locations of flight paths since there are no visual records associated with this type of survey. However, it can confidently be assessed based on the recorded data that whooper swans migrate through the wider area in which the Proposed Development is located and as such may traverse the Proposed Development at times. No habitual night roost was

identified in the vicinity of the proposed development; as such, the audio registrations recorded during surveys are likely to be indicative of dispersed migration to and from roost/wintering sites further south outside the hinterland survey area.

Roosting Sites

The dawn/dusk VP surveys confirmed the absence of whooper swan roosting in the locality of the proposed development. Occasional use of Esker Bog for day roosting and grazing was observed; however surveys indicated no evidence of night roosting. Based on hinterland survey results, observed flight patterns, and desktop information, the primary night roost in the hinterland is assessed to be at Derryarkin adjacent to the Yellow River wind farm (HVP 17). Wintering whooper swans often roost at the same sites; however, they can also vary which night roost they use. Based on observed swan numbers and frequency of observations, there is also potential for sites such as the Bord Na Móna ash repository site (HVP 16) and Rathvilla Quarry Pond (VP 8) to be used by roosting whooper swans. An observation of six whooper swans in flight at 7:55 (25 minutes after dawn) on 25/11/2024 flying from the direction of the cutover bogs to the west near Ballyhugh (HVP 7) towards Esker Bog is also potentially indicative of night roosting on the bogs to the west, which provide suitable roosting habitat. The landscape characteristics of the wider region contain abundant habitats for roosting and grazing whooper swan. As such, while some patterns can be inferred for the locality of the proposed development and surrounding hinterland, the opportunities for wintering whooper swans to avail of numerous suitable areas in the region give considerable scope for variation in use of roosting/grazing sites and also provides abundant opportunities for dispersed smaller groups to occupy the landscape. It is noted that larger wintering whooper swan populations occur elsewhere in County Offaly, particularly along the Little Brosna and Shannon Callows in the west of the county which have mean populations of 100-300 wintering whooper swan. High numbers (240 swans) have also been recorded at Cloghanhill in the west of the county. The closest I-WeBS site (Raheen Lough, located 13.6km southwest of T7) has also previously been noted to hold up to 58 wintering whooper swans. Recent counts are not available for Cloghanhill and Raheen Lough.

7.3.2.1.26 Woodcock

Breeding Wader Surveys (2021, 2022)

There were two records of roding woodcock at breeding wader survey site 6 near the Grand Canal (17th May and 5th June 2021), confirming breeding activity in the study area. These observations were associated with an area of recently replanted forestry/scrub in the northeastern part of the study area, located outside the Proposed Development site c. 735m northwest of T1. There were four observations of red-listed woodcock, all of which were recorded on 9th June 2022 along breeding wader transect W2. Woodcock was noted as occupying territory in this area and were recorded calling on three occasions and roding once. Hinterland Surveys (2021, 2022) Red-listed woodcock was recorded twice during summer 2021 hinterland surveys. One observation was noted at TR17/Wader survey site 6 on 17th May. Woodcock was also heard at TR22 on 6th June. During winter 2021/22, there was one observation of a single woodcock at HVP 7 (25th February 2022). There were no records of woodcock during any other surveys.

7.3.2.2 Other Species

In addition to the target species detailed above, a number of other species of conservation concern were also recorded during surveys at the Proposed Development. These are listed in Table 7-20.

Table 7-21: Key Receptors Assessment

Species	BoCCI	Annex I (Y/N)	NRA Evaluation	Receptor Evaluation for Impact Assessment (Sensitivity)	Key Receptor	Rationale
Black-headed gull (*Larus ridibundus*)	Amber	N	Local Importance (High Value)	Medium	Yes	This species was recorded during the 2022 breeding season and the 2022/23 non-breeding season. They were recorded during vantage point (VP) surveys. foraging behaviour was observed.
Brambling (*Fringilla montifringilla*)	Amber	N	Local Importance (High Value)	Medium	No	This species was recorded during winter 2021/22. Feeds primarily in arable stubble during winter. This habitat is not present within the Proposed Development footprint.
Buzzard (*Buteo buteo*)	Green	N	County Importance	Low	Yes	This species was recorded across all seasons over the two-year survey period, including VP surveys.
Common Coot (*Fulica atra*)	Amber	N	Local Importance (High Value)	Medium	No	Recorded as an additional species near VP1 in summer 2021. No other observations. suitable habitats not present at Proposed Development.

Common Gull (*Larus canus*)	Amber	N	Local Importance (High Value)	Medium	Yes	This species was recorded during the 2022/23 non-breeding season.
Cormorant (Phalacrocorax carbo)	Amber	N	County Importance	Medium	Yes	This species was recorded during the 2021/22 non-breeding season.
Goldcrest (*Regulus regulus*)	Amber	N	Local Importance (High Value)	Medium	Yes	This species was recorded during the breeding season of 2021 and also winter 2022-23 and may use wooded habitats subject to loss during the construction phase.
Golden Plover (*Pluvialis apricaria*)	Red	Y	County Importance	Very High	Yes	This species was recorded regularly during the non-breeding season and have been observed to winter in the locality. They were observed in large flocks of up to 1,000 in the flight activity study area, and flocks up to 1,500 birds in the surrounding hinterland.
Great Black-backed gull (*Larus marinus*)	Green	N	Local Importance (High value)	Low	Yes	Flight activity for this species was recorded during the 2021 breeding season.
Greenfinch (*Carduelis chloris*)	Amber	N	Local Importance (High value)	Medium	Yes	This species was recorded during the breeding and non-breeding seasons across multiple years and may use hedgerow habitat which will be lost during the construction phase.
Grey Heron (*Ardea cinerea*)	Green	N	Local Importance (High Value)	Low	Yes	This species occurs in the locality. potentially subject to construction disturbance and indirect effects via changes in water quality.
Greylag Goose (*Anser anser*)	Amber	N	National Importance	Medium	Yes	Greylag goose was recorded once in the 2023-2024 non-breeding season commuting over the Proposed Development site within the 500m buffer. There were no records of foraging or breeding within or adjacent to the site.
Hen Harrier (*Circus cyaneus*)	Amber	Y	County Importance	Very High	Yes	This species was observed during the non-breeding season with hunting behaviour observed over cutover bog and farmland habitats. There were also isolated observations of transitory/casual roosting to the east of the southern part of the proposed development site and within the Proposed Development site near T4.
House Martin (*Delichon urbicum*)	Amber	N	Local Importance (High value)	Medium	Yes	No breeding habitat present within proposed footprint or zone of influence. Potentially subject to barrier and displacement effects.
House Sparrow (*Passer domesticus*)	Amber	N	Local Importance (High value)	Medium	Yes	Potentially affected by habitat loss and disturbance.
Kestrel (*Falco tinnunculus*)	Red	N	National Importance	High	Yes	Kestrel were recorded throughout all seasons, indicating a resident population is present in the local region. Hunting behaviour was observed.
Kingfisher (*Alcedo atthis*)	Amber	Y	County Importance	Very High	Yes	One incidental record during hinterland surveys in Winter 2021-22 confirms this

						species is present in the region. Potential for indirect effects via changes in water quality.
Lapwing (*Vanellus vanellus*)	Red	N	Local Importance (High Value)	High	Yes	This species was observed across all seasons, most commonly observed in groups. Attempted breeding on Esker Bog Rathlumber adjacent to Proposed Development.
Lesser Black-backed Gull (*Larus fuscus*)	Amber	N	Local Importance (High Value)	Medium	Yes	This species was observed across all seasons with foraging behaviour also observed.
Linnet (*Carduelis cannabina*)	Amber	N	County Importance	Medium	Yes	Potentially affected by habitat loss and disturbance.
Little Egret (*Egretta garzetta*)	Green	Y	Local Importance (High Value)	Very High	Yes	This species occurs in the locality. potentially subject to construction disturbance and indirect effects via changes in water quality.
Little Grebe (*Tachybaptus ruficollis*)	Green	N	Local Importance (High Value)	Low	Yes	There was one observation of flight activity during the 2022 breeding VP survey in the 30-100m height band.
Mallard (*Anas platyrhynchos*)	Amber	N	County Importance	Medium	Yes	Mallards were observed in all seasons. Flight activity traversed the 500m buffer. suitable habitats present on adjacent cutover bogs.
Meadow pipit (*Anthus pratensis*)	Red	N	County Importance	High	Yes	Observed during 2021 and 2022 breeding bird transect surveys and VP surveys.
Merlin (*Falco columbariu*)	Amber	Y	County Importance	Very High	Yes	Merlin were recorded in the 2021/22 and 2023/24 non-breeding seasons. The region in which the Proposed Development is located includes suitable foraging habitat mosaics for merlin.
Mute Swan (*Cygnus alor*)	Amber	N	County Importance	Medium	Yes	This species was recorded in the flight activity survey study area during the 2021 breeding season and the 2022/23 non-breeding season.
Peregrine (*Falco peregrinus*)	Green	Y	County Importance	Very High	Yes	This species was recorded in the flight activity survey study area during the breeding season. Hunting and landing on peat areas was also observed.
Redshank (*Tringa tetanus*)	Red	N	County Importance	High	Yes	Heard calling near VP3 during autumn migration VPs 2022.
Redwing (*Turdus iliacus*)	Red	N	County Importance	High	Yes	Recorded during VP surveys and wintering bird transects. May forage in hedgerows and agricultural habitats at the Proposed Development site.
Ringed Plover (*Charadrius hiaticula*)	Amber	N	Local Importance (High Value)	Medium	No	Observed and detected through audio recorders in the wider area during 2021 Breeding Wader Surveys. Not recorded at or near the Proposed Development.
Sand Martin (*Riparia riparia*)	Amber	N	Local Importance (High Value)	Medium	Yes	No breeding habitat present within proposed footprint or zone of influence. Potentially subject to barrier and displacement effects.
Short-eared Owl (*Asio flammeus*)	Amber	Y	County Importance	Very High	Yes	Observed hunting to east of Proposed Development during winter 2023/24. Some

						flight activity overlapped the 500m buffer near T5.
Skylark (*Alauda arvensis*)	Amber	N	Local Importance (High Value)	Medium	Yes	Recorded at transects TR1, TR2 and TR4 during breeding bird surveys. Singing skylarks were also noted in field south of TR1 during spring 2024 audio device deployment.
Snipe (*Gallinago gallinago*)	Red	N	County Importance	High	Yes	This species was observed across all seasons with feeding activity recorded. Breeding activity was recorded in the wider area, and one occupied territory was recorded near the Proposed Development (along W3 in Esker Bog Rathlumber).
Sparrowhawk (*Accipiter nisus*)	Green	N	Local Importance (High Value)	Low	Yes	Sparrowhawk were recorded during both the breeding and non-breeding seasons, with hunting behaviour observed around the margins of the study area.
Spotted flycatcher (*Musicicapa striata*)	Amber	N	Local Importance (High Value)	Medium	Yes	This species was observed in the 2021 breeding season and may use hedgerow habitat subject to loss/disturbance during construction.
Starling (*Sturnus vulgaris*)	Amber	N	Local Importance (High Value)	Medium	Yes	Potential for breeding and wintering birds to be affected by habitat loss and disturbance.
Stock Dove (*Columba oenas*)	Red	N	County Importance	High	Yes	Confirmed to be present in study area during breeding and non-breeding seasons.
Swallow (*Hirundo rustica*)	Amber	N	Local Importance (High Value)	Medium	Yes	No breeding habitat present within proposed footprint or zone of influence. Potentially subject to barrier and displacement effects.
Swift (*Apus apus*)	Red	N	County Importance	High	Yes	No breeding habitat present within proposed footprint or zone of influence. Potentially subject to barrier and displacement effects.
Whooper Swan (*Aythya fuligula*)	Amber	Y	County Importance	Very High	Yes	Whooper Swans were recorded across multiple winter seasons. This species occasionally traversed the 500m buffer, and wintering herds are known to roost and graze in the surrounding region. Transient/casual use of fields near T3 for grazing was also recorded. Audio surveys detected nocturnal flight calls during the spring and autumn 2024 migrations periods.
Willow Warbler (*Phylloscopus trochilus*)	Amber	N	County Importance	Medium	Yes	Recorded during 2021 breeding season. Potential to use wooded habitats subject to construction loss/disturbance.
Woodcock (*Scolopax rusticola*)	Red	N	Local Importance (High Value)	High	Yes	Recorded during breeding wader surveys. Breeding/territorial behaviour noted in open woodland near T4 and near Grand Canal.
Yellowhammer (*Emberiza citronella*)	Red	N	Local Importance (High Value)	High	Yes	Recorded in agricultural areas during 2021 and 2022 Breeding Bird Transects. Potential to use hedgerows subject to construction loss/disturbance.

7.5 Assessment of Impacts and Effects

The effects of infrastructure such as wind farms on birds are highly variable and depend on a wide range of factors including the specification of the development, the topography of the surrounding land, the habitat affected and the numbers and species of birds present (Drewitt, A., and Langston, R., 2006).

Developments such as wind farms in general have many effects on birds, including potential direct habitat loss and fragmentation, displacement due to disturbance, death, and injury due to collisions and disruption of local or migratory movements, with a consequent increase in energy expenditure (Drewitt, A., and Langston, R., 2008). However, the principal concerns in terms of adverse effects on birds are (1) disturbance/displacement, (2) collision, (3) habitat loss/change and (4) barriers to movement (Langston, R., 2010). Of these, only two are applicable during construction: 1) disturbance and/or displacement and 2) habitat loss/alteration. Habitat loss is the primary potential direct impact during construction and although disturbance and/or displacement could be viewed as effective habitat loss, it is essentially indirect (SNH, 2017) and therefore covered under Indirect Impacts. With regard to impacts on bird species, it is considered that the main potential sources of impacts on avian fauna is the

construction of the Proposed Development, particularly the construction of turbines and the associated road network, as well as the operational phase of the turbines.

7.5.2.2 Potential Operational Phase Effects

No indirect construction stage effects via impacts on the aquatic environment are predicted for any NHAs or pNHAs due to lack of a hydrological connection.

Similarly to the construction phase, since none of the NHAs designated for peatland habitats only (Black Castle Bog NHA, Daingean Bog NHA, Carbury Bog NHA, Milltownpass Bog NHA and Cloncrow Bog-New Forest NHA), in addition to Grand Canal pNHA, Ballina Bog pNHA and Rahugh Ridge pNHA do not have defined ornithological interests, there is no potential for effects in this category for these national sites.

The primary concern in terms of potential operational effects on sand martin associated with The Long Derries, Edenderry pNHA would be barrier effect. However, this has been assessed as Long-term Not Significant (see Section 7.5.4). Considering this, in addition to the fact that long range foraging is likely to occur irregularly only, it is unlikely that sand martin associated with The Long Derries, Edenderry pNHA will be affected by the proposed development during operation. No operational phase effects have been identified for green-listed whitethroat and cuckoo.

Raheenmore Bog pNHA is within the breeding territory of a merlin pair and also notes snipe as an ornithological interest. Regarding merlin, only wintering merlin have been observed at the proposed development. The foraging range of merlin during the breeding season is within 5km, putting the proposed development beyond the foraging range of any pair occurring at Raheenmore Bog pNHA. An effective collision risk of zero was identified for merlin, due to lack of flight activity at potential collision height within the 500m turbine buffer.

Operational phase disturbance/displacement and barrier effects for merlin are assessed as Long-term Not Significant (see Section 7.5.4). While a Long-term Moderate disturbance/displacement effect for snipe was identified at the proposed development, this localised effect would not impact any snipe breeding at Raheenmore Bog pNHA located 11 km west. Species which occur at Raheen Lough pNHA that have been observed at the proposed development include whooper swan, mallard and little grebe. The predicted yearly collision rates (see Section 7.5.4 and appendix 7.8) for grey heron, mallard and whooper swan are respectively 0.0, 0.32 and 0.01, resulting in Long-term Imperceptible effects for grey heron and mallard and Long-term Not significant effects for whooper swan.

Disturbance/displacement and barrier effects were assessed as Long-term Imperceptible for grey heron, and Long-term Not significant for mallard. Long-term Not Significant to Slight disturbance/displacement and barrier effects were identified for whooper swan (see Section 7.5.4). Considering the low magnitude of potential operational effects identified, potential for effects on these species potentially occurring at both the proposed development Raheen Lough pNHA remains similarly low.

7.5.3 Construction Phase

7.5.3.1 Direct Effects: Habitat Loss or Alteration

Habitat loss can be direct through land take of breeding or foraging habitats for key species or indirect such as effective habitat loss through avoidance or disturbance due to the above factors. For direct effects during construction, land take of potential breeding or foraging habitat is the primary effect. This may constitute land stripping or vegetation removal affecting ground nesting birds, hedgerow removal or trimming if this takes place during the breeding season and loss of nesting or roosting sites such as trees. Effects on avifauna were assessed following guidance in Percival (2007). As outlined previously, key avian receptors have been assigned an evaluation of importance (or sensitivity) for assessment. Following this, the significance of potential effects is rated as a product of both the magnitude of the predicted effect and the importance value (sensitivity) of the key receptor affected, based on the probability of the likely effect occurring. The construction of access tracks, turbine foundations and hardstanding, the substation compound, peat deposition area and temporary site compounds will result in some habitat damage and loss. The vast majority of the proposed Turbine Delivery Route (TDR) for the wind farm development will not require any construction works. However, minor and temporary works are proposed at three specific locations to facilitate the safe transport of wind turbine components.

These include two locations along the L-5006 and one at the junction of the R-402 and R-420 (see Figure 2 2 in Chapter 2). At these points, temporary interventions will involve limited hedge or tree cutting, topsoil stripping, and

the placement of hardcore to support vehicle passage. All works are designed to be short-term. Upon completion of turbine deliveries, hedgerows will be reinstated and all disturbed areas will be allowed to naturally revegetate. As such, the Proposed TDR nodes will result in some temporary habitat damage and loss, primarily affecting improved agricultural grassland and short sections of hedgerow.
For the purpose of the consideration of the potential effects on birds, species have been grouped into four categories, namely passerines, doves/pigeons, birds of prey, game birds and waders/waterfowl. A passerine is any bird of the order Passeriformes, which includes more than half of all bird species. A notable feature of passerines is the arrangement of their toes (three pointing forward and one back) which facilitates perching. The group are sometimes known as perching birds or, less accurately, as songbirds. Pigeons/doves belong to the order Columbidae composed of birds with stout bodies, short necks, and slender bills which primarily feed on seed, fruits, and plants. Birds of prey are raptors that actively hunt other bird species. Gamebirds are birds that traditionally could be hunted, and terrestrial species often include pheasants and inland wader species such as snipe and woodcock. Waders are primarily shorebirds with the majority of species eating small invertebrates picked out of mud or exposed soil. Waterfowl are swimming gamebird and are comprised of duck, geese, and swan.

7.5.3.1.1 Passerines/Non-target Species

The loss of habitat due to the construction of the project has the potential to affect some passerines. Habitat loss is inevitable in the development of any windfarm, when the development of turbine foundations and hard stands, access roads and other associated construction is considered. This can result in reduced feeding and nesting opportunities for birds, in particular the loss of hedgerows or other wooded habitats for passerine species. However, direct habitat loss by the development of wind farms tends to be relatively small (Drewitt and Langston 2006). The area in which the wind farm site is located is predominantly composed of improved agricultural grassland, mixed broadleaved/conifer woodland, recently felled woodland/scrub and conifer plantation. Hedgerows and treelines are present in agricultural land. Mixed broadleaved woodland is also present but is outside the Proposed Development footprint and as such there will be no loss of this habitat type. The overall habitat survey study area is 120.39 ha in extent. The Proposed Wind Farm will result in the following habitat loss (% loss of total habitat within study area):

Within the habitats present onsite, goldcrest, greenfinch, spotted flycatcher and linnet (Percival sensitivity: Medium), typically use woodland, scrub and occasionally linear wooded habitats such as hedgerows and treelines. A variety of wooded habitats are present within the wind farm site, ranging from semi-natural to intensively managed types. The cumulative habitat loss across all semi-natural wooded habitat types (all wooded habitats combined, omitting WD4 Conifer plantation) will be 12.6%, equating to a Percival effect magnitude of Medium (5-20% habitat lost). Thus, the overall Percival significance for these species is Low. The corresponding EPA effect is a Long-term Not significant Effect in the local context which is Reversible. House sparrow (Percival sensitivity: Medium) breeds throughout Ireland and usually stays close to human habitation-mainly around farm buildings and built-up areas including parks and gardens. Nests in cavities in buildings, especially under eaves or holes formed by missing brickwork. There is an absence of suitable nesting habitats on-site, and therefore no effects are predicted in terms of nesting habitat for this species. Percival impact significance is Low (1-5% habitat loss for open foraging habitats; 1-5% habitat loss for linear wooded habitats). As such, the corresponding EPA effect for house sparrow is a Temporary, Not significant Effect in the local context which is Reversible. Swallow, house martin, sand martin (Percival sensitivity: Medium) and swift (Percival significance: High) are aerial species that forage over open habitats. Swallow, swift and house martin require buildings for nesting, and sand martin typically nest in sand banks or crevices in walls or bridges. There is no potential nesting habitat for these species within the Proposed Development footprint. Thus, a Short-term, Imperceptible Effect which is Reversible in the local context is predicted for these species.
Meadow Pipit (Percival sensitivity: High) and Skylark (Percival sensitivity: Medium) are ground-nesting birds, that use open habitats with some low-lying vegetative cover (typically grassland and heath) for breeding and foraging purposes. While peat harvesting and intensive agricultural management has limited the amount of suitable habitat for these species, the potential for these species to breed in artificial or disturbed habitats remains. Specifically, meadow pipit and skylark were recorded along TR2 which traverses improved agricultural grassland and were also noted along TR4 traversing the boundary between mixed conifer/broadleaved woodland and the open peat expanse of Esker Bog. Skylark were noted to be active along TR1, and further observations during audio detector deployment in the field south of TR1 noted multiple skylarks singing in this area. Considering these observations, there is potential for these species to breed in areas of agricultural grassland overlapped by proposed infrastructure (although breeding success would be threatened by the rotating schedule of high-density mob grazing practiced on

the intensive dairy farm providing the majority of agricultural land for the Proposed Development). Considering the limited occurrence of potential but sub-optimal breeding habitat (1.46% of improved agricultural grassland), Percival effect magnitude is Low, equating to overall Percival significance of Low. The corresponding EPA effect for these species is a Long-term, Not significant effect in the local context which is Reversible. Redwing (Percival sensitivity: High) are winter visitors which use trees/hedgerows and open habitats to forage in. This species has been added to the red list due to the severity of long and short-term declines in its wintering population. Loss of open foraging habitats remains below 5%, while loss of linear wooded habitats (treelines and hedgerow) remains below 5%. As such, Percival effect significance is Low (1-5% habitat lost).
Furthermore, suitable foraging habitat is generally abundant in agricultural landscapes which are common in the surrounding landscape. Thus, the corresponding EPA effect for redwing is a Long-term, Not significant effect in the local context which is Reversible. Starlings (Percival sensitivity: Medium) primarily forage in grassland and open habitats, and typically nest in the eaves of old buildings, but also use cavities in mature trees and also roost in reedbeds. No suitable tree-nesting cavities were observed and no old buildings are present within the proposed footprint. Loss of open foraging habitats will remain below 5% (Low magnitude effect) (resulting in Percival effect significance of Low); thus, the corresponding EPA effect for starling is a Temporary, Not significant effect, which is Reversible in the local context. Stock dove are typically found within farmland (usually associated with cereal production areas) and woodland habitats and prefer mature trees for nesting. Due to the absence of breeding evidence and suitable foraging and breeding habitats in the Proposed Development footprint, it is unlikely for stock dove to be affected by habitat loss. Thus, a Temporary, Imperceptible effect in the local context which is Reversible is predicted for stock dove. Willow warbler (Percival sensitivity: Medium) are predominantly found in scrubby woodland and along the edges of bogs and marshes, and less frequently recorded in hedgerows, woodlands and well-vegetated gardens. An area of open/scrubby woodland near T4 which offers potential habitat for willow warbler will be lost within the proposed peat deposition area footprint. Percival effect significance is Medium (5-20% habitat loss) (overall significance is Low). The potential effects are Long-term and Not significant to Slight in the local context and are Reversible (Criteria: EPA, 2022). Yellowhammer (Percival sensitivity: High) is a species associated with arable landscape and hedgerows. There will be some loss hedgerow and treeline habitat which could be used by this species. However, loss of these habitats is limited. Percival effect significance is Low (1-5% habitat loss affecting Treelines) to Negligible to Low. Thus, the corresponding EPA effect predicted for yellowhammer is a Short-term, Not significant Effect in the local context which is Reversible.

7.5.3.1.2 Target Species

Table 7-24 displays the effect character as well as the significance of direct construction phase effects for target species, without the implementation of mitigation.

7.5.3.2 Indirect Effects: Disturbance/Displacement

High levels of activity and disturbance during construction may cause birds to vacate territories close to works, especially for species vulnerable to disturbance. The displacement of birds from areas within and surrounding developments can effectively amount to habitat loss (Drewitt, A. L. and Langston, R. H., 2006). If a habitat is therefore avoided as a result of the disturbance, then effective habitat loss can occur. Examples of causes of disturbance during construction which may lead to displacement are vehicle and personnel movements, vibration and noise impacts from the construction process and visual intrusion (Drewitt, A. L. and Langston, R. H., 2006). Indirect effects may occur on species linked to aquatic habitats through pollution events, sediment laden runoff and dust deposition.

7.5.3.2.1 Passerines/Non-target Species

The effect of disturbance/displacement for medium sensitivity species including goldcrest, greenfinch, spotted flycatcher, linnet, house sparrow, skylark, starling and willow warbler is assessed as Temporary, Imperceptible and Reversible in a local context. The effect of disturbance/displacement for high sensitivity species including meadow pipit, redwing, yellowhammer and stock dove is assessed as Temporary, Not Significant and Reversible in a local context.

7.5.4 Operational Phase

7.5.4.1 Direct Effects:

Collision Risk Studies on operational impacts of wind farms (Pearce-Higgins et al., 2009) show that certain species exhibit levels of turbine avoidance during operational phases which may be extrapolated to reductions in breeding

bird densities. however, this may not be as significant as previously thought, certainly in comparison to impacts during construction (Pearce-Higgins et al., 2012). It seems that there is little evidence for consistent post-construction population declines in any species, suggesting for the first time that wind farm construction can have greater effects on birds than wind farm operation. this is supported in the literature (Devereux et al., 2008). A recent study on the effects of wind turbines on the distribution of wintering farmland birds (Devereux et al., 2008) did not find any consistent patterns of turbine avoidance across the species groups studied (corvids, seedeaters, gamebirds, and skylark). The primary cause of direct effects on birds during the operational phase of a development is collision risk. Collision risk behavioural observations of birds in relation to operational wind farms provide the basis of studies on collision risk. Fixed point observations of flight behaviour, flight lines into, through and out of the area and information about the birds' use of the area help to inform the environmental evaluation of the Proposed Development. Bird mortality may result from potential bird collision with turbine structures or turbine blades. Not all bird species are equally susceptible to collision, and some species suffer proportionately high levels of collision mortality (Drewitt and Langston, 2008). Morphology, physical flight characteristics and differences in vision are all influencing factors. Martin and Shaw (2010) suggest that it is the characteristics of the section of a bird's visual field that projects forward and hence 'looks' that are the key factors. In some species the vertical extent of the forward binocular vision is reduced and therefore the bird is rendered blind, if, whilst in the process of flying, it undertakes behaviour such as the detection of conspecifics (member of the same species), remote food sources, etc. (Martin, 2011 and Martin and Shaw, 2010).

Other species have reduced fovea (region of the eye responsible for sharp central vision), are emmetropic (default focus is distant) or may contain blind spots in their field of vision (as an evolutionary trait) which may cause susceptibility to collision. Flight height or the flight heights which birds habitually use along either migration or local flight paths is also an influencing factor. Relative size and high wing loading (or low manoeuvrability) are influencing factors as larger birds with poor manoeuvrability are generally perceived as at greater risk of collision with structures (see Brown et al., 1992, quoted in Drewitt and Langston, 2006). Various species therefore exhibit different morphological and behavioural attributes which may contribute to collision risk. Recent studies show that modern, larger multi-MW turbines show comparable fatality estimates with older generation models and expected increases in fatalities due to increases in rotor surface are not as expected, possibly due to increased altitude, increased distance between turbines and slower rotation speeds (Krijgsveld et al., 2009). Appraisal of collision risk for the Proposed Development is based on a rotor diameter of 162m and hub height 104m, resulting in a maximum and minimum swept height of 185m and 23m respectively (see Chapter 2 Description of Development). Relatively little is known about collision as a threat to birds. One problem is that most studies rely on the number of corpses found, but this can be extremely unreliable, since it is known that corpses are quickly removed by predators. At a wind farm site in Co. Tipperary in 2011, it was found that 72% of bird corpses left out were removed after five days. At this site in Co. Tipperary in 2012, scavengers were present at a bird corpse within forty-five minutes of it being placed in the vicinity of a turbine (J. Kearney principal ecologist FT, per. comm. 2022). The colour, mode, intensity, and density of lighting has been shown to influence the degree to which birds (specifically, nocturnally migrating passerines) are attracted to wind turbines at night.

Studies have shown that red lighting is more attractive to birds, and that steady burning lights are more attractive than flashing ones, while structures with no lighting were the least attractive (Kerlinger et al., 2010. Gehring et al., 2009). The directional intensity of lighting is also a factor in reducing the attraction of birds. As such, specification of aviation obstruction lighting to minimise effects on birds is included under operational mitigation measures.

7.5.4.1.1 Collision Risk Model Analysis

The Collision Risk Model (CRM) Report (See Appendix 7.8) presents the results of collision risk modelling for the Proposed Wind Farm. This modelling used data from vantage point surveys carried out during the non-breeding winter seasons of 2021-22, 2022-23 and 2023-2024, as well as the breeding seasons of 2022, 2023 and 2024. The modelling was carried out using the NatureScot Collision Risk Model (Band, 2024). The spreadsheet accompanying the NatureScot report was used to calculate collision probabilities for birds transiting through the rotors. The following target species were recorded during vantage point surveys (VPs 1-4): Black-headed gull, Buzzard, Common gull, Cormorant, Golden Plover, Great Black-backed gull, Greylag Goose, Grey Heron, Hen Harrier, Kestrel, Lapwing, Lesser-black backed gull, Little Egret, Little Grebe, Mallard, Merlin, Mute Swan, Peregrine, Redshank, Snipe, Sparrowhawk and Whooper Swan. A total of 17 species were selected for collision risk modelling, namely Buzzard, Black-headed gull, Golden Plover, Great Black-backed gull, Greylag Goose, Grey Heron, Hen Harrier, Kestrel, Lapwing, Lesser Black-backed Gull, Little Egret, Mallard, Mute Swan, Peregrine, Snipe, Sparrowhawk and Whooper Swan. These species have been selected because they were recorded within the 500m buffer of the proposed turbines

(the flight activity survey area) at rotor swept heights, and are of conservation concern: i.e., they are red or amber-listed in Birds of Conservation Concern Ireland 2020-2026 (Gilbert et al., 2021), and/or are listed on Annex I of the Birds Directive or green-listed and sensitive to wind farm developments (i.e., buzzard). For all the other species recorded but not included for collision risk modelling, the effective collision risk can be assumed to be zero. As the Proposed Grid Connection will be buried underground there is no resultant collision risk associated with this element of the Proposed Development.

Passerines

Collision by resident passerines is not considered likely to be a significant issue as their flight activity is generally well below the height of rotor blades and the proposed impact of collision risk will be a Long-term Imperceptible Reversible Effect. Non-Passerines Potential collision risk to non-passerine target species is outlined in Table 7-25. Where potential for effects has been identified, potential effects at different population scales are examined (i.e. national, county and local scale) (please see CRM report Appendix 7.8 for details on how population sizes were determined). While the use of different population scales is utilised to provide a detailed and nuanced picture of effects, the basis of assessment is potential National scale population effects.

Table 7-25: Potential Collision Risk to Target Species

Key Receptor (Sensitivity)	Direct Effect (Collision Risk)	Significance without Mitigation
Black-headed gull (Medium)	SNH guidance (SNH, 2019) recommends an avoidance rate of 99.2% for smaller gulls such as black-headed gull. **Predicted number of collisions (assuming 99.2% avoidance) is 0.00 per year.**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** *(>1% population lost).* By cross-tabulating ***Medium*** sensitivity and ***Negligible*** magnitude, a ***Very Low*** significance of effect is predicted.
		Significance (EPA, 2022): The proposed impact of collision risk will be a ***Long-term, Imperceptible*** effect.
Buzzard (Low)	A total of 27 Buzzard fatalities have been recorded within the European Context, in a review of 46 wind farms up to 2004 (Hötker et al., 2006). However, this number is low in relation to the estimated European population of up to one million pairs (Gensbol, 2008) and best available knowledge suggests mortality due to wind farms is not sufficient to cause significant population declines of this green-listed species. A local population of 15 buzzards within a 5x5km square area overlapping the Proposed Wind Farm is estimated based on survey observations. It is noted that the county population is an estimate based on the proportion of the national population split by county area, used due to lack of a county estimate. Buzzard is a green-listed species of low conservation concern due to its ongoing expansion in population size and range. The national population estimate available for the species was taken from the Article 12 report covering the period 2008-2012. As this data is more 10 years old it does not account for the continued expansion of the species range throughout Ireland and therefore certainly underestimates the current population size for this species. **Predicted number of collisions per year (assuming 98% avoidance rate) is 0.5 per year (0.017% of national population, 0.7% county population and 3.33% local population)**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost) at national and county scale and ***Low*** (1-5% population lost) at local scale. Cross-tabulating ***Low*** sensitivity and both ***Negligible*** and ***Low*** magnitude, a ***Very Low*** significance of effect is predicted. ***Significance (EPA, 2022):*** The proposed impact of collision risk will be a ***Long-term, Imperceptible*** effect.
Great black-backed Gull (**Medium**)	A published review of the number of bird fatalities owing to collision with wind turbines showed there were zero fatalities across 46 European wind farms (Hötker et al., 2006). Furthermore, the published avoidance rate is 99.56% (Furness, 2019), suggesting great black-backed gulls exhibit high levels of micro-avoidance at wind farms. **Predicted number of collisions per year (assuming 99.56% avoidance rate) is 0.00 per year.**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost). Cross-tabulating ***Medium*** sensitivity with ***Negligible*** magnitude, a ***Very Low*** significance of effect is predicted. ***Significance (EPA, 2022):*** The proposed impact of collision risk will be a ***Long-term, Imperceptible*** effect.

Golden Plover **(Very High)**	Golden Plover have been recorded in low numbers as collision fatalities at wind farms (Hötker et al., 2006. Grunkorn 2011). The SNH guidance (SNH, 2018) does not provide a specific avoidance rate for Golden Plover, but states that for species not covered by the guidance "we recommend a default value of 98% ". However, the review study based on 3 years of post-construction monitoring sites included in the CRM (Appendix 7-8 and Gittings, 2022) indicates a much higher avoidance rate should be applied for non-breeding Golden Plover populations. The studies had robust survey methodologies and were carried out at wind farm sites with high levels of Golden Plover flight activity. The review considers that an avoidance rate of 99.8% is a suitable precautionary estimate for winter Golden Plover. In further support of a high micro-avoidance rate, a study in the Netherlands of three operational wind farms where Golden Plovers were both diurnally and nocturnally active found no fatalities (Krijgsveld et al., 2009). No breeding or roosting Golden Plover were recorded during surveys, reducing magnitude. While a collision rate of 3.96 per year is predicted, the predicted effects at county and national remain Negligible and Low at local level. It is noted that the local population estimate of 201 wintering birds is a conservative estimate based on average flock size observed. **Predicted number of collisions (assuming 99.8% avoidance) is 3.96 per year (0.005% of national population, 0.071% county population and** **1.97% local population).**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost) for national and county populations. Effect magnitude is ***Low*** for the local population. Cross-tabulating ***Very High*** sensitivity with ***Negligible*** magnitude, a ***Low*** significance of effect is predicted. Cross-tabulating ***Very High*** sensitivity with ***Low*** magnitude, a ***Medium*** significance of effect is predicted. ***Significance (EPA, 2022):*** The proposed impact of collision risk will be a ***Long-term, Not significant*** effect for national and county populations and ***Long-term Slight*** effect at local population level.
Greylag **G**oose (**Medium**)	SNH guidance (SNH, 2025) recommends an avoidance rate of 99.8% for all goose species. Due to the very limited amount of flight activity recorded for this species, no collision mortality is predicted. **Predicted number of collisions per year (assuming 99.8% avoidance rate) is 0.00 per year.**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost). Cross-tabulating ***Medium*** sensitivity with ***Negligible*** magnitude, a ***Very Low*** significance of effect is predicted. ***Significance (EPA, 2022):*** The proposed impact of collision risk will be a ***Long-term, Imperceptible*** effect.
Grey Heron (Low)	SNH guidance (SNH, 2025) recommends the default avoidance rate of 98% for grey heron, due to absence of published evidence supporting a higher avoidance rate. Due to the very limited amount of flight activity and frequently low flight altitudes recorded for this species, no collision mortality is predicted. **Predicted number of collisions per year (assuming 98% avoidance rate) is 0.00 per year.**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost). Cross-tabulating ***Low*** sensitivity with ***Negligible*** magnitude, a ***Very Low*** significance of effect is predicted. ***Significance (EPA, 2022):*** The proposed impact of collision risk will be a ***Long-term, Imperceptible*** effect.

Hen Harrier (Very High)	SNH guidance (SNH, 2025) recommends an avoidance rate of 99% for hen harrier, based on published evidence (Whitfield & Madders, 2006). No Hen Harriers were observed breeding onsite, so potential collision risk is significantly reduced due to the absence of the territorial display known as 'sky-dancing', which often occurs at heights within the predicted rotor envelope. Documented as occasionally soaring or arriving at winter roosts 'at height' (Watson, 1977). however, all infrequent/casual roosting observed involved low altitude flight. Literature suggests flying at low heights is a 'ubiquitous trait' supported by a number of studies (e.g. Whitfield and Madders, 2006). The species has a high published avoidance rate (99%) (SNH, 2017) in relation to wind turbines. Due to the absence of a breeding population, habitually low flight altitudes, in addition to the majority of flight activity being focused outside the 500m turbine buffer, predicted collision mortality for hen harrier is limited to less than one collision over the 35-year lifespan of the Proposed Development. A national population of 95.5 birds is estimated based on the national hen harrier survey undertaken in 2022 (Ruddock et. al 2024). While there is no breeding population in Co. Offaly, the population at the nearest SPA (Slieve Bloom Mountains	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost). Cross-tabulating ***Very High*** sensitivity with ***Negligible*** magnitude, a ***Low*** significance of effect is predicted. ***Significance (EPA, 2022):*** The proposed impact of collision risk will be a ***Long-term, Not significant*** effect.
	SPA) is considered to provide a useful county/SPA level population (5 pairs) (Ruddock et. al 2024). A conservatively low local wintering population of two birds is estimated based on survey observations in the study area. **Predicted number of collisions per year (assuming 99% avoidance rate) is 0.00 per year.**	
Kestrel (High)	Twenty-nine fatalities were recorded across 46 wind farms in a published review of the effects of turbine collision on birds in the European Context (Hötker et al., 2006). The published avoidance rate is 95% (SNH, 2016). **Kestrel has a predicted collision rate of 0.35 per year.** **At national level this represents an annual loss of 0.002% of the population. This represents a loss of 0.075% of the county population** (estimate based on proportion of national population split by county area, used due to a lack of a county estimate). **At local population level** (estimated proportionally based on national population), **this represents 1.522%.** As such, the predicted magnitude of collision effects for Kestrel remain Negligible at national and county scale, and Low at the local scale.	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost) at national and county scale, and ***Low*** (1-5 % population lost) at local scale Cross-tabulating ***High*** sensitivity with ***Negligible*** magnitude, a ***Very Low*** significance of effect is predicted. Cross-tabulating ***High*** sensitivity with ***Low*** magnitude, a ***Low*** significance of effect is predicted. ***Significance (EPA, 2022):*** The proposed impact of collision risk will be a ***Long-term, Not significant*** effect.

Lapwing (High)	SNH guidance (SNH, 2025) recommends the default avoidance rate of 98% for lapwing, due to absence of published evidence supporting a higher avoidance rate. Lapwing activity was regularly observed during both the winter and breeding seasons, with activity focused on Esker Bog Rathlumber. A proportion of the flights over this bog intersected the 500m turbine buffer, resulting in potential for collision risk. Lapwing is a gregarious species, often occurring in large flocks, particularly during winter. It can be susceptible to turbine collisions due to its tendency to gather in flocks and embark on meandering/wheeling flights. The estimated local population was calculated based on a highly conservative estimate based on average flock size (19 birds). **Predicted number of collisions per year (assuming 98% avoidance rate) is 2.88 per year (0.004% of national population, 0.076% county population and 15.158% local population.**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost) at national and county scale. The local population estimate based on maximum flock size results in a ***Low*** magnitude effect (1-5 % population lost) at local scale, while the local population estimate based on average flock size results in a ***Medium*** magnitude effect (5-20 % population lost) at local scale. Cross-tabulating ***High*** sensitivity with ***Negligible*** magnitude, a ***Very Low*** significance of effect is predicted at national and county scale. Cross-tabulating ***High*** sensitivity with ***Low*** magnitude, a ***Low*** significance of effect is predicted (local max. population). Cross-tabulating ***High*** sensitivity with ***Medium*** magnitude, a ***High*** significance of effect is predicted (local avg. population). ***Significance (EPA, 2022):*** When considering effects at the national and county scale, the proposed impact of collision risk will be a ***Long-term, Imperceptible*** to ***Not significant*** effect. At the local scale the proposed impact of collision risk will be a ***Long-term, Slight*** to ***Moderate*** effect.
Lesser Black-backed Gull (Medium)	A published review of 46 European wind farms (Hötker et al., 2006) found 45 fatalities across wind farms. However, the published avoidance rate is 99.56% (Furness, 2019), suggesting birds exhibit a high level of micro-avoidance. **The predicted collision risk for Lesser Black-backed Gull is 0.26 per year (assuming 99.56% avoidance rate). This equates to 0.8% of the local population/0.129% of county population/0.004% of national population.**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost). Cross-tabulating ***Medium*** sensitivity with ***Negligible*** magnitude, a ***Very Low*** significance of effect is predicted. ***Significance (EPA, 2022):*** The proposed impact of collision risk will be a ***Long-term, Imperceptible*** effect.
Little Egret (Very High)	SNH guidance (SNH, 2025) recommends the default avoidance rate of 98% for little egret, due to absence of published evidence supporting a higher avoidance rate. Due to the very limited amount of flight activity and frequently low flight altitudes recorded for this species, no collision mortality is predicted. **Predicted number of collisions per year (assuming 98% avoidance rate) is 0.00 per year.**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost). Cross-tabulating ***Very High*** sensitivity with ***Negligible*** magnitude, a ***Low*** significance of effect is predicted. ***Significance (EPA, 2022):*** The proposed impact of collision risk will be a ***Long-term, Not significant*** effect.
Mallard (Medium)	A total of 18 fatalities were recorded across 46 wind farms in a published review of the effects of turbine collision on birds in the European Context (Hötker et al., 2006). **Predicted number of collisions per year (assuming 98% avoidance rate) is 0.32 per year (0.001% of national population, 0.048% county population and 0.9% local population.**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost). Cross-tabulating ***Medium*** sensitivity with ***Negligible***, a ***Very Low*** significance of effect is predicted at national and county level. ***Significance (EPA, 2022):*** The proposed impact of collision risk will be a ***Long-term, Imperceptible*** effect.

Mute Swan (Medium)	A total of eight fatalities were recorded across 46 wind farms in a published review of the effects of turbine collision on birds in the European Context (Hötker et al., 2006). The published avoidance rate for swans is 99.5% (SNH, 2025), suggesting birds exhibit a high level of micro-avoidance. **Predicted number of collisions per year (assuming 99.5% avoidance rate) is 0.00 per year.**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost). Cross-tabulating ***Medium*** sensitivity with ***Negligible***, a ***Very Low*** significance of effect is predicted. ***Significance (EPA, 2022):*** The proposed impact of collision risk will be a ***Long-term, Imperceptible*** effect.
Peregrine (Very High)	Evidence of collision fatality is low, with only two birds recorded in published reviews of wind farm fatalities (Hötker et al., 2006). The SNH recommended avoidance rate for collision-risk modelling is 98% (SNH, 2025). The local population is estimated conservatively as two birds, based on the presence of a breeding population in the region. **Predicted number of collisions per year (assuming 98% avoidance rate) is 0.01 per year (0.001% of national population, 0.042% county population and 0.5% local population.**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost). Cross-tabulating ***Very High*** sensitivity with ***Negligible*** magnitude, a ***Low*** significance of effect is predicted. ***Significance (EPA, 2022):*** The proposed impact of collision risk will be a ***Long-term, Not significant*** effect.
Snipe (High)	Evidence of collision fatality is low, with only one bird recorded in published reviews of wind farm fatalities (Hötker et al., 2006). The SNH recommended avoidance rate for collision-risk modelling is 98% (SNH, 2025). The local population is estimated conservatively as 10 birds, based on survey observations. **The predicted collision risk for snipe (assuming 98% avoidance rate) is 0.01 per year (0. 0.000% of national population, 0.005% county population and 0.1% local population.**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost). Cross-tabulating ***High*** sensitivity with ***Negligible*** magnitude, a ***Very Low*** significance of effect is predicted. ***Significance (EPA, 2022):*** The proposed impact of collision risk will be a ***Long-term, Imperceptible effect.***
Sparrowhawk (Low)	Sparrowhawk is a resident species of the wind farm study area, although no breeding has been recorded within the site. Published fatality rates are low, with two fatalities from a review of 46 wind farms across Europe (Hötker et al., 2006). The local population is estimated conservatively as 3 birds, based on survey observations. **The predicted collision risk for sparrowhawk (assuming 98% avoidance rate) is 0.01 per year (0.000% of national population, 0.003% county population and 0.1% local population.**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost) at national and county scale, and ***Low*** (1-5% population lost) at local scale Cross-tabulating ***Low*** sensitivity with both ***Negligible*** and ***Low*** magnitude, a ***Very Low*** significance of effect is predicted at all scales. The proposed impact of collision risk will be a ***Long-term, Imperceptible effect.***

Whooper Swan (Very High)	Studies on wintering swans have found low levels of collision mortality, even in sites with a high degree of transit flights (n=1664 in one case) through operational wind farms and relatively high numbers (>500) of birds regularly present (Fijn et al., 2012). In a review of swan and goose fatalities at wind farms only one whooper swan fatality was recorded from monitoring undertaken at 46 different wind farms across 8 countries (Hötker et al., 2006). Recommended avoidance rates from SNH are 99.5% (SNH, 2010), based on literature reviews of recorded fatalities. this suggests a high micro-avoidance of turbines. In relation to nocturnal flight activity recent studies utilising radar on both offshore and coastal wind farms in Europe have recorded macro-avoidance rates in wildfowl at least as high, or higher at night than during the day, implying that diurnal avoidance rates are comparable to those in periods of lower visibility (Desholm, and Kahlert, 2005). Best scientific knowledge suggests comparable if not higher avoidance rates by wildfowl during perceived periods of poor visibility. Best scientific knowledge therefore suggests overall a high avoidance rate and consequent low fatality estimate for wind turbines in relation to Whooper Swans both in relation to diurnal flight activity and activity in crepuscular and nocturnal periods. **The predicted collision risk for whooper swan (assuming 99.5% avoidance rate) is 0.01 per year (0.000% of national population, 0.002% county population and 0.029% local population.**	***Significance (Percival, 2003):*** The magnitude of the effect is assessed as ***Negligible*** (>1% population lost). Cross-tabulating ***Very High*** sensitivity with ***Negligible*** magnitude, a ***Low*** significance of effect is predicted. ***Significance (EPA, 2022):*** The proposed impact of collision risk will be a ***Long-term, Not significant*** effect.

Response: Using Bird Collision data from Percival 2003 is not acceptable. Windturbines have increased in size since that period & up-to-date models are available such as - Scottish Nature: Guidance on using an updated collision risk model to assess bird collision risk at onshore wind farms 2024,

Birds and windfarms: what are the real issues? Steve Percival. British Birds 98 • April 2005 • 194-204 identified the 2005 background to Turbine Type in the following tables – Note no large turbines >1.5Mw in analysis. The obvious conclusion is that these historic references have zero relevance to 7.2Mw Turbines:

Table 1. Bird-windfarm collision studies: summary of findings.

Species group	Sites studied	Windfarm size	Turbine type	Exposure to collision risk	Incidence of collision	Population effect
Divers	Burgar Hill [1,2]	S	S/M	M	Nil	No
Cormorants	Buffalo Ridge [3]	VL	M	L	Nil	No
	Blyth [4,5]	S	S	L	VS	No
Swans	Yukon [6]	S	S	S	Nil	No
	Urk [7]	M	S	M/L	VS	No
Geese	Buffalo Ridge [3]	VL	M	L	Nil	No
	Klondike [8]	M	M	M	S	No
	Kreekrak [12]	S	S	M	S	No
	Gotland [10]	L	M	L	Nil	No
	Urk [7]	M	S	M	Nil	No
Ducks	Blyth [4,5]	S	S	L	S	No
	Buffalo Ridge [3]	VL	M	L	VS	No
	San Gorgonio [11]	VL	S	-	VS	No
	Kreekrak [12]	S	S	L	M	No
Eagles, vultures, hawks	Altamont [11,13]	VL	S	L	S	Likely
	Tehachapi [11]	VL	S	-	VS	Possible
	San Gorgonio [11]	VL	S	-	VS	No
	Tarifa [14,16]	VL	S	L	VS	Possible
	Navarre [15]	VL	M	L	S	Possible
Harriers	Buffalo Ridge [3]	VL	M	M	Nil	No
	Altamont [11,13]	VL	S	L	VS	No
	Foot Creek Rim [8]	L	M	-	VS	No
Falcons	Altamont [11,13]	VL	S	L	S	Possible
	Burgar Hill [1]	S	S	S	VS	No
	Novar [17]	M	M	M	VS	No
	Tehachapi [11]	VL	S	-	VS	No
	Tarifa [14, 16]	VL	S	L	VS	Possible
Upland gamebirds	Buffalo Ridge [3]	VL	M	S	VS	No
	Novar [17]	M	M	S	VS	No
	Tehachapi [11]	VL	S	-	VS	No
Owls	Altamont [11,13]	VL	S	L	VS	Possible
	San Gorgonio [11]	VL	S	-	VS	No
	Tehachapi [11]	VL	S	-	VS	Possible
Waders	Kreekrak [12]	S	S	L	S	No
	Gotland [21]	L	M	L	VS	No
	Blyth [4,5]	S	S	M/L	VS	No
	Oosterbierum [18]	M	S	M/L	VS	No
	Ovenden Moor [19]	M	S	L	VS	No
	Buffalo Ridge [3]	VL	M	L	VS	No
Gulls	Blyth [4,5]	S	S	L	M	No
	Kreekrak [12]	S	S	L	M	No
	Zeebrugge [20]	M	S/M	L	L	Possible
	Buffalo Ridge [3]	VL	M	L	Nil	No
Terns	Zeebrugge [20]	M	S/M	L	M	Possible
	Blyth [4,5]	S	S	M	Nil	No
Passerines	Blyth [4,5]	S	S	M/L	Nil	No
	Buffalo Ridge [3]	VL	M	L	M	No
	Oosterbierum [18]	M	S	L	L	No

KEY

Sources: 1. Meek *et al.* 1993; 2. Haworth 2002; 3. Johnson *et al.* 2000; 4. Still *et al.* 1995; 5. Painter *et al.* 1999; 6. Mossop 1998; 7. Winkelman 1989; 8. Young *et al.* 2003; 9. Johnson *et al.* 2003; 10. Percival 1998b; 11. Erickson *et al.* 2001; 12. Musters *et al.* 1995, 1996; 13. Thelander *et al.* 2003; 14. SEO/BirdLife 1995; 15. Lekuona 2001; 16. Janss 2000; 17. Bioscan 2001; 18. Winkelman 1992a; 19. EAS 1997; 20. Everaert *et al.* 2002; 21. Percival 2000.

Windfarm size: VL = very large (>200 turbines); L = large (50-200 turbines); M = medium (10-50 turbines); S = small (<10 turbines).

Turbine type: L = large (>1.5 MW); M = medium (500 KW-1.5 MW); S = small (<500 KW).

Exposure to collision risk: (based on number of flights at rotor height in proximity to turbines per year: L = large (>10,000); M = medium (1,000-10,000); S = small (<1,000).

Incidence of collision: L = large (>10/turbine/yr); M = medium (1-10/turbine/yr); S = small (0.1-1/turbine/yr); VS = very small (<0.1/turbine/yr).

Population effect: determined on the basis of the total numbers killed in relation to the population dynamics.

Table 2. Bird-windfarm disturbance studies: summary of findings.

Species group	Sites studied	Habitat	Windfarm size	Turbine type	Disturbance distance
Cormorant	Blyth [1]	Coastal	S	S	None *
Swans	Urk [3]	Farmland and coastal	M	S	None (Bewick's), 300 m (Whooper)
Geese	Germany [4,5]	Farmland	M	S/M	Up to 600 m
	Urk [3]	Farmland and coastal	M	S	None
	Denmark [6]	Farmland	L	M	1-200 m
	Gotland [7]	Coastal marsh	L	M	0-25 m
	Toronto [8]	Parkland	S	M	None
Ducks	Tunø Knob [9]	Offshore	M	M	None
	Utgrunden [10]	Offshore	S	L	None
	Urk [3]	Coastal	M	S	Up to 300 m
Raptors	Bryn Tytli [16]	Upland moor	M	S	None
	Altamont [17]	Grassland	VL	S	None
Waders: breeding	Ovenden Moor [11]	Upland moor	M	S	None
	Various UK sites [12]	Upland	S/M	S/M	None
	Gotland [22]	Coastal and farmland	L	M	None
	Oosterbierum [13]	Lowland farmland	S	S	Up to 300 m
	Germany [13]	Lowland farmland	S/M	S/M	Up to 200 m
Waders: non-breeding	Blyth [1]	Coastal	S	S	None
	Tjaereborg [2]	Farmland	S	M	800 m
	Zeebrugge [14]	Coastal	M	S/M	Up to 250 m
	Oosterbierum [15]	Farmland	M	S	500 m
Gulls	Tjaereborg [2]	Farmland	S	M	800 m
	Blyth [1]	Coastal	S	S	None
Terns	Zeebrugge [14]	Coastal	M	S/M	None
	Blyth [1]	Coastal	S	S	None
Passerines	Various UK sites [12]	Upland	S/M	S/M	None
	Buffalo Ridge [18]	Grassland	VL	M	1-200 m
	Bryn Tytli [16]	Upland moor	M	S	None
	Burgar Hill [20]	Upland moor	S	S	None
	Novar [21,23]	Upland moor	M	M	None

KEY

Sources: 1. Still *et al.* 1995; 2. Pedersen and Poulsen 1991; 3. Winkelman 1989; 4. Kowallik & Borbach-Jaene 2001; 5. Kruckenberg & Jaene 1999; 6. Larsen & Madsen 2000; 7. Percival 1998a; 8. James 2003; 9. Guillemette *et al.* 1998, 1999; 10. Pettersson & Stalin 2003; 11. Bullen Consultants 2002; 12. Thomas 1999; 13. Ketzenberg *et al.* 2002; 14. Everaert *et al.* 2002; 15. Winkelman 1992b; 16. Green 1995; 17. Thelander *et al.* 2003; 18. Leddy *et al.* 1999; 19. Phillips 1994; 20. Meek *et al.* 1993; 21. Bioscan 2001; 22. Percival & Percival 1998; 23. Percival 2002.

Windfarm size: VL = very large (>200 turbines); L = large (50-200 turbines); M = medium (10-50 turbines); S = small (<10 turbines).

Turbine type: L = large (>1.5 MW); M = medium (500 KW-1.5 MW); S = small (<500 KW).

Disturbance distance: None* indicates no significant disturbance effect; * disturbance noted during construction but not operation.

7.5.4.2 Indirect Effects: Disturbance and Displacement

There is evidence that the rotor blades of wind turbines during operation can displace or exclude some species, which effectively results in habitat loss for these birds. Habitat loss can be direct through land take of breeding or foraging habitats for key species or indirect such as effective habitat loss through avoidance or disturbance due to factors such as perceived collision risk.

Birds may therefore avoid areas proximal to turbines until habituation takes place. There are examples in the literature of habituation in species such as geese and swans (See Fijn et al., and Madsen and Boertmann, 2008). Available evidence suggests that breeding passerines are not adversely affected by the presence of wind turbines, and for this reason they are omitted from Table 7-26. For example, a German study found no effect on numbers or spatial distribution of skylarks within 1km of turbines (Langston and Pullan, 2004). Whitfield and Madders (2006), suggest that most studies do not detect any significant displacement of raptor species by wind turbines although there are occasional notable exceptions.

7.5.4.3 Indirect Effects: Barrier Effect

One of the potential operational effects of wind farms is avoidance where the wind farm may act as a barrier to movements (Masden et al., 2009). The effect of birds altering their migration flyways or local flight paths to avoid any infrastructure is a form of displacement (Drewitt and Langston, 2006). The primary effect of barrier effect is increased energy expenditure when birds have to fly further to circumvent an obstacle. Effects can be highly variable and range from slight 'checks' in-flight direction, height, or speed, through to larger diversions around objects.

Studies have shown that birds on migration may show avoidance of wind farms (Masden, 2009) but the observed distances involved were trivial in regard to total migration distances, and hence energy expenditure. In relation to nocturnal flight activity recent studies utilising radar on both offshore and coastal wind farms in Europe have recorded macro-avoidance rates in wildfowl at least as high, or higher at night than during the day, implying that diurnal avoidance rates are comparable to those in periods of lower visibility (Desholm, and Kahlert, 2005). In the same study migrating flocks at night were recorded increasing their distance from individual turbines once inside the wind farm and also travelling in the corridors between turbines (Desholm, and Kahlert, 2005). Potential disturbance and barrier effects due to the operation of the Proposed Wind Farm are outlined in Table 7-26.

Table 7-26: Potential Operational Effects to Non-Passerine Target Species

Key Receptor (Sensitivity)	Indirect Effect (Displacement/Barrier effects)	Significance without Mitigation
Black-headed gull (Medium)	**Disturbance/Displacement:** Of a literature review, carried out by Percival (2003), all studies which indicated gull species being significantly affected or being a species found to have collided, were identified at wind farms on coastal habitats. It is uncertain that disturbance may affect gull species inland. Gulls will be more at risk from collision impacts as a result of their flight behaviour, but less sensitive to disturbance and displacement effects (Humphreys et al., 2015). Due to the limited amount of Black-headed gull activity detected during surveys, the effect magnitude remains low. **Barrier Effect:** Barrier effects on either migration or regular flights of Black-headed gull were identified in just three out of eight studies examined in Hötker et al., 2006. The overall barrier effect results were shown to be not significant. Due to the limited amount of Black-headed gull activity detected during surveys and reduced susceptibility to barrier effect the effect magnitude remains negligible.	**Disturbance/Displacement:** Magnitude of effect is assessed as **Low**, species sensitivity is **Medium**, and the overall effect significance is **Low** (Criteria: Percival, 2003). The significance of effects is also assessed as Long-term **Not Significant** (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Medium**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). Significance of effects to migrating birds in terms of energy expenditure assessed as Imperceptible to Slight. significance of daily barrier effect assessed as Imperceptible to Slight. overall significance considered a Long-term **Imperceptible-Slight** effect (Criteria: EPA, 2022).
Buzzard (Low)	**Disturbance/Displacement:** In a review of the published impacts of wind farms on Buzzard populations (Hötker et al., 2006), it was found that overall, impacts on Buzzard populations post-construction, across both winter and breeding seasons was not significant and that Buzzards do show habituation to the presence of wind farms (Hötker et al., 2006). It should also be noted that just one case of habituation is documented in this study with a second case showing signs of a lack of habituation. Considering this, in conjunction with the high amount of displacement habitats in the surrounding area, the magnitude of disturbance effect is assessed as Negligible. **Barrier Effect:** Barrier effects on either migration or regular flights of Buzzard has been shown at two out of six studies to date (2004) in a European context (Hötker et al., 2006). The overall barrier effect results were shown to be not significant.	**Disturbance/Displacement:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Low**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). The significance of effects is also assessed as Long-term **Imperceptible** (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Low**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). Significance of effects to migrating birds in terms of energy expenditure assessed as Imperceptible to Slight. Significance of daily barrier effect assessed as Imperceptible to Slight. overall significance considered a Long-term **Imperceptible-Slight** effect (Criteria: EPA, 2022).
Common Gull (Medium)	**Disturbance:** Of a literature review, carried out by Percival (2003), all studies which indicated gull species being significantly affected or being a species found to have collided, were identified at wind farms on costal habitats. It is uncertain that disturbance may impact gull species in-land. **Barrier Effect:** Species such as gulls will be more at risk from collision impacts as a result of their flight behaviour, but less sensitive to disturbance and displacement effects (Humphreys et al., 2015). For gull species such as Lesser Black-Backed, Herring and Greater Black-Backed Gull, some studies indicate evidence for attraction, whereas others for displacement, with the remainder indicating no significant response (Cook et al., 2014. Humphreys et al., 2015).	**Disturbance:** Magnitude of effects is assessed as **Low**. Species sensitivity is **Medium**, overall effect significance is **Low** (Criteria: Percival 2003). Magnitude Not Significant due to published habituation to wind farms. Overall significance considered Long-term **Not Significant** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effects is assessed as Negligible (<1% habitat lost), species sensitivity is Medium, overall effect significance is **Very Low** (Criteria: Percival, 2003). Magnitude to migrating birds in terms of energy expenditure assessed as Imperceptible. magnitude of daily barrier effect assessed as Imperceptible. Overall significance considered an **Imperceptible** Long-term effect (Criteria: EPA, 2022).

Cormorant (Medium)	**Disturbance:** In a review of the published impacts of wind farms on birds (Hötker et al., 2006), there was no information available on Cormorant populations post-construction. The limited number of Cormorants observed flying over site suggests any impacts will be low. **Barrier Effect:** Barrier effects on either migration or regular flights of Cormorant has been shown for 2 out of 6 studies to date (2004) in a European context (Hötker et al., 2006), with the overall effect significance being non-significant. The limited number of Cormorants observed flying over site suggests any impacts will be low.	**Disturbance:** Magnitude of effects is assessed as **Low**. Species sensitivity is **Medium**, overall effect significance is **Low** (Criteria: Percival 2003). Overall significance considered Long-term **Not Significant** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effects is assessed as **Negligible**, species sensitivity is **Medium**, overall effect significance is **Very Low** (Criteria: Percival, 2003). Magnitude to migrating birds in terms of energy expenditure assessed as Imperceptible. magnitude of daily barrier effect assessed as Imperceptible. Overall significance considered an **Imperceptible** Long-term effect (Criteria: EPA, 2022).
Golden Plover (Very High)	**Disturbance/Displacement**: Literature suggests differences in densities pre-and post-construction of wind farms is significant (Pearce-Higgins et al., 2012). displacement is not significant but may occur up to 400m (Sansom et al. 2016). Pearce-Higgins et al. (2009) recorded a reduced occurrence of Golden Plovers within 200m of turbines across 12 upland wind farms. However, Fielding and Haworth (2010) and Douglas et al. (2011) suggest that under some circumstances, Golden Plovers may be more tolerant of wind farm infrastructure. At Farr wind farm, Fielding and Haworth (2010) showed that the median distance of 16 Golden Plover nests to the nearest turbine was 168.8m, with nine nests being less than 200m and three less than 100m from the nearest turbine. At Beinn Tharsuinn wind farm, Douglas et al. (2011) found that the distribution of breeding Golden Plovers appeared to be unaffected by proximity to turbines or tracks, with no evidence for this lack of association changing through time Depending on the level of habituation to disturbance, a buffer zone of 200-500m is suggested in Goodship and Furness (2022) to protect nesting Golden Plover as well as foraging and roosting birds during the nonbreeding season from pedestrian disturbance. However, the proposed development is outside the established range of breeding golden plover in Ireland. While some golden plover flight activity overlapped the proposed development, the majority was located to the east, and ground-based golden plover observations were focused to the north-west of the proposed development. The observations of Golden Plover activity recorded during VP surveys confirm this species winters in the locality, but that activity is focused the north-east and south-east of the proposed development. As such, the predicted magnitude for disturbance is Negligible. **Barrier Effect:** High published avoidance rates of wind farms (Krijgsveld et al., 2009) and changes in densities within wind farms post construction (Pearce-Higgins et al., 2012), suggests wind farms act as significant barriers to Golden Plover. Considering the regular occurrence of Golden Plover flocks during the non-breeding season, there is potential for this species to be affected by barrier effect. However, since activity is focused primarily the north-east and south-east of the proposed development, the potential for barrier effect is diminished. Considering these factors, the predicted magnitude for barrier effect is Low.	**Disturbance/Displacement**: Magnitude of effect is assessed as **Negligible**, species sensitivity is **Very High**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Due to the observed patterns of site utilisation by golden plover, disturbance/displacement affecting wintering and/or foraging habitat is assessed as a **Long-term Not Significant** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Low**, species sensitivity is **Very High**, and the overall effect significance is **Medium** (Criteria: Percival, 2003). The significance of effects to migrating birds in terms of energy expenditure is assessed as Slight to Moderate, and the daily barrier effect is assessed as Moderate, based on literature indicating high published avoidance rates of wind farms. Overall, the significance of effect is considered a Long-term **Slight to Moderate** effect (Criteria: EPA, 2022).

Great black-backed gull (Low)	**Disturbance/Displacement:** Of a literature review, carried out by Percival (2003), all studies which indicated gull species being significantly affected or being a species found to have collided, were identified at wind farms on coastal habitats. It is uncertain that disturbance may affect gull species inland. Furthermore, in a review of the published impacts of wind farms on bird populations (Hötker et al., 2006), it was found that common gulls do show habituation to the presence of wind farms (Hötker et al., 2006). Gulls will be more at risk from collision	**Disturbance/Displacement:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Low**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). The overall significance of effect is considered to be a Long-term **Imperceptible** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Low**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003).
	impacts as a result of their flight behaviour, but less sensitive to disturbance and displacement effects (Humphreys et al., 2015). **Barrier Effect:** Information on barrier effects on either migration or regular flights of Great Black-backed Gull is limited. Lack of barrier effect has been shown in a single study to date (2004) in a European context (Hötker et al., 2006). At the level of gulls as a grouping, 14 out of 22 studies indicated a lack of a barrier effect.	The significance of effects to migrating birds in terms of energy expenditure and daily barrier effect is assessed as Imperceptible, and the overall significance is considered a Long-term **Imperceptible** effect (Criteria: EPA, 2022).
Greylag Goose (Medium)	**Disturbance/Displacement:** Due to the absence of records of this species using the proposed development or surrounding lands detected during surveys, effect magnitude remains negligible. **Barrier Effect:** Barrier effects on either migration or regular flights of Greylag Goose were identified in both studies examined in Hötker et al., 2006. Due to the extremely limited amount of Greylag Goose activity detected during surveys (only one record of an individual) the effect magnitude remains negligible.	**Disturbance/Displacement:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Medium**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). The significance of effects is also assessed as Long-term **Imperceptible** (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Medium**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). Significance of effects to migrating birds in terms of energy expenditure assessed as Imperceptible to Slight. Significance of daily barrier effect assessed as Imperceptible to Slight. Overall significance considered a Long-term **Imperceptible-Slight** effect (Criteria: EPA, 2022).
Grey Heron (Low)	**Disturbance/Displacement:** In a review of the published impacts of wind farms on birds (Hötker et al., 2006), they found that typically, birds of open habitats were avoiding turbines by several hundred metres. Grey Herons were an exception to this rule and were frequently found close to or within wind farm sites, suggesting habituation. **Barrier Effect:** Hötker et al., 2006 found evidence of a barrier effect in four out of seven cases, with the remaining three showing no barrier effect. Results were deemed not significant.	**Disturbance/Displacement:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Low**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). The significance of effects is considered Imperceptible, based on published evidence of habituation to wind farms, and the overall significance is assessed as a Long-term **Imperceptible** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Low**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). The significance of the daily barrier effect is assessed as Imperceptible, and the overall significance is considered to be a Long-term **Imperceptible** effect (Criteria: EPA, 2022).
Hen Harrier (Very High)	**Disturbance/Displacement:** The area of potentially suitable winter roosting habitat for hen harrier to the norther of T4 which would remain following proposed peat deposition is located between 210-350m from the closest turbine i.e. T4. Considering the suggested buffer of 300-750m for pedestrian and aircraft disturbance noted in Goodship and Furness (2022), there is some potential for disturbance of hen harrier potentially using this area to arise from operational noise from T4. However, due to the highly infrequent/transient use of this area observed, in addition to the abundance of suitable displacement habitats in the locality and wider landscape, the magnitude of this disturbance to roosting hen harrier remains negligible.	**Disturbance/Displacement:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Very High**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Overall significance is assessed as a **Long-term Not Significant** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Very High**, and the overall effect significance is **Low** (Criteria: Percival, 2003). The significance of effects to birds in terms of energy expenditure is assessed as **Not Significant**, and the magnitude of the daily barrier effect is assessed as **Not Significant** to **Slight**. The overall significance is

	Noise disturbance/visual intrusion unlikely to deter foraging hen harrier as evidence suggests birds may continue to utilise wind farms post construction (Robinson et al., 2012). **Barrier Effect:** Although barrier effect has been documented in at least one study in the European context. recent evidence suggests that birds continue to use wind farms post construction (Whitfield and Madders, 2006) (Robinson et al., 2012) indicating wind farms may not be significant barriers.	considered a Long-term **Not Significant** effect (Criteria: EPA, 2022).
House Martin (Medium)	**Disturbance/Displacement**: Studies on the impact of wind farms during both construction (Pearce-Higgins et al., 2012) and operation (Pearce-Higgins et al., 2009) have found little evidence of significant disturbance effects on passerine species. Evidence suggests that flying insects are attracted to turbines (Long, et. al, 2011. Scholz & Voigt, 2021) which in turn, attracts insectivorous birds, especially hirundines and Swifts (Ahlén, 2002). This evidence further suggests that construction of wind farms, instead of disturbing birds, may in fact actually lure such bird species into the rotor sweep zone, thus significantly increasing collision risk. House martin activity was observed incidentally during VP surveys and was also noted during Breeding Bird Transects. The predicted magnitude for disturbance is Low. **Barrier Effect:** Hötker et al., 2006 found evidence of a barrier effect in house martin in two cases. However, as mentioned above, attraction of insects to turbines may further attract insectivorous bird species, which would reduce/preclude barrier effect. The predicted magnitude for barrier effect is Low.	**Disturbance/Displacement:** Magnitude of effect is assessed as **Low**, species sensitivity is **Medium**, and the overall effect significance is **Low** (Criteria: Percival, 2003). The overall significance is assessed as a Long-term **Imperceptible** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Low**, species sensitivity is **Medium**, and the overall effect significance is **Low** (Criteria: Percival, 2003). The significance of effects to migrating birds in terms of energy expenditure and daily barrier effect is assessed as Imperceptible, and the overall significance is considered to be a Long-term **Imperceptible** effect (Criteria: EPA, 2022).
Kestrel (High)	**Disturbance/Displacement:** Disturbance (in terms of minimal distance to wind farm) has been recorded in 14 studies on wind farms in Europe (Hötker et al., 2006). Habituation to wind farms has been recorded in one case, however the only other case recorded the opposite (Hötker et al., 2006). A case study on the impacts of wind farms on birds conducted in southern Spain (Farfán et al., 2009), found that raptors utilise the space around the wind farm with lower frequency than prior to its existence, which represented a displacement of the home range of these species. In particular, Kestrel was noted to decline sharply in the second year of operation, with other raptor species showing a decline in the first year. Other studies found less evidence of displacement. Whitfield and Madders (2006) rated kestrel as having a 'low' sensitivity to displacement. The related American kestrel (Falco sparverius) was also given a rating of 'low' sensitivity. Pearce-Higgins et al. (2009) found equivocal evidence for weak avoidance of turbines by kestrel (quote below). 'Previous analyses for raptors have generally found only low levels of turbine avoidance (Hötker 2006.	**Disturbance/Displacement:** Magnitude of effect is assessed as **Medium**, species sensitivity is **High**, and the overall effect significance is **High** (Criteria: Percival, 2003). The significance of effects is considered Slight to Moderate, based on the equivocal evidence of disturbance noted in published cases and the occurrence of the majority of kestrel flight activity away from turbine locations. The overall significance is assessed as a Long-term **Slight** to **Moderate** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Medium**, species sensitivity is **High**, and the overall effect significance is **High** (Criteria: Percival, 2003). The significance of effects in terms of energy expenditure is considered Moderate. The magnitude of the daily barrier effect is assessed as Slight, as published literature indicates low avoidance rates of wind farms due to habituation. Overall, the significance is assessed as a Long-term **Slight to Moderate** effect (Criteria: EPA, 2022).

	Hötker et al. 2006. Madders & Whitfield 2006), with some species, such as kestrels, known to continue foraging activity close to turbines and to be susceptible to collision (Barrios & Rodríguez 2004, 2007). We found hen harrier and buzzard showed reduced flight activity around turbines, with equivocal evidence for weak avoidance by kestrel, broadly reflecting the sensitivity of these species anticipated by Madders & Whitfield (2006). Raptors did not appear to alter their flight height in response to turbine proximity, at least at the gross scale examined.' **Barrier Effect:** Barrier effects have been shown to a degree in either migrating or regular kestrel flight paths within the European context (3 of 5 studies. Hötker et al., 2006).	
Lapwing (High)	**Displacement/Disturbance:** Disturbance (in terms of minimal distance to wind farm) has been recorded for lapwing in 13 studies (breeding season)/32 studies (non-breeding season) on wind farms in Europe. Habituation to wind farms has been recorded in three out of five cases (non-breeding season) and two out six cases (breeding season). The height of turbines was found to have a statistically significant relationship with distance from wind farms for non-breeding lapwing (distance from wind turbines increased with turbine height) (Hötker et al., 2006). Lapwing were recorded frequently during surveys. The majority of activity was located away from proposed turbine locations, with the highest activity levels associated with Esker Bog Rathlumber and agricultural fields to the north-east of T3. As such, considering the distribution of lapwing records, and location of potential breeding habitat away from the Proposed Development, the predicted magnitude for disturbance is Low. **Barrier Effect:** Barrier effects have been shown to a degree in either migrating or regular lapwing flight paths within the European context (5 of 6 studies. Hötker et al., 2006).	**Disturbance/Displacement:** Magnitude of effect is assessed as **Low**, species sensitivity is **High**, and the overall effect significance is **Low** (Criteria: Percival, 2003). The significance of effect is assessed as **Long-term** and **Not Significant** (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Medium**, species sensitivity is **High**, and the overall effect significance is **High** (Criteria: Percival, 2003). Based on the observed low proportion of lapwing flights traversing the proposed turbine locations, the realised barrier effect will be reduced. Significance of effects in terms of energy expenditure assessed as Moderate. magnitude of daily barrier effect assessed as Slight as literature suggests low published avoidance rates of wind farms with habituation. overall significance considered a **Slight** to **Moderate** Long-term effect (Criteria: EPA 2022).
Kingfisher (Very High)	**Disturbance:** In a review of the published impacts of wind farms on birds (Hötker et al., 2006), there was no information available on Kingfisher populations post-construction. The species was not recorded on-site, so any effects are likely to be negligible. **Barrier Effect:** Barrier effects on either migration or regular flights of Kingfisher has not been shown to date (2004) in a European context (Hötker et al., 2006). Kingfisher fly low when commuting and mainly follow watercourses, making it unlikely that turbines would represent a barrier to movement.	**Disturbance:** Magnitude of effects is assessed as **Negligible**. Species sensitivity is **Very High**, overall effect significance is **Low** (Criteria: Percival 2003). The significance of effects is considered Long-term and **Imperceptible** (Criteria: EPA, 2022). **Barrier Effect:** Magnitude to commuting birds in terms of energy expenditure assessed as Imperceptible. magnitude of daily barrier effect assessed as Imperceptible. overall significance considered an **Imperceptible** Long-term Impact (Criteria: EPA 2022).
Lesser Black-backed gull (Medium)	**Disturbance/Displacement:** Of a literature review, carried out by Percival (2003), all studies which indicated gull species being significantly affected or being a species found to have collided, were identified at wind farms on coastal habitats. It is uncertain that disturbance may affect gull species inland. Gulls will be more at risk from collision impacts as a result of their flight behaviour, but less sensitive to	**Disturbance/Displacement:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Medium**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). Significance of effects is assessed as a **Long-term Imperceptible** effect (Criteria: EPA, 2022). **Barrier Effect:**

	disturbance and displacement effects (Humphreys et al., 2015). **Barrier Effect:** For gull species such as Lesser Black-backed, Herring and Great Black-backed, some studies indicate evidence for attraction, whereas others for displacement, with the remainder indicating no significant response (Cook et al., 2014. Humphreys et al., 2015).	Magnitude of effect is assessed as **Negligible**, species sensitivity is **Medium**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). Significance of effects to migrating birds in terms of energy expenditure assessed as Imperceptible. Significance of daily barrier effect assessed as Imperceptible. Overall significance considered a **Long-term Imperceptible** effect (Criteria: EPA, 2022).
Little egret (Very High)	**Disturbance/Displacement:** Little egret is a member of the heron genus (Ardea) and as such will have similar characteristics and sensitivities to grey heron. A review of the published impacts of wind farms on birds (Hötker et al., 2006) found that typically, birds of open habitats were avoiding turbines by several hundred metres. Grey Herons were an exception to this rule and were frequently found close to or within wind farm sites, suggesting habituation. Considering the close genetic, ecological and behavioural relationships between grey heron and little egret, this tendency towards habituation is similarly applicable for little egret. **Barrier Effect:** Hötker et al., 2006 found evidence of a barrier effect for grey heron (also applicable to little egret) in four out of seven cases, with the remaining three showing no barrier effect. Results were deemed not significant.	**Disturbance/Displacement:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Very High**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Significance of effects **Imperceptible** due to published evidence of habituation of herons to wind farms. overall significance considered **Long-term Imperceptible** effect (Criteria: EPA 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Very High**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Significance of daily barrier effect assessed as Imperceptible. Overall significance considered to be a **Long-term Imperceptible** effect (Criteria: EPA 2022).
Little Grebe (Low)	**Disturbance/Displacement:** There is no suitable habitat for little grebe within the proposed development site. There is limited potential for small numbers of this species to use bog pools in the cutover bogs to the east and west of the proposed development. **Barrier Effect:** There was just one little grebe record across all flight activity surveys, indicating this species does not habitually or frequently traverse the proposed development. As such, potential for barrier effects remains negligible.	**Disturbance:** Magnitude of effects is assessed as **Low**. Species sensitivity is **Low**, overall effect significance is **Very Low** (Criteria: Percival 2003). The significance of effects is considered Long-term and **Imperceptible** (Criteria: EPA, 2022). **Barrier Effect:** Magnitude to commuting birds in terms of energy expenditure assessed as Imperceptible. magnitude of daily barrier effect assessed as Imperceptible. overall significance considered an **Long-term Imperceptible** Impact (Criteria: EPA 2022).
Mallard (Medium)	**Disturbance/Displacement:** In a review of the published effects of wind farms on Mallard populations (Hötker et al. 2006), it was found that habituation to wind farms occurred across both winter and breeding seasons. **Barrier Effect:** Barrier effects on either migration or regular flights of Mallard have been shown for three out of five studies in a European context (Hötker et al. 2006). The overall barrier effect was not shown to be significant.	**Disturbance:** Magnitude of effect is assessed as **Medium**, species sensitivity is **Medium**, and the overall effect significance is **Low** (Criteria: Percival, 2003). The significance of effects is considered **Long-term** and **Not Significant** (Criteria: EPA, 2017). **Barrier Effect:** Magnitude of effect is assessed as **Low** , species sensitivity is **Medium**, and the overall effect significance is **Low** (Criteria: Percival, 2003). The significance of effects is considered **Long-term** and **Not Significant** (Criteria: EPA, 2022).
Merlin (Very High)	**Disturbance/Displacement:** Merlin were observed infrequently during surveys, with two observations during winter 2021-22 VP surveys, and two observations during winter 2023-24. This species was not recorded during any other surveys. Considering the observed low usage of the site by merlin, the predicted magnitude of disturbance/displacement is Negligible. **Barrier Effect:** Hötker et al., 2006 found evidence of a barrier effect for merlin in a single study.	**Disturbance/Displacement:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Very High**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Significance of effects Not Significant due to low number of sightings (four in total) during the total survey period. Overall significance considered as **Long-term Not Significant** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Very High**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Significance of effects to birds in terms of energy expenditure assessed as Not Significant. magnitude of daily barrier effect assessed as Not Significant. overall significance considered Long-term **Not Significant** effect (Criteria: EPA, 2022).

Mute Swan (Medium)	**Disturbance/Displacement:** Possible disturbance from feeding areas during wintering period (Oct-March) dependant on availability of food resources (e.g. improved agricultural grassland/stubble). Literature suggests possible short-term displacement of 200- 400m (Fijn et al., 2012) (Rees, 2012) followed by habituation (Fijn et al., 2012) with little evidence of permanent post construction displacement (Rees, 2012). This species was not recorded feeding within the flight activity or transect surveys study area. **Barrier Effect:** There are two types of barrier effect; those to migrating birds along migration routes and daily barrier effects due to placement of turbines between feeding and roosting sites. Barrier effect can be related to perceived collision risk (SNH, 2014). Barrier effects along migration routes of wildfowl have been shown to cause only small effects on total migration distance (Masden, 2009). Swans have been shown to exhibit horizontal avoidance as they fly past the outer edge of wind farms (Fijn et al., 2012) and distances of up to 200m have been noted for whooper swans (Rees, 2012). In the Netherlands, Bewicks Swans have been recorded adjusting their flight paths to the presence of turbines during both light and darkness, with no large deflections or panic reactions recorded and birds were recorded flying around and between rows of turbines (Fijn et al., 2012). Distances between turbines at the referenced site (300-400m) (Fijn et al., 2012) are lower than those at Ballinla (500 – 700m). In relation to nocturnal flight activity, recent studies utilising radar on both offshore and coastal wind farms in Europe have recorded macro-avoidance rates in wildfowl at least as high, or higher at night than during the day, implying that diurnal macro-avoidance rates are comparable to those in periods of lower visibility (Desholm, and Kahlert, 2005).	**Disturbance:** Magnitude of effects is assessed as **Low,** reducing to **Negligible** with habituation. Species sensitivity is **Medium**, overall effect significance is **Low** (Criteria: Percival 2003). Considering the limited occurrence of mute swan within the study area and habituation, significance of effects is considered **Long-term Not significant** reducing to **Long-term Imperceptible** with habituation (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Medium**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). Magnitude to commuting birds in terms of energy expenditure assessed as Imperceptible. magnitude of daily barrier effect assessed as Imperceptible. overall significance considered an **Imperceptible Long-term** Impact (Criteria: EPA 2022).
Peregrine (Very High)	**Disturbance/Displacement:** Possible disturbance to foraging birds through noise, visual intrusion. No displacement from breeding sites is likely due to none being recorded within the proposed site boundary or surrounding locality. Peregrine are known to nest in urban areas often in cathedrals with	**Disturbance/Displacement:** Magnitude of effect is assessed as **Negligible**, species sensitivity is Very High, and the overall effect significance is **Low** (Criteria: Percival, 2003). Significance of effects Not Significant due to absence of breeding sites within or near the proposed site

	loud ringing bells, as well as quarries where regular rock-breaking works are undertaken. For example, Moore et al. (1997), estimated that 65 quarries were occupied in Ireland between 1991 and 1993. Thus there is evidence to suggest that the species is tolerant of noise and human activity. **Barrier Effect:** Hötker et al., 2006 report one case of barrier effect in Peregrines. Barrier effects on either migration or regular flights of Peregrine has not been shown to date in a European context (Hötker et al., 2006). Observed flight path distribution, in addition to the large distance between proposed turbines mean the wind farm is unlikely to act as a significant barrier to a high-flying and far-ranging species such as Peregrine.	and evidence suggesting tolerance to noisy human activities. Overall significance considered **Long-term Not Significant** effect (Criteria: EPA 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Very High**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Significance of effects to migrating birds in terms of energy expenditure assessed as Not Significant. significance of daily barrier effect assessed as Not Significant. overall significance considered to be a **Long-term Not Significant** effect (Criteria: EPA, 2022)
Sand Martin (Medium)	**Disturbance/Displacement:** Studies on the impact of wind farms during both construction (Pearce-Higgins et al., 2012) and operation (Pearce-Higgins et al., 2009) have found little evidence of significant disturbance effects on passerine species. Evidence suggests that flying insects are attracted to turbines (Long, et. al, 2011. Scholz & Voigt, 2021) which in turn, attracts insectivorous birds, especially hirundines and Swifts (Ahlén, 2002). This evidence further suggests that construction of wind farms, instead of disturbing birds, may in fact actually lure such bird species into the rotor sweep zone, thus significantly increasing collision risk. **Barrier Effect:** Hötker et al., 2006 did not include any studies on sand martin, but did review studies on the closely related species house martin, which found evidence of a barrier effect in in two cases. However, as noted above, attraction of insects to turbines may further attract insectivorous bird species, which would reduce/preclude barrier effect. The predicted magnitude for barrier effect is Low.	**Disturbance/Displacement:** Magnitude of effect is assessed as Low, species sensitivity is Medium, and the overall effect significance is **Low** (Criteria: Percival, 2003). Significance considered **Long-term Imperceptible** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Low**, species sensitivity is **Medium**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Significance of effects to migrating birds in terms of energy expenditure assessed as Imperceptible. Significance of daily barrier effect assessed as Imperceptible. Overall significance considered to be a **Long-term Imperceptible** effect (Criteria: EPA, 2022).
Short-eared Owl (Very High)	**Disturbance/Displacement:** A review of the published impacts of wind farms on birds (Hötker et al., 2006) did not note any studies which identified operational disturbance or displacement effects for short-eared owl. A study examining barn owl breeding success has shown no declines in areas of high disturbance levels in the UK, such as near military activity (Shawyer, 2011). It is unlikely that noise from turbines would significantly affect the foraging activites of wintering short-eared owl. **Barrier Effect:** Given the low population/activity levels indicated by surveys in addition to the limited size of the overall wintering population, avoidance of the proposed wind farm is unlikely to induce significant energetic expenditure on either flight daily patterns of birds or birds undertaking longer journeys such as migration. It is also noted the turbine layout features large gaps (minimum of 500m) between individual turbines, avoiding a 'wall' or barrier effect.	**Disturbance/Displacement:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Very High**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Overall significance considered to be a **Long-term Not significant** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Very High**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Overall significance considered to be a **Long-term Not significant** effect (Criteria: EPA, 2022).

Sparrowhawk (Low)	**Disturbance/Displacement:** In a review of the published impacts of wind farms on Sparrowhawk populations (Hötker et al., 2006), it was found that overall, effects on Sparrowhawk populations post-construction, across both winter and breeding season was not significant. Sparrowhawk do show habituation to the presence of wind farms (Hötker et al., 2006). Breeding was not proven although the regular occurrence of sparrowhawk indicates that this species likely breeds locally outside the site. The predicted magnitude for disturbance is Negligible **Barrier Effect:** Sparrowhawk is considered to be less sensitive or less willing to change their original migration direction when approaching wind farms (Hötker et al., 2006). Three cases of no barrier effect are reported by Hötker et al., 2006, with one case of barrier effect. The predicted magnitude for barrier effect is Negligible	**Disturbance/Displacement:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Low**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). Overall significance considered to be a Long-term **Imperceptible** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **Low**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). Overall significance considered to be a **Long-term Imperceptible** effect (Criteria: EPA, 2022).
Snipe (High)	**Disturbance/Displacement:** Literature suggests differences in densities pre- and post-construction of wind farms has a significant impact upon Snipe within an area (Pearce-Higgins et al., 2012). Snipe were also shown by Pearce-Higgins et al. (2009) to use areas of habitat within 400m of turbines less than expected, leading to an expected 48% decline in abundance within 500m of the turbines. The presence of snipe including records of breeding behaviours were recorded in peatland habitats including areas within 500m of proposed turbines. The predicted magnitude for disturbance is Medium. **Barrier Effect:** Recorded infrequent activity contains low level of flight activity within the 500m turbine buffer. The Proposed Wind Farm is unlikely to act as a significant barrier to a species such as Snipe. The predicted magnitude for barrier effect is Negligible.	**Disturbance/Displacement:** Magnitude of effect is assessed as **Medium**, species sensitivity is **High**, and the overall effect significance is **High** (Criteria: Percival, 2003). Due to the low number of records within the 500m buffer, in addition to abundant displacement habitat in the locality, overall significance considered a **Long-term Moderate** effect (Criteria: EPA 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **High**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). Overall significance considered to be a **Long-term Imperceptible** effect (Criteria: EPA, 2022).
Stock Dove (High)	**Disturbance/Displacement:** A review of the published impacts of wind farms on birds (Hötker et al., 2006) did not note any disturbance/displacement effects applicable to stock dove. Stock dove breed in lowland agricultural landscapes in the east and south of Ireland, utilising tree holes for nesting (Birdwatch Ireland, 2025d). No potential nesting features were identified within or near the Proposed Development during surveys. In the event of a nesting site occurring (outside) near the Proposed Wind Farm, there is limited potential for disturbance to occur. **Barrier Effect:** Hötker et al., 2006 found evidence of a barrier effect for stock dove in two studies.	**Disturbance/Displacement:** Magnitude of effect is assessed as **Low**, species sensitivity is **High**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Overall significance considered to be a Long-term **Not significant** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **High**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). Overall significance considered to be a Long-term **Imperceptible** effect (Criteria: EPA, 2022).

Swallow (Medium)	**Disturbance/Displacement:** Studies on the impact of wind farms during both construction (Pearce-Higgins et al., 2012) and operation (Pearce-Higgins et al., 2009) have found little evidence of significant disturbance effects on passerine species. Evidence suggests that flying insects are attracted to turbines (Long, et. al, 2011. Scholz & Voigt, 2021) which in turn, attracts insectivorous birds, especially hirundines and Swifts (Ahlén, 2002). This evidence further suggests that construction of wind farms, instead of disturbing birds, may in fact actually lure such bird species into the rotor sweep zone, thus significantly increasing collision risk. Swallow (amber listed) were recorded on the wing during breeding bird transect surveys and also during VP surveys, with individuals, pairs and flocks of 21 (observed over transect 2 near T1-T3) and 80 (feeding over bog outside wind farm) noted. There is no nesting habitat within or in close proximity to the Proposed Wind Farm. The predicted magnitude for disturbance is Low. **Barrier Effect:** Hötker et al., 2006 found evidence of a barrier effect for swallow in four cases. However, as mentioned above, attraction of insects to turbines may further attract insectivorous bird species, which would reduce/preclude barrier effect. The predicted magnitude for barrier effect is Low.	**Disturbance/Displacement:** Magnitude of effect is assessed as Low, species sensitivity is Medium, and the overall effect significance is **Low** (Criteria: Percival, 2003). Significance considered **Long-term Imperceptible** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Low**, species sensitivity is **Medium**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Significance of effects to migrating birds in terms of energy expenditure assessed as Imperceptible. Significance of daily barrier effect assessed as Imperceptible. Overall significance considered to be a **Long-term Imperceptible** effect (Criteria: EPA, 2022).
Swift (High)	**Disturbance/Displacement:** Evidence suggests that flying insects are attracted to turbines (Long, et. al, 2011. Scholz & Voigt, 2021) which in turn, attracts insectivorous birds, especially hirundines and Swifts (Ahlén, 2002). This evidence further suggests that construction of wind farms, instead of disturbing birds, may in fact actually lure such bird species into the rotor sweep zone, thus significantly increasing collision risk. Swift activity observed during surveys was limited, with four records at VP1, three records at VP2 and three at VP4. There is no swift nesting habitat within or in close proximity to the Proposed Wind Farm. The predicted magnitude for disturbance is Low. **Barrier Effect:** Hötker et al., 2006 found evidence of a barrier effect in Swift in two cases. However, as mentioned above, attraction of insects to turbines may further attract insectivorous bird species, which would reduce/preclude barrier effect. The predicted magnitude for barrier effect is Low	**Disturbance/Displacement:** Magnitude of effect is assessed as **Low**, species sensitivity is **High**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Significance considered **Long-term Not significant** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Low**, species sensitivity is **Medium**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Significance of effects to migrating birds in terms of energy expenditure assessed as Imperceptible. Significance of daily barrier effect assessed as Imperceptible. Overall significance considered to be a **Long-term Not significant** effect (Criteria: EPA, 2022).
Whooper swan (Very High)	**Disturbance/Displacement:** Possible disturbance from feeding areas during wintering period (Oct-March) where suitable food resources are available (e.g. improved agricultural grassland/stubble). Literature suggests possible short-term displacement of 200- 400m (Fijn et al., 2012) (Rees, 2012) followed by habituation (Fijn et al., 2012) with little evidence of permanent post construction displacement (Rees, 2012).	**Disturbance/Displacement:** Magnitude of effect is assessed as **Low**, species sensitivity is **Very High**, and the overall effect significance is **Medium**, reducing to **Low** with habituation (Criteria: Percival, 2003). Significance considered **Long-term Not Significant** to **Slight** effect due to absence of regular grazing or roosting sites, in addition to habituation (Criteria: EPA, 2022).

	Considering that just two incidents of casual use of agricultural land at the proposed development by grazing whooper swans were observed across all surveys, it is assessed that there are no habitual whooper swan grazing sites within or in close proximity to the proposed development which could be disturbed due to operation of turbines. Considering this in conjunction with the potential for short-term displacement noted above, in addition to an abundance of suitable habitat in the local area, potential effects remains low prior to habituation. **Barrier Effect:** There are two types of barrier effect; those to migrating birds along migration routes and daily barrier effects due to placement of turbines between feeding and roosting sites. Barrier effect can be related to perceived collision risk (SNH, 2014). Barrier effects along migration routes of wildfowl have been shown to cause only small effects on total migration distance (Masden, 2009). Swans have been shown to exhibit horizontal avoidance as they fly past the outer edge of wind farms (Fijn et al., 2012) and distances of up to 200m have been noted for whooper swans (Rees, 2012). In the Netherlands, Bewicks Swans have been recorded adjusting their flight paths to the presence of turbines during both light and darkness, with no large deflections or panic reactions recorded and birds were recorded flying around and between rows of turbines (Fijn et al., 2012). Distances between turbines at the referenced site (300-400m) (Fijn et al., 2012) are lower than those at Ballinla (500 – 700m). In relation to nocturnal flight activity, recent studies utilising radar on both offshore and coastal wind farms in Europe have recorded macro-avoidance rates in wildfowl at least as high, or higher at night than during the day, implying that diurnal macro-avoidance rates are comparable to those in periods of lower visibility (Desholm, and Kahlert, 2005).	**Barrier Effect:** Magnitude of effect is assessed as **Low**, species sensitivity is **Very High**, and the overall effect significance is **Medium** (Criteria: Percival, 2003). Significance of effects to migrating birds in terms of energy expenditure assessed as Not significant. Significance of daily barrier effect assessed as **Not significant** to **Slight**. Overall significance considered to be a **Long-term Not significant** to **Slight** effect (Criteria: EPA, 2022).
Woodcock (High)	**Disturbance/Displacement**: There is potential for displacement arising from habitat alteration (turbine felling buffers) and from disturbance caused by operational turbines, and to a lesser extent occasional human presence associated with maintenance activities. A study of the impacts of wind turbines on woodcock undertaken in Kilkenny (Gittings, 2019) indicated that 'a displacement effect may occur within 250m of wind turbines, although there are confounding factors that affect the interpretation of the results. The surveys did not find any evidence of a displacement effect extending over the 250-500m distance band'. The potential displacement within the 0-250m distance band is in line with the results of a similar study carried out in Germany (Dorka et al., 2014). Based on observed woodcock breeding display behaviour, the potential for this species to nest within 250m of the proposed T4 location must be considered. The potential for intra-species audibility of roding calls to be affected by noise from operational turbines must also be considered.	**Disturbance/Displacement:** Magnitude of effect is assessed as **Low**, species sensitivity is **High**, and the overall effect significance is **Low** (Criteria: Percival, 2003). Significance considered a Long-term **Not Significant** effect (Criteria: EPA, 2022). **Barrier Effect:** Magnitude of effect is assessed as **Negligible**, species sensitivity is **High**, and the overall effect significance is **Very Low** (Criteria: Percival, 2003). Significance of effects to migrating birds in terms of energy expenditure assessed as Imperceptible. Significance of daily barrier effect assessed as Imperceptible. Overall significance considered to be a Long-term **Imperceptible** effect (Criteria: EPA, 2022).
	While displacement of nesting and roding birds could occur closer to proposed turbines located in wooded habitats, the availability of abundant displacement habitat in the local area reduces the magnitude of these effects. Disturbance/displacement of breeding birds at construction stage are of higher concern than operational disturbance/displacement. As such, a Low magnitude effect is predicted in this regard. **Barrier Effect:** Home ranges are small with birds recorded flying up to 1km from nests sites to forage (Hoodless and Hirons 2007). No published evidence of barrier effect to migrating birds is available (Hötker et al., 2006).	

7.5.6 Cumulative Effects

Direct effects on avifauna during construction are primarily land-take related, mainly due to the loss of nesting habitats to key species. Other sources of land-take as outlined above, do have the potential for cumulative effects on nesting or resident farmland or woodland species (the typical landscape characters). Species such as robin may be affected cumulatively by further loss of hedgerows due to farming practices, etc. Even though cumulative land take is unlikely to result in range loss of any species which frequent the subject site, mitigation may be required to neutralise the effect of the Proposed Development.

Disturbance or effective habitat loss (indirectly caused by disturbance) is more difficult to quantify, especially as most species of birds may habituate to disturbance over time.

Direct effects on avifauna during operation which may be cumulatively added to by other existing pressures or Proposed Developments include collision related mortality, ongoing disturbance/displacement, and barrier effect. Flight height, or the flight heights which birds habitually use along either migration or local flight paths, is an influencing factor in determining whether the Proposed Development will combine with additional wind farms to produce additive, synergistic or antagonistic effects. These effects include increased Barrier Effect (potentially obstructing migratory flightpaths), increased collision risk (through combined mortality in susceptible species) and increased disturbance to birds utilising foraging grounds whilst on migration.

7.5.6.2.2 Agriculture

Land management practices in the wider area which are considered in combination with the effects of the Proposed Development are agriculture and forestry. It is proposed that all agricultural activities within the planning boundary will cease for the duration of the construction and commissioning phase. Agricultural activities within the wider Study Area will continue and will be separated from construction activities by appropriate stock proof fencing. Agriculture has been identified as a pressure for waterbodies in the Figile sub-catchment, including those located downstream of the Proposed Development. Agriculture in this subcatchment can produce elevated levels of sediment as well as diffuse phosphorus entering freshwater waterbodies. Excess phosphorus is a key concern to surface waterbodies. Diffuse phosphorus losses from agriculture are particularly difficult to manage as the sources do not occur uniformly in the landscape, but from ‘hot spots’, or critical source areas where runoff pathways connect phosphorus sources to rivers and streams. It takes only very small amounts of phosphorus to be lost, relative to the amounts used in agriculture, to cause a water quality problem. Cattle in the area may use watercourses as a source of water for drinking or as a crossing point during drier conditions. Unrestricted access of cattle to watercourses can potentially result in increases in the levels of organic nutrients found in surface waters and can alter habitats as a result of access and impact water quality by way of faecal contamination. The Proposed Development is assessed as having likely, short-term, moderate negative cumulative effect on water quality in combination with the surrounding agriculture in the environs, without mitigation measures. In the absence of suitable mitigation measures with regards to protection of water quality during the lifetime of the Proposed Development , but in particular during the construction phase, there is potential for significant cumulative water quality effects as a result of the proposal in-combination with agricultural activity in the surrounding area. However, the implementation of water quality mitigation measures and other measures designed to protect surface waters as detailed in Section 6.5.2 will prevent significant effects arising as a result of the proposal and therefore, significant cumulative effects in-combination with agriculture are not likely to occur.

7.5.6.4.3 Cumulative Collision Risk (Operational Phase)

Potential cumulative effects in terms of collision risk are unlikely to exceed the highest effect magnitude (Longterm Slight effects) identified for the Proposed Development and the other wind farms in the surrounding region discussed above. There is potential for cumulative Long-term Moderate effects at County scale to whooper swans migrating through the region at night during spring and autumn prior to mitigation.

7.5.6.4.4 Cumulative Disturbance/Displacement/Barrier Effect (Operational Phase)

Potential cumulative effects in terms of disturbance/displacement are unlikely to result in significant cumulative effects at regional or national level. There is potential for Long-term Not significant to Slight cumulative effects at local level due to the proximity of surrounding existing wind farms.

7.6.3 Mitigation Measures During the Operational Phase of the Project

7.6.3.1 Turbine Lighting

Turbine lighting will be designed to minimise attraction of nocturnal migrants and insects. White lights will not be used. Where required by the Irish Aviation Authority, turbines will be fitted with medium-intensity fixed red obstacle lights (2000 candelas), equipped with baffles to direct light skyward and reduce ground-level visibility.

7.6.3.2 Activity and Collision Monitoring

While no potential significant operational effects have been identified above local level, to ensure that the operational phase of the Proposed Development does not result in significant adverse effects on ornithological receptors, a comprehensive post-construction monitoring programme will be implemented. This programme is designed to assess the efficacy of mitigation measures, detect any unforeseen impacts, and inform adaptive management strategies

7.6.3.3 Nocturnal Migration Monitoring and Curtailment

The collision risk assessment concluded that no species were predicted to experience significant collision mortality under the proposed turbine layout and operational parameters. This conclusion was based on low predicted collision rates, high species-specific avoidance rates, and the spatial distribution of flight activity relative to turbine locations.

Appendix 07-1 Baseline Ornithology Report Year 1.pdf
Appendix 07-2 Baseline Ornithology Report Year 2.pdf
Appendix 07-3 Additional VP results years 3-4.pdf
Appendix 07-4 Flight path observations years 3-4.pdf
Appendix 07-5 Winter 2024-25 Transect survey results.pdf
Appendix 07-6 Hen Harrier Roost Survey Report.pdf
Appendix 07-7 Whooper Swan Report.pdf
Appendix 07-8 Collision Risk Model Report.pdf

Birds Survey data of bird species and an analysis in relation of the results is set out in the EIAR. The potential effects of the Proposed Development are then described in terms of the construction, operation and decommissioning phases of the development. It is acknowledged that the Proposed Wind Farm will likely give rise to a measurable reduction in the distribution and abundance of birds locally within the site.

8.3 Baseline Environment

8.3.1 Site Location and Description

The site of the Proposed Development is located in a rural area of east Co. Offaly. The site is approximately 4km west of the Edenderry town boundary and 24km east of Tullamore. The Proposed Wind Farm is within the townlands of Ballinla, Ballybrittan and Leitrim in the municipal district of Edenderry, Co. Offaly. The Proposed Development red line boundary includes a total land area of approximately 42ha. The existing land cover at the site is a mix of agricultural land and coniferous forests.

The Grand Canal is to the north of the Proposed Development, approximately 500m from the nearest Turbine. The majority of the main development site consists of pastures while the more elevated areas of the site are composed of coniferous forest, which are owned and managed by forestry companies. The surrounding land includes some pastures and lands principally occupied by agriculture. The lands within the site of the Proposed Development are owned by a number of different private landowners and one semi state body. Primary access to the main development site will be provided from the local public road linkage (L5010) between the L-5006 in the east and the R400 to the west. The Proposed TDR will include development in the townlands of Leitrim, Ballyfore Big, Ballyleakin, and Ballina (Geashill By) Co. Offaly. The Proposed Grid Connection is approximately 8km and is located along road networks within the townlands of Lumville, Clarkville, Ballyfore Little, Griffinstown and Ballycullane

8.3.2 Topography

The topography of the Proposed Wind Farm is generally flat with minor slopes. The ground level ranges from approximately 80m AOD to 92m AOD.

8.3.3 Soil, Subsoil and Geology

The soils and geology at the site of the proposed development are summarised as follows:

• The soils beneath the majority of the site are mapped by Teagasc (Teagasc, 2025) as predominately peat (Basin Peats, Blanket Peats (some)' (IFS Soil Code: Cut), 'Grey Brown Podzolics, Brown Earths (mediumhigh base status)' (IFS Soil Code: BminDW), 'Surface water Gleys, Ground water Gleys' Mineral Mainly Poorly Drained (IFS Soil Code: BminPD) and 'Peaty Gleys' (IFS Soil Code: BminPDPT) and localised areas of fine loamy drift.

• The subsoil or quaternary sediments beneath the Proposed Wind Farm are mapped by the GSI (GSI, 2024) as primarily cut over raised peat (GSI, 2025) and limestone derived till along the Proposed Grid Connection.

• The bedrock beneath the site is mapped by the GSI (GSI, 2025) as the Edenderry Oolite Member (New Code: CDEDEN) described as visean limestone and calcareous shale. The Proposed Grid Connection crosses through a geological contact with limestone of the Lucan formation where the L5006 come in close proximity to Ballykillen Hill.

• There are no karst features mapped by the GSI (GSI, 2024) at the site or within a 2km radius of the site.

8.3.5 Hydrogeology

8.3.5.1 Site Hydrogeology and Groundwater Levels

Ground investigations, in the form of peat probing and soakaway testing, were completed for portions of the Proposed Development area by Ground Investigations Ireland (GII) during August 2024 and September 2024 (GII, 2024), (refer to EIAR Volume III, Appendix 8-1). The ground investigations in the northern section of the Proposed Wind Farm included the excavation of eight soakaway pits to a maximum depth of 2.1m below ground level (mbGL), logging of soils encountered, and preparation of a factual report. The ground conditions encountered are summarised as follows:

• Topsoil was encountered from ground level to depths typically ranging from 0.2mbGL to 0.35mbGL.

• Gravelly CLAY and SAND with low cobble content was encountered between 0.35mbGL and the final depth of excavation at 2.1mbGL.

• Groundwater was encountered as seepage at a depth of 2.0mbGL in trial pit SA06 only.

• Soakaway testing for the site concluded that four of the eight testing locations failed with the remaining returning an f value ranging between 1.188E-05 m/s and 7.475E-06 m/s. It was subsequently concluded that the site was unsuitable for discharge to ground. In the southern section peat probes were carried out in the peat subsoils of the southern section. Refusal of the probe was at depths ranging from 0.27m to 4.04m

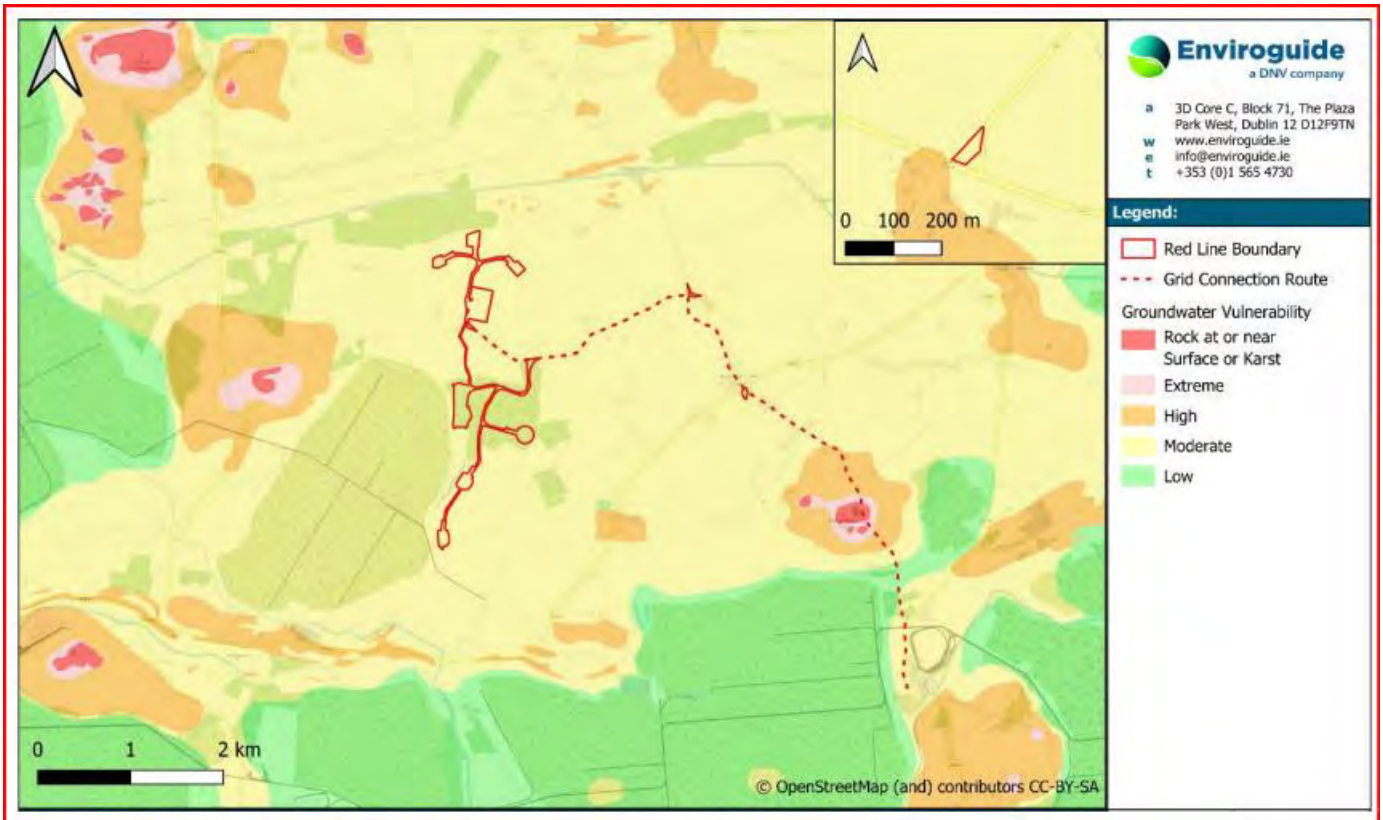


Figure 8-4: Groundwater Vulnerability

8.3.7 Flood Risk

A flood risk assessment (FRA),refer to EIAR Volume III, Appendix 8-2, developed by MWP (MWP, 2025), assessed the potential flood risk associated with fluvial, groundwater, coastal and pluvial flooding for the site and Proposed Development. A summary of the main findings of this FRA is as follows.

• The report was prepared in the context of The Planning System and Flood Risk Management – Guidelines for Planning Authorities, November 2009 (PSFRM), published by the Office of Public Works and the Department of Environment, Heritage and Local Government.

• The Proposed Development includes for the construction of seven turbines, hardstands, foundations, access tracks, internal underground connector cable, substation, LiDAR station, felling areas and ancillary development.

• The Stage 1 and 2 flood risk assessments indicated that there is potential for flooding at this site. The potential source of flooding was identified as fluvial flooding from the Leitrim watercourse and the Lumville watercourse.

• In particular, the NIFM published flood extents which indicate that this site may be vulnerable to flooding.

• A Stage 3 Detailed FRA was carried out to assess flood risk issues in sufficient detail to provide a quantitative appraisal of potential flood risk to the site.

• There are no flow records available for the Leitrim watercourse and the Lumville watercourse. The IH124 flood estimation method was selected as the most appropriate flood estimation method to calculate the flood flows for catchments.

• In order to predict the flood extents and flood levels at the site, a combined 1D-2D hydraulic model was created using HEC-RAS river modelling software.

• The model was used to create a flood zone map of the existing site which indicates the extent of Flood Zones A and B. Areas of the site outside of these Flood Zones are in Flood Zone C.

• Flood mapping indicates that the proposed substation is located within Flood Zone B. **Turbine 1 is located in Flood Zone B which has a moderate probability of flooding (0.1% to 1% probability (between 1 in 100 and 1 in 1,000) for river flooding**. The remaining six turbines are located in Flood Zone C which has a low probability of flooding (less than 0.1% annual exceedance probability or 1 in 1000).

• To ensure that there is no unacceptable flood risk, the following mitigation measures are recommended: o The design flood level for the proposed substation is the 0.1%AEP Mid-Range Future Scenario (MRFS) flood level plus 500mm freeboard. The design flood level for the proposed seven turbines is the 1%AEP MRFS flood level plus 500mm freeboard

It was concluded that, once the proposed mitigation measures are implemented, the Proposed Development will not have an adverse impact on flooding elsewhere.

Residual risks associated with the development were also assessed and are considered to be acceptable.

8.3.8 Water Supply and Drinking Source Protection

A search of the GSI groundwater well database (GSI, 2025) was conducted to identify registered wells and groundwater sources in the surrounding area. There are twenty-two (22) groundwater sources recorded at the Proposed Development or within a 2km radius of the Proposed Development.

8.5.2 Operational Phase

The operational phase of the Proposed Development will consist of up to seven wind turbines and associated infrastructure. The wind farm is designed for a 35-year operational lifespan. Surface water will be managed in line with SuDS principles, ensuring water is treated and attenuated before being discharged offsite. The surface water management system installed during construction will remain in place and be maintained throughout the operational phase. Further details are provided in Chapter 3: Civil Engineering. There will be no direct discharges to watercourses. Instead, clean water drains will discharge into channels aligned with natural ground contours. These channels will act as weirs, dispersing flow across vegetated areas to promote infiltration and reduce runoff velocity. During operation, maintenance personnel will infrequently visit the substation. On days when maintenance occurs, an average of two workers is expected on site, generating approximately 100l of wastewater per day. This wastewater will be collected in a twin-hull holding tank equipped with a level alarm. The tank will be emptied by a licensed contractor and the contents treated at an authorised facility. Potable water use is estimated at 50l/d and will be supplied via bottled water. Rainwater harvesting will support wastewater facilities at the substation compound. The power generation process will not produce emissions or pollutants. Operational waste is expected to be minimal and may include lubricating oils, cooling fluids, and packaging from spare parts. Hazardous materials will be handled and disposed of by approved contractors in accordance with the Waste Management (Hazardous Waste) Regulations, 1998. All other waste will be removed from site and either reused, recycled, or disposed of at authorised facilities following best practice.

8.6.1.4 Accidental Spills and Leaks – Water Quality

During construction, there is the potential , the groundwater vulnerability will temporarily be increased and there will be an increased risk to the underlying bedrock aquifer due to any accidental release of deleterious materials (e.g., fuels or other hazardous materials being used onsite), through the failure of secondary containment or a materials handling accident at the Site, to exposed granular subsoils or bedrock creating a direct pathway to the underlying bedrock aquifer. Furthermore, in productive fissured bedrock areas like the Rhode, GWB, there is a high degree of interconnection between groundwater and surface water. In a worst-case scenario, and in the absence of mitigation, the release of contaminants used onsite could enter the underlying aquifer and rapidly migrate towards receiving watercourses including the Leitrim Stream, the Kinnafad Stream, the Figile River and downstream waterbodies.

8.6.1.6 Flood Risk

During the construction phase, there is a potential risk that flood events, particularly those associated with intense or prolonged rainfall, could mobilise pollutants present onsite. These pollutants may include suspended sediments, hydrocarbons, cementitious materials, and other deleterious substances associated with construction activities. Floodwaters can act as a transport mechanism, carrying these contaminants offsite and into nearby surface waterbodies resulting in a temporary deterioration in water quality due to contaminant mobilisation and increased sedimentation.

8.6.2.4 Accidental Spills and Leaks – Water Quality

Lubricating and cooling oils required for the operation and maintenance of the Proposed Development will be stored and handled in accordance with the site's operating plan. Underground cables are not expected to require maintenance during the operational phase. However, in the unlikely event of a hazardous material release, such as a failure of secondary containment or a materials handling accident, deleterious substances could infiltrate the underlying groundwater or migrate offsite via surface water drainage.

The assumptions in this chapter give reasons for concern. Blades decompose & have to be cleaned to remove detritus regularly. These mechanisms deposit deleterious materials, chemicals & detritus onto the ground surface. With up to 500mm of flooding across the site & with 22 groundwater sources & in the area of a geological fault, contamination of groundwater sources cannot be ruled out. This must be read in the context of periodic visits to the site.

Hydrology and Hydrogeology There are several private Water Supply schemes in the area, which source their water from both the bedrock aquifers. No hydrogeological assessment has been completed in relation to each of these sources, based on groundwater levels, aquifer types, hydraulic gradients and distances involved. Several activities will take place at the Proposed Wind Farm site, some of which will have the potential to significantly affect the hydrological/hydrogeological regime or water quality at or downstream of the Proposed Wind Farm site. These significant potential effects generally arise from sediment input from runoff and other pollutants such as hydrocarbons and cement-based compounds.

The application omits reference of a geological fault crossing the site which in association with a karst conduit, if one existed near the development, could create an impact on groundwater flows.

The application has not adequately assessed this risk or proposed measures to reduce the risk. The submitted EIAR does not adequately assess the potential impacts of the proposed development on groundwaters, private and public water sources and groundwater recharge.

Appendix 08-1 Peat Probing and Soakaway Results.pdf

The Peat probes indicate ground levels between 69-74m, However Clause 8.3.2 Topography, indicates levels between 80-92mOD.

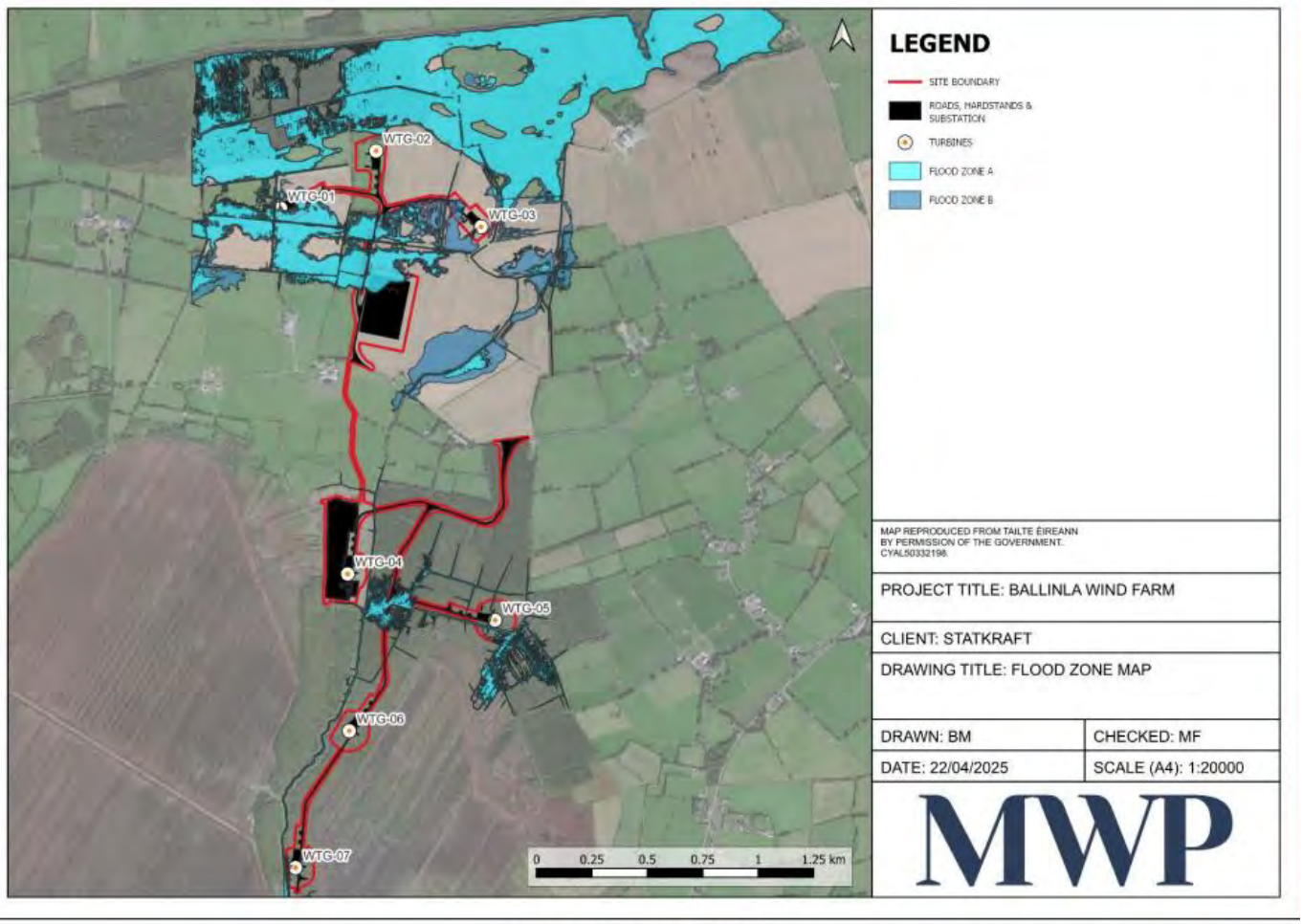


Figure 5-2: Flood Zone Map

5.4 Post Development Scenario

The post-development situation includes for the proposed substation, turbine hardstands, access tracks and turning heads. The hydraulic model was adjusted to include the proposed access track alignment and hardstands. This involved adjusting the DTM to include new internal site access tracks and 7 No. Wind Turbine foundations and Hardstand areas. **The DTM was raised by 600mm above existing ground levels at locations where the access tracks and hardstands are proposed**. The revised DTM of the model is indicated on below Figure 5-3.

The changes to the flood extents are highlighted on Figure 5-4 below. There is an increase in flood extent east of Turbine 4 .

The increase in flood extent is outside the proposed development site boundary. The increase in flood extents occurs in lands used for forestry. The impact of the proposed development on flood levels is mapped on Figure 5-5 below for the 0.1% AEP event, as this provides a slightly more conservative value when compared to the 1% AEP MRFS. There is no difference in water surface elevation for the proposed development. However, there is a localised area west of Turbine 5 which indicates an increase in water surface elevation of approximately 20mm. This afflux can be attributed to the proposed access track which intersects the floodplain at this location. However, the afflux as a result of the proposed access track is well within the 300mm, which is a recommendation of the OPW for land affected by the construction of a bridge/culvert and at locations where properties are not at risk of flooding. The flood levels upstream and downstream of the proposed development site will not be adversely affected. Figure 5-6 below shows the existing and proposed flow hydrograph downstream of Turbine 7. As can be seen, there is no appreciable difference in hydrograph shape and the peak flow passed downstream is unchanged. Therefore, it is concluded that the proposed development will not adversely impact flood risk elsewhere.

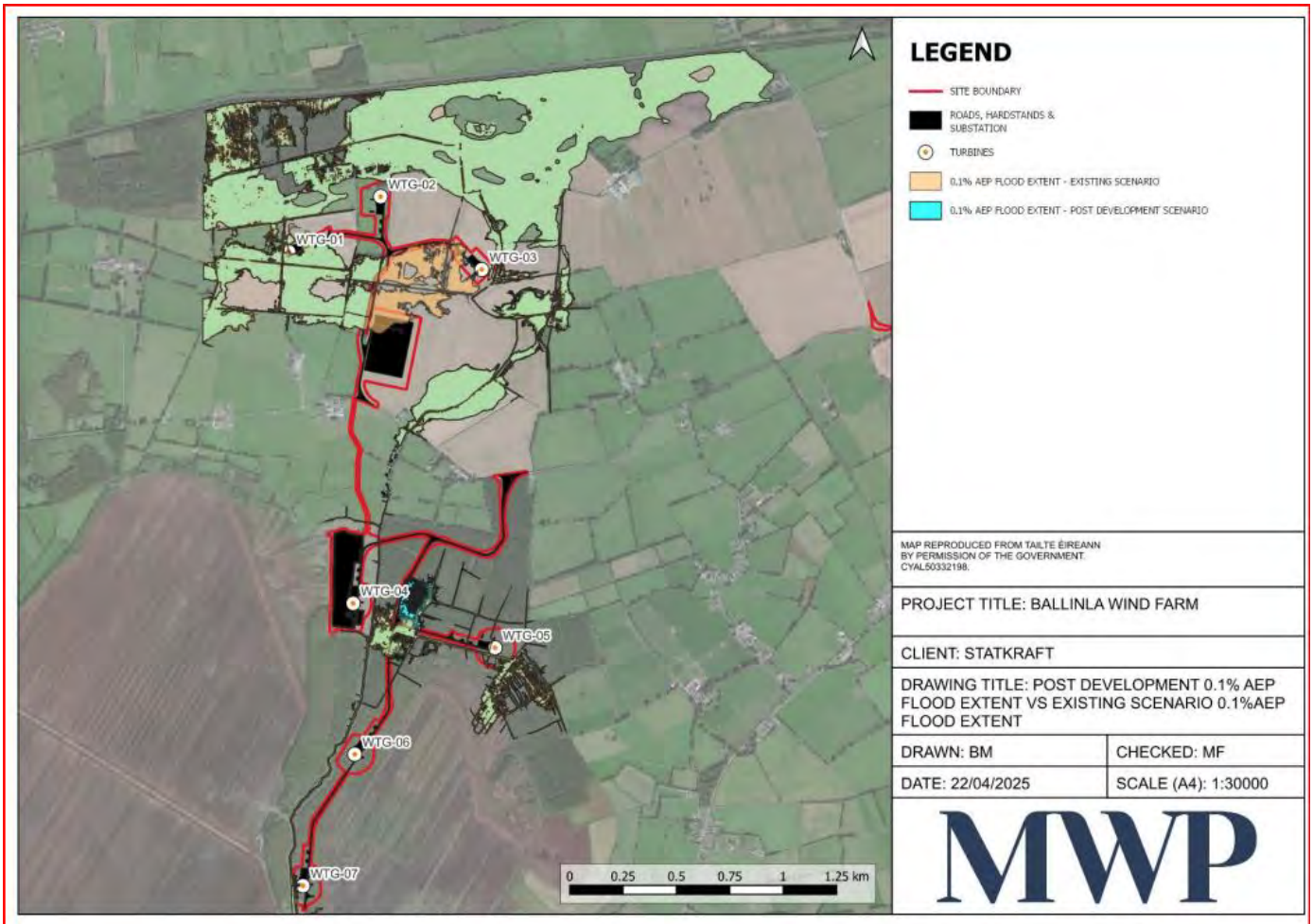
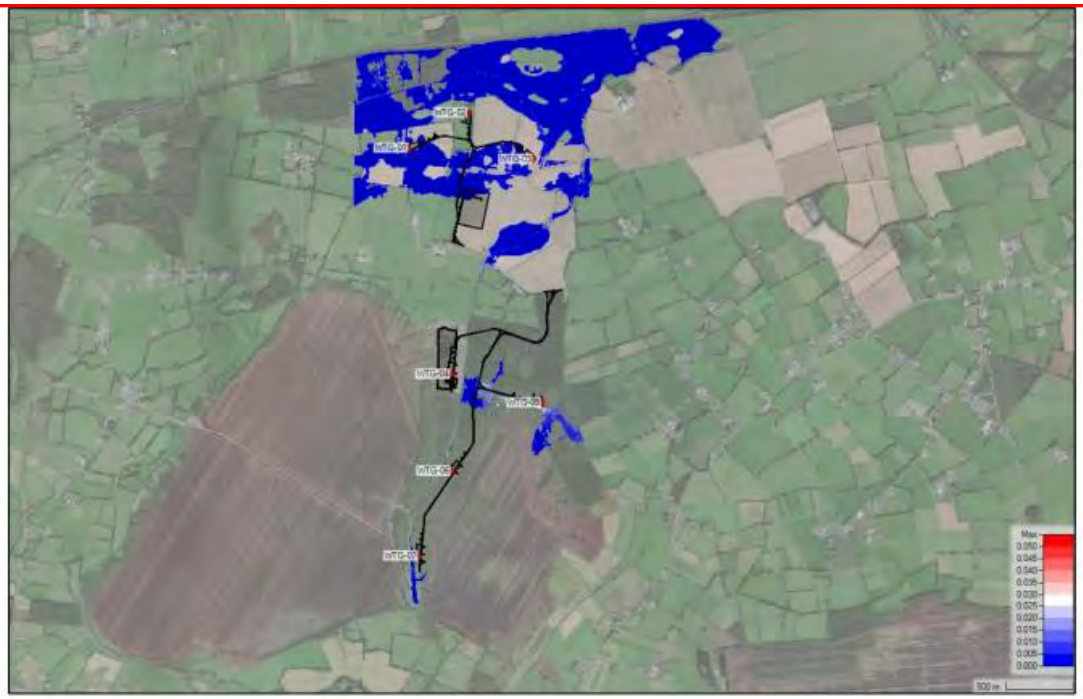


Figure 5-4: Post Development 0.1%AEP Flood Extent vs Existing Scenario 0.1%AEP Flood Extent



igure 5-5: Post Development 0.1%AEP Water Surface Elevation vs Existing Scenario 0.1%AEP Water Surface Elevation

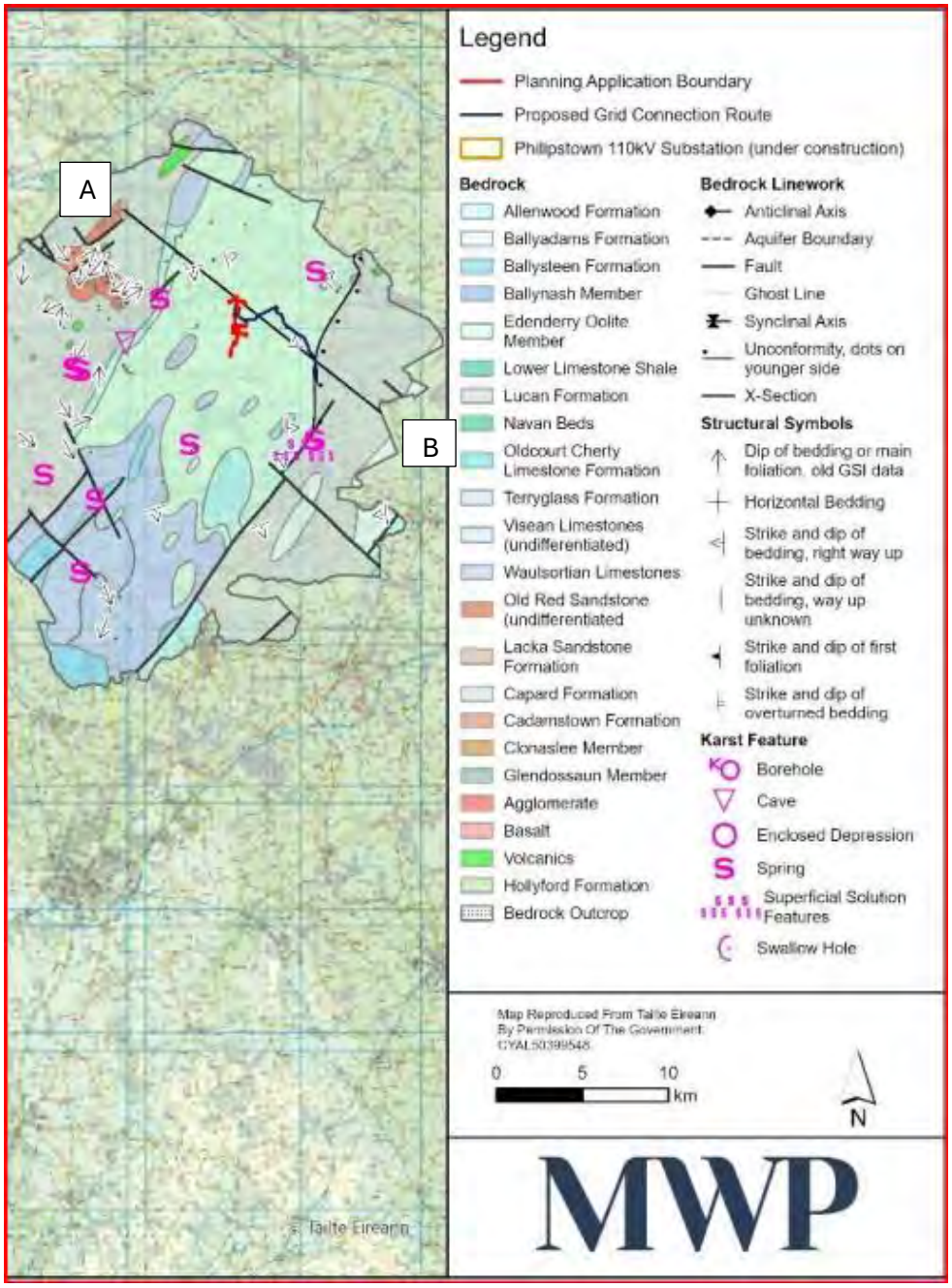
It seems that the lands to the east of the windfarm will be subject to future floods as a result of the windfarm development. No consent was sought or provided for such flooding.

4.6 Drinking Water

The river drinking water protected areas (DWPA) are represented by the full extent of the WFD river waterbodies from which there is a known qualifying abstraction of water for human consumption as defined under Article 7 of the WFD. The Figile_040 waterbody is identified (EPA, 2024) as a drinking water river supplying the Clonbulloge PWS, under Article 7 of the WFD. The Figile_040 is located approximately 1.4km downstream of the Proposed Wind Farm and 0.25km from the Proposed Grid Connection. It is noted that the watercourse draining the Proposed Wind Farm (Leitrim Stream) confluences with the Figile River approximately 50m downstream of the Clonbulloge WTP.

9.3.3 Topography

The site is described as being mostly flat land with one gentle slope in the area of the substation. The elevations range from **69.5m to 78.6m AOD.**



Note Fault line A-B passing through the site

9.3.11 Spoil Deposition Area

Within the Proposed Wind Farm, there is one permanent spoil deposition area located in a commercially forested area that will be cleared to accommodate T4, this area will be used for surplus excavated material generated during construction. The area is proposed to hold 86,600m3 of material and will raise the ground level at the area by 2m. The spoil deposition area will have an engineered slope, so that peat slippage will not occur. The engineered slope will encircle the area to contain the peat and other subsoils used within the berm. Once finished the deposition area will be allowed to revegetate naturally. The deposition area has been included in the Peat Stability Risk Assessment report in Appendix 9. The deposition area is fully outlined in MWP drawing number 23882-MWP-00- 00-DR-C-5035.

This change in contours could be the reason for flooding of lands to the east of the site.

Appendix 09 - Peat Stability Risk Assessment.pdf

10.3 Relevant Legislation, Policy and Guidance

The assessment of effects for the Proposed Development has been undertaken with reference to the most relevant guidance documents relating to environmental noise and vibration. The following guidance documents have been consulted when preparing this chapter of the EIAR:

• Department of the Environment, Heritage, and Local Government (DEHLG) Wind Energy Development Guidelines (hereafter referred to as WEDG (DEHLG, 2006),with cognisance of Draft Revised Wind Energy Development Guidelines 2019 Department of Housing, Local Government and Heritage (the draft Guidelines).

• World Health Organisation (WHO) Environmental Noise Guidelines for the European Region (2018).

The applicant may have consulted with the WHO Environmental Noise Guidelines but he does not accept their 37dBA threshold.

10.3.2.5 Operational Phase Noise – Wind Turbines

The noise assessment documented in this chapter is based on guidance in relation to acceptable levels of noise from wind farms as contained in the document Wind Energy Development Guidelines for Planning Authorities published by the Department of the Environment, Heritage and Local Government in 2006. These guidelines are in turn based on detailed recommendations set out in the Department of Trade and Industry (UK) Energy Technology Support Unit (ETSU) publication The Assessment and Rating of Noise from Wind Farms (1996). The ETSU document has been used to supplement the guidance contained within the Wind Energy Development Guidelines publication where necessary.

10.6.2 Operational Phase

10.6.2.1 Assessment of Wind Turbine Noise

Using the assessment methodology described in Section 10.4.5 the predicted cumulative turbine noise levels have been calculated at all NSLs within the study area of the Proposed Development. A worst-case omni-directional cumulative turbine noise prediction assessment has been carried out using the ISO 9613-2 calculation standard and best practice guidance for turbine noise prediction contained in the IOA GPG. These calculations are based on 'worst-case' conditions favourable to noise propagation, i.e., downwind propagation from source to receiver and/or downward refraction under temperature inversions.

The results of the cumulative noise prediction models have been compared against the turbine noise limits that have been assigned to each of the NSL's as presented in Section 10.5.2.1 which in turn have been derived in accordance with the criteria set out in Section 10.3.2.5. At all NSLs the worst cumulative omni-directional cumulative turbine noise levels are below the noise criterion curves, and at rated power at 11 m/s the highest predicted noise level is 41.9dB LA90, which is more than 1dB below the minimum 43dB night-time threshold, regardless of background noise levels. Appendix 10-8 presents the predicted cumulative omni-directional turbine results at all NSLs in tabulated form. Table 10-27 presents the result of the turbine noise predictions and assessment review at 13 no. locations with the highest levels of wind turbine noise predicted, at all other locations the maximum turbine noise levels are predicted to be <40 Db LA90. Noise contours for the omni-directional rated power wind speed (i.e., highest noise emission) are presented in Appendix 10-7

Table 10-27: Review of Predicted Turbine Noise Levels against Relevant Criteria

NSL ID	Details	Noise Level, dB LA90 at Standardised Wind Speed, m/s								
	Parameter	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
H010	Predicted	29.9	30.8	35.0	39.2	40.6	40.8	41.0	41.3	41.4
	Daytime Criterion	40	40	40	40	45	45	45	46.3	50.7
	Daytime Excess	--	--	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43	44.7	47.8
	Night-time Excess	--	--	--	--	--	--	--	--	--
H019	Predicted	29.9	30.8	35.0	39.2	40.6	40.8	41.0	41.3	41.4
	Daytime Criterion	40	40	40	40	45	45	45	46.3	50.7
	Daytime Excess	--	--	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43	44.7	47.8
	Night-time Excess	--	--	--	--	--	--	--	--	--
H030	Predicted	29.8	30.7	35.0	39.2	40.6	40.7	40.9	41.3	41.4
	Daytime Criterion	40	40	40	40	45	45	45	46.3	50.7
	Daytime Excess	--	--	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43	44.7	47.8
	Night-time Excess	--	--	--	--	--	--	--	--	--
H089	Predicted	29.5	30.4	34.6	38.9	40.2	40.4	40.6	41.0	41.1
	Daytime Criterion	40	40	40	40	45	45	45	46.3	50.7
	Daytime Excess	--	--	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43	44.7	47.8
	Night-time Excess	--	--	--	--	--	--	--	--	--
H163	Predicted	29.8	30.7	35.0	39.2	40.6	40.8	40.9	41.3	41.4
	Daytime Criterion	40	40	40	40	45	45	45	46.3	50.7
	Daytime Excess	--	--	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43	44.7	47.8
	Night-time Excess	--	--	--	--	--	--	--	--	--
H210	Predicted	28.7	31.7	36.0	39.5	40.3	40.4	40.4	40.4	40.4

	Daytime Criterion	40	40	40	40	45	45	45	46.3	50.7
	Daytime Excess	--	--	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43	44.7	47.8
	Night-time Excess	--	--	--	--	--	--	--	--	--
H248	Predicted	30.4	31.2	35.5	39.7	41.1	41.3	41.5	41.8	41.9
	Daytime Criterion	45	45	45	45	45	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--	--	--
H320	Predicted	28.7	31.7	36.0	39.5	40.4	40.4	40.4	40.4	40.4
	Daytime Criterion	40	40	40	40	45	45	45	46.3	50.7
	Daytime Excess	--	--	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43	44.7	47.8
	Night-time Excess	--	--	--	--	--	--	--	--	--
H447	Predicted	29.9	30.9	35.1	39.3	40.7	40.9	41.0	41.4	41.5
	Daytime Criterion	40	40	40	40	45	45	45	46.3	50.7
	Daytime Excess	--	--	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43	44.7	47.8
	Night-time Excess	--	--	--	--	--	--	--	--	--
H461	Predicted	28.7	29.7	33.9	38.1	39.5	39.7	39.8	40.2	40.3
	Daytime Criterion	40	40	40	40	45	45	45	46.3	50.7
	Daytime Excess	--	--	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43	44.7	47.8
	Night-time Excess	--	--	--	--	--	--	--	--	--

Description of Effects

The predicted cumulative noise levels associated with the Proposed Development are within best practice noise criteria recommended in the Irish guidance 'Wind Energy Development Guidelines for Planning Authorities' (2006), therefore it is not considered that a significant effect is associated with turbine noise from the Proposed Development. While noise levels at low wind speeds will increase due to the development and specifically the operation of the turbines, the predicted levels will remain low, albeit new sources of noise will be introduced to the soundscape.

10.6.5.2 Wind Turbine Noise

Existing permitted and proposed wind farm developments with the potential for cumulative impacts have been considered as part of the turbine noise impact assessment. A review of existing, proposed and permitted wind turbine developments in the wider study has been undertaken in accordance with the guidance contained in the IOA GPG, as outlined in Section 10.4.5.4. A cumulative wind turbine assessment has been scoped in for Cloncreen Wind Farm and Mount Lucas Wind Farm as the contributions from these wind farms and the results have been presented in Section 10.6.2.1. All other wind farm turbines at distances greater than 5km from the Proposed Development are more than 10dB below the lowest turbine noise limit and therefore have not been included in the cumulative assessment.

10.7 Mitigation and Monitoring Measures

The assessment of potential effects has demonstrated that the Proposed Development is expected to comply with the identified criteria for the construction, operational and decommissioning phases of the project and therefore no specific mitigation measures are required. However, to ameliorate any potential noise effects that may present during the Proposed Development, a schedule of noise control measures has been formulated.

10.7.1.2 Operational Phase Wind Turbine Noise

An assessment of the operational turbine noise levels has been undertaken in accordance with best practice guidelines and procedures as outlined in Section 10.3.2.5 of this Chapter. A review of other wind turbine developments in accordance with the IOA GPG guidance has confirmed that the cumulative contribution of turbine noise from other sites, namely Cloncreen Wind Farm and Mount Lucas Wind Farm could be scoped in to the cumulative assessment, but all other windfarms at a distance greater than 5km could be scoped out as they are not significant. The findings of the cumulative assessment confirmed that the predicted operational noise levels from the Proposed Development will be within the relevant best practice noise criteria. Therefore, no specific mitigation measures are required. If alternative turbine models within the proposed specifications are considered for the Proposed Development, an updated noise assessment will be prepared to confirm that the noise emissions will comply with the noise criteria as per best practice guidance outlined in Section 10.3.2.5 and/or the relevant operational criteria associated with the grant of planning for Proposed Development.

Amplitude Modulation

In the event of a complaint which indicates potential AM associated with turbine operation, the operator will employ a qualified acoustic consultant to assess the level of AM in accordance with the methods outlined in the IOA Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) namely, Institute of Acoustics IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group Final Report: A Method for Rating Amplitude Modulation in Wind Turbine Noise (9 August 2016) or subsequent revisions.
The measurement method outlined in the IOA AMWG document, known as the 'Reference Method', will provide a robust and reliable indicator of AM and yield important information on the frequency and duration of occurrence, which can be used to evaluate different operational conditions including mitigation. These mitigation measures, if required, will consist of the implementation of operational controls for the relevant turbine type, which will include curtailment of turbines under specific operational conditions. In the absence of widely accepted and robust planning conditions to control amplitude modulation (AM) from wind turbines, the commitments outlined in this EIAR are considered best practice. The proposed approach will ensure that any negative impacts arising from AM associated with the operation of the Proposed Development will be effectively addressed by the operator.

Table 10-30: Residual Effects

Stage	Potential Effect	Pre-Mitigation Impact	Pre-Mitigation Significance of Effect	Mitigation Measures	Post-Mitigation Impact	Residual Effect
Operational	Wind Turbine Noise	Negative, not significant and long-term	Not Significant	Refer to Section 10.7.1.2	Negative, not significant and long-term	Not Significant
Operational	Fixed Plant Noise	Negative, not significant and long-term	Not Significant	Refer to Section 10.7.1.2	Negative, not significant and long-term	Not Significant

Appendix 10-1 Glossary of Acoustic Terms.pdf

Appendix 10-2 Cumulative Screening.pdf

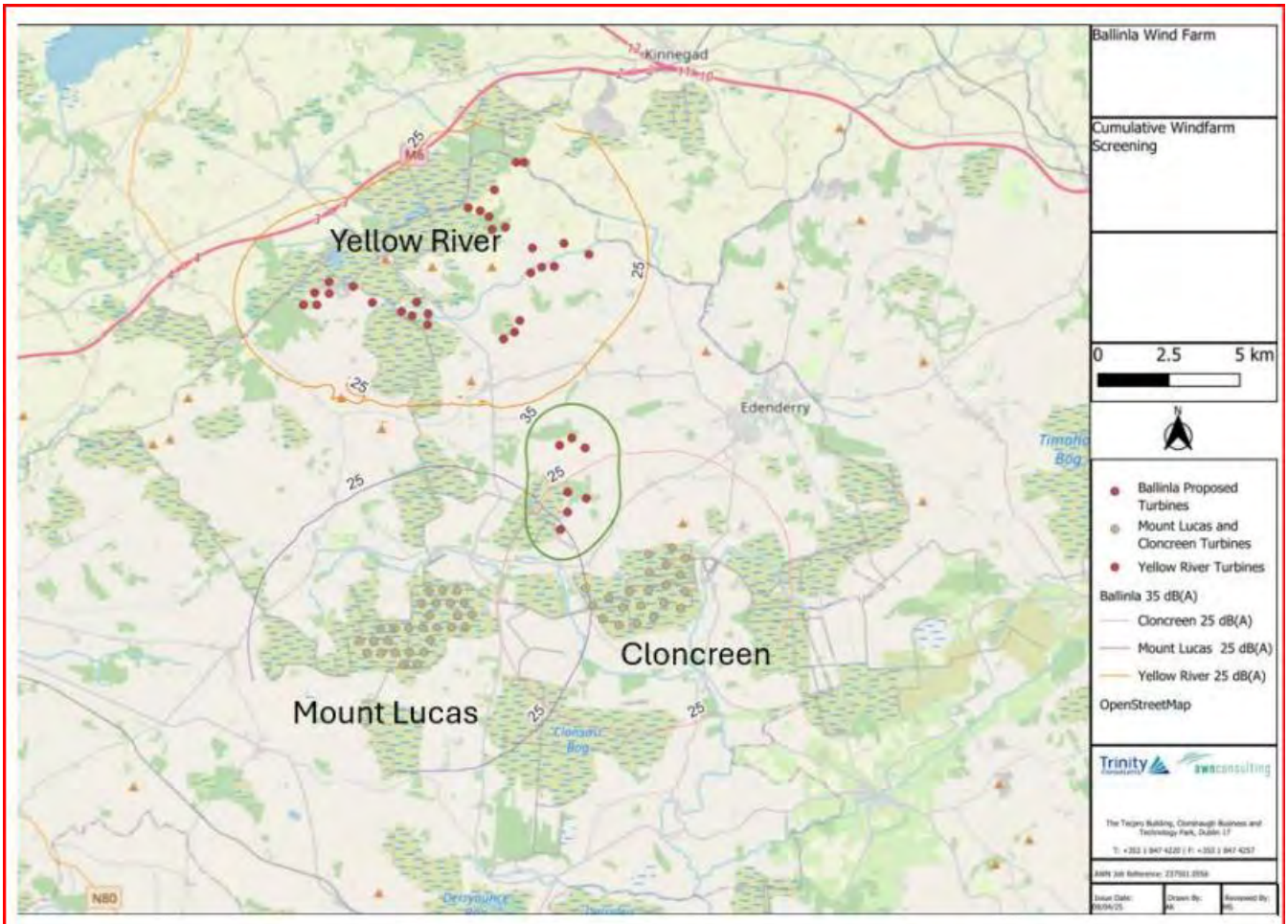


Figure 1: 35 dB L_{A90} contour for the Proposed Development (in green) and 25 dB L_{A90} contours from surrounding wind farms.

Figure 1 presents the 25 dB LA90 contours for each of the wind farms listed above, along with the 35 dB contour for the Proposed Development. It can be seen that the contours for Yellow River are separated from the 35 dB contour for the Proposed Development, therefore it is not necessary to include these wind farms in the cumulative noise modelling. The contour for Mount Lucas and Cloncreen wind farms clearly intersects the 35 dB for the Proposed Development, therefore there is a potential for cumulative turbine noise impacts with these wind farms and they have been included in the cumulative noise modelling calculations for the Proposed Development.

Response: The 43dBA contour should be provided for all of the surrounding windfarms

Appendix 10-3 Calibration Certificates.pdf

Appendix 10-4 Sound Power Levels.pdf

No sound power levels are provided for Infrasound at less than 20Hz level

Appendix 10-5 Noise Model Parameters.pdf

Topographic Screening

In the IOA GPG, section 4.3.11 the following is stated: "Topographic screening effects of the terrain (ISO 9613-2, Equation 12) should be limited to a reduction of no more than 2 dB, and then only if there is no direct line of sight between the highest point on the turbine rotor and the receiver location." The modelling software takes account of these limitations on the degree of screening from terrain. The "valley correction" from section 4.3.9 of the IOA GPG is also applied where relevant.

At a consultation meeting on the 5/9/2025 with Statkraft, we were refused access to the modelling software. Such software is part of the lacunae for a planning application. Refusal of access to such software invalidates the application.

Appendix 10-6: 523 Number Noise Sensitive Locations in Study Area.pdf

APPENDIX 10-6 NOISE SENSITIVE LOCATIONS IN STUDY AREA

NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)	
	Easting	Northing		Easting	Northing		Easting	Northing
H001	655,494	732,751	H021	658,227	732,964	H041	654,203	732,473
H002	654,530	732,565	H022	659,081	730,236	H042	654,039	732,499
H003	655,318	734,147	H023	653,511	732,402	H043	658,900	730,152
H004	654,221	733,972	H024	655,656	734,224	H044	657,853	730,158
H005	655,230	734,084	H025	658,903	730,367	H045	655,522	732,752
H006	654,766	733,809	H026	654,195	730,602	H046	657,461	728,331
H007	653,407	732,725	H027	658,557	734,086	H047	654,182	727,434
H008	658,933	731,908	H028	658,767	730,760	H048	655,667	727,331
H009	656,995	727,744	H029	657,131	727,796	H049	657,781	732,617
H010	655,967	730,834	H030	656,379	730,576	H050	655,168	734,037
H011	658,974	730,224	H031	654,617	732,588	H051	653,877	730,552
H012	657,898	729,213	H032	653,416	732,688	H052	653,318	733,457
H013	659,008	730,333	H033	653,583	732,405	H053	657,739	729,952
H014	657,623	729,003	H034	654,270	733,807	H054	658,942	730,442
H015	653,377	732,295	H035	654,248	727,425	H055	658,005	734,123
H016	655,591	732,764	H036	657,693	732,749	H056	656,815	734,353
H017	658,234	733,985	H037	657,737	728,875	H057	653,963	730,553
H018	654,532	730,734	H038	659,035	730,195	H058	659,058	728,898
H019	656,416	730,540	H039	656,818	734,378	H059	658,805	728,725
H020	658,843	730,180	H040	659,779	732,387	H060	657,842	727,645

NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)	
	Easting	Northing		Easting	Northing		Easting	Northing
H061	655,473	730,744	H083	655,690	727,308	H105	659,506	732,202
H062	653,313	733,117	H084	656,731	733,915	H106	657,635	732,843
H063	655,303	732,741	H085	657,304	733,359	H107	657,740	729,918
H064	653,455	730,831	H086	657,710	732,718	H108	659,433	730,455
H065	653,520	733,631	H087	657,469	730,956	H109	657,332	733,100
H066	654,441	733,855	H088	658,932	730,248	H110	653,413	732,664
H067	655,386	734,138	H089	655,858	730,788	H111	653,686	732,426
H068	653,444	731,303	H090	658,800	730,133	H112	658,809	728,693
H069	653,409	733,583	H091	654,561	732,573	H113	657,785	729,215
H070	658,862	730,199	H092	653,373	732,656	H114	654,398	733,846
H071	653,415	732,643	H093	655,414	734,202	H115	658,817	728,804
H072	657,316	728,177	H094	653,439	733,599	H116	655,505	734,237
H073	657,277	727,340	H095	653,992	733,894	H117	657,410	727,381
H074	658,337	731,603	H096	653,538	733,649	H118	657,667	732,901
H075	659,147	732,610	H097	653,367	733,384	H119	656,961	727,366
H076	653,428	732,445	H098	659,104	731,941	H120	658,851	730,106
H077	657,617	732,984	H099	654,825	732,692	H121	654,865	734,028
H078	653,320	733,410	H100	658,917	730,231	H122	657,754	730,455
H079	658,814	728,658	H101	658,983	730,230	H123	653,323	733,389
H080	653,327	732,931	H102	657,870	729,753	H124	657,347	728,208
H081	657,658	728,818	H103	654,132	732,461	H125	657,391	733,555
H082	656,909	733,654	H104	657,250	727,762	H126	653,311	733,152

NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)	
	Easting	Northing		Easting	Northing		Easting	Northing
H127	653,950	732,408	H149	653,643	732,421	H171	655,772	732,807
H128	653,838	732,447	H150	656,082	733,110	H172	655,119	727,374
H129	654,106	733,919	H151	658,085	729,533	H173	657,865	730,129
H130	653,909	730,616	H152	653,409	731,133	H174	654,730	733,917
H131	657,882	730,281	H153	653,545	730,149	H175	657,440	728,217
H132	657,398	727,320	H154	654,515	733,866	H176	656,705	727,289
H133	658,501	729,861	H155	655,285	734,092	H177	655,977	732,993
H134	657,271	727,754	H156	653,449	730,885	H178	655,423	734,152
H135	654,035	727,418	H157	653,414	732,626	H179	654,328	732,569
H136	655,475	730,808	H158	657,840	732,637	H180	657,665	732,814
H137	656,607	734,324	H159	658,858	730,111	H181	653,327	733,513
H138	653,383	732,211	H160	659,259	730,094	H182	656,035	726,869
H139	659,355	733,708	H161	659,092	728,910	H183	658,061	732,335
H140	657,042	727,818	H162	657,275	731,954	H184	655,122	734,074
H141	655,717	734,236	H163	656,267	730,763	H185	658,927	730,499
H142	655,197	734,053	H164	659,822	732,496	H186	658,925	730,524
H143	653,327	733,513	H165	657,157	727,850	H187	654,803	732,637
H144	653,327	733,513	H166	658,911	730,174	H188	654,334	732,483
H145	653,349	731,908	H167	658,477	729,843	H189	653,950	732,408
H146	654,082	733,919	H168	657,506	732,986	H190	654,037	727,489
H147	659,002	728,855	H169	657,026	727,794	H191	655,359	733,896
H148	658,703	729,777	H170	656,613	733,408	H192	653,349	733,536

NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)	
	Easting	Northing		Easting	Northing		Easting	Northing
H193	653,886	731,825	H215	658,039	734,127	H237	659,034	728,878
H194	657,696	728,771	H216	658,943	730,191	H238	658,864	730,472
H195	658,783	731,882	H217	654,106	730,657	H239	658,078	729,709
H196	654,023	733,897	H218	653,362	732,700	H240	658,794	728,488
H197	653,721	732,426	H219	655,346	734,126	H241	657,870	729,753
H198	655,218	732,794	H220	654,940	733,993	H242	659,606	732,109
H199	654,998	733,968	H221	653,607	733,732	H243	654,052	733,915
H200	658,857	728,817	H222	654,545	727,362	H244	655,471	734,165
H201	655,343	732,778	H223	653,611	732,410	H245	655,493	734,079
H202	655,345	734,176	H224	657,372	732,996	H246	656,274	727,286
H203	653,166	731,452	H225	658,848	730,511	H247	657,040	733,558
H204	656,971	733,576	H226	656,701	734,002	H248	655,783	730,959
H205	655,334	734,055	H227	657,658	728,799	H249	655,715	727,231
H206	657,714	734,179	H228	653,378	732,238	H250	656,776	727,262
H207	658,370	733,974	H229	657,356	733,499	H251	655,174	730,757
H208	653,492	733,628	H230	653,456	730,859	H252	655,556	732,756
H209	657,885	730,419	H231	656,668	733,889	H253	654,996	732,674
H210	657,574	727,279	H232	657,789	732,584	H254	653,323	732,991
H211	656,669	733,916	H233	657,809	733,162	H255	657,284	728,131
H212	657,608	733,005	H234	653,434	732,381	H256	657,306	733,393
H213	654,037	732,441	H235	652,863	731,204	H257	658,990	730,364
H214	657,134	734,062	H236	658,973	730,383	H258	657,881	730,316

NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)	
	Easting	Northing		Easting	Northing		Easting	Northing
H259	654,296	732,499	H281	658,337	729,740	H303	654,706	727,305
H260	656,727	733,334	H282	657,694	729,454	H304	654,736	732,619
H261	655,438	730,784	H283	654,672	732,604	H305	653,317	733,433
H262	655,033	733,967	H284	658,967	728,762	H306	654,162	733,477
H263	655,624	734,213	H285	653,558	733,657	H307	658,894	730,219
H264	653,845	730,550	H286	655,899	732,932	H308	658,917	730,184
H265	655,573	734,198	H287	657,657	728,848	H309	655,244	732,800
H266	654,169	732,464	H288	657,332	727,328	H310	658,849	730,088
H267	658,956	730,408	H289	655,759	734,252	H311	658,006	729,341
H268	657,168	733,582	H290	658,077	734,131	H312	653,320	733,025
H269	657,973	729,303	H291	659,060	730,262	H313	654,425	732,532
H270	657,620	730,686	H292	653,389	731,282	H314	659,666	732,371
H271	657,570	732,929	H293	653,995	730,635	H315	659,536	732,872
H272	655,313	734,106	H294	655,433	732,785	H316	658,627	731,114
H273	655,160	734,074	H295	653,761	732,435	H317	657,242	728,053
H274	653,159	731,495	H296	654,832	732,642	H318	655,297	732,791
H275	653,331	733,365	H297	657,907	730,243	H319	655,132	734,019
H276	653,549	732,401	H298	654,100	732,455	H320	657,618	727,295
H277	657,599	733,027	H299	657,939	728,726	H321	654,186	727,524
H278	657,595	728,406	H300	655,495	733,659	H322	654,913	733,943
H279	656,700	733,972	H301	654,876	732,649	H323	658,786	728,795
H280	655,300	727,628	H302	655,050	732,828	H324	658,932	730,470

NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)	
	Easting	Northing		Easting	Northing		Easting	Northing
H325	658,677	730,045	H347	657,904	728,745	H369	657,645	728,888
H326	657,900	734,218	H348	654,363	732,577	H370	656,892	727,390
H327	654,644	732,595	H349	658,173	729,601	H371	653,959	730,623
H328	653,471	733,610	H350	655,076	734,051	H372	655,271	734,135
H329	658,050	732,352	H351	655,699	732,841	H373	657,912	729,713
H330	657,668	732,084	H352	657,897	730,199	H374	657,193	727,834
H331	654,116	727,501	H353	655,092	727,364	H375	657,557	734,130
H332	655,548	734,135	H354	656,663	733,948	H376	656,357	734,024
H333	655,042	734,039	H355	657,769	732,644	H377	653,227	731,326
H334	655,707	727,300	H356	658,715	728,726	H378	653,759	732,380
H335	654,453	732,540	H357	657,642	732,952	H379	654,589	732,581
H336	653,372	732,378	H358	657,875	730,342	H380	654,963	731,455
H337	659,370	732,628	H359	653,835	730,614	H381	659,955	732,586
H338	657,758	728,763	H360	659,617	730,506	H382	657,598	730,740
H339	653,417	732,706	H361	654,579	733,884	H383	657,688	730,671
H340	659,068	731,951	H362	655,676	732,779	H384	657,834	730,045
H341	654,489	727,442	H363	654,481	733,862	H385	658,828	728,595
H342	657,955	729,672	H364	655,523	732,812	H386	654,067	732,447
H343	658,716	729,908	H365	657,417	727,762	H387	653,555	730,468
H344	653,377	732,267	H366	657,589	730,810	H388	659,142	730,186
H345	653,392	731,852	H367	653,372	732,596	H389	654,774	732,629
H346	653,422	732,547	H368	658,074	732,317	H390	657,163	727,394

NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)	
	Easting	Northing		Easting	Northing		Easting	Northing
H391	653,869	732,460	H413	654,824	733,970	H435	656,923	727,379
H392	653,780	730,537	H414	656,669	733,857	H436	657,157	727,972
H393	655,755	732,860	H415	658,173	730,581	H437	655,411	730,734
H394	657,812	728,754	H416	654,996	734,019	H438	654,921	732,657
H395	657,730	728,840	H417	655,101	733,999	H439	653,262	730,601
H396	657,490	728,195	H418	653,965	732,482	H440	657,615	730,713
H397	656,782	733,819	H419	653,520	730,205	H441	657,842	730,184
H398	657,423	728,200	H420	654,014	732,433	H442	653,423	731,765
H399	653,534	730,180	H421	653,355	731,818	H443	654,263	730,623
H400	659,286	730,076	H422	657,317	731,895	H444	657,664	730,071
H401	654,704	733,912	H423	658,753	730,777	H445	657,660	730,051
H402	654,239	727,520	H424	657,601	727,693	H446	655,428	727,548
H403	653,416	732,605	H425	658,308	730,786	H447	656,531	730,466
H404	657,489	728,365	H426	653,374	732,126	H448	657,625	733,475
H405	656,668	733,808	H427	654,138	730,608	H449	653,705	730,527
H406	654,106	730,578	H428	654,517	732,620	H450	653,583	730,576
H407	655,629	727,348	H429	657,298	734,111	H451	658,824	730,156
H408	653,729	732,372	H430	657,283	728,032	H452	653,815	730,545
H409	655,261	734,083	H431	657,873	730,082	H453	655,433	732,736
H410	657,008	727,771	H432	654,678	733,904	H454	655,588	732,818
H411	654,357	730,609	H433	658,545	729,885	H455	653,369	733,490
H412	655,299	732,737	H434	653,417	732,564	H456	653,347	733,497

NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)		NSL ID	Co – Ordinates (ITM)	
	Easting	Northing		Easting	Northing		Easting	Northing
H457	653,349	733,536	H479	652,821	731,225	H501	653,541	727,471
H458	653,355	733,552	H480	655,848	732,864	H502	653,508	727,468
H459	657,794	730,008	H481	657,069	733,612	H503	653,430	727,492
H460	657,688	728,676	H482	655,070	733,980	H504	653,170	727,498
H461	656,897	730,503	H483	657,516	732,717	H505	653,174	727,575
H462	657,899	729,726	H484	653,326	732,958	H506	653,116	727,605
H463	657,008	727,346	H485	656,630	733,304	H507	653,084	727,610
H464	654,242	732,482	H486	653,795	732,443	H508	653,056	727,613
H465	653,904	730,574	H487	658,890	728,836	H509	653,028	727,616
H466	657,741	729,886	H488	658,845	731,883	H510	652,998	727,627
H467	654,341	733,863	H489	657,362	733,456	H511	652,894	727,569
H468	654,963	732,668	H490	654,001	727,420	H512	652,828	727,585
H469	658,955	730,266	H491	653,936	727,422	H513	652,774	727,631
H470	655,198	734,108	H492	653,894	727,332	H514	652,773	727,768
H471	653,334	732,557	H493	653,829	727,107	H515	652,756	727,868
H472	657,104	734,057	H494	653,759	727,143	H516	652,812	727,836
H473	657,339	730,801	H495	653,758	727,107	H517	652,818	727,867
H474	656,863	727,402	H496	653,858	727,457	H518	652,847	727,927
H475	654,222	730,660	H497	653,797	727,467	H519	652,877	727,952
H476	653,336	733,253	H498	653,746	727,464	H520	652,884	728,058
H477	659,031	730,302	H499	653,695	727,520	H521	652,729	728,245
H478	653,327	733,513	H500	653,656	727,526	H522	652,958	728,199
H523	652,918	728,282						

We checked the grid references for 5 of these sensitive receptors and the distances between turbines & houses have been exaggerated to a large extent, which decreases predicted noise levels. The corresponding noise levels are not reliable.

Appendix 10-7 Predicted Cumulative Noise Contour at 11ms.pdf

APPENDIX 10-7 PREDICTED CUMULATIVE NOISE CONTOUR

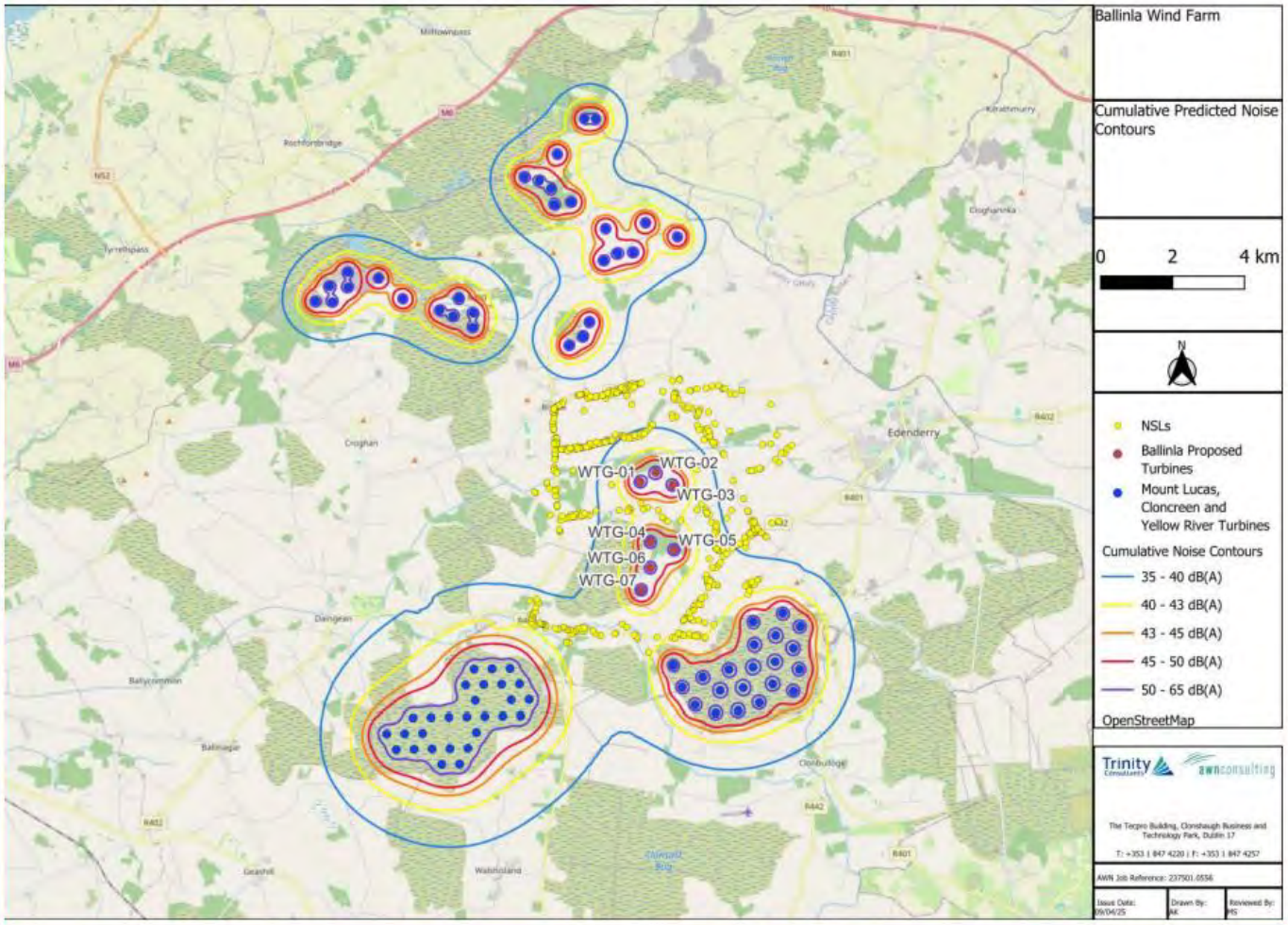


Table 2-1: Proposed Turbine Dimensions and Co-ordinates

Turbine Ref. No.	Hub Height	Blade Length	Turbine tip height (m)	Grid Co-ordinates (ITM)	
T1	104	79.35	185	655751 (X)	731543 (Y)
T2	104	79.35	185	656181 (X)	731802 (Y)
T3	104	79.35	185	656655 (X)	731460 (Y)
T4	104	79.35	185	656053 (X)	729897 (Y)
T5	104	79.35	185	656718 (X)	729689 (Y)
T6	104	79.35	185	656060 (X)	729191 (Y)
T7	104	79.35	185	655818 (X)	728575 (Y)

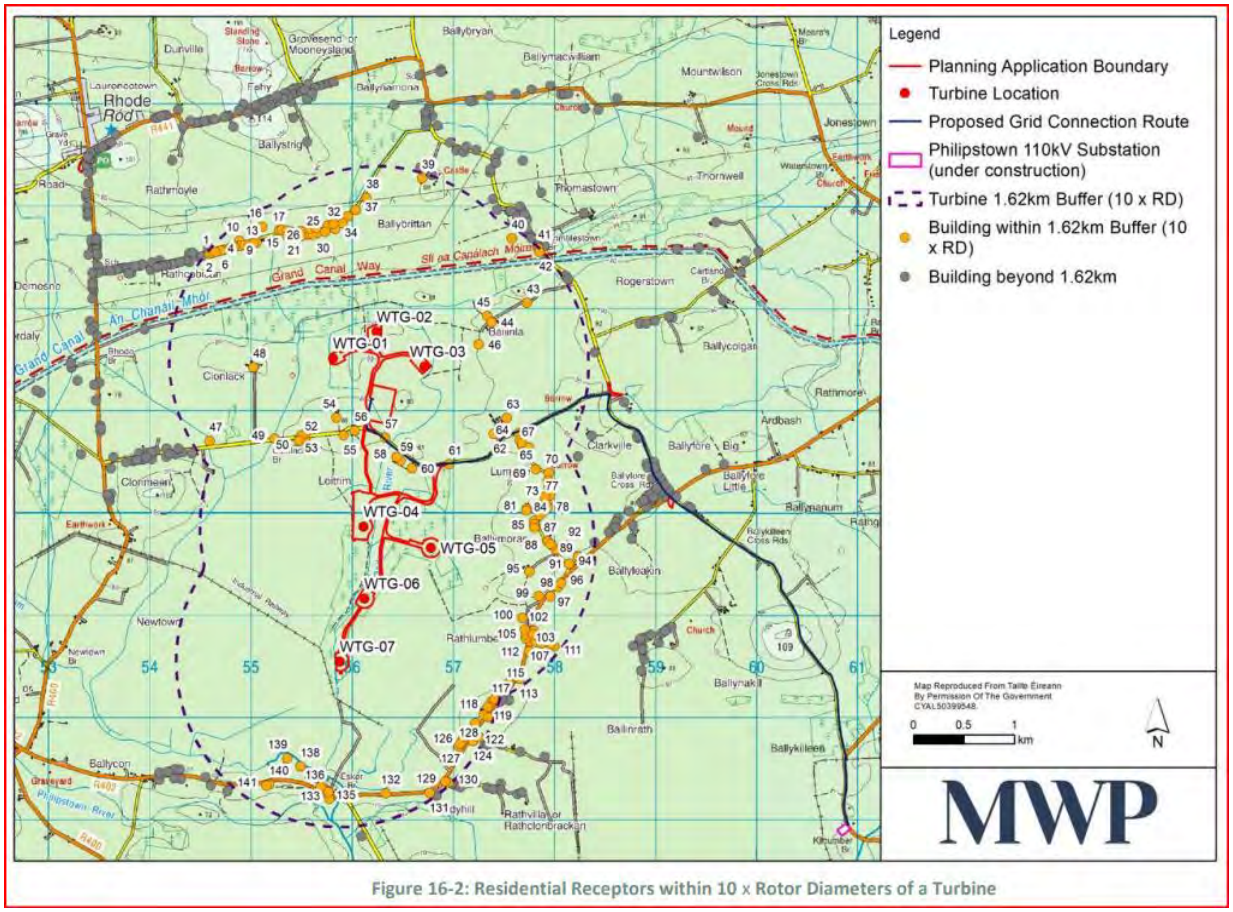


Figure 16-2: Residential Receptors within 10 x Rotor Diameters of a Turbine

APPENDIX 10-6 NOISE SENSITIVE LOCATIONS IN STUDY AREA (Houses selected) Note 1km grid on map in Blue

H046	657,461	728,331	H063	655,303	732,741	H064	653,455	730,831
H081	657,658	728,818	H095	653,992	733,894			

Pythagorean Theorem

Critical nodes	X -Coor-dinate	differ-ence	Square of dif-ference	y- Coordi-nate	differ-ence	Square of difference	Sum differences columns 4 & 7	Square root to get distances between nodes
T3	656655			731460				
House 46	657461	806	649636	728331	-3129	9790641	10440277	T3 to House 46 3231m
T3	656655			731460				
House 63	655303	-1352	1827904	732741	1281	1640961	3468865	T3 to House 63 1862m
T3	656655			731460				
House 64	653455	-3200	10240000	730831	-629	395641	10635641	T3 to House 64 3261m
T5	656718			729689				
House 81	657658	940	883600	728818	-871	758641	1642241	T5 to House 81 1281m
T5	656718			729689				
House 95	653992	-2726	7431076	733894	4205	17682025	25113101	T5 to House 95 5011m

The grid distances in Column 9 do not correspond with the map locations above & thus undermine the entire noise contour data & application. No reliance can be accepted for Appendix 10.6 results as the separation distances have been exaggerated.

The AM (Amplitude Modulation) impact has not been assessed. The 2006 Noise Guidance arguably may be considered outdated due to the passing of time and does not account for AM noise impact.

Infrasound is high level sound at frequencies below 20 Hz. This was a prominent feature of passive yaw "downwind" turbines where the blades were positioned downwind of the tower which resulted in a characteristic "thump" as each blade passed through the wake caused by the turbine tower. With modern active yaw turbines (i.e. the blades are upwind of the tower and the turbine is turned to face into the wind by a wind direction sensor on the nacelle activating a yaw motor) this is no longer a significant feature. Notwithstanding same, this low frequency noise impact was tested in the recent court case, ref [2024] IEHC136 - Margaret Webster and Keith Rollo (Plaintiffs) and Ross Shorten and Joan Carty (Plaintiffs) and Meenacloghspar (Wind) Ltd (Defendant). The Judge's ruling states that 'the fact that AM and thump AM remain to be regulated does not mean that the court should ignore these characteristics and 'existing planning guidance effectively (WEDG 2006) is not responsive to the issues complained of - AM, thump AM etc'

The judgement also states that 'Low frequency noise (sound up to approximately 150 hertz) only slightly above the threshold of audibility can cause considerable disturbance and is more difficult to mask and get used to than other types of noise…..on the balance of probabilities that whilst low frequency noise is not the dominant characteristic of the WTN, there is a significant element of audible low and lower frequency noise which manifests as thump AM' It is considered that these 2006 noise guidelines therefore do not include sufficient guidance, particularly in relation to AM (Amplitude Modulation) and 'thump' AM noise which creates the 'whoosh' or 'thump' sound which has been found to cause nuisance.

The "thump" AM noise from a wind turbine is a type of sound characterized by fluctuating amplitude, specifically the modulation of the turbine's aerodynamic noise. This modulation is often described as a "thump," "swish," or "whoosh" sound and is related to the frequency at which the turbine blades pass by. (https://iea-wind.org/wp-content/uploads/2021/05/IEA-Wind-TCP-Task-39-FactSheet-Amplitude-Modulation-20181006.pdf)

In relation to the proposed substation, which will operate on a 24-hour basis, a night time criterion of 35 dB LAeq,T is considered appropriate for the operation of the substation. The substation design will ensure that the noise emissions do not contain audible tones or impulsive characteristics at the nearest NSLs. The report goes on to state that significant vibration impacts are not associated with the proposed development. However, given the lack of clarity and assessment in relation to major elements of the proposed development such as blasting or rock breaking at the borrow pit, it is considered that this claim has not been substantiated.

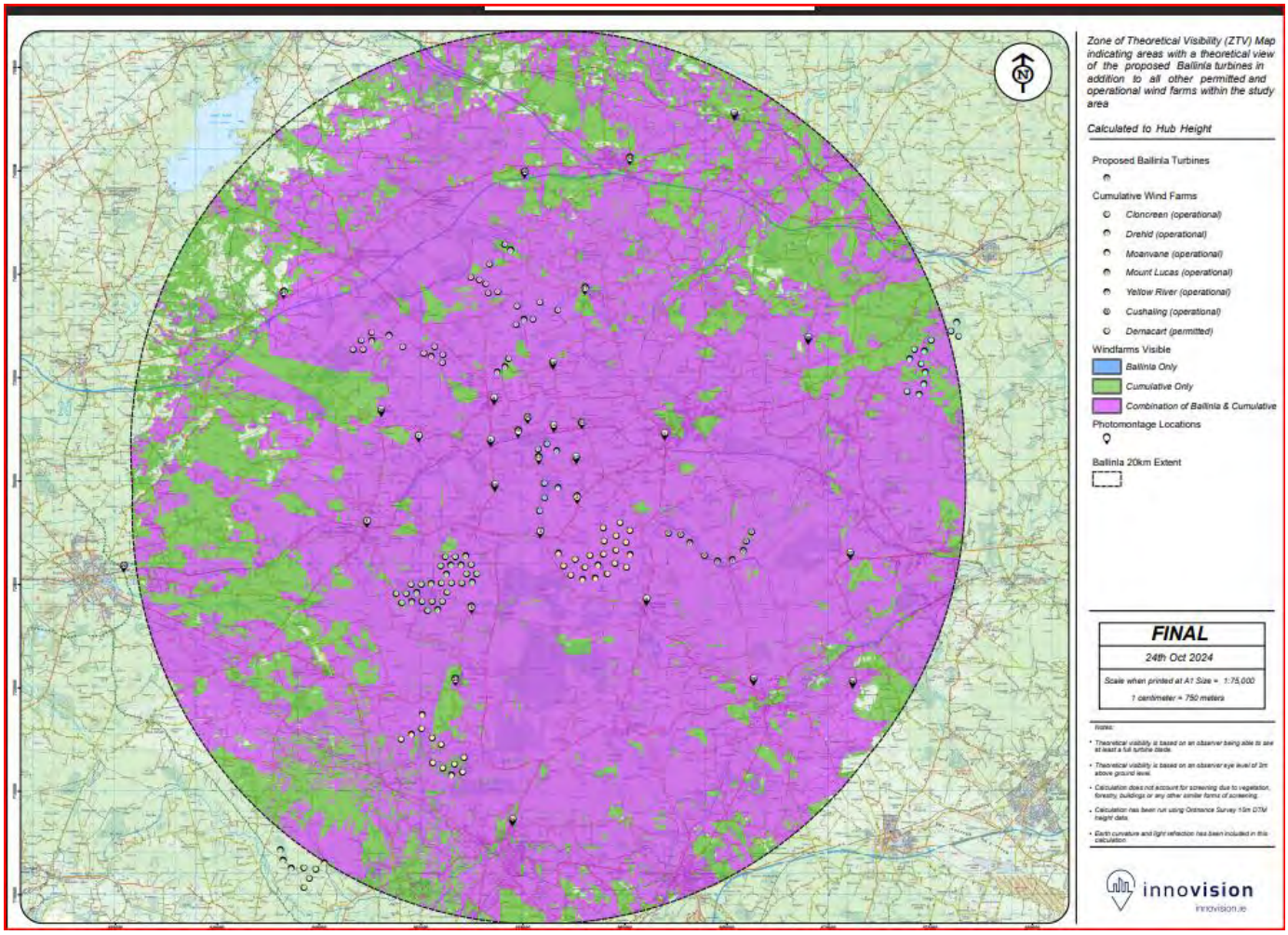
Furthermore, according to Met Eireann, prevailing wind in Ireland comes from the South and West. **In this regard, dwelling houses in the immediate vicinity of the proposed windfarm area located just in excess of 700m to the east and north east of the site, ie 'down wind' of the site and are more likely therefore to suffer from noise and nuisance noise. Having regards to the potential noise and nuisance impacts of AM and thump AM on residential amenity, as highlighted in the recent Court ruling set out above, it is considered that the potential significant impacts of noise have not been adequately addressed so as to rule out the potential for impact.**

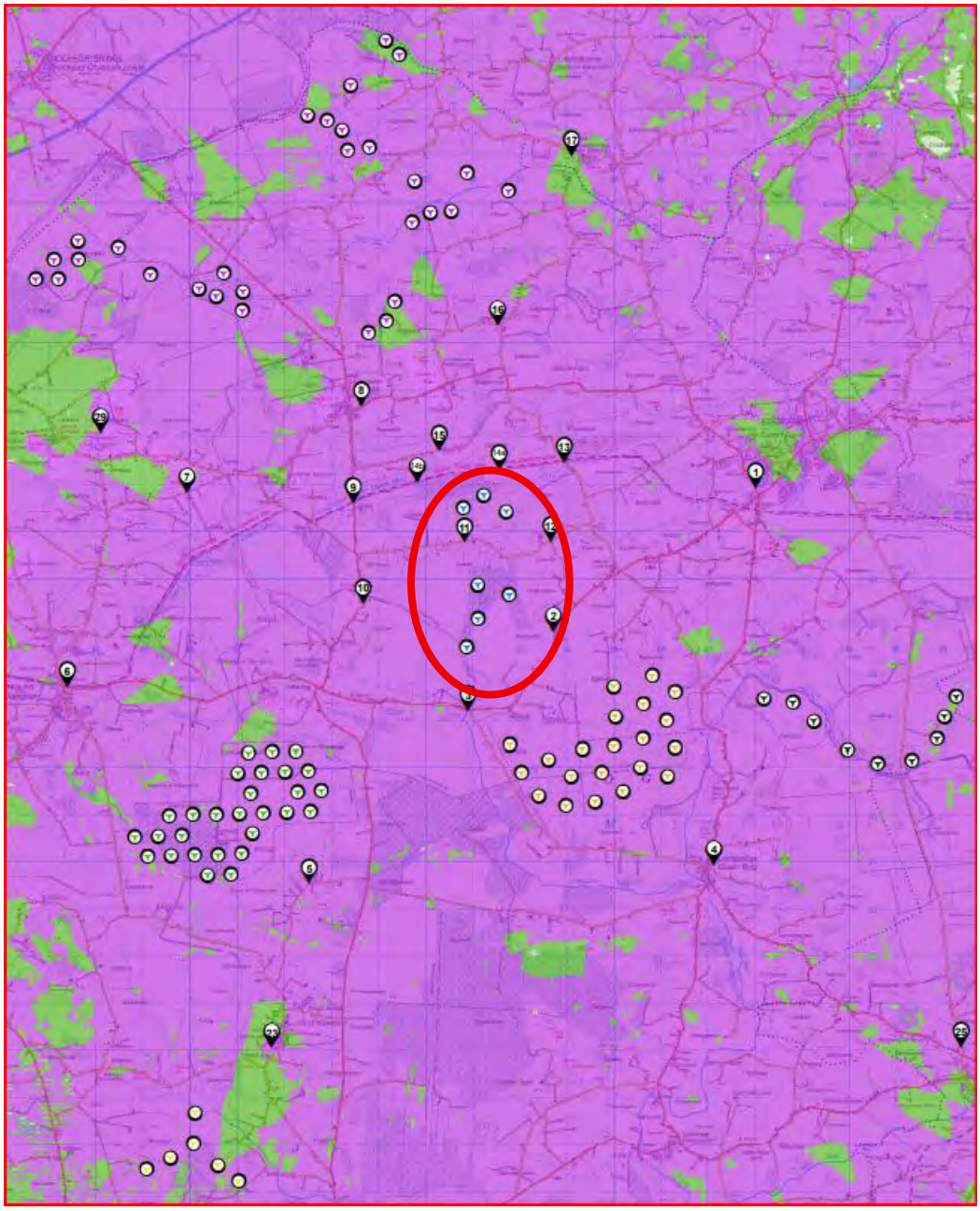
In relation to impacts on landscape, we have considered a number of contributing factors, including:
- Reviews of the documentation provided by the applicant including Landscape Visual Impact Assessment and photomontages
- The context of relevant policy guidelines
- Site visits to the development site and surrounding areas and landscapes
We have serious concerns regarding the visual impact of the proposed turbines and substation, in particular the visual impact on neighbouring dwelling houses located to the east and north east, given the scale and proximity and extent of visibility of the proposed development from these residential sites.
The Applicant either understates or omits the degrees of impact on the most sensitive aspects of the receiving environment – namely nearby residential receptors with little or no visual screening of the development.
It is difficult to understand why these effects have not been characterised as being 'Very Significant' An effect which, by its character, magnitude, duration or intensity, significantly alters most of a sensitive aspect of the environment. (EPA Guidelines]
Proximity to a Residential Cluster
The north-eastern part of the proposed development lies close to a concentration of existing dwellings on the L5050 These are illustrated on Figure 16.2 above.
Having regard to:
• the height of these turbines (185 m),
• their proximity,
• the lack of significant screening by existing topography or mature vegetation,
• the local concentration of rural dwellings compared to other equivalent areas in the general vicinity,
• the concentration of windfarms surrounding the rural community,
• the presence of a horse stud farm,
• the presence of a pedigree bull breeding farm,
• the orientation of the more-used amenity garden areas,
• the location of the turbines at a higher elevation than the dwellings, and
• the availability of alternative turbine locations within the applicant's holding, and having regard to the material supplied by the applicant, it appears that the proposed development will give rise to:
• a locally significant, avoidable, and concentrated adverse effect on the principal residential amenities of a concentration of dwellings, to such a degree as to constitute a disproportionate and unreasonable burden of avoidable impacts on residential amenity that could not reasonably be argued to constitute the proper planning and sustainable development of the area;
• a scale and quantity of development which, having regard to the significance of effects on the sensitivities of adjoining land uses, would constitute overdevelopment; and
• a magnitude of impact that, due to in-combination and cumulative effects, will amplify the perceived significance of other effects, such as noise, nuisance, and loss of amenity and land value.

The proposed 38kV electricity substation and ancillary plant and equipment is also of serious concern in relation to its siting on a prominent and elevated site, north of a number of existing dwelling houses located on the local road. The substation control building has a max ridge height of 6.4m with attached antennae/dishes up to 7.5m in height. Compared to the anticipated visual impact of the wind turbines the substation on its own would be very low impact. However, having regard to the elevated location, the in-combination effect with the turbines is such that the substation would, compared to other structures in the area, stand out as a disproportionately visible element of the windfarm in the landscape.

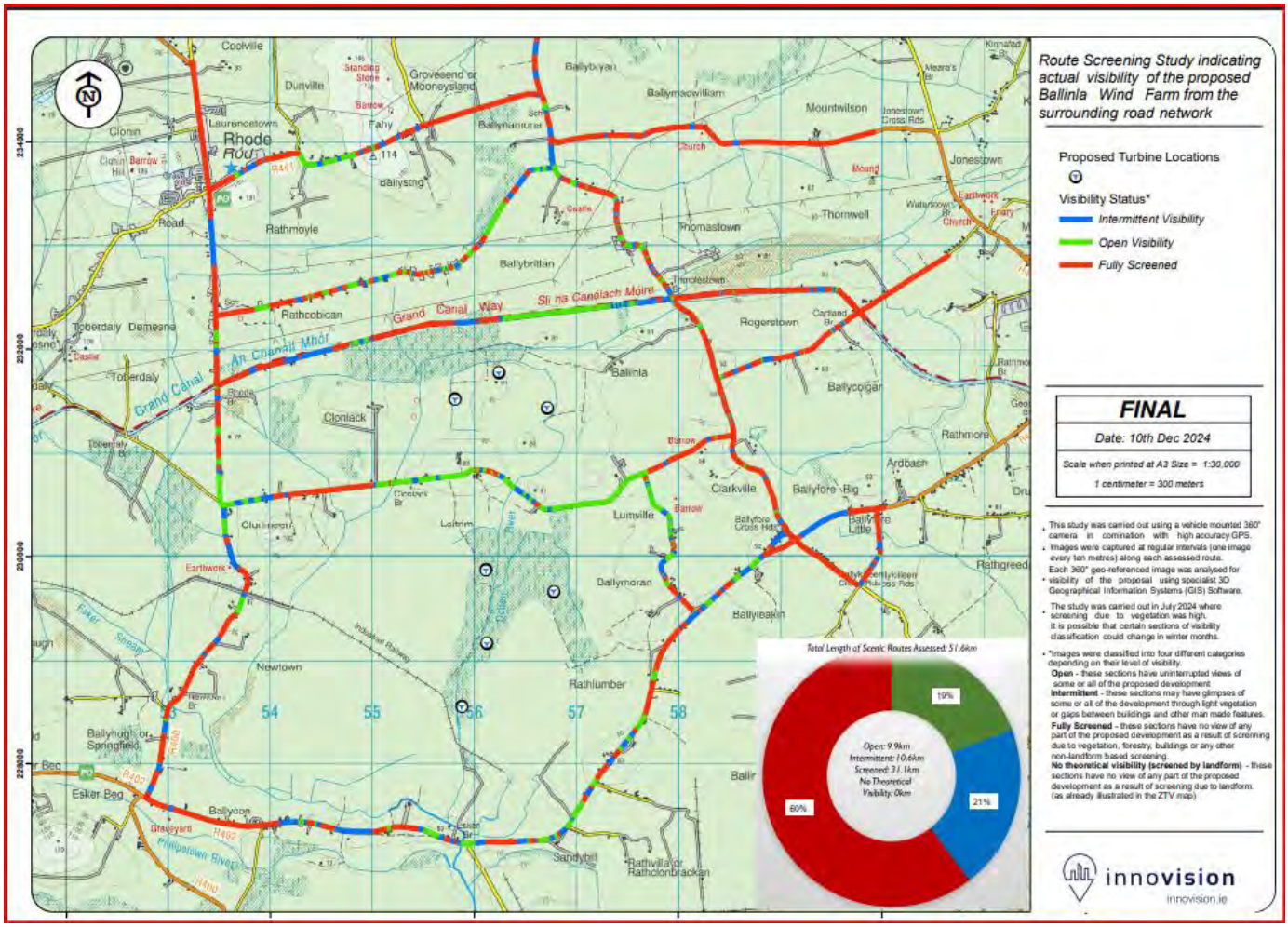
VP No.	Existing View	Receptor Type	VP Sensitivity	Visual Impact Magnitude	Significance/ Quality/ Duration of Impact
VP11	**L5010 at Leitrim townland** This view is afforded from a local road at Leitrim townland which represents local community receptors in the vicinity. To the north is an open and slightly elevated view across a broad agricultural land features a farmstead with a substantial two storey dwelling in near middle distance. Beyond this is a lower lying landscape of forestry and peatland scrub out of which rises the Yellow River Wind Farm in the distance. To the south is a similar scenario but without foreground dwellings. However it should be noted that there are a cluster of rural dwellings to the east and west that share similar views. In the middle distance of the southerly view, the Cloncreen turbines rise out of the vegetated lowlands context.	LC	**Medium-low**	This location represents a settled local road that runs between the northern and southern clusters of the proposed development and thus, there will be prominent views of close turbines in both directions. When combined with the more distant turbines of the Yellow River Wind Farm to the north and the Cloncreen Wind Farm to the south, the proposed wind farm generates something of a sense of being surrounded by turbines. The four proposed turbines to the south are generally further away from the viewer than those to the north and do not appear overbearing or intensely spaced. However those to the north are closer and rise above the intervening dwelling at a dominating scale, albeit they do not appear overbearing for the viewer at this VP location and may not from the dwelling itself given its viewing context without the scale gauge of a built structure within an otherwise broad rural context. The proposed development increases the scale and intensity of built development in a manner that is already characteristic of the view, but generates some scale / distance ambiguity with the more distant existing wind turbines. Given the relative distances to existing turbines, there is not a sense of visual stacking and instead the sense of perspective generated by the scale difference serves to highlight the extent of the view. On balance of all of these factors, including the cumulative scenario, the magnitude of visual impact is deemed to be High.	**Substantial-moderate / Negative / Long-term**
VP12	**L5010 at Lumville townland** This view is representative of local receptors and local road users. In this instance, the foreground features several nearby dwellings to the south and one to the northwest. The view generally more open beyond the dwellings to the south with a flat, middle distance vegetated horizon above which rises the distant turbines from the Mount Lucas Wind Farm. To the northwest is a band of mature trees that substantially contain the view in the near middle distance.	LC	**Medium-low**	Even though this viewpoint is only a short distance east along the same local road as VP11 it has quite a different viewing context in relation to the proposed wind farm due to the degree of intervening screening and this highlights the variation that occurs generally within the central study area. The turbines to the south are partially and intermittently visible above and between foreground dwellings and vegetation, albeit at a prominent scale and with some clutter and ambiguity due to their movement and relationship with intervening features. The hub and partial blade set of one turbine and the blade tip of another can be seen in the opposite direction above the near treeline an views are likely to be clearer in winter. Again the turbines present at a prominent scale and with a degree of ambiguity as to their scale and distance relative to the intervening screening elements. They generally contribute to an increased scale and intensity of development in this local context. On balance of these factors, the magnitude of visual impact is deemed to be High-medium.	**Moderate / Negative / Long-term**

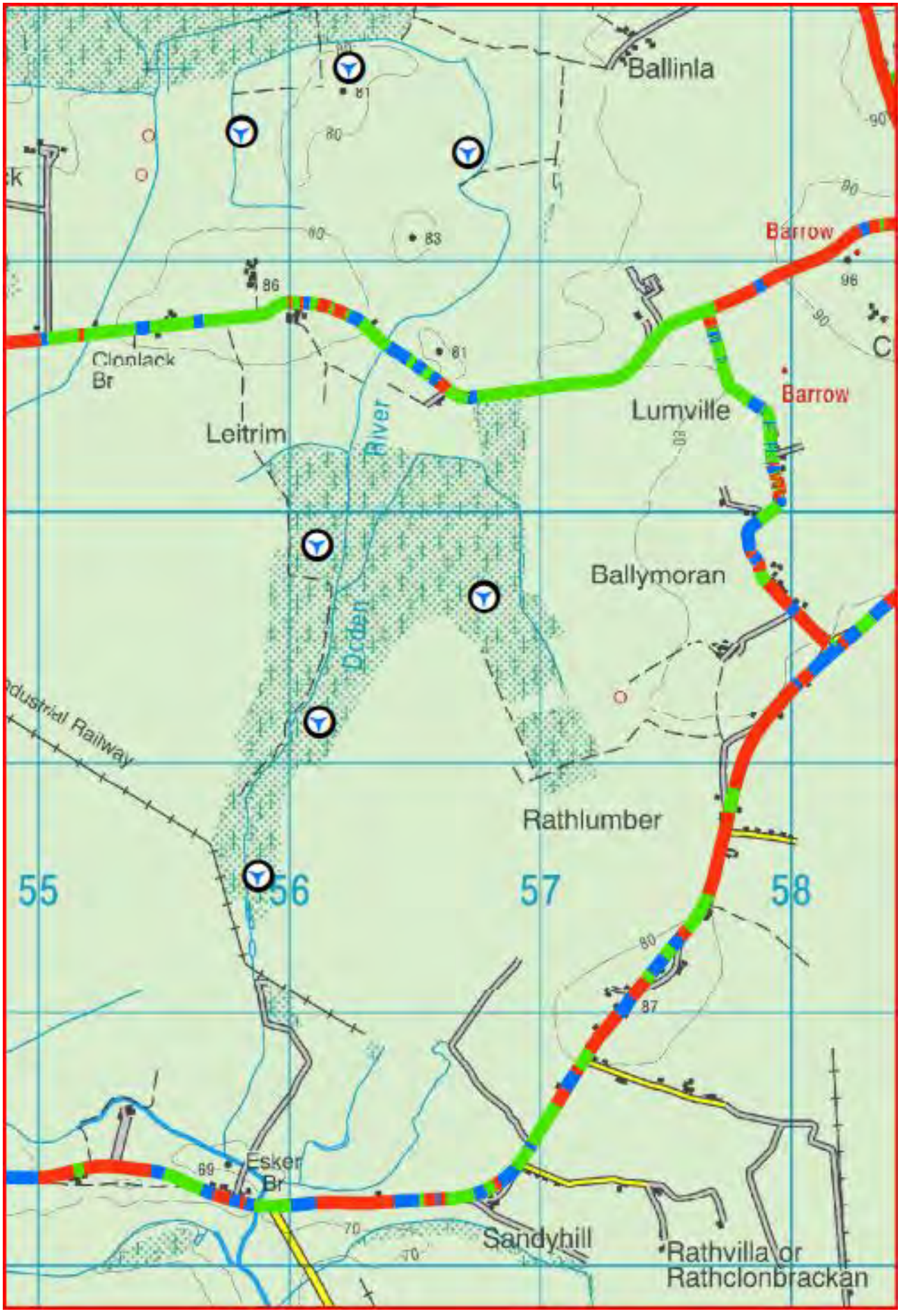
Appendix 11-2_Ballinla ZTV Map.pdf





Appendix 11-3_Route Screening Study Map.pdf




Ballinla
Barrow
Barrow
Clonlack
Br
Leitrim
Lumville
Ballymoran
Rathlumber
Esker
Br
Sandyhill
Rathvilla or
Rathclonbrackan
55
56
57
58

12.4 Baseline Environment 12.4.1

Mapping Overview The mapping to accompany the text is presented as follows. Figure 12.3 is a vertical aerial image on which the archaeological sites listed on the Sites and Moments Record (SMR) are indicated by red dots and structures listed in the National Inventory of Architectural Heritage (NIAH) are indicated by blue dots.

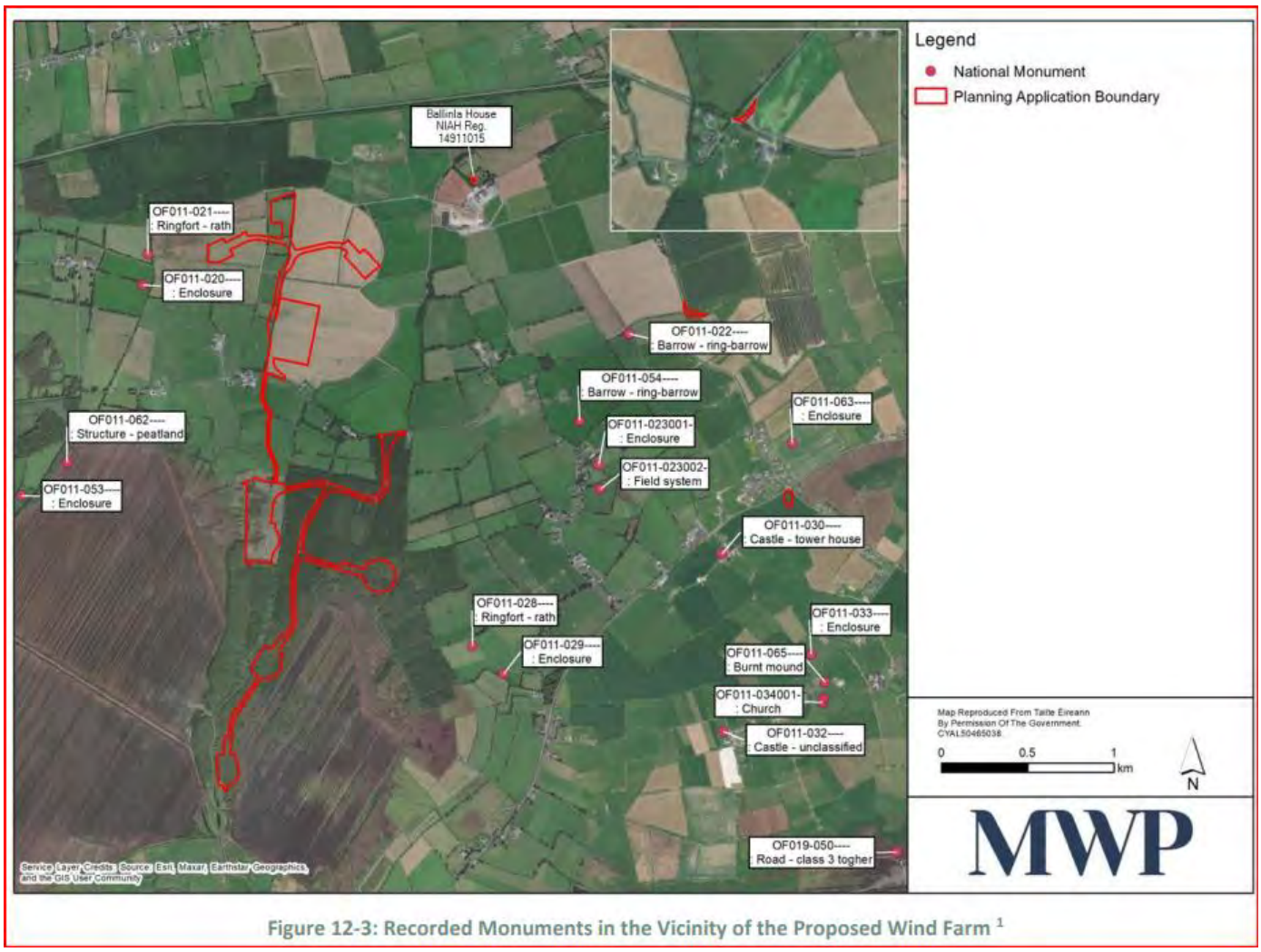


Figure 12-3: Recorded Monuments in the Vicinity of the Proposed Wind Farm [1]

Table 12.1 List of Recorded Monument in the Vicinity of Proposed Development

RWP no.	County	Townland	Classification	Depiction on First Ed Map	Depiction on Second Ed Map	ITM co	ITM co	Distance to Nearest Element
OF011-020----	OFFALY	CLONLACK	Enclosure	Null	Hachured	655347.8	731358.8	c.420m
OF011-021----	OFFALY	CLONLACK	Ringfort - rath	Null	Hachured	655380.8	731530.8	c.415m
OF011-022----	OFFALY	CLARKVILLE	Barrow - ring-barrow	Null	'Mote'	658165.6		c.1.5km
OF011-023001-	OFFALY	BALLYMORAN	Enclosure	Null	Not indicated	657987	730326.9	c.1.4km
OF011-023002-	OFFALY	BALLYMORAN	Field system	Null	Not indicated	658000.2	730188	c.1.4km
OF011-028----	OFFALY	RATHLUMBER	Ringfort - rath	Null	Hachured	657259.4	729288.4	c.680m
OF011029-—	OFFALY	RATHLUMBER	Enclosure	Null	Not indicated	657438	729129.7	c.870m
OF011-033----	OFFALY	BALLYNAKILL (Coolestown By.)	Enclosure	Null	Not indicated	659217.3	729235.5	c.2.5km
OF011-053----	OFFALY	CLONMEEN	Enclosure	Null	Not indicated	654646.6	730148.3	c.1.5km
OF011-054----	OFFALY	CLARKVILLE	Barrow - ring-barrow	Null	Not indicated	657881.2	730578.3	c.1.3km
OF011-062----	OFFALY	LEITRIM	Structure - peatland	Not indicated	Not indicated	654911.2	730340.2	c.1.6km

Table 12.2 Information on Structures/Buildings Listed in the NIAH

Reg No.	Original Use	In Use As	Townland	County	Date From	Date To	Rating	Distance
14911015	Farmhouse	N/A	Ballinla	Offaly	1840	1845	Regional	c.740m
14911008	Bridge	Bridge	Rogerstown	Offaly	1775	1800	Regional	c.1.4.km
14911022	House	House	Ballymoran	Offaly	1780	1820	Regional	c. 900

Some of the most notable houses in the area includes Ballinla House. Ballinla House is listed in the NIAH (Reg. 14911015, see Plate 12.17) and described as a detached three-bay two-storey farmhouse, built 1842, on an Lshaped plan. …. Occupied, 1901. 1911. Disused, 2004'. The house remains in good order and lies at 740m from the

nearest element of the proposal and a series of farm buildings, open agricultural land and a grove of trees separate the house from the Proposed Development.

Plate 12-21: Ballinla House (NIAH Reg. 14911015) Located 740m from the Nearest Turbine

Lumville House is not listed in the NIAH as it has long since been demolished and a modern dwelling and farm sheds have been developed on and around the house site. Little is known about the former house, however notable formal gardens (Figure 12.4A) were once a feature, in particular a large rectangular canal with apsidal ends suggest a designed garden of later seventeenth or early-eighteenth century character. The house and garden may have been built by Elnathan Lum, who came to Ireland during the reign of King Charles II. Lum prospered as a banker in Dublin and bought the estate of Lumville. His grandson Francis Lum of Lumville was created a baronet in 1775. After his death the estate passed to distant cousins and the title became extinct and it is likely therefore that the house declined in importance after that time. It is possible that some of the later eighteenth century reclamation and land improvements such as recorded on the first edition Ordnance Survey map (Figure 12.4A) related to the Lumville Estate.

Ballmoran House (NIAH ref 14911022) stands at a distance of 900m to the east of the Proposed Development. The house is described as Detached three-bay two-storey house, built c.1800, with return to rear and extension to south-west……. Once home to the Odlum Quaker family, renowned for their cereal products. The house is given a 'Regional' rating in the NIAH and is separated from the nearest proposed turbines by extensive areas of standing forestry.

Built Heritage

There are two Georgian houses in Leitrim area. These dwellings are protected & it is not permitted to change the windows from single glazing to double/triple glazing to decrease the noise levels. The noise effect on these dwellings is very significant with serious operational effects.

Cumulative Effects

Negative cumulative effects from the existing windfarms have been identified & are significant.

13.2.2 Assessment Criteria

13.2.2.1 Air Quality

Traffic TII guidance documents (TII, 2022A/2022B) state that the following scoping criteria shall be used to determine whether the air quality impacts of a project can be scoped out or require an assessment based on changes between 'DoSomething' traffic scenario (with the Proposed Development) compared to the 'Do-Minimum' traffic scenario (without the Proposed Development):

- Road alignment will change by 5m or more.
- Annual average daily traffic (AADT) flows will change by 1,000 or more. or
- **Heavy goods vehicle (HGV) (vehicles greater than 3.5 tonnes, including buses and coaches) flows will change by 200 AADT or more. or**
- Daily average speed change by 10 kph or more.
- Peak hour speed will change by 20kph or more.

If the above criteria are not met, then a quantitative assessment of construction traffic can be scoped out and the effects are considered to be not significant. The construction stage traffic, as described in Chapter 15 Material Assets Traffic and Transport, is below the above criteria and therefore no further detailed impact assessment is required.

The HGV flows will change by more than 200AADT & a quantitive assessment is required.

13.4.2 Construction Phase

13.4.2.1 Air Quality & Dust Emissions

Traffic movements during the construction phase are outlined in the Material Assets (Traffic and Transport) Chapter 15. Over the course of the construction of the Proposed Development, activities across the site will vary resulting in different staff numbers and different trip generation depending on the activities being undertaken at any given time. Given the phasing of construction across the site, the peak construction period will occur when different activities are being undertaken in different phases. Based on this, it is possible to estimate the peak traffic movements to the site based on the stage of development where multiple phases are underway. During the proposed 18 months construction duration, the proposed construction works would increase Annual Average Daily Traffic (AADT) volumes up to 70 vehicles, including 30 heavy vehicles, which equates to an AADT increase of up to 4.3% on regional roads. The proposed grid construction works along public roads would increase AADT volumes on those roads by 18 vehicles, including nine two-way heavy vehicles. During peak construction traffic generation periods, **the peak daily increase in daily traffic volumes would be up to 220 vehicles, including up to 180 HGVs.** The construction highest peak hour increase in traffic volumes would be up to 18 heavy vehicles. The peak daily increase in traffic volumes generated by the proposed grid construction works along public roads would be up to 53 vehicles, including 26 two-way heavy vehicles.

Note Clause 3.11.1 Construction phase peak traffic of 440vehicles per day.

The peak construction stage traffic has been reviewed and screened out based on the following assessment criteria:

- AADT changes by 1,000 or more during construction.
- HGV changes by 200 or more.
- A change in speed band.
- A change in carriageway alignment by 5m or greater.

The construction stage traffic has the potential for a not significant, negative and short-term impact on air quality.

This assessment is incorrect as the HGV changes are greater than 200 per day.

13.4.2.2 Vehicle Emissions

Traffic levels, summarised in Chapter 15 Material Assets of this EIAR, during the construction phase are below the TII criteria (refer to Section 13.2.2.1) and therefore a quantitative assessment of construction traffic was not required.

The HGV flows will change by more than 200AADT & a quantitive assessment is required.

13.4.3.4 Carbon Savings and Losses from the Wind Farm

Once operational, the electricity generated by the wind farm will displace electricity that would otherwise have been produced by burning fossil fuels. This will also displace the associated greenhouse gas emissions. However, there will be some carbon losses due to the manufacturing process of the wind turbines. In order to demonstrate

that the carbon savings will significantly outweigh any potential carbon losses, a methodology made available by the Scottish Government in an excel worksheet titled 'Calculating carbon savings from wind farms on Scottish peatlands' was applied to this development.

Table 13-16: CO2 Losses Due to the Proposed Development

Source	CO_2 Losses (tonnes CO_2 equivalent)
Losses due to turbine manufacture, construction & decommissioning	43,818
Losses due to felling forestry	8,349
Losses due to DOC & POC leaching	76
Losses from soil organic matter	34,641
Losses due to reduced carbon fixing potential	26
Total	**86,911**

13.5.2 Operational Phase It is not expected that any significant adverse effects to the climate will occur during the operational phase, therefore no mitigation measures are required.

This is not factually correct. For every Mw of renewable energy, a Mw from fossil fuel or nuclear fuel will be needed as a back-up when the wind doesn't blow or the sun doesn't shine. On top of that the carbon usage to upgrade the grid will also use carbon.
Additional effects from the 3^0Centigrade drop from the wake will effect vegetation growth over a large radius.
These losses have to be included in any analysis of carbon losses.

Appendix 13 Carbon Calculator.pdf

13.4.2.1 Construction Phase Proposed Wind Farm

There are no other existing electrical services within the main Proposed Wind Farm that would be affected by the proposed wind farm infrastructure or construction works.

13.4.7.1 Construction Phase Construction phase waste may consist of hardcore, concrete, spare steel reinforcement, cable wires, shuttering timber and building materials. The waste from all components of the project will be stored in the demarcated areas within the construction compound and collected during and at the end of the construction phase and taken offsite to be reused, recycled and disposed of in accordance with best practice procedures at an approved facility. Plastic waste will be taken for recycling by an approved contractor and disposed or recycled at an approved facility. Hazardous materials, such as fuels and lubricant oils, used during construction that require disposal will be disposed of in accordance with all applicable laws and regulations. Domestic type waste generated by contractors will be collected onsite, stored in an enclosed skip at the construction compounds and disposed of at an appropriately authorised facility. The types of wastes to be generated will be similar to established construction waste streams and will not require unusual or new treatment options. Waste volumes will not be significant as to require new permitted treatment, storage and disposal facilities as there is sufficient capacity at licensed disposal or recycling facilities in proximity to the Proposed Development. Waste Management procedures have been included in the CEMP in EIAR Volume 3 Appendix 2-1. During the construction phase the effects of waste and effects on the capacity of waste management facilities will be slight, negative, localised, indirect and short term and likely due to the implementation of the CEMP.

Proposed Grid Connection

The Proposed Grid Connection is assessed within this EIAR and will be a part of a future planning application separate to the Proposed Wind Farm application. It is proposed to construct a 110kV grid connection cable within the public road between the proposed onsite substation and existing Philipstown 110kV substation. The underground cabling will be constructed in a trench within the public road corridor. Where existing electrical services are located in the public road, the cable will avoid these services by providing ducting above, below or on the other side of the road corridor. Prior to construction being undertaken, a survey of underground services along the grid route will be undertaken to identify their location and design the layout of the grid route cables to avoid any interference with or risk to the existing services and networks under the road. The relevant authorities will also be consulted during this phase and will approve the proposed approach and methods prior to the initiation of construction. This will avoid any effects on existing electrical networks along the grid route. During the process of connecting the Proposed Development to the national grid, some minor, brief disruption to electrical supply, at a local level are likely. However, during this process, EirGrid will balance the loading on the network to ensure that no significant disruption occurs, and significant effects do not arise.

Where existing water supply or wastewater networks are located in the public road, the grid cable will avoid these services by providing ducting above, below or on the other side of the road corridor. Prior to construction being undertaken, a survey of underground services along the grid route will be undertaken to identify their location and design the layout of the grid cabling to avoid any interference with or risk to the existing services and networks under the road. The relevant authorities will also be consulted during this phase and will approve the proposed approach and methods prior to the initiation of construction. This will avoid any effects on existing water infrastructure along the grid route. Pre-mitigation construction effects are described as neutral, imperceptible, localised, direct, likely, and temporary.

In the absence of an assessment of alternatives, this is not accepted.

Proposed TDR The accommodation works for the TDR will require some brief disruption to electrical supplies due to movement of existing overhead lines and poles at three pinch points along this route (at locations ref: No. 7, 8 and 9 of the TDR report EIAR Vol 3 Appendix 2-2) when the turbine components are being delivered to site. The ESB and relevant local authorities will be consulted on these proposed temporary changes and will need to approve them and facilitate the dis-connection and reconnections of the affected lines and poles.

During construction there will likely be a neutral, not significant, localised, brief and direct effects on electrical infrastructure and supply associated with the grid route connection, TDR and the rerouting of the permitted 38kV overhead powerline through the Proposed Wind Farm.

13.4.2.2 Operational Phase

The electricity generated by the Proposed Development will assist to displace electricity produced from coal, oil and gas fired power plants, thus reducing emission from these power plants. Once operational, there will be no direct emissions to the atmosphere from the Proposed Development. The CO2 offset by the wind farm will further assist Irelands CO2 reduction commitments under the Paris Agreement and Ireland's CAP 2025 The proposal will maximise a natural asset (wind) which is a renewable resource and therefore constitutes a positive effect. Therefore, the effects on grid capacity and electrical infrastructure are considered to be a likely, direct, long term, regional, significant, and positive effect during the operational phase. **There is a possibility that additional replacement turbine components may need to be delivered from time to time during the operational phase. This may require additional temporary accommodation works along the delivery route similar to those during the construction phase. This will likely be a neutral, not significant localised, brief and direct effect on electrical infrastructure and supply associated with the TDR.**

13.4.6.2 Operational Phase

During the operational phase, maintenance personnel will visit on a semi-regular basis. The daily average wastewater production during the operational phase is estimated from the average number of workers on site, which is expected to be two workers, resulting in a typical wastewater production rate of 100 litres per day, on days where workers are present onsite. The wastewater generated during the operational phase at the onsite substation will be managed by a holding tank which is fitted with an alarm to indicate levels and when it is due to be emptied. The holding tank will be emptied by a permitted contractor and brought to a licenced wastewater treatment plant. Potable water required during the operational phase is estimated to be approximately 20 litres per day. This water will be supplied as bottled water. Welfare facilities during the operational phase will utilise rainwater harvesting at the substation. The volumes of both potable water and wastewater associated with the operational phase are considered slight and would result in a neutral, imperceptible, localised, long-term, direct and likely effect on the water supply and wastewater utilities.

13.4.7.2 Operational Phase

During the operational phase, minimal amounts of solid waste will be generated, which will be collected onsite and transported to a licensed disposal facility, or recycling facility by a waste hauling contractor. Hazardous materials, such as gear and hydraulic oils used in the operation of the wind turbines and mineral oils used in transformers, will be disposed of in accordance with all applicable laws and regulations. The effects of waste and effects on the capacity of waste management facilities will be slight, negative, localised, indirect, likely and long term.

Response: If the aforementioned Nuclear bomb exploded in Ballinla, these Consultants would classify the impact as neutral/negative, slight, localised, not significant, brief & with a direct effect

Material Assets

The report sets out the potential impacts on material assets such as potential impacts on existing public drinking water infrastructure, traffic volumes and the public road network capacity, impacts on services located within the public roads including telecommunications, water, gas and electricity infrastructure. The proposed development includes a 38kv substation on site and a 38kV grid connection to the 110kV ESB substation at Philipstown. The approx 8km long grid connection is proposed to be constructed mainly in the public road network along Local roads.

The anticipated grid connection infrastructure will severely limit the public road capacity and the Local Authority's ability to carry out its functions in respect of maintenance works and future services provision.

The consideration of Alternative Grid Connection Cabling Route Options is not included in this application. The preferred option is frequently to locate the infrastructure within the public road network. **The public road network is**

of limited capacity and grid connection installations risk restricting or sterilising the road network for future development. It impacts Road Authorities in terms of their ability to carry out its functions in respect of maintenance works and future services provision.

Appendix 14 Telecommunications Impact Study.pdf

15.3.1.1 L5010 Road Characteristics

In the vicinity of the Proposed Ballinla Wind Farm site and west of the site, the L5010 has a typical road carriageway width **of 3.5m and 3.6m,** with circa 2.0m wide verges on both sides. There are existing verge widths in excess of 2.0m on sections of the L5010 located on horizontal alignment curves. East of the Proposed Wind Farm, the L5010 has carriageway widths of 3.8m and 4.0m. The L5010 extends for circa 5.3km from its priority T-junction with the L5006, in the east, to its priority T-junction with the R400 in the west.

Approximately 1.3km south of its L5010 junction, the L5006 forms crossroads junction with the R402 Regional Road at Ballyfore and has a typical road carriageway width of 4.6m, with variable width grass verges. North of its L5010 junction, the L5006 has a typical road carriageway width of 4.4m, including at its Trimblestown Bridge on the Grand Canal.

In the vicinity of Ballyfore, the R402 has a typical road carriageway width of 6.2m with centreline and hard strip road markings.

Note 6.2m is not 7m as required for Type 3 Single Carriageway Roadway.

15.3.1.2 L5006 Road Characteristics

South of its R402 crossroads junction at Ballyfore, the L5006 has typical road carriageway widths of 4.2m and 4.4m on its northern local section, and 5.0m on its southern local section, with variable width grass verges. A 3.8m wide road carriageway with hard strip markings is provided on the southern end of the L5006, at and in the vicinity of its priority T-junction with the R401 Regional Road.

Immediately south of its L5006 junction, **the R401 has a typical road carriageway width of 6.2m with centreline and hard strip road markings.**

Note 6.2m is not 7m as required for Type 3 Single Carriageway Roadway.

Approximately 3.2km south of its L5010 T-junction, the R400 forms a right-left staggered crossroads junction with the R402 at Mount Lucas. Between its L5010 and R402 junctions, **the R400 has typical rural road carriageway widths of 5.3m and 5.1m with centreline and hard strip road markings**. a typical urban road carriageway width of 5.5m at Mount Lucas.

Note 5.1 -5.3m is not 7m as required for Type 3 Single Carriageway Roadway.

15.3.1.3 R400 Road Characteristics

North of its L5010 T-junction, **the R400 has a typical road carriageway width of 5.5m with centreline and hard strip road markings.** The R400 has a reduced carriageway width at its Rhode Bridge on the Grand Canal, where a traffic signals control is provided to alternate traffic movements. North of the Grand Canal, the R400 has urban controlled pedestrian crossing facilities, footways and recessed school set-down parking at Rhode.

Note 5.1 -5.3m is not 7m as required for Type 3 Single Carriageway Roadway.

15.3.1.4 R402 Road Characteristics

The R402 at Mount Lucas has an urban central median marking with 3m wide traffic lanes in each direction and footways.

15.3.1.5 R401 Road Characteristics

The R401 has a vertical crest curve bridge on the River Figile, approximately 220m south of the Philipstown substation (under construction) access. The R401 has a reduced road carriageway width of 4.2m on the bridge, with a posted Stop for northbound traffic for priority for southbound traffic at the bridge.

15.3.1.6 Speed Limits 50 km/hour urban speed limit zones are provided on the L5006 at Ballyfore, on the R400 and R402 at Mount Lucas, and on the R400 at Rhode. Elsewhere on the Proposed Development local road network, the existing rural roads are located within the 80 km/hour rural non-national speed limit zone. The site inspection and road network inventory for the preparation of this chapter assessment was carried out during October 2024, which was prior to the introduction of new 60 km/hour speed limits on rural Local Roads on the 7th of February 2025 by the Department of Transport.

15.3.1.8 National and Regional Network

As shown in Figure 15-3, the R400 links with the M6 Motorway, north of Rhode, at the M6 Junction 3. The R402 extends southwest to the R420, on the southeast of Tullamore, where the R420 has a typical road carriageway width of 7m with hard strips. The R420 links with the N52 National Secondary Road at Tullamore. The N52 extends north of Tullamore to M6 Junction 5.

15.3.2 Existing Traffic Volumes

An onsite 24 hours classified traffic volumes survey was carried out by Idaso, on behalf of MWP, on the L5010 at the Proposed Development, on Thursday 14th March 2024.

Onsite peak traffic hours' classified road traffic volumes were recorded by MWP on Wednesday 16th October 2024, on the existing local and regional public roads, in the vicinity of the Proposed Development, including along the Proposed Grid Connection route and Proposed TDR. The recorded peak traffic hour at each location occurred between the hours 4.00pm to 6.00pm. The peak hour traffic volumes were factored on the basis of TII's automatic traffic counter data, for the nearby N52, to establish typical Annual Average Daily Traffic (AADT) volumes for the latest full year, 2023, on the local road network. The equivalent TII automatic traffic counter data for the M6 and N52 are also provided. The existing baseline traffic volumes are provided in Table 15-1. These are total two-way vehicles at the road locations identified. The volumes of peak hour Heavy Goods Vehicles (HGVs) and the proportions (%) of AADT HGVs are also provided.

Table 15-1: Existing Traffic Volumes

Road Location	Total Vehicles (HGVs)	
	2024 PM Peak Hour	2023 AADT (% HGVs)
L5010 @ WF site	15 (0)	154 (4.5%)
L5006, north of R402	63 (2)	647 (3.6%)
L5006, south of R402	70 (2)	712 (3.2%)
R401, south of L5006	251 (26)	2,573 (13.2%)
R400, north of R402	152 (4)	1,552 (2.7%)
R402 @ L5006 (Ballyfore)	366 (16)	3,745 (4.6%)
R402 @ R400 (Mount Lucas)	393 (17)	4,022 (4.5%)
R402 @ Edenderry	648 (14)	6,622 (2.2%)
M6 Motorway, west of Junction 5	1,743 (80)	20,071 (7.6%)
N52 south of M6	1,754 (55)	15,059 (7.3%)
R420 between N52 and R402	776 (40)	7,951 (5.3%)

The rural road link capacity of the R402 and R401 regional roads within the 80 km/hour rural speed limit zone, estimated on the basis of the TII Rural Road Link Design DN-GEO-03031 May 2023, for a typical road carriageway width of 6m, is provided in Table 15-2. The equivalent rural road link capacity of the R420 for its typical road carriageway width of 7m is also provided. The TII rural road link capacities are an AADT capacity at Level of Service (LOS) D. TII does not provide rural road link capacities for rural roads with typical road carriageway widths of less than 6.0m.

Table 15-2: Estimated Regional Rural Roads TII Road Link Capacity

Regional Rural Road	TII Rural Road Link		
	Type	Carriageway Width (m)	AADT Capacity (Vehicles)
R402 and R401 Rural Roads	Type 3 Single	6.0	5,000
R420 Rural Road	Type 2 Single	7.0	8,600

These AADT capacities are not relevant to Regional roads with widths less than 7m & do not apply in this area. Thus, the R402 Edenderry at 6,622 AADT is well over the capacity of far less than 5,000 AADT. Reducing the AADT for the R402 from 6622 in Table 15.1 to 4022 in Table 15.3 is questionable.

The estimated existing rural road link AADT volume/capacity ratios for the R402 and R401 rural roads in the vicinity of the Proposed Development, including along the Proposed Grid Connection, are provided in Table 15-3, on the basis of the TII Rural Road Link Design, for the latest full year, 2023. The equivalent estimated existing rural road link AADT volume/capacity ratio for the R420, between its N52 and R402 junctions, which is along the Proposed TDR, is also provided.

Table 15-3: Estimated TII Regional Rural Road Link 2023 AADT Volume/Capacity Ratios

80 km/hour Rural Road	2023 AADT Vehicles	AADT Capacity (Vehicles) @ LOS D	AADT Volume/Capacity Ratio
R402	4,022	5,000	81%
R401	2,573	5,000	52%
R420	7,951	8,600	93%

The R402 is operating within its estimated rural road link AADT capacity, with a 2023 volume/capacity ratio of 81%. The R401 is operating well within its estimated rural road link AADT capacity, with a 2023 volume/capacity ratio of 52%.

The R420, between its N52 and R402 junctions, is operating within its estimated rural road link AADT capacity, with a 2023 volume/capacity ratio of 93%.

15.3.3 Future Conditions

The roads and transportation objectives and policies of OCC are set out in their Offaly CDP 2021-2027. OCC has adopted a restrictive policy in relation to new development on certain regional routes in the interests of preserving the traffic capacity of these routes and in order to avoid the creation of traffic hazards. These include the northern section of the R400 between Rhode and the county boundary, the R402 and the R420. It is the Councils' objective to protect the capacity, efficiency and road safety of the foregoing Regional Roads.

The estimated existing rural road link AADT volume/capacity ratios for the R402, R401 and R420 rural roads in the vicinity of the Proposed Development, including along the Proposed Grid Connection and Proposed TDR, are provided in Table 15-7, on the basis of the TII Rural Road Link Design, for the predicted 2027, 2029, 2034 and 2044 AADT volumes, with the TII predicted traffic growth rates.

Table 15-7: Predicted TII Rural Regional Road Link AADT Volume/Capacity Ratios with TII Growth

80 km/hour Rural Road	Year	AADT Vehicles	AADT Capacity (Vehicles) @ LOS D	AADT Volume/Capacity Ratio
R402	2027	4,231	5,000	85%
	2029	4,340		87%
	2034	4,480		90%
	2044	4,684		107%
R401	2027	2,727	5,000	55%
	2029	2,807		56%
	2034	2,914		58%
	2044	3,084		62%
R420	2027	8,370	8,600	97%
	2029	8,589		100%
	2034	8,869		103%
	2044	9,284		108%

The R402 would continue to operate within its estimated rural road link AADT capacity at Level of Service (LOS) D, in 2027, 2029 and 2034, with volume/capacity ratios of 85%, 87% and 90%, respectively. The R402 would operate in excess of its LOS D AADT rural link capacity in 2044, with a volume/capacity ratio of 107%.

The R401 would continue to operate within its estimated rural road link AADT capacity at LOS D, in 2027, 2029, 2034 and 2044, with volume/capacity ratios of 55%, 56%, 58% and 62%, respectively.

The R420, between its N52 and R402 junctions, would operate within its estimated rural road link AADT capacity at LOS D, in 2027 with volume/capacity ratio of 97%. would operate at its LOS D AADT rural link capacity in 2029 (post the peak construction year 2027), with a volume/capacity ratio of 100%. Post the Proposed Development opening year (2029), the R420 would operate in excess of its LOS D AADT rural link capacity in 2034 and 2044, with volume/capacity ratios of 103% and 108%, respectively

15.4.1 Construction Phase

15.4.1.2 Access

Two site entrances are proposed to provide access to the northern and southern sections of the Proposed Wind Farm from the L5010.

Access for the Proposed Grid Connection and Proposed TDR construction works along public roads would be via the associated existing roads.

15.4.1.3 Hours and Duration

The proposed construction hours are 7.00am to 7.00pm, Monday to Friday and 7.00am to 4.00pm on Saturdays. On occasion, the working day may extend outside normal working hours when critical elements of the works need to be advanced.

15.4.1.4 Staff

The expected peak staff would be up to 60 construction personnel, which would generate approximately 40 car and van trips, both to and from the site each working day, on the basis of an average vehicle occupancy rate of 1.5 personnel per vehicle.

15.4.1.5 Delivery Vehicle Volumes

Subsoil and topsoil will be reused onsite where possible for landscaping, surplus soils will be stored in a designated spoil deposition area with the Proposed Wind Farm. Over the 18-month construction period, it's expected that up to 10,973 truckloads of construction materials will be delivered to the site, while around 623 loads, mainly from the Proposed Grid Connection works along the public road, will be removed. All construction materials would be transported using standard heavy vehicle delivery trucks with capacities of 10m3 and 20 tonnes, and 8m3 for concrete trucks. The peak daily and hourly imported loads would occur during periods of the substation access road/track works, turbine hardstand works, substation formation works and concrete works. The proposed construction works heavy vehicle loads are provided in Table 15-9.

Table 15-9: Proposed Construction Works Heavy Vehicle Loads

Total Construction (18 months)	Typical Daily	Peak Daily	Highest Hourly Peak
11,596	30	180	18

The abnormal loads associated with the Proposed Development would be delivered in consultation with OCC, other County Councils and TII motorway operators located along the proposed turbine delivery route and An Garda Síochána, during off-peak traffic periods. A total of 90 delivery vehicles would be required for the seven turbines in delivery convoys during the night. This could result in temporary delays for other local traffic during the off-peak traffic delivery periods.

15.4.1.6 Delivery Vehicle Routes

The potential material sources for the Proposed Development construction are detailed in Chapter 2 Description of the Proposed Development of this EIAR, and include likely suppliers located in the northwest, southeast and northeast of the Proposed Development site. The majority of materials for delivery to site will be sourced from local quarries.

It is envisaged that the delivery of construction materials would be typically circa 50% via the R400/R402, and circa 50% via the R5006/R402, but could be up to 100% via either direction during specific periods of construction. The haul routes to the Proposed Wind Farm are presented in Figure 15-4.

The routing for the delivery of the Proposed Wind Farm components is summarised in Chapter 2 and detailed in Appendix 2-2 TDR Assessment Report, and would be via the R5006/R402, R420, N52 and M6.

No construction delivery vehicles would access the site via the northern section of the L5006 and its Trimblestown Bridge on the Grand Canal.

15.4.1.7 Traffic Volumes

Traffic volumes have been calculated based on the spoil excavation and construction material volumes in Chapter 3 Engineering Table 3-1. The predicted typical daily volumes, peak daily traffic volumes and highest peak hour traffic volumes generated by the Proposed Development construction are provided in Table 15-10, including heavy vehicles (HVs).

Table 15-10: Proposed Construction Works Traffic Volumes

Total Two-Way Vehicles (HVs)		
Typical Daily	Peak Daily	Highest Peak Hour
140 (60)	440 (360)	36 (36)

The predicted 2027 AADT, peak daily and highest peak hour traffic volumes, on the existing local and regional roads in the vicinity of the Proposed Development site, with the proposed construction works' traffic volumes, are provided in Tables 15-11 and 15-12, respectively,

Table 15-11: Predicted 2027 AADT Traffic Volumes with Proposed Construction

Road Location	Total Vehicles (HVs)			
	AADT	Total Vehicles (inc HVs)	HVs Only	Change (%)
L5010 @ WF site	232 (38)	+70	+30	43.2%
L5006, north of R402	750 (56)	+70	+30	10.3%
L5006, south of R402	766 (35)	+18	+18	2.4%
R401, south of L5006	2,745 (396)	+18	+18	0.6%
R400, north of R402	1,701 (78)	+70	+30	4.3%
R402 @ L5006 (Ballyfore)	4,010 (225)	+70	+30	1.8%
R402 @ R400 (Mount Lucas)	4,301 (236)	+70	+30	1.7%
R402 @ Edenderry	7,023 (196)	+70	+30	1.0%
R420 between N52 and R402	8,440 (508)	+70	+30	0.8%

Table 15-12: Predicted 2027 Peak Traffic Volumes with Proposed Peak Construction

Road Location	Total Vehicles (HVs)			
	Peak Daily	Change	Highest Peak Hour	Change
L5010 @ WF site	382 (188)	+220 (180)	34 (18)	+18 (18)
L5006, north of R402	900 (206)	+220 (180)	83 (20)	+18 (18)
L5006, south of R402	801 (52)	+53 (26)	76 (5)	+3 (3)
R401, south of L5006	2,780 (413)	+53 (26)	265 (32)	+3 (3)
R400, north of R402	1,851 (228)	+220 (180)	175 (22)	+18 (18)
R402 @ L5006 (Ballyfore)	4,160 (375)	+220 (180)	399 (36)	+18 (18)
R402 @ R400 (Mount Lucas)	4,231 (206)	+220 (180)	427 (37)	+18 (18)
R402 @ Edenderry	6,953 (166)	+220 (180)	690 (33)	+18 (18)
R420 between N52 and R402	8,370 (478)	+220 (180)	825 (62)	+18 (18)

During the proposed 18 months construction duration, the proposed construction works would increase AADT volumes up to 70 vehicles, including 30 heavy vehicles, which equates to an AADT increase of up to 4.3% on During peak construction traffic generation periods, the peak daily increase in daily traffic volumes would be up to 220 vehicles, including up to 180 heavy vehicles. The construction highest peak hour increase in traffic volumes would be up to 18 heavy vehicles. The peak daily increase in traffic volumes generated by the proposed grid construction works along public roads would be up to 53 vehicles, including 26 two-way heavy vehicles.

15.4.1.8 TII TTA Assessment Thresholds

The predicted increases in AADT volumes on the existing R400, R402, R420 and R401 Regional Roads, during the Proposed Development 18 months construction phase, are less than the volumetric threshold (5%) identified by TII in their TTA Assessment Guidelines for consideration of sensitive locations.

15.4.1.9 Volume/Capacity Ratios

The estimated existing rural road link AADT volume/capacity ratios for the R402, R401 and R420 rural roads in the vicinity of the Proposed Development, including along the Proposed Underground Grid Connection route and Turbine Delivery Route, are provided in Table 15-13, on the basis of the TII Rural Road Link Design, for the predicted 2027 AADT volumes, with the TII predicted traffic growth plus the Proposed Development construction.

Table 15-13: Predicted TII Rural Regional Road Link AADT Volume/Capacity Ratios with TII Growth Plus Proposed Construction

80 km/hour Rural Road	Year	AADT Vehicles	AADT Capacity (Vehicles)	AADT Volume/Capacity Ratio
R402	2027	4,301	5,000	86%
R401	2027	2,745	5,000	55%
R420	2027	8,440	8,600	98%

The R402, R401 and R420 would continue to operate within their estimated rural road link AADT capacities at Level of Service (LOS) D, with the predicted 2027 AADT traffic volumes on the basis of the TII predicted traffic growth plus the Proposed Development construction, with volume/capacity ratios of 86%, 55% and 98%, respectively. This compares to ratios of 85%, 55% and 97%, respectively, without the Proposed Development construction.

15.4.1.11 Road Pavements Monitoring

HV traffic volumes generated by the Proposed Development construction could result in damage to existing and proposed road pavements on public roads, including at vehicle turning, accelerating and decelerating locations. To ensure the integrity of the local road network during the construction phase, a road pavement monitoring programme will be implemented. This will involve pre-construction road and bridge condition surveys on the haul routes on the L5010 and L5006, including photographic and structural assessments, to establish a baseline. Monitoring will continue throughout the construction period, with periodic inspections to identify any deterioration attributable to construction traffic, particularly from HVs. Post-construction surveys will also be carried out, and any damage directly linked to project activities will be repaired in consultation with OCC.

15.7 Mitigation Measures 15.7.1 Construction Phase
All traffic management and road signage will be in accordance with the Department of Transport (DoT) Traffic Signs Manual Chapter 8: Temporary Traffic Measures and Signs for Road Works. in agreement with Laois County Council and OCC.

In consultation with OCC's Roads Department, vehicle passing bays will be provided along the L5010, prior to the commencement of the proposed site construction, to facilitate two-way vehicle traffic movements.

Appendix 15 Ballinla WF Traffic Management Plan.pdf

2.2.2 Temporary Construction Compound
A temporary construction compound will be provided at the proposed substation site, and will include materials' storage/laydown areas, parking and staff facilities.

Temporary construction materials' storage for the Proposed Grid Connection Route along the public road network may be provided at existing site locations convenient to the works' locations, as the route works progress, which would be subject to the pre-approval of the planning authority prior to the works.

2.2.6 Delivery Vehicle Volumes
All construction material excavated for the Proposed Development and associated works would be retained onsite. Over the 18-month construction period**, it's expected that up to 10,973 truckloads** of construction materials will be delivered to the site, while around 623 loads, mainly from the Proposed Grid Connection works along the public road, will be removed. All construction materials would be transported using standard heavy vehicle delivery trucks with capacities of 10m3 and 20 tonnes, and 8m3 for concrete trucks. The peak daily and hourly imported loads would occur during periods of the substation access road/track works, turbine hardstand works, substation formation works and concrete works.

2.6.1 Materials Haulage Routes

The potential material sources for the proposed development construction are detailed in Chapter 2 Description of the Proposed Development of the EIAR, It is envisaged that the delivery of construction materials would be typically circa 50% via the R400/R402, and circa 50% via the R5006/R402, but could be up to 100% via either direction during specific periods of construction. The haul routes on the local road network at the Proposed Development are outlined in Figure 2-1. The routing for the delivery of wind turbine components is detailed in Appendix 2-2 Turbine Delivery Route Assessment Report, and would be via the R5006/R402, R420, N52 and M6.

No construction delivery vehicles would access the site via the northern section of the L5006 and its Trimblestown Bridge on the Grand Canal.

2.6.3 L5010 Vehicle Passing Bays

In consultation with OCC's Roads Department, vehicle passing bays will be provided along the L5010, prior to the commencement of construction, to facilitate two-way vehicle traffic movements.

2.7 Transport Management System

The Transport Management System (TMS) for the Proposed Development will serve as a comprehensive framework to coordinate and control all transport-related activities throughout the lifecycle of the project. This system is designed to ensure the safe, efficient, and environmentally responsible movement of personnel, materials, and equipment to and from the site, while minimising disruption to the local community and road network.
The TMS will include a centralised scheduling system to manage deliveries, particularly during peak construction phases.
All deliveries, including abnormal loads such as turbine components, will be pre-scheduled and coordinated with local authorities, including An Garda Síochána and OCC. Escort vehicles will accompany abnormal loads and temporary traffic control measures.

A Just-in-Time (JIT) delivery approach will be adopted to reduce on-site congestion and limit the environmental footprint of transport activities. Materials and turbine components will be delivered only when required, minimising the need for storage and reducing the number of vehicles on local roads. This strategy will be supported by dynamic scheduling tools and close coordination with suppliers to ensure timely and efficient deliveries aligned with construction progress.

To support the safe movement of vehicles, the TMS will incorporate real-time communication protocols between site personnel, delivery drivers, and traffic marshals. This will be supported by the use of GPS tracking for key deliveries and a site-based logistics coordinator responsible for overseeing daily transport operations.

The system will enforce strict adherence to designated haul routes, speed limits, and delivery time windows to avoid sensitive periods.

Table 16-4: Shadow Flicker Results adjusted for Average Regional Sunshine Hours

House	Total Hours per year		Max Hours per day	
	(Theoretical Conservative Scenario)	(Adjusted Annual Regional Sunshine Scenario)	(Theoretical Conservative Scenario)	(Adjusted Daily Regional Sunshine Scenario)
1	21.9	6.1	0.45	0.13
2	25.3	7.1	0.46	0.13
3	29.7	8.3	0.46	0.13
4	30.9	8.7	0.47	0.13
5	31.4	8.8	0.47	0.13
6	28.6	8.0	0.48	0.13
7	27	7.6	0.48	0.13
8	25.4	7.1	0.48	0.13
9	38.2	10.7	0.47	0.13
10	18.7	5.2	0.46	0.13
11	37.3	10.4	0.47	0.13
12	35.5	9.9	0.46	0.13
13	33.6	9.4	0.46	0.13
14	31	8.7	0.47	0.13
15	28.8	8.1	0.48	0.13
16	30.9	8.7	0.47	0.13
17	31.4	8.8	0.51	0.14
18	30.6	8.6	0.51	0.14
19	30	8.4	0.5	0.14
20	34.2	9.6	0.53	0.15
21	33.8	9.5	0.53	0.15
22	29.7	8.3	0.51	0.14
23	30	8.4	0.54	0.15
24	24.4	6.8	0.5	0.14
25	24.6	6.9	0.52	0.15
26	22.5	6.3	0.5	0.14
27	15.7	4.4	0.47	0.13
28	19.5	5.5	0.49	0.14
29	8.6	2.4	0.36	0.10
30	16.1	4.5	0.48	0.13
31	5.9	1.7	0.31	0.09
40	24	6.7	0.44	0.12

House	Total Hours per year		Max Hours per day	
	(Theoretical Conservative Scenario)	(Adjusted Annual Regional Sunshine Scenario)	(Theoretical Conservative Scenario)	(Adjusted Daily Regional Sunshine Scenario)
41	28.8	8.1	0.45	0.13
42	29.5	8.3	0.45	0.13
43	35	9.8	0.57	0.16
44	79.2	22.2	0.83	0.23
45	85.5	23.9	0.84	0.24
46	113.7	31.8	1.41	0.39
47	33	9.2	0.5	0.14
48	65.1	18.2	1.27	0.36
49	38.5	10.8	0.57	0.16
50	73	20.4	0.61	0.17
51	63.2	17.7	0.57	0.16
52	70.9	19.9	0.61	0.17
53	60	16.8	0.53	0.15
54	65.3	18.3	0.7	0.20
55	32.6	9.1	0.47	0.13
56	7.5	2.1	0.33	0.09
57	1.4	0.4	0.16	0.04
58	56.2	15.7	1.13	0.32
59	71.4	20.0	1.26	0.35
60	93	26.0	1.19	0.33
61	39.3	11.0	0.65	0.18
62	21	5.9	0.45	0.13
63	54.1	15.1	0.78	0.22
64	53.5	15.0	0.62	0.17
65	47.9	13.4	0.52	0.15
66	47.7	13.4	0.5	0.14
67	45.3	12.7	0.51	0.14
68	52.8	14.8	0.52	0.15
69	23.6	6.6	0.54	0.15
70	25	7.0	0.5	0.14
71	18.4	5.2	0.52	0.15
72	18.2	5.1	0.52	0.15
73	18.2	5.1	0.52	0.15
74	17.5	4.9	0.52	0.15
75	17.7	5.0	0.52	0.15
76	19.3	5.4	0.55	0.15
77	19.1	5.3	0.55	0.15

House	Total Hours per year		Max Hours per day	
	(Theoretical Conservative Scenario)	(Adjusted Annual Regional Sunshine Scenario)	(Theoretical Conservative Scenario)	(Adjusted Daily Regional Sunshine Scenario)
78	18.7	5.2	0.54	0.15
79	18.6	5.2	0.55	0.15
80	19.8	5.5	0.57	0.16
81	36.8	10.3	0.65	0.18
82	37.2	10.4	0.65	0.18
83	21.2	5.9	0.59	0.17
84	23.7	6.6	0.62	0.17
85	23.7	6.6	0.63	0.18
86	23.9	6.7	0.63	0.18
87	20	5.6	0.57	0.16
88	20	5.6	0.57	0.16
89	19.3	5.4	0.56	0.16
90	18.9	5.3	0.56	0.16
91	17.9	5.0	0.54	0.15
92	14.8	4.1	0.49	0.14
93	13.4	3.8	0.46	0.13
94	15.4	4.3	0.49	0.14
95	32.2	9.0	0.67	0.19
96	18.7	5.2	0.51	0.14
97	20.3	5.7	0.52	0.15
98	25.7	7.2	0.55	0.15
99	35.4	9.9	0.6	0.17
100	32.3	9.0	0.53	0.15
101	12.8	3.6	0.43	0.12
102	13.2	3.7	0.42	0.12
104	6.3	1.8	0.3	0.08
109	3.2	0.9	0.21	0.06
110	12.4	3.5	0.39	0.11
111	13.4	3.8	0.4	0.11
116	30.3	8.5	0.44	0.12
117	25	7.0	0.45	0.13
118	17.1	4.8	0.45	0.13
119	16.5	4.6	0.46	0.13
120	15.6	4.4	0.45	0.13
121	20.7	5.8	0.48	0.13
122	26.7	7.5	0.47	0.13
123	24.4	6.8	0.46	0.13

House	Total Hours per year		Max Hours per day	
	(Theoretical Conservative Scenario)	(Adjusted Annual Regional Sunshine Scenario)	(Theoretical Conservative Scenario)	(Adjusted Daily Regional Sunshine Scenario)
124	33.1	9.3	0.47	0.13
125	35.1	9.8	0.5	0.14
126	33	9.2	0.51	0.14
127	30.2	8.5	0.51	0.14
128	26.6	7.4	0.51	0.14

Note Shadow Flicker of 113.7hrs per annum, over 141 days from Table 16.2 for House No. 46. This is based on the Model, which isn't provided & the incorrect grid references. These numbers are not reliable. This level of exposure is very significant.

17.2.1 Population and Human Health

During the construction phase there is potential for adverse effects on population and human health in relation to material assets, traffic and transport, water, air quality, noise and vibration and landscape and visual resources.

The construction phase of the Proposed Development will give rise to increased traffic including abnormal loads for delivery of turbine components and is likely to create some short-term inconvenience for other road users. A CTMP will be implemented to manage traffic coming to and from the Proposed Development and minimise disturbance to local residents. Plant and machinery used during the construction phase have the potential to cause short term disturbance through noise and dust emissions. This interaction of effects may also occur at the decommissioning phase of the development.

The impacts are considered to be temporary and mitigation measures are set out to ensure no significant interaction effects on population and human health arise. These effects have an insignificant potential to pollute and create temporary disturbance for occupants of nearby dwellings. The interactive effects are likely to be short term and not significant.

During the operational phase, however, there is potential for long term adverse effects on population and human health in relation to landscape and visual and noise and vibration effects. At the same time the Proposed Development will have slight positive effects on air quality, climate change and energy security. The interactive effects are likely to be long term and not significant.

17.2.2 Biodiversity and Ornithology

Bird species associated with aquatic habitats (e.g. kingfisher, little egret, whooper swan) may be indirectly affected by changes in water quality or hydrological regimes.

Construction and operational noise may cause disturbance or displacement of sensitive bird species, particularly during the breeding season.

While primarily focused on human receptors, landscape and visual changes may also influence bird behaviour, particularly for species sensitive to changes in open vistas or those that rely on visual cues for navigation.

17.2.3 Water

The potential effects associated with surface water and ground water due to the construction and operational phases of the Proposed Development are addressed individually and in detail, in particular in relation to suitable mitigation measures to minimise effects, within the preceding individual chapters.

17.2.4 Land and Soils

The excavation, stockpiling and movement of soil for the Proposed Development has the potential to effect air quality from increased dust emissions associated. There is also potential for related effects on surface and ground water, biodiversity, heritage, landscape, noise and vibration and traffic and transportation

17.2.5 Noise and Vibration

Noise and vibration have the potential to effect population and human health, land and soils, biodiversity and traffic and transportation.

These adverse interactions of biodiversity and ornithology, land and soil, water, air quality and climate, noise, and traffic and transport effects are likely to result in not significant effects. Due to the distance of the proposed works from sensitive locations vibration effects are not likely to arise.

During the operational phase, the only minor noise effects will be associated with the turbine operations and maintenance traffic. This noise will have long-term, not significant effects on population and human health (for nearby residents) and biodiversity.

17.2.6 Landscape and Visual Effect

During the operational phase, the proposed turbines will be prominent in some views from very close to the site and will be visible from certain long-distance viewpoints. Overall, the Proposed Development will be visible from a number of different viewpoints, the sensitivity was generally assessed as Medium-low for these receptors, this reflecting typical views influenced by a combination of the surrounding working landscape and wind energy development.

17.2.7 Cultural Heritage

As cultural heritage is an integral component of landscape character, any alteration to the setting or visibility of heritage assets may result in indirect impacts on the perceived landscape during the operational phase. These interactions extend to land and soils, where changes in land use and soil structure may influence the integrity of heritage features embedded in the terrain. Additional interactions may occur with water, where changes in drainage or sedimentation could affect waterlogged archaeological sites, and with noise and vibration, which may pose risks to built heritage during construction. Given that cultural heritage is a component of landscape character, the indirect effects on cultural heritage also have potential to affect the landscape character during the operational phase.

17.2.8 Air Quality and Climate

Once operational, it is generally accepted that the Proposed Development will make a slight, indirect, positive contribution to air quality and climate and population and human health. These interactive effects are likely to be long term and slightly positive.

Wake effects are not included

17.2.9 Material Assets – Built Services

17.2.10 Material Assets- Traffic and Transport

During the construction phase there is potential for adverse interactive effects between traffic and transport and population and human health, air quality, material assets, landscape and visual, and noise and vibration. These effects have an insignificant potential to pollute and create temporary disturbance for occupants of nearby dwellings.

During the operational phase there is potential for long term imperceptible adverse interactive effects on population and human health, landscape and visual, and noise and vibration effects.

17.2.11 Shadow Flicker

The Proposed Development has the potential to give rise to long term shadow flicker and visual effects on the health of residents of surrounding dwelling during the operational phase only. Wind turbines will, however, be equipped with a shadow flicker module to prevent shadow effects at critical times so that there will be no shadow flicker at sensitive receptors/nearby dwellings during the wind farm operational phase.

The operational phase is forty years & the applicant may have disposed of the development as has happened with nearby windfarm developments in Offaly. Software has a habit of breaking down or becoming obsolete. A simpler method would be to shut off the turbines for the two-hour period each day.

The findings in each chapter of the EIAR require to be substantiated & accurate in relation to grid coordinates & separation distances to allow a robust assessment of the potential interactions of effects. The use of loose English to confuse is not acceptable. In the absence of adequate detailing and survey results to substantiate the applicants conclusion in relation to significant impacts on the environment, interaction, #=======

Major Accidents and Natural Disasters

The report outlines the potential risks and any likely significant environmental effects arising from any vulnerability of the proposed development to risks of major accident and/or natural disasters. The potential natural disasters that may occur are identified as flooding and fire.

The report concludes that the scenarios with the highest risk are contamination and fire/explosion. There is a potential risk of contamination from Proposed Development site activities during the construction, operational and decommissioning phases from potential release of hydrocarbons. Mitigation measures, which are included to reduce the risk of accidental spillage and contamination of pollution risk to groundwater are not adequate, where they failed to identify a Geological Fault traversing the site.

No fire safety risk assessment was provided, which could have assisted in the identification of any major risks of fire on Proposed Development, and mitigation of the same during operation

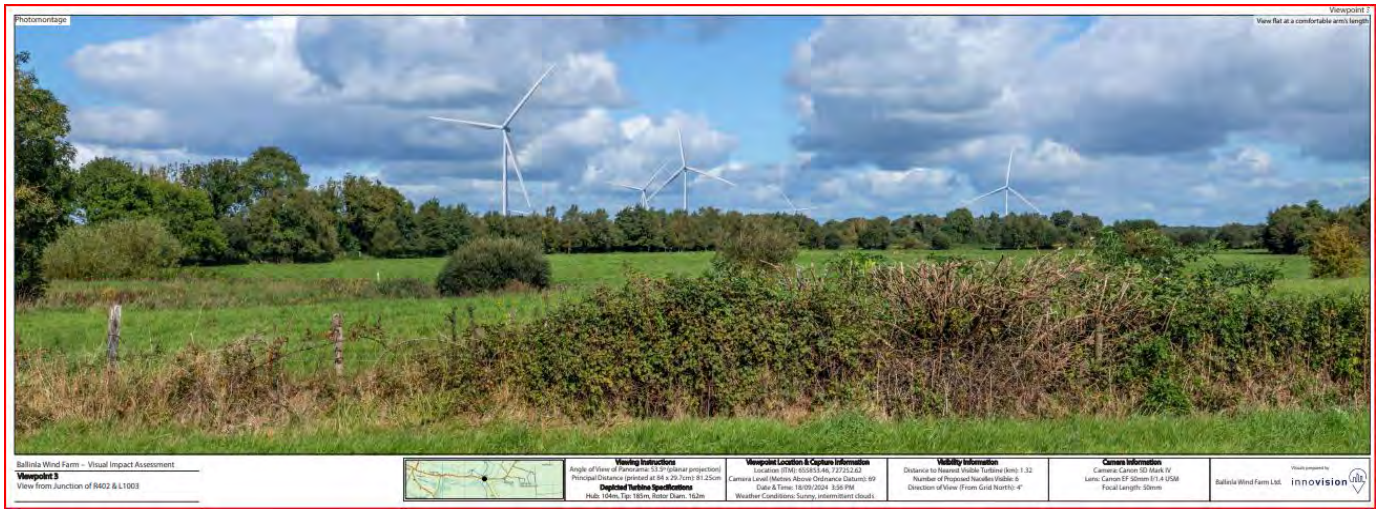
Interactions of Effects

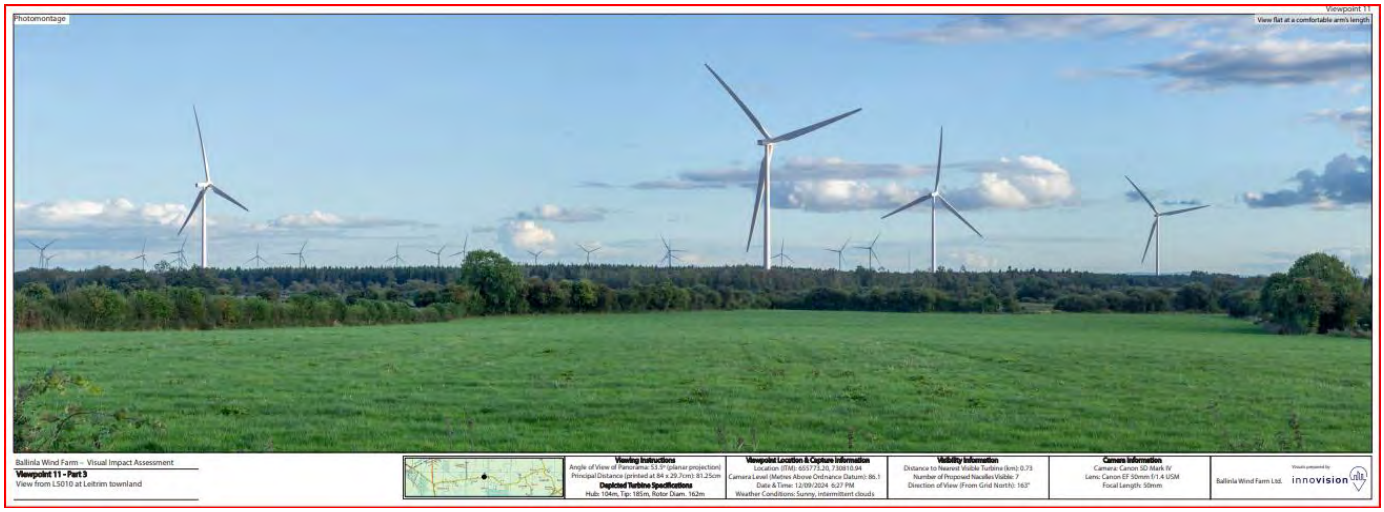
The findings in each chapter of the EIAR require to be substantiated to allow a robust assessment of the potential interactions of effects. In the absence of adequate detailing and survey results to substantiate the applicant's conclusion in relation to significant impacts on the environment, interaction, a thorough assessment of potential interactions of effects cannot be carried out.

Schedule of Mitigation Measures

The interaction of effects, having regard to the environmental impact assessment & the effectiveness of proposed mitigation measures cannot be relied upon due to the information gaps and inadequacy of the EIAR.

Ballinla_WF_Photomontage_Booklet_2025_07_03_web.pdf





Note 6 photomontages of nearby rural areas determines that the effect of the proposed development is hugely significant on the sensitive receptors.

4.2.4.2.15 Proposed Grid Connection

Although subject to a separate planning application, the Proposed Grid Connection to the national electricity grid has been assessed as part of this AA screening to ensure a comprehensive understanding of potential cumulative impacts. The connection comprises a 110kV underground cable extending approximately 8km from the proposed 110kV substation to the newly constructed Philipstown 110kV substation. The route follows internal access tracks for approximately 0.5km before entering the public road network at the L-5010. From there, the cable runs east for 2km to the L-5006, then south for 5km along the L-5006, and finally 1km along the R401 to the grid connection point. The alignment primarily follows existing road corridors, minimising land take and environmental disturbance. The cabling will be installed using open-cut trenching within the road carriageway or roadside verge, depending on site-specific constraints. Typical trench dimensions will be approximately 1.2m wide and 1.2m deep, with cable ducts laid in a sand or fine gravel bed and backfilled with suitable material. Where required, temporary traffic management measures will be implemented to ensure safety and minimise disruption.

Joint bays will be installed at regular intervals (typically every 500m to 1,000m) to facilitate cable splicing. These will involve localised excavation of larger pits, typically 3m x 2m in size, and will be reinstated upon completion. Additional infrastructure such as link boxes and marker posts will be installed at accessible locations for maintenance purposes. The Proposed Grid Connection includes approximately 18 watercourse crossings, comprising one EPA-mapped stream and multiple agricultural land drains. Crossing methodologies for land drains will be selected based on site-specific hydrological and ecological sensitivities and may include open-cut trenching during dry periods, installation through existing culverts. HDD will be adopted at the EPA registered water crossing to avoid direct disturbance. HDD is also proposed for the identified Bord na Móna rail crossings near Edenderry Power Station.

All disturbed areas, including verges and hedgerows, will be reinstated following construction in accordance with best practice and landowner agreements

4.2.4.3 Operational Phase

The Proposed Development is expected to have a lifespan of circa 35 years. The Proposed Development is designed to operate when wind speeds at the hub height are within the operating range of the wind turbines. Most turbine models have a cut in wind speed of 3m/s with optimum generation at approximately 12.5m/s. The turbines are expected to have a cut out wind speed of 25m/s.

The alternative routes for a grid connection are not included with this application.

Ballinla Wind Farm Planning Report.pdf

Through the assessment of the submitted EIAR and planning documentation, **there are concerns in relation to the information submitted and proposals for excessive levels of potential adverse impact which cannot be mitigated against, particularly impacts of landscape and visual effects, shadow flicker and noise, impact on roads infrastructure and capacity due to grid connection works.** The separation distances are not remotely in compliance with the 2006 or 2019 Wind Energy Guidelines & the separation distances to sensitive receptors are grossly exaggerated, which impact on operational noise & shadow flicker. The suggestion that the Regional Roads are within capacity for AADT are also wrong. These fundamental effects are incapable of being mitigated because they arise from the location, extent and scale of the proposed works and their proximity and position relative to local dwellings and the receiving environment.

We observed at site inspections and internal observations as well as having regard to the location, scale and design of the proposed development, relative to existing dwellings and sensitive receptors in the receiving environment, that the view that that the **proposed development will give rise to significant effects on many nearby dwellings in the receiving environment**, in particular local dwellings to the east in the townland of Leitrim. The impact arises from the extent and scale of the proposed works for and as a result of the erection of the wind turbines, their relative close proximity and their operational impact being upwind to these dwellings. The cumulative effects of the proposed development will also impose an unreasonable and disproportionate environmental loading on the rural population of the overall receiving area.

While proximities between individual turbines and individual dwellings appear to fall beyond the 700m considered in the 2019 draft guidelines, this is by no means currently a definitive distance beyond which no impact is assumed or expected. We consider that the cumulative effects visual, noise and shadow flicker would exceed the reasonable threshold of what a local population can be expected to tolerate.

The development is also considered within the context of the existing and proposed wind farms to the south & south-west and east of the site, together with a 8km grid connection route extending on Local roads connecting to the Phillipstown substation. Previous guidelines and policy are somewhat limited in application to the proposed development having regard to the turbine height of 185m. Older policies were also framed at a time when the existing and permitted windfarms did not exist to provide a policy context. In addition, scientific knowledge and recent court case judgements in relation to impacts associated with noise have significantly advanced over the last number of years which are not, as yet incorporated into the guidelines. Cumulative exposure to noise and highly contrasting visual intrusion will fundamentally alter the landscape character of the immediate area containing numerous dwellings with similarly high levels of effects on a further number of dwellings. Furthermore, the cumulative impacts will have adverse impacts for a wider catchment of residents and services, having regard to significant volumes of construction traffic, disruptions and diversions associated with the subject site and grid connection, which may run sequentially or in tandem with permitted grid connection route works. **These factors militate against a grant of permission on the grounds of excessive and adverse impacts on residential amenities.**

Following the above assessment, the following is concluded:

- there are significant deficiencies in the quality and quantum of data provided, particularly in the areas of landscape and visual effects, noise, archaeology & separation distances between turbines & between turbines & sensitive receptors.

- insufficient detail has been provided on the matter of cumulative effects, especially in regard to the likely effect on the residential amenity of the immediately adjacent residential areas,

- there is evidence that the proposed turbines, by reason of their size and scale, will give rise to excessive levels of adverse effects on residential amenity due to the cumulative effects of visual intrusion, combined with noise, flicker and disturbance of access on many nearby dwellings in and around the townland of Leitrim. These effects are integral and incapable of being mitigated because they arise from the extent and scale of the proposed works and their proximity and position relative to dwellings.

- We consider that the substation, by virtue of its location on a prominent site, will fail to successfully integrate into the landscape and will be visually obtrusive in the landscape for many years to come.

- The applicant has failed to demonstrate that the proposed 38kv grid connection cable route running from the site via the Local Roads to the Phillipstownt sub-station is the optimal routing solution in line with objectives of the Climate Action Plan 2024 and NRA guidelines. In the absence of demonstrating that the proposed grid connection is technically feasible, the proposed development presents a significant risk to the local road network.

- The applicant has failed to adequately assess or demonstrate that the proposed development would not have significant adverse impacts on sub-surface archaeology.

- A significant portion of this site lies within a karst aquifer with numerous local wells, further boreholes need to be excavated to investigate increased fissuring/karstification at Turbine foundations, and substation. There is also a Fault on site which could indicate the presence of underground rivers or caves. The karst aquifer, further increased karstification of the area and presence of wells & fault indicate to a high chance that there are karst conduits running throughout this site. No further investigations have been carried out in this regard and the applicant has not conclusively demonstrated that the proposed development would not impact the groundwater in this regard.

- We do not consider that that all impacts could be overcome by means of the substantial further information which would be required to address the highlighted deficiencies in the EIAR.

Balancing nature and economic interests in the European Union: On the concept of mitigation under the Habitats Directive. Lorenzo Squintani. c 2019 The Author. *Review of European, Comparative & International Environmental Law* Published by John Wiley & Sons Ltd. wileyonlinelibrary.com/journal/reel. DOI: 10.1111/reel.12292

"THE FOUR CRITERIA TO ESTABLISH A MITIGATION MEASURE"

3.1 | Mitigation measures in context

Article 6 of the Habitats Directive gives teeth to the Directive by establishing proactive, preventive and procedural requirements for the conservation of Natura 2000 sites. This provision refers to three kinds of measures: conservation, preventive and compensatory measures. It does not refer to mitigation measures. Before discussing what the latter measures are, it is important to briefly explain what the former three measures are, in order to distinguish between them.

***Conservation measures** are covered by Article 6(1) of the Directive. These measures focus on positive and proactive interventions to maintain and improve the status of conservation of a Natura 2000 site. Any measure leading to deterioration therefore falls outside the realm of this concept.*

***Preventive measures** are envisaged under Article 6(2) of the Directive and aim at avoiding deterioration, similarly to conservation measures. Yet these kind of measures do not need to take the form of positive action, as in the context of Article 6(1). Non-action is also a form of preventive measure, if it prevents damage from occurring. What matters under this provision is avoiding disturbance that is likely to affect the objectives of the Directive significantly, particularly its conservation objectives in relation to Natura 2000 sites.*

*Compensation measures are mentioned in Article 6(4) of the Directive, which establishes an exception to the obligation contained in Article 6(3). Together, Articles 6(3) and 6(4) describe a two-step – or, in case the derogation clause is used, a three-step – procedure for granting development consent to plans or projects likely to have a significant effect on a Natura 2000 site, based on a 'first come, first serve' approach. The concepts of 'plan' (such as land-use plans, sectoral plans, etc.) and 'projects' (such as construction works or other interventions in the natural environment) have to be interpreted broadly, and **include also developments outside a Natura 2000 site**, which are likely to have a significant effect on it (the so-called 'external effect'**). In light of the precautionary principle, the assessment of the effects of plans of projects inside or outside Natura 2000 sites – either individually or in combination with other plans or projects (so-called cumulative impacts) – is based on the likelihood of effects, not on their certainty**. If the screening phase indicates **the presence of a potentially significant negative effect, an appropriate assessment needs to be performed, in light of***

the site's ecological functions and conservation objectives. A negative outcome should lead to the refusal of authorization.

Yet, Article 6(4) of the Directive specifies that if, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, a Member State must take all compensatory measures necessary to ensure that the overall coherence of a Natura 2000 site is guaranteed. All the constitutive elements of this derogation clause have to be interpreted restrictively, for balancing environmental protection and economic development. In particular, the concept of compensation measures entails, typically, the designation of like-for-like replacement habitat. In the view of the European Commission, what matters is that the function performed by the affected site is successfully recreated elsewhere.

Adequate implementation and enforcement of Article 6 of the Directive strengthens nature conservation. Yet the complex relationship between Articles 6(3) and 6(4) has led to uncertainty as to what 'adequately implemented and enforced' means, and where 'gold-plating' starts. In particular, in certain Member States questions have arisen on the extent to which measures adopted to avoid damage can be taken into account in concluding that no significant adverse effect will occur.

It is here that the concept of mitigation measures enters into the legal discussion under Article 6 of the Directive, creating much uncertainty, and potential abuses.

Thanks to the judgments in the Waddenzee, Sweetman, Briels and Orleans cases, it can confidently be established that mitigation measures are allowed under the Habitats Directive only if four cumulative requirements are met:

(i) the measure aims at preventing the damage caused by a specific plan/project (functional linkage criterion);

(ii) the measure must ensure that this damage (specificity criterion);

(iii) will be prevented (prevention criterion); and

(iv) that there is no doubt about this preventive effect (no-doubts criterion).

In Sweetman, the Court clarified that the specificity criterion refers to each individual conservation objective, justifying the designation of that site in the list of Sites of Community Importance (SCIs) in accordance with the Directive. Similarly, from Briels it is clear that, under the prevention criterion, measures provided to replace a damaged area with another cannot be taken into account in the assessment of the implications of a project provided for in Article 6(3). In the judgment under review, the Court confirmed both criteria by stating: the case-law relating to Article 6 of the Habitats Directive requires a distinction to be drawn between protective measures forming part of the plan or project at issue and intended to avoid or reduce any direct adverse effects caused by it, in order to ensure that that plan or project does not adversely affect the integrity of the sites concerned, which are covered by Article 6(3), and measures which, in accordance with Article 6(4), are aimed at compensating for the negative effects of the plan or project on that site and cannot be taken into account in the assessment of the implications of that plan or project on that site …

Moreover, according to the Court's case-law, it is only when it is sufficiently certain that a measure will make an effective contribution to avoiding harm to the integrity of the site concerned, by guaranteeing beyond all reasonable doubt that the plan or project at issue will not adversely affect the integrity of that site, that such a measure may be taken into consideration in the 'appropriate assessment''within the meaning of Article 6(3) of the Habitats Directive

The use of the adverb 'likely' in Article 6(3) of the Directive was clearly linked to the precautionary principle by the Court of Justice already in the Waddenzee case. Since then, the requirement that there should be no scientific doubt about the ability to prevent the specific damage of a specific project has gained clarity. The Court of Justice made clear that there are two ways of complying with this criterion.

First, a proposed measure can qualify as a mitigation measure under Article 6(3) of the Directive if, at the moment of the authorization of the plan or project, 'the procedures needed to accomplish the alleged mitigation measures have already been carried out'. Clearly, the implementation of a mitigation measure makes it easier to analyse whether the significant negative effects of a plan or project have been avoided or not.

The concept of 'project' must be interpreted broadly. The PAS (Dutch Programma Aanpak Stikstof 2015–2021, PAS) judgment clarifies that this concept is probably even broader than originally thought. Indeed, not only the Court of Justice defines this concept without linking it to that used in the EIA Directive, that is, by covering activities not covered by the EIA Directive. Most importantly, the Court defines it by linking its meaning to the effects of the activities on the protected site. Indeed, the Court states that it is important to examine whether such activities are likely to have a significant effect on a protected site. This is an effects-based test, which is capable of covering any kind of activity, even the spreading of fertilizers.

In the context of the establishment of mitigation measures, following Briels, it remained unclear whether mitigation measures have to be 'functionally' linked to a project development, that is, whether the proposed measures are part of the scrutinized project or of a mitigation scheme or restoration programme that does not take into account the specific project under scrutiny. Following Orleans, the present judgment confirms that a proposed mitigation measure must aim at avoiding the damage caused by the plan or project under scrutiny specifically. Management plans and generic restoration measures taken under Articles 6(1) and 6(2) of the Habitats Directive can be taken into account under the concept of mitigation measures when scrutinizing a specific project only if they specifically address the negative effects of that project.

What matters is that there is no reasonable scientific doubt as to the absence of adverse effects of each plan or project on the integrity of the site concerned. Therefore, there is no de-linking effect, meaning that the conservation goals of the Directive can be used to review the appropriateness of the assessment of a specific plan, differently than in other fields of EU environmental law, such as under the Nitrates Directive

The approach to the no-doubts criterion is a very stringent one. It stems from the Orleans case, in which the Court of Justice ruled that only those measures which are completed at the moment of the appropriate assessment can be taken into account as mitigation measures. Orleans concerned the development of a large part of the port of Antwerp (Belgium), affecting a Natura 2000 site. The Court found that the Belgian Regional Development Implementation Plan allowing the project only did so after the sustainable establishment of habitats and habitats of species in core ecological areas. Second, the Court ruled that a decision would have to declare that habitats in the nature reserves had in fact been sustainably created, and the application for a planning permit relating to implementing the intended use of the area concerned would also have had to include that decision. Accordingly, the negative effects would have taken place only after that certainty regarding the effectiveness of the positive effects had been proven.

Yet, the Court ruled that such certainty would have been acquired only after the plan had been adopted, and thus that the proposed measures could not qualify as mitigation measures under Article 6(3) of the Directive.

The second way in which a measure could qualify as a mitigation measure under Article 6(3) of the Directive is when there is no scientific doubt about the effectiveness of the proposed measure.

This means that, even when a measure has not been carried out yet, it is still possible to speak of a mitigation measure. What matters is that there is scientific certainty about the effectiveness of such a measure, thus avoiding the significant damage that would otherwise occur. This criterion is clearly less demanding than the previous one. Still, the question is when scientific certainty exists about the effectiveness of a measure. This criterion could therefore be more difficult to fulfil in practice than it seems. It is still unclear what burden of proof the Court would consider to be sufficient under this approach. In the present judgment, the Court left this matter to the national court to decide, in an exercise of judicial subsidiarity. Yet, it cannot be discounted that the Court of Justice will formulate some guidance in future case law if called upon to clarify this issue.

Roads

It seems that the route of delivery for the wind turbines & nacelles could be from a number of ports. There are many overbridges between these ports & the site with a maximum clearance of 5.03m. No indication is provided as to how these turbines will pass under these overbridges.

The weight of the nacelle is c400tonnes & no assessments or knife edge load assessments are provided for the structural capacities of River, Stream or Culvert crossings plus watermain & gas pipeline crushing. The Applicant does not include the weight of the nacelle in his application. Bridge damage might not be immediate. This is similar to the ESB Generators locked in Dublin Port as the M50 Westlink bridge couldn't carry the weight.

The proposed development is located along a legacy narrow roadway L5010 with limited passing facilities. The granting of this industrial facility will negate the level of safety for the local residents. The additional development is likely to lead to an over intensification of traffic on a local road without footpaths. The proposed development is premature pending major road improvement works to allow lorries to pass each other. The proposed development may also need for third party cooperation to improve the road as the existing carriageway has an average width of only 3.5 metres. The overuse of the substandard local road by commercial lorries has both the potential to endanger pedestrian safety, due to the absence of a footpath, by reason of traffic hazard and create obstruction at times when two trucks are attempting to pass. The proposed development located on such a narrow local road is likely to constitute a risk to pedestrian safety.

The proposed development is located on the L5010 local road that is substandard in terms of width and alignment. The scale of traffic generated by the proposed development over the R402, L5006 & L5010 both at construction and operational stage would render the road unsuitable to carry the increased loads arising from the development, would endanger public safety by reason of traffic hazard and obstruction of road users, Children, Pedestrians & Cyclists, would be premature having regard to the deficiency in the road network serving the rural area within which the site is located, would set an undesirable precedent for similar development of this scale and nature elsewhere & would seriously injure the residential amenities of the area and would therefore be contrary to the proper planning and sustainable development of the area.

The Development would lead to an over intensification of traffic on a substandard local road. It is, therefore, recommended that the development be refused due to the hazard and obstruction concerns outlined above.

The proposed development of a windfarm facility is not serviced by a suitable transportation network.

The road network is not ideally suitable for the scale of construction traffic required to develop the Windfarm Facility.

The development is totally dependent on the transport of construction materials, labour and raw materials by substandard/restricted roads.

The road network is primarily a network of "legacy roads". These roads do not have a road structure as envisaged in the design standards. Rather the network depends on the periodic replacement of a thin road surface course or courses without the necessary road capping layer and sub-base being present beneath (directly on the subgrade). This renders the road liable to significant damage from HGV traffic (especially over-weight vehicles) caused by the transfer of wheel loads to the subgrade at stress levels above that which the subgrade can support.

Turbine locations

Grid references for the 7 turbines in a N/S alignment.

Using Excel to calculate the distances between Turbines, it can be seen that the distances range from 502m, 584m, 662m, 697m, & 825m.

The 2006 & 2019 Wind Energy Guidelines specify a separation factor of 7 for prevailing downwind & 3 crosswind.

The spacings for the N/S turbines should be 1.134km downwind & E/W should be 486m crosswind & not as indicated.

Wind Turbine Separation Distances Matter, June 2014. Peter R Mitchell, AM, BChE

"Evidence is that the manufacturer-recommended separation distances of 7 to 8 rotor diameters for turbines in line with the prevailing wind and 5 rotor diameters for turbines abreast, still allows turbulent air exiting one turbine to retain significant turbulence when entering the next; so the manufacturers' recommended spacings can be considered as an unfortunate compromise and inadequate to contain noise.

The most efficient turbine spacing, i.e., that which allows the turbines to economically extract the most energy from the wind, has been shown to be some 15 rotor diameters. Most efficient extraction of useful energy will approximately coincide with the least production of waste energy, namely sound and vibration.

The Waubra Foundation currently considers that for a block of turbines that is likely to be subject to changing wind directions, noise will be minimised if the turbine spacing in all directions approaches the most efficient spacing of about 15 rotor diameters.”. http://waubrafoundation.org.au/resources/shepherd-khubbard-h-noise-radiation-characteristics-westinghouse-wwg-0600-wind-turbine-generator/

CONCLUSIONS

The application should have provided up-to-date studies on Biodiversity, Hydrology, Geoheritage incl. Coalmines, Noise & Vibration, Social impacts, Cultural & Historic Heritage & Landscape effects to name a few.

The proposal has the potential for a range of significant impacts including:

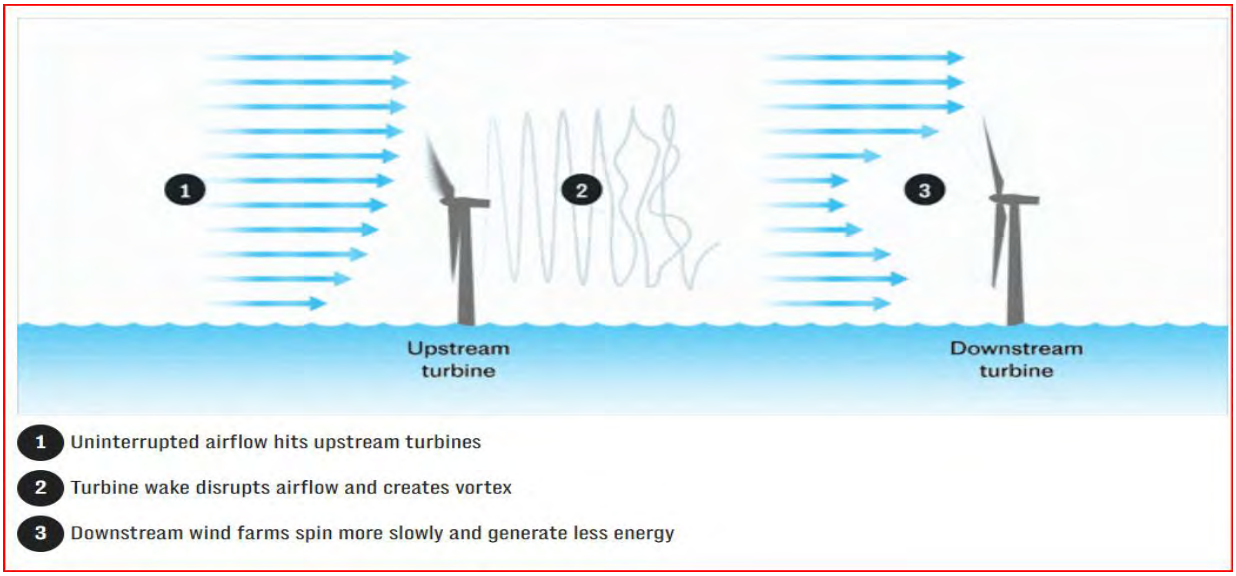
- The windrose indicates that the prevailing wind for 59% of the year is from the South/Southwest direction. For a windfarm in a N/S alignment, this means lower energy generation due to wake effects, rain, turbulence & to the likelihood of Flicker on the houses to the North/Northeast.

- Dispute over wake losses between developers of two huge offshore wind farms one of many currently under-way in UK planning system. Equinor and SSE 1/5/2025 say that wake losses caused by an RWE offshore wind project will cost their massive Dogger Bank arrays £582m ($778m) over their lifetime, arguing it would be "perverse" not to require mitigation or compensation as a result. The Norwegian oil major and British power giant submitted the estimate last week in the planning proceeding for Dogger Bank South, a 3GW project that German utility RWE is developing. **This indicates the similar losses to downwind property, agricultural lands & the availability of access to such data for the Wind Energy Industry to take such proceedings. This data is not included with this application.**

The main problem for the wind industry is that there is currently a lot of uncertainty,” says Pablo Ouro, a renewable energy expert who is leading the Manchester University study. “And uncertainty is not good news for financial projects.”

Wind theft happens when air hits the turbines of one wind farm and is disrupted, leaving behind less powerful air flows for wind farms positioned further downstream. It had not been much of a problem for the offshore wind industry until relatively recently. But there is only so much seabed that is suitable for fixed wind turbines, and the turbines themselves are growing in size. As recently as the mid-2010s, a typical turbine was just shy of 200 metres tall. Now, monsters like the world’s largest turbine being built in Bradenberg, Germany, can reach as high as 364 metres – higher than London’s Shard skyscraper. And as the turbines grow bigger, so do their wakes. This means that for upcoming projects, the wake effect of one wind farm can easily still hit another as far as 37 miles (60km) away, says Ouro. The differences from the wake effect are not huge, in the sense that there will not be an impact of more than say 4pc to 5pc,” Ouro says. “But actually, for a relatively large wind farm over more than one year, that’s a lot of money.

Earlier this year, for example, Ørsted and Equinor complained that Total’s proposed Outer Dowsing wind farm off the Yorkshire coast could cost them a combined £363m in lost revenues. Ørsted estimated that the scheme would affect its existing Race Bank, Hornsea 1 and Hornsea 2 projects, sapping 0.52pc, 0.67pc and 0.68pc of their outputs respectively at a total cost of up to £199m. Meanwhile, Equinor says its Dudgeon and Sheringham Shoal projects will lose 0.88pc and 0.76pc respectively, with planned extensions also set to suffer. The company predicts the cumulative impacts could amount to up to £164m in lost revenues. Elsewhere, Scottish Power owner Iberdrola alleges that RWE’s proposed Five Estuaries project will reduce the output of its East Anglia 2 wind farm by as much as 2.1pc. And yet another row is raging in the Irish Sea, where Ørsted is duking it out with EnBW, BP and Flotation Energy over the effects upcoming projects could have on its existing portfolio



- Adverse impact on property & land values plus farm viability from downwind Wake effects.

- Failure to provide Plans & Particulars of the proposed Windfarm turbines.

- Failure to comply with Survival Speed of 57kph as outlined in Vesta Brochure vis a vis Birr Meterological. Station Wind Gust speeds greater than 57kph, which are over this limit on 13% of time over 160-year period & constitutes a Health & Safety hazard to adjoining properties from destruction.
- Failure to provide turbine setback distances to achieve noise levels below 30dbA in low noise areas.

- Adverse impact on the habitats of Birds, particularly migratory birds & bats. Adverse impact on Biodiversity including Bats & the flypath from Iceland to the Wexford slobs for migrating birds. The tip speed of the wind turbine at C92m/s indicates a speed of 331.2kph. No Bird or Bat could avoid such a speed.

- Adverse impact on Restoration of nature as included in EU Directive. Reference number: 10.2/3/4

- Adverse impact on shallow soils/Bog & potential for landslides. On the basis of the information submitted with the application, ABP cannot be satisfied that the proposed development would adequately mitigate risk associated with potential landslide as a consequence of the development of the proposed wind farm in association with seismic vibration through the foundations causing liquefaction of the shallow soils. In view of the above, it is considered that the proposed development would constitute an unacceptable risk of pollution of watercourses in the area. The proposed development would, therefore, be contrary to the proper planning and sustainable development of the area.

- Adverse impact on human & animal health. No plans or designs or noise readings related to distances or wake effects provided.

- Adverse impact on drinking water catchment due to biohazards & the elevated risk of a major accident arising from a landslide event or underground coalmine collapse adjoining geological fault lines, the proposal would pose a serious danger to the environment potentially causing extensive pollution of waterbodies within and in the vicinity of the site. Given the extent of existing wind farm activity in the wider area, to which the proposed development would add to, the Bord Pleanala cannot be satisfied that the cumulative environmental assessment of the likely effects of the proposed development on avifauna can reasonably exclude the possibility of a significant impact.

- Adverse impact on Traffic & Roads from a Nacelle weighing up to 400tonnes with dimensions 10.9m in length, 4.09m in width & 4.15m in height & on a 2-4 axle articulated flat-bed truck. With the weight of the truck included, the fully laden weight will be circa 450 tonnes. A 2-4 axle articulated flat bed truck is not capable of

carrying this weight or permitted by law [S.I. No. 5 of 2003 Clause 13] & would severely damage roads, bridges & culverts

- S.I. No. 5/2003 – Road Traffic (Construction and Use of Vehicles) Regulations 2003

13. (1) Subject to Regulation 12 and to this Regulation, the weight laden of an articulated vehicle having a total of 4-axles shall not exceed 35 tonnes.
(2) The weight laden of an articulated vehicle having 4-axles may exceed 35 tonnes but shall not exceed 38 tonnes if the vehicle-
(a) consists of a 2-axle tractor unit and a 2-axle semi-trailer,
(b) is equipped with twin tyres and an air suspension system or an equivalent system on each driving axle,
I is equipped with a brake system approved in accordance with the requirements of the Directive 71/320/EEC of 26 July 1971[4] as amended by Directive 98/12/EC of 27 January 1998 [5] which includes antilock devices in addition to any other devices necessary for the satisfactory operation of the service brakes under all conditions of loading, and
(d) is equipped with a plate complying with the requirements of the Regulations of 2000.

- Breaches of the Precautionary Principle on numerous grounds.

- Adverse effects from Blade failure due to delamination at skin & adhesive, fatigue failures from cyclic loading, use of flammable laminates in blade construction.

CJEU Case 258/11 at 44
"So far as concerns the assessment carried out under Article 6(3) of the Habitats Directive, it should be pointed out that it cannot have lacunae and must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the works proposed on the protected site concerned."

Judgement of the Court Case 258/11
Article 6(3) of Council Directive 92/43/EEC of 23rd May 1992 on the conservation of natural habitats and of wild fauna and flora must be interpreted as meaning that a plan or project not directly connected with or necessary to the management of a site will adversely affect the integrity of that site if it is liable to prevent the lasting preservation of the constitutive characteristics of the site that are connected to the presence of a priority natural habitat whose conservation was the objective justifying the designation of the site in the list of sites of Community importance, in accordance with the Directive. The precautionary principle should be applied for the purposes of that appraisal.

Environmental Impact of Wind Farms. Bošnjakovi´c, M.; Hrka´c, F.; Stoi´c, M.; Hradovi, I. Environments 2024, 11, 257. https://doi.org/ 10.3390/environments11110257

Toxicity
The toxicity of substances to humans can be expressed in different ways and is often expressed in CTUh (Comparative toxic unit for human). Onshore wind farms have an average of around 3.9 CTUh/TWh.

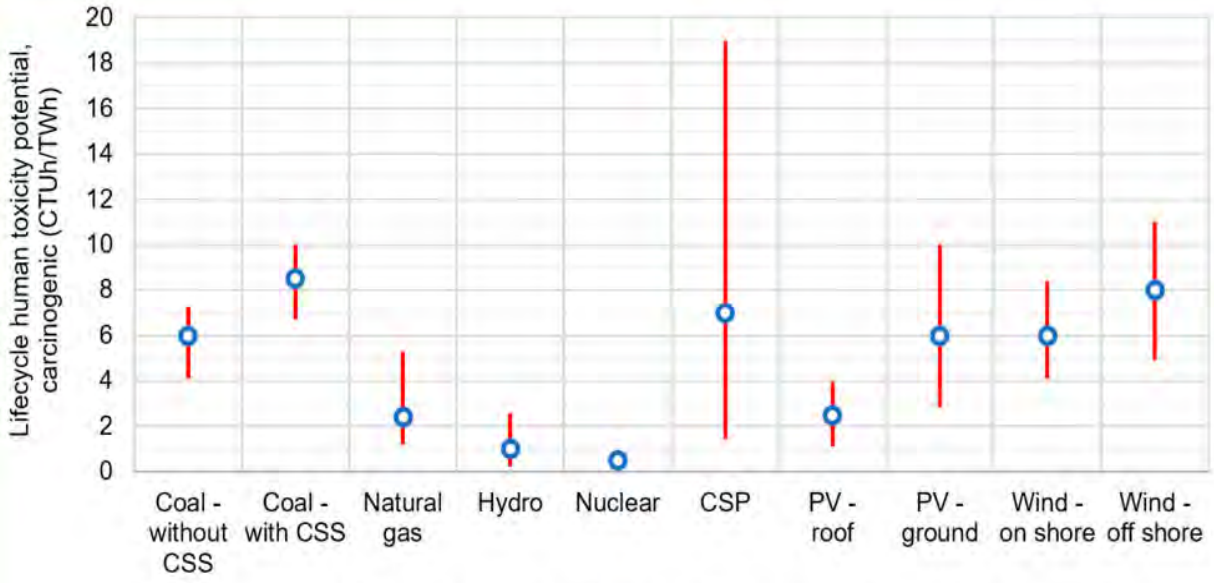


Figure 4. Lifecycle human toxicity potential, carcinogenic. The red line represents the range and the circle represents the median.

Danger of Ice Flying off the Blades

Ice build-up on the rotor blades of wind turbines can pose a serious threat to people and objects in the immediate vicinity. It is, therefore, important to assess the dangers associated with ice shards falling and flying from the rotor blades. Icing can also lead to the failure of wind turbines because the structural integrity is impaired. The hazard posed by ice depends on the severity of the icing, the type of icing, the wind, the rotor speed and other environmental conditions. ***A piece of ice with a weight of 0.2 kg and a density of 500 kg/m3 falling from a height of 30 to 50 m is considered fatal if the impact has a kinetic energy of more than 40 J.***

Danger of Blade Parts Flying Off

A "blade failure" can have a number of causes and can result in either whole blades or parts of blades being thrown from the turbine. ***A total of 537 separate incidents have been recorded. It has been documented that parts of the blades have travelled up to 1.6 km.*** *In Germany, parts of the blade penetrated the roofs and walls of nearby buildings. For this reason, a law was passed in Germany (Bavaria) in 2016 requiring a minimum of two kilometers to be kept between dwellings or workplaces and wind turbines, and Ireland is considering a similar measure.*

Impact on Radio Waves and Air Traffic

Offshore wind turbines can interfere with radar systems on board ships and on land as well as radars used to monitor air traffic. Wind farms located near weather radars can cause false echoes that can be misinterpreted as weather phenomena such as precipitation or thunderstorms. The reason for the interference lies in the structure of the turbines, the height of the turbines and the displacement of the rotors, which can reflect radar signals. In addition, telecommunication and data transmission signals can be weakened when wind turbines are in the line of sight (LOS) for radio communications. In general, two types of effects of wind farms on radar systems can occur:

- *Formation of radar shadows behind wind turbines, which can result in lower targets being poorly recognised or not recognised at all. The relatively high frequencies used by the radar are attenuated when the signal passes through the wind farm, i.e., they shorten the range of the radar.*
- *Reflection of the radar beams from the wind turbines can lead to false radar targets (false echoes).*

Radar systems work by recognising weak reflections that are often in motion. In addition, the rotor blades of wind turbines produce false reflections in the direction of the receivers, causing the radar to misinterpret the signals. While the wind farm industry is growing rapidly, they are causing serious interference problems in critical civil and military radio systems, degrading radar detection range and increasing the complexity of air surveillance and navigation missions.

Habitat Destruction

Based on 84 studies of onshore wind farms in 22 countries, (Tolvanen et al). presented data on the average distance of habitat displacement from the edge of wind farms. The predominant height of wind towers in the studies was 50–99 m.

For birds, bats and mammals, habitat displacement accounted for 63%, 72% and 67% of cases, respectively. Cranes, owls and semi-wild reindeer showed consistent habitat displacements of up to 5 km on average. Gallinaceus birds showed movements of up to 5 km on average, but "no movement" was reported in 40 cases. Bats were displaced by an average of up to 1 km in most cases. Waders, birds of prey, sparrows and black-winged stilts moved their habitats by up to 500 m on average.

Furthermore, human-caused forest landscape fragmentation may lead to a rise in the number of predators (Pasanen-Mortensen and Elmhagen, 2015). For instance, infrastructure like buildings and maintenance roads could attract fox activity (Hradsky et al. 2017), so the risk of predation may be higher near wind farms. Grouse are known to be sensitive to human disturbance (Coppes et al 2017). Many grouse species are site-loyal and therefore highly vulnerable if their habitat overlaps with areas that are suitable for wind turbine installation, particularly in the absence of another suitable habitat (Braunisch et al. 2015).

Collision with a Wind Farm

For some bat species, the installation of wind turbines creates new habitats because there are more insects to feed on in the vicinity of the wind turbines. ***Direct causes of bat death at wind turbines are well recognised and include barotrauma (Rollins et al. 2012) and collisions with rotating blades (Horn et al. 2008) or a combination of both.***

The potential threats of wind farms to birds are well documented in the literature, for example. Research suggests that mortality rates (although they may be relatively high in certain areas) are highly variable and depend on a number of factors such as the bird species, the size and the location of the wind farm and others. (Barclay et al. 2007) reported a mortality rate of 0.00–9.33 birds per year per turbine and a mortality rate of 0.00–42.7 for bats.

The selective shutdown of wind farms along the bird migration route using radar is very effective in reducing collision rates (Tomé et al 2017).

Noise Onshore Wind Farm

Noise pollution has a negative impact on wildlife as it disrupts mechanisms that are crucial for their survival. According to studies, noise can result in the following:

- *Result in physiological trouble, such as genuine hearing loss or persistently elevated stress hormone levels.*
- *Be viewed as a direct danger, which would lead to an increase in predatory behaviour at the expense of foraging or the departure of the afflicted region, which would result in the loss of habitat.*
- *Distract attention during foraging and reduce foraging efficiency.*
- *Interfere with animal communication by reducing the distance from which the signal can be perceived and lowering the quantity of information that can be taken out of the signal, such as the sound of a predator or approaching potential prey.*
- *Influence the reproductive process. Taubmann et al. reported that noise disturbs grouse up to a distance of 865m. Increasing turbine noise, turbine visibility, and turbine shadow during the breeding season reduced the likelihood of selecting a breeding site.*

The roles that these processes play in determining the effects of noise pollution on different species are not mutually exclusive. Different species respond differently to noise as they have different sensitivities to noise. In general, noise pollution alters animal communities. The effects of noise can contribute to the reduction in biodiversity and also threaten the sustainability of local ecosystems.

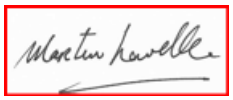
The Effects of Vibrations from Wind Turbines on the Ecological System

The impact of vibrations is one of the aspects to be considered when analysing the impact of wind turbines on the environment. Vibrations are mechanical oscillations that can be caused by the operation of the wind farm and its components. In this chapter, the effects of vibrations on the environment are analysed, taking into account the possible consequences for living beings, structures and the surrounding space.

The source of vibrations in wind farms is the rotating parts of the turbines, such as rotor blades and generators. The rotation of these parts generates periodic vibrations that are transmitted to the ground via the foundations of the wind farm. These vibrations can have a negative impact on the animals in the surrounding area, especially on their sensitive acoustic perception. A study by Estefania Velilla and colleagues from 2021 shows how vibrations from wind farms

affect the abundance of earthworms in the soil. The relative intensity of vibrations in the soil was measured and the results showed a decrease in the number of earthworms near the wind turbines, which is considered a negative impact on soil organisms. A decrease in earthworms was found in a radius of about 200 m around the wind turbines, where the noise level decreased by an average of 23 ± 7dB. Earthworms are considered important engineers of the ecosystem, and interference with their abundance, survival and reproduction can indirectly affect important processes such as water filtration, nutrient cycling and carbon sequestration. In addition, the vibrational noise generated by the wind turbine can mask the vibrational signs of approaching moles, making earthworms in noisy areas more vulnerable to predation (Dominoni et al. 2020).

Wind farms generate noise that can have harmful effects on humans and animals, especially in the vicinity of the wind farm. Problems noted in humans include insomnia, headaches and the like. For animals, there is a wide range of potential impacts: from possible hearing damage to interference in foraging, predator marking, habitat abandonment and more. The moving rotor blades of the wind farm can pose a risk of collision and death for birds and bats.

Signed: 

Martin Lavelle, BE.

15th October 2025

INTRODUCTION

Reference Number 1.9: The proposed development is not in compliance with [2023/2413: DIRECTIVE (EU) 2023/2413 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652]

Reference number 1.10: The High Court [2024] IEHC 136 [2018 8457 P] Between: Margaret Webster and Keith Rollo Plaintiffs and Meenacloghspar (Wind) Limited Defendant And [2018 8458 P] Between: Ross Shorten and Joan Carty Plaintiffs and Meenacloghspar (Wind) Limited Defendant Judgment Of Ms. Justice Emily Egan Delivered on The 8th day Of March 2024

Reference Number 1.11: Victorian Supreme Court in *Uren v Bald Hills Wind Farm Pty Ltd* [2022] VSC 145 (Uren)

Reference Number 1.12:
Decision of the Council of State No. 465036 of 8 March 2024

Reference Number 1.13: SITE SUITABILITY

distance from Turbine m	dba Sound power (These numbers do not include for an extra 5dba for downwind crest of hill or humidity/cold weather increases. Wear & Tear friction noise increases & Turbulence						
1	104	105	106	107	108	109	110
2	98	99	100	101	102	103	104
4	92	93	94	95	96	97	98
8	86	87	88	89	90	91	92
16	80	81	82	83	84	85	86
32	74	75	76	77	78	79	80
64	68	69	70	71	72	73	74
128	62	63	64	65	66	67	68
256	56	57	58	59	60	61	62
512	50	51	52	53	54	55	56
1024	44	45	46	47	48	49	50
2048	38	39	40	41	42	43	44
4096	32	33	34	35	36	37	38

This Table indicates a setback distance of over 2,048m from the turbines to meet WHO Standards of 37dbA. The 4.2MW turbine generates 106dbA plus 5dbA for top of hill plus 2dbA for climate factors plus turbulence effects from wake plus wear/tear. This means a setback of 4,096m & not 500m. The operational windspeed noise will be increased to cater for wake effect turbulence, separation distances of turbines, bearing wear & friction from insect detritus.

The following information was answered from various sources with difficulty. It is noted that the Applicant failed to include any such information with the application.

It would seem that the applicant is selecting turbines for c7m/s in order to reduce noise levels to give the appearance of compliance with Standards. This ignores the effects of higher windspeeds & the noise generated above the WHO Standard of 37dbA.

None of these curves have been provided by the Applicant & the application should be rejected.

Winds on the Beaufort scale

Wind	Designation	From Winds km/h	m/s	Knots	mph	Effect
0	Calm	< 1	< 0,3	< 1	< 1	Nothing
1	Light air	1 - 5	0,3 - 1,5	1 - 3	1 - 3	Diversion of smoke
2	Light breeze	6 - 11	1,6 - 3,3	4 - 6	4 - 7	Contractions of leaves
3	Gentle breeze	12 - 19	3,4 - 5,4	7 - 10	8 - 12	Movement of branches
4	Moderate breeze	20 - 28	5,5 - 7,9	11 - 15	13 - 17	Movement of limbs
5	Fresh breeze	29 - 38	8,0 - 10,7	16 - 21	18 - 24	Movement of small trees
6	Strong breeze	39 - 49	[illegible]	22 - 27	25 - 30	Movement strong branches
7	High wind	50 - 61	13,9 - 17,1	28 - 33	31 - 38	Movement of trees
8	Gale	62 - 74	[illegible]	34 - 40	39 - 46	Difficulty in walking
9	String gale	75 - 88	20,8 - 24,4	41 - 47	47 - 54	House damage
10	Storm	89 - 102	24,5 - 28,4	48 - 55	55 - 63	Uprooting of trees
11	Violent storm	103 - 117	28,5 - 32,6	56 - 63	64 - 73	Storm damage
12	Hurricane	> 118	> 32,7	> 64	> 74	Devastation

It would seem that the upper limit for the Nordex 7.2Mw, as identified above is 17.1m/s & not 25m/s as stated in application

Birr Met Eireann data is available by month from 1850 to 2010 & shown below in metres/second Table 1 & knots in Table 2. The speeds in m/s above the 57m/s Survival speed are coloured yellow.
These breaches above Survival speed are regular over the period (13%) & it would be grossly negligent to grant permission in such circumstances as the application does not comply with Proper Planning or Sustainable Development. The blade tip speeds, as above, are given as 92m/s [331.2kph]]. In a survival failure, this speed could cause fatalities & damage at large distances.

These speeds are considerably faster than a F1 Grand Prix racing car. Any suggestion that a Bat or Bird could avoid such a blade at this speed is simply not possible.

Reference Number 1.14-Table 1: Birr Wind gust speeds 1850 to 2010 in metres per second

Met Eireann Birr maximum wind gusts 1850 – 2010 in m/s. converted from Knots - Factor[1/1.944]
Survival wind speed for Vesta V117-4.2 is ≤57m/s
Note all cells highlighted in yellow ≥57m/s. It should be also noted that Birr data is at ground level plus 10m, which would be far lower than Seskin top of turbine heights.

Birr m/s WIND GUST SPEEDS

Year	Jan	Feb	March	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
1850	48	21.3	5.3	42	37.1	21	41.7	24.4	35.2	20.3	36.4	31.9
1851	74.4	9.5	37.5	17	14.9	45.3	46.8	29.2	15.6	46.9	20.8	26.9
1852	57.9	38.1	15.7	16.7	22.6	93.6	45.9	43.1	10.4	22.2	92.1	82.1
1853	51.2	15.6	35.9	38.1	13.4	35.2	44.5	39	25.5	75.1	40.3	9
1854	44.1	10	14.9	2.9	72.8	55.8	41	29.2	14.9	21.5	26.2	33.7
1855	5.3	19.9	45.5	13.4	29.5	28.4	40.9	43.9	18.7	38.9	16.5	20.3
1856	41.9	27.8	8.3	42.6	75.1	37	29.5	41	39.2	33	13.2	47.2
1857	33.5	20.9	33.9	54.8	28.6	39.6	19.3	21.2	41.6	31.3	35.2	14.3

1858	24.9	16.5	20.3	52.5	36.3	11.7	36.3	27.1	36.5	39.5	21.5	54.6
1859	27.8	17.6	33.3	45.9	4.6	20.9	21	27.5	63.1	22.6	46.8	44.2
1860	62.5	18.6	39.5	34.1	44.2	67.7	39.8	75.8	20	32	36.1	28.2
1861	24.3	27.2	50.4	11.3	4.2	48.4	108.2	66.4	67.2	48.4	43.9	25.3
1862	52.4	14.8	50.2	38.4	50.6	37	45.3	38.2	19.8	63.5	25.5	37.9
1863	40.7	21.6	33.1	16.3	13.2	11.8	4.3	49.3	47.9	55	53.2	36.6
1864	23.7	8.9	34.5	15.3	21.6	42.4	10.6	22.6	43.6	49	56.6	28
1865	50.7	35.4	23.5	13.7	48.2	11.1	41.4	36.8	6.3	52.7	55	40.4
1866	54.1	33.8	31.7	23.4	14.9	33.6	11.9	48.1	60	28.3	38.5	46.2
1867	34.4	31.2	29.4	38.8	40.1	13.3	49.9	37.8	17.2	61.4	16.6	14.9
1868	41.4	32	40.7	28.8	28.6	20.3	31.6	64	36.8	29.9	30.2	54.4
1869	53	33.7	23.3	36.6	48.6	19.8	28.1	27.1	80.2	8.1	38.2	67
1870	38.5	22	28	12.3	28.9	10.2	21.5	21.3	45.9	95.1	18.1	23.9
1871	37.3	27.4	26.5	27.3	26.5	37.7	68.2	28.8	8.4	45.7	22.2	31.4
1872	45.1	31.4	28	30	26.9	43.1	28.6	63.5	42.8	58.6	48.6	68.9
1873	69.9	11.8	54.9	23.4	27.6	18.7	54.9	64.1	53.3	51	26.6	14.9
1874	35.8	21.3	22.8	23.4	29.8	22.8	37.9	67.7	50.6	51.9	47	54.7
1875	63.4	15.4	13.7	10.3	25.4	41.8	33.8	40.1	85.6	39.9	34.2	25.6
1876	15.8	54.4	58	26.9	9.8	20.5	22.2	44.8	57.9	41.8	32.7	64.4
1877	61.9	30.3	34.6	39.4	27.1	48.7	30.3	57.1	33.7	45.7	71.1	43.8
1878	37.3	21.5	15.8	18.7	44.7	67.5	33.4	49.5	40.7	37.7	23	16
1879	22	43	20.8	29.3	33.3	64	39.2	59.3	60.1	16.2	11.2	24.3
1880	12.8	35.1	46.4	53	18.2	37.1	95.9	22.1	27.3	33.1	46.9	40
1881	8.9	43.4	30.3	17.6	32.5	53.7	24.6	61.7	51.7	32.7	53.4	62.9
1882	29.9	30.6	32.8	40.5	35.9	39.5	56.7	43	21.5	43.8	69.5	44
1883	64.7	47	8.2	22.6	33.6	22.5	51	51.9	44.4	46.8	55	24.3
1884	46.5	44.2	37	20.5	28.2	11.1	41.9	17	23.3	32	42.2	54.2
1885	28.9	38.2	21.3	42.2	28.1	15.5	28.1	40.7	66.5	49.1	24.6	12.6
1886	52.7	23.8	37.1	26.1	41.3	23.7	31.2	28.8	40.6	56.2	40.5	64.3
1887	36.7	16.3	17.1	24.7	18.1	4.4	38	32.5	21.8	34.5	28.5	34
1888	28	8	40.5	21.3	27.3	63.1	58.4	31.5	9.3	17.9	32.2	50.4
1889	28.9	22.2	18.7	24.2	42.8	16	24.8	63.1	11.5	40.9	20.1	40.5
1890	76.4	10.6	40.7	9.1	19.7	32.7	29.1	43.2	42.4	30.9	69.7	25.3
1891	24.7	2.2	18.8	24.6	40.6	39.7	28	91.3	26.5	44.7	35	78.2
1892	22.9	38.1	7.6	13.2	61.7	24.9	48.1	102.4	57.3	30	50.8	16.9
1893	37.8	38.8	10.1	10.7	35.4	34.3	28.6	49.2	30	41.1	24.6	52
1894	51.3	42.6	27.3	63.8	32.7	24.9	52.9	40	4	43.1	45.6	37.8
1895	28.9	11.2	38.9	25.2	9	10.7	46.8	63.5	5.8	37.4	57.4	48.4
1896	13	19	60.3	11.8	4.4	27.8	69.9	33.7	72.6	32.5	13.7	55.8
1897	23.8	21.4	60.3	56.7	17.4	49.5	30.5	55.1	29.1	34.6	67.3	51
1898	24.3	21	10.5	46.7	34.8	42.9	14.5	82.9	39.4	27.4	67.6	32
1899	45.2	29.8	16.6	38.7	43.9	24.2	44.8	57.5	30.7	20.8	36.8	50.9
1900	53.7	30.7	9.7	28.2	30	50.6	23.5	97.9	18.3	57.3	53.8	52.9
1901	35.9	17.1	37.9	26.2	23.7	37	15.9	36.2	50.8	34.4	53.8	39
1902	39.7	26.2	30.2	26.1	26	19.9	25.7	32	20.5	22	60.9	38.1

1903	62	42.3	71.7	18.2	21.8	15.5	66.4	68	41.7	58.3	32.8	34.2
1904	46.1	57.9	36.5	26.2	42.5	21.2	48.5	42.7	30.7	32.4	31	25
1905	30.1	20.6	55.4	24.3	11.9	19.2	17.6	70.6	18.6	17.5	32.4	24.8
1906	52.1	34.8	29.6	22.3	46.2	29.5	45.6	45.5	15.3	60.5	21.7	30.9
1907	15	22.5	35.8	32.6	37.7	39	64.1	42.8	13.6	63	36.9	46.2
1908	39.4	30.6	38.4	22.7	36.8	20.5	33.4	49.1	70.9	20.5	32.3	41.6
1909	36.3	12.7	39.8	55.3	34	22.5	25.8	15.4	27.4	56.3	25.8	48.4
1910	46.8	55	25.7	35.5	27.8	48.9	39.3	58	9.1	22.1	37.7	40.4
1911	21.9	35.1	17.2	21.3	16.5	28.9	37.5	31.1	21.8	53.3	53.4	66.8
1912	35.2	41.7	46.8	13	17.4	64.8	62.4	60.4	5	28.3	22.2	53.6
1913	62.3	16.5	51.5	51	45.3	42.8	13.4	16.9	41.8	47.4	40.2	33.1
1914	16.1	58.8	44.7	27.3	20.7	11.9	31.2	53.9	22.1	23.9	46	69.5
1915	52.8	54.2	10.4	22.5	6.4	25.7	60.3	51.7	19	38.2	39.5	55.6
1916	33.1	54.2	26.3	39.1	65	37.4	36.2	41.4	31.7	77.7	48.9	38.9
1917	12.8	23.8	32.1	15	43	20.2	33.9	117.9	22.8	51	32.5	18.9
1918	28.6	49	27.9	13.5	26.7	15.6	45.4	31	68.9	47.3	40	62
1919	36.2	17.8	24.3	19.7	33	49.1	23.1	30.7	33.5	12	27.1	68.2
1920	58.2	48	36.9	38.8	34	15.7	56.8	27.8	22.1	75.6	39.1	34.6
1921	48.4	12	37	10.3	26.3	9.9	52.4	43.9	28.7	34.5	36.8	54.9
1922	37	51.5	21.5	29.6	24.1	17.9	34.4	41.5	49.9	15.1	11	52.4
1923	38.3	62.4	30.8	37.9	17.4	12.2	36.9	70.2	43.7	58.7	38.6	41.7
1924	51.6	16	10.1	43.3	55.3	37.7	38.5	49.3	88.2	45	53.4	70.1
1925	43.1	68.8	6.1	49.6	62.1	7.2	51.9	23.9	24.1	28.3	28	22.5
1926	59.4	28.4	13.5	24.4	33.6	34.1	65.3	38.3	27	28.7	43.6	12.9
1927	44.2	31.7	45	20.1	10.3	36.3	38.7	56.1	63.8	24.9	32.5	28.2
1928	50.8	50.9	42.3	24.1	28.3	56.9	27.5	53.5	20.2	70.9	51.1	46
1929	19.2	43	6.9	11.8	33.6	22.1	45.4	64.8	10.8	53.1	52	84.9
1930	64.3	7.3	48.9	23.9	21.5	23.6	41	74.6	50.5	60.6	38.5	45.1
1931	24.2	33	27.6	39.6	36.8	52.4	51.2	33.3	32.7	25.8	80.5	28.3
1932	51.5	3	16.5	29	35.9	7.4	48.3	19.1	48.5	43.1	16.8	56.9
1933	37.3	30.3	43.4	12.9	26.4	32.8	40.7	30.5	18.3	27.6	15	25.2
1934	58	2.2	38	24.7	26.1	25.2	23.6	59.8	65.6	45.3	17.8	67.1
1935	16.2	39.4	17.8	23.1	13.6	62.4	12.3	42.2	74	50.6	52.6	19.3
1936	51.7	23.3	20.1	29.8	12.9	38.7	80.2	25.1	61	25.5	40.1	40.9
1937	58.5	54.3	26.9	34.7	35.9	26.7	50.3	43.5	52.3	25.2	19.2	25.4
1938	57.4	18.9	17.7	2	47.4	45	87.6	53.4	26.6	95.1	61.1	43.2
1939	65.7	35.8	35.2	14.1	17.4	29.8	47	18.9	29.4	11.3	96.6	29
1940	32.4	50.5	27.7	32.9	11.8	14	44.2	6.6	27.6	81.2	54.7	45.8
1941	28.9	47.8	30	21.8	34.3	9.8	36.4	40.4	12.7	34.9	63.4	30.2
1942	54.4	12.3	36.5	24.2	45.7	4	50.5	71.1	57.4	32.7	8.6	48.9
1943	65.6	23	11	19.7	42.1	39.3	26.1	58.1	32.7	49.2	35.5	28.9
1944	52.2	18.1	7.2	20.4	41.8	23	39.9	49.7	57	58.1	66.2	50.5
1945	26.3	40.8	22.2	17.2	42.4	47.6	54.9	30.6	47.2	38	8.7	54.3
1946	64.5	67.9	18.9	13.7	26.4	46.4	60.4	88.2	68.7	17.2	47.2	63.2
1947	46.1	24.7	59.5	50.5	60.2	58.5	37.8	10.9	48.9	49.6	56.7	37.7

1948	91.6	28.4	36.9	26.6	31.2	50.3	26.3	37.4	43.1	49.3	38.1	74.5
1949	26	34	29.6	29.9	22.9	9.4	38.3	50.6	13.2	83.2	42.3	53
1950	16.7	51.7	22.1	34.1	15.9	24.3	70.3	57.8	71	41.1	36.3	29.4
1951	48.9	33.4	50.4	23.5	23	18.1	21.2	53.2	59.5	25.4	40.5	74.4
1952	58.1	11.3	14.6	25.3	49.7	29	20.9	38	27.7	67.6	26.5	38.5
1953	20.7	20.3	5.6	37.7	22.5	12.9	43	62.3	35.3	40.5	35.5	36.5
1954	28.2	53.3	30.7	15.6	52.2	31.9	46.6	53.7	63.9	64.8	51.3	50.1
1955	34.8	31	19.2	35.9	42.5	54	6.9	17.1	45.3	20.2	33.3	56
1956	38.4	11.2	25.8	11.5	17.4	30.7	59.8	66.2	61.4	31.6	24.7	55
1957	54.4	40	47.8	20.7	26.8	10.8	59.4	22.6	44.7	55.2	9.2	35.8
1958	49.2	44.7	20.3	19.3	52.1	43.8	51.5	78.9	52	23.7	26.5	45.6
1959	27.4	14.7	28.7	45.2	23.5	29.9	33.7	9.5	18.6	73.4	41.9	92.5
1960	43.6	22.9	21.6	30.5	35.4	40.5	74.8	57.9	66.9	34.5	78	65.6
1961	68.1	39.8	6.9	61.5	29.8	24.7	50.3	32.7	49.1	43.2	30	30.5
1962	44.8	16.9	28.2	25.5	35.3	18.7	27.2	59.4	75.7	16.7	39.6	39.3
1963	4.8	15.8	43.5	22.6	29.2	29.3	32.2	41.3	26.3	61.3	59.2	12.2
1964	22.4	12.8	39.2	37.9	36.2	26.8	37.4	52.1	24.7	39.2	29.7	70.7
1965	57.3	4.1	46.1	35.4	46.4	40.5	48.6	45.4	35.1	17.4	42.6	60.2
1966	37	38.8	22.1	48.5	40	58.3	22.8	50.9	35.2	70.9	23.4	43.7
1967	31.7	45.9	19.7	16.7	59.6	10.3	18.2	36.2	47.6	74.5	33.2	28.1
1968	54.6	7.1	32.2	26.7	38	29.5	12.7	43.8	56.5	42.6	52.7	65
1969	53.7	16.9	21.1	29.7	24.1	27.9	16.3	16.1	13.3	17.5	43	39.2
1970	24.4	45.5	19.4	50.7	15.5	21	39	26.6	47.2	36.4	69.3	17.5
1971	22.3	24.7	30.7	20.4	30.9	26.6	22.7	29.5	15.2	35.6	36.2	22.6
1972	42	22.8	32.8	32.2	45.6	27.5	33	24.9	5.6	22.7	53.7	37.6
1973	28.7	20.5	11.9	20.9	34.1	9.3	49.5	46.4	39.6	33.1	61.2	32
1974	74.3	28.7	14.8	15.3	30.8	24	50.5	45.8	61.7	26	30.6	39.5
1975	68	18.8	13.7	20.2	14.7	3.7	38.9	14.3	63.8	42.2	24.2	21.9
1976	36.2	22	28.9	13.6	35.5	15.2	28	3.2	41.3	66.7	31.9	29
1977	26	60.4	30.1	37.2	11.8	39.6	18.4	55	25.6	49.2	39.6	36.4
1978	37.6	26.6	40	25.6	7.6	25.8	34.3	31.4	21.6	23.5	40.9	57.2
1979	24.2	21.5	33.7	40.3	48.8	23.9	13.9	53.8	20.8	46.3	47.9	59.7
1980	28.1	35	41.5	18.6	14.2	25.1	53.1	36.4	50.9	47.2	35.4	45.1
1981	19.8	29.9	44.8	6.9	59.7	33.1	29.1	11.9	58	42.5	30.6	30.9
1982	34.3	33.1	43.7	12.2	26.5	44.1	7.7	56.6	32	59.5	55	47.4
1983	51.7	20.6	46.8	33.8	62.2	26.5	26.7	33.2	52.2	51.1	13.6	65.2
1984	66.2	28.7	30.3	18.3	9.4	13.8	18.7	50.7	41.9	40.4	48.6	43.7
1985	11.9	13.1	31.8	25.8	36.8	35	51.6	91.6	28.1	30.8	23.9	44.8
1986	41.3	1.2	45.3	28.5	52.5	52	28.5	71.8	1.2	51.7	48.4	65.4
1987	14	24.2	28.5	32.2	6.6	59.6	13	28.1	48.9	47.3	33	25.2
1988	63.3	31	51.6	6	39.9	24.3	49.4	45.2	28.1	43.6	22.2	19.2
1989	30.9	38.3	49.4	27.2	10.5	30.9	6.3	46.3	32	44.7	14.4	29.5
1990	53.9	86.9	7.8	24.8	12.4	32	28.5	22.5	10.5	73.3	32	49.9
1991	39.9	31.3	28.1	54.3	2.3	46.9	32.9	38.1	25.8	50.1	45.3	17.1
1992	33.6	21.1	44.7	38.9	25.8	16.7	33.5	59.8	44	25.3	43.4	35.2

1993	41.3	7	22.1	56.7	44.1	55.9	25.5	18.4	47.3	18.4	29.9	79.7
1994	55.4	40.9	49.4	51.6	29.8	21.7	32.9	33.1	43.6	28	30.3	71.6
1995	76.9	58.5	35.3	15	19.3	9.1	30.3	18	23	72.4	43.6	24.6
1996	40.1	46.4	51.4	31.8	28.2	13.5	26.9	49.7	14.5	71	44	13.4
1997	13.7	63.5	9	20.1	38.6	59.3	39.6	87.9	17.2	59.7	39.9	36.8
1998	52.1	13.4	43.7	45.3	13	84.8	40.7	26.1	32.2	67.1	50.6	47.1
1999	57.6	17.1	29	24.9	28.8	34.4	19.7	21.8	70.2	24.7	46.9	85.3
2000	27.9	50.1	16.1	23.9	29.2	21	32.8	34.8	51.3	70.8	67.8	38.6
2001	14.4	21	33.7	44.2	20.6	29.8	18.9	48.4	27.4	46.1	21.2	15.9
2002	58.2	64.4	21.9	37.3	56.4	52.1	33.8	26.5	12.1	63.7	67	39.6
2003	22.1	13.2	18.8	22.9	52.1	36.1	37.1	4.2	19.7	15.6	32.9	28.8
2004	41.7	14.2	29.8	26.1	15.4	25.8	21.6	36.8	36.4	74.6	29.3	40.1
2005	59.8	21.1	32.5	38	27.5	15	43.5	27	29.8	49.8	36.6	25.3
2006	16.6	19.2	62.1	23.6	43.8	13.7	33.8	59.5	55.4	68.6	52.3	62.1
2007	39.2	32.6	31.6	4.9	24	97.7	87.2	55.2	12.7	16.5	45	44
2008	95.8	17.4	42.5	7	7	28.2	63.6	105.3	55.1	56	27.4	30.8
2009	41.3	12	19.8	43.2	38.6	23.8	65	63	21	28.1	84.7	27
2010	39	30.2	36.6	19	16.7	23.1	76.3	22.8	67.7	32.3	74.6	6.4

Summary of Birr Wind gusts greater than 57kph by Decade: 13% (1 failure in every 7.7 months) **of months above SURVIVAL SPEED is not proper planning or sustainable development**		
Decade	Number of Months with wind gusts > 57kph	% of monthly failures over 120 months per decade & over 1,920 months per 150 years
1850 – 1859	9	8
1860 – 1869	12	10
1870 – 1879	20	17
1880 – 1889	9	8
1890 – 1889	19	16
1900 – 1909	14	12
1910- 1919	14	12
1920 – 1929	15	13
1930 – 1939	19	16
1940 – 1949	21	18
1950 – 1959	17	14
1960 – 1969	19	16
1970 – 1979	10	8
1980 – 1989	11	9
1990 – 1999	18	15
2000 – 2009	20	17
Total over 160 years	**247**	**13**

Table 2: Birr Wind gust speeds 1850 to 2010 in knots

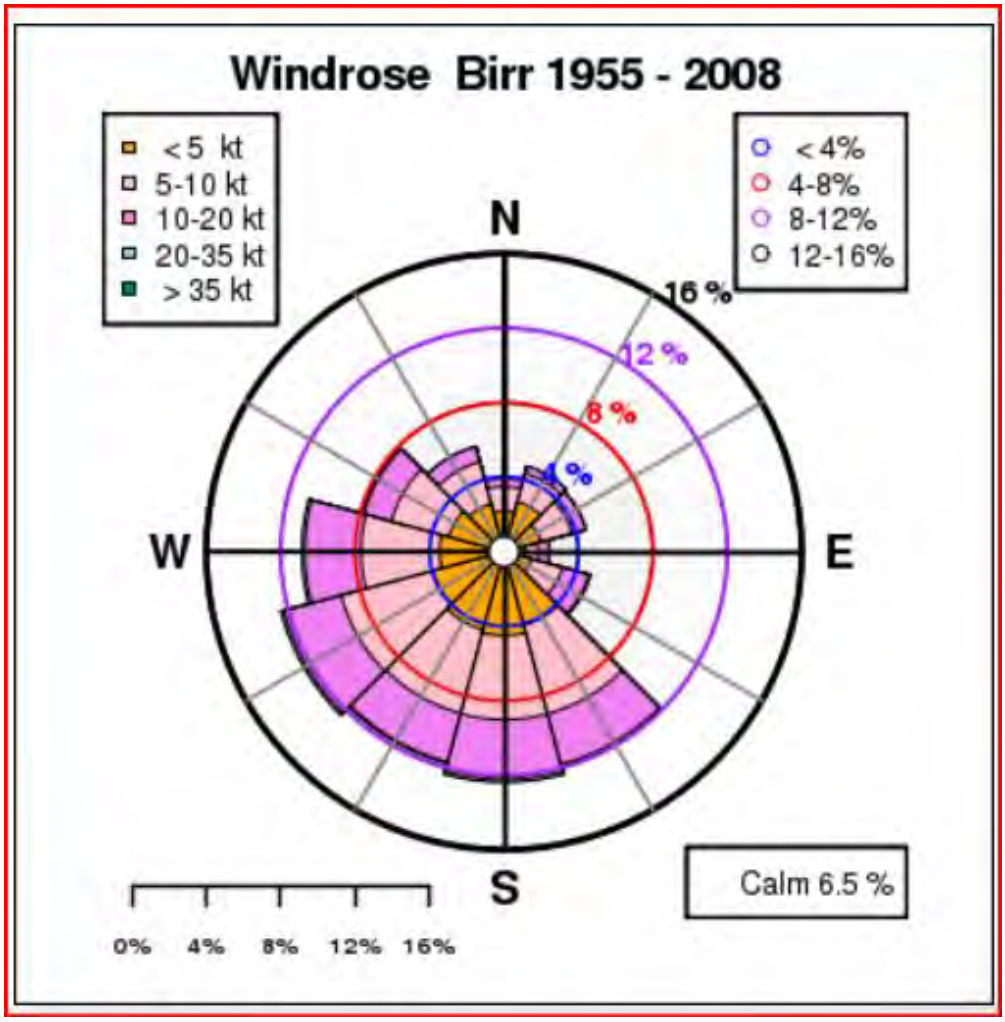
Easting	Northings	Latitude	Longitude	elevation (metres)	Station	County						
208016.8	203400.5	53.08143	-7.88109	73	Birr	Offaly						
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1850	93.3	41.5	10.3	81.7	72.2	40.9	81	47.5	68.4	39.5	70.8	62

1851	144.7	18.4	72.9	33.1	28.9	88	90.9	56.7	30.3	91.2	40.5	52.2
1852	112.6	74	30.6	32.5	43.9	181.9	89.3	83.7	20.3	43.1	179.1	159.6
1853	99.6	30.3	69.8	74	26.1	68.4	86.5	75.9	49.5	146	78.4	17.5
1854	85.7	19.5	28.9	5.6	141.6	108.5	79.8	56.7	28.9	41.7	50.9	65.6
1855	10.3	38.7	88.4	26.1	57.3	55.3	79.5	85.4	36.4	75.7	32	39.5
1856	81.5	54	16.1	82.9	146	72	57.3	79.8	76.2	64.2	25.6	91.8
1857	65.1	40.6	65.9	106.5	55.6	77	37.5	41.2	80.9	60.9	68.4	27.8
1858	48.4	32	39.5	102.1	70.6	22.8	70.6	52.6	70.9	76.8	41.7	106.2
1859	54	34.2	64.8	89.3	8.9	40.6	40.9	53.4	122.7	43.9	90.9	85.9
1860	121.5	36.2	76.8	66.2	85.9	131.6	77.3	147.4	38.9	62.3	70.1	54.8
1861	47.3	52.8	97.9	22	8.1	94	210.3	129.1	130.7	94	85.4	49.2
1862	101.9	28.7	97.5	74.7	98.3	71.9	88.1	74.2	38.4	123.4	49.5	73.7
1863	79.2	41.9	64.3	31.7	25.7	22.9	8.4	95.8	93.2	106.9	103.4	71.1
1864	46	17.3	67.1	29.7	41.9	82.5	20.6	43.9	84.8	95.2	110	54.4
1865	98.6	68.8	45.7	26.7	93.7	21.6	80.5	71.6	12.2	102.4	106.9	78.5
1866	105.2	65.8	61.7	45.5	29	65.3	23.1	93.5	116.6	55.1	74.9	89.9
1867	66.8	60.7	57.1	75.4	78	25.9	97	73.4	33.5	119.4	32.3	29
1868	80.5	62.2	79.2	55.9	55.6	39.4	61.5	124.5	71.6	58.2	58.7	105.7
1869	103.1	65.5	45.2	71.1	94.5	38.4	54.6	52.6	156	15.7	74.2	130.3
1870	74.9	42.7	54.4	23.9	56.1	19.8	41.7	41.4	89.2	184.9	35.1	46.5
1871	72.6	53.3	51.6	53.1	51.6	73.2	132.6	55.9	16.3	88.9	43.2	61
1872	87.6	61	54.4	58.4	52.3	83.8	55.6	123.4	83.3	114	94.5	133.9
1873	135.9	22.9	106.7	45.5	53.6	36.3	106.7	124.7	103.6	99.1	51.8	29
1874	69.6	41.4	44.4	45.5	57.9	44.4	73.7	131.6	98.3	100.8	91.4	106.4
1875	123.2	30	26.7	20.1	49.3	81.3	65.8	78	166.4	77.5	66.5	49.8
1876	30.7	105.7	112.8	52.3	19	39.9	43.2	87.1	112.5	81.3	63.5	125.2
1877	120.4	58.9	67.3	76.5	52.6	94.7	58.9	111	65.5	88.9	138.2	85.1
1878	72.6	41.7	30.7	36.3	86.9	131.3	65	96.3	79.2	73.2	44.7	31.2
1879	42.7	83.6	40.4	56.9	64.8	124.5	76.2	115.3	116.8	31.5	21.8	47.2
1880	24.9	68.3	90.2	103.1	35.3	72.1	186.4	42.9	53.1	64.3	91.2	77.7
1881	17.3	84.3	58.9	34.3	63.2	104.4	47.8	119.9	100.6	63.5	103.9	122.2
1882	58.2	59.4	63.8	78.7	69.8	76.7	110.2	83.6	41.7	85.1	135.1	85.6
1883	125.7	91.4	16	43.9	65.3	43.7	99.1	100.8	86.4	90.9	106.9	47.2
1884	90.4	85.9	71.9	39.9	54.9	21.6	81.5	33	45.2	62.2	82	105.4
1885	56.1	74.2	41.4	82	54.6	30.2	54.6	79.2	129.3	95.5	47.8	24.4
1886	102.4	46.2	72.1	50.8	80.3	46	60.7	55.9	79	109.2	78.7	125
1887	71.4	31.7	33.3	48	35.1	8.6	73.9	63.2	42.4	67.1	55.4	66
1888	54.4	15.5	78.7	41.4	53.1	122.7	113.5	61.2	18	34.8	62.5	98
1889	56.1	43.2	36.3	47	83.3	31.2	48.3	122.7	22.4	79.5	39.1	78.7
1890	148.5	20.6	79.2	17.6	38.3	63.5	56.6	84	82.4	60	135.5	49.2
1891	48.1	4.3	36.5	47.8	79	77.1	54.5	177.5	51.6	86.9	68.1	152
1892	44.5	74	14.8	25.7	120	48.5	93.6	199	111.4	58.4	98.8	32.8
1893	73.5	75.5	19.7	20.8	68.9	66.7	55.6	95.6	58.3	79.9	47.9	101
1894	99.7	82.8	53.1	124	63.6	48.4	102.9	77.7	7.8	83.7	88.6	73.4
1895	56.1	21.7	75.7	49	17.4	20.8	90.9	123.4	11.3	72.8	111.6	94.1
1896	25.3	36.9	117.3	23	8.6	54.1	135.9	65.6	141.2	63.2	26.7	108.5
1897	46.2	41.6	117.3	110.2	33.8	96.2	59.3	107.1	56.5	67.2	130.9	99.2

1898	47.3	40.9	20.4	90.8	67.6	83.4	28.1	161.1	76.6	53.2	131.5	62.3
1899	87.8	58	32.3	75.3	85.3	47	87	111.7	59.7	40.4	71.6	99
1900	104.4	59.7	18.8	54.9	58.4	98.3	45.7	190.4	35.5	111.3	104.6	102.9
1901	69.7	33.3	73.7	51	46	71.9	31	70.3	98.7	66.8	104.5	75.9
1902	77.1	50.9	58.7	50.7	50.5	38.7	49.9	62.2	39.8	42.8	118.4	74
1903	120.6	82.2	139.4	35.3	42.4	30.1	129	132.1	81	113.3	63.8	66.4
1904	89.7	112.5	70.9	51	82.7	41.3	94.3	83	59.7	63	60.2	48.6
1905	58.5	40.1	107.7	47.2	23.1	37.3	34.2	137.3	36.1	34	63	48.2
1906	101.3	67.6	57.6	43.4	89.8	57.4	88.7	88.4	29.8	117.7	42.2	60
1907	29.1	43.7	69.5	63.4	73.3	75.9	124.7	83.2	26.4	122.5	71.7	89.8
1908	76.6	59.4	74.7	44.2	71.6	39.8	64.9	95.5	137.8	39.9	62.7	80.9
1909	70.6	24.6	77.4	107.6	66	43.7	50.1	29.9	53.3	109.5	50.1	94
1910	90.9	106.9	50	69	54	95	76.4	112.7	17.6	42.9	73.2	78.6
1911	42.6	68.2	33.5	41.4	32	56.1	72.9	60.4	42.4	103.6	103.9	129.8
1912	68.5	81	90.9	25.3	33.8	125.9	121.3	117.5	9.7	55.1	43.2	104.2
1913	121.2	32	100.1	99.2	88.1	83.2	26	32.9	81.3	92.2	78.2	64.3
1914	31.3	114.3	86.9	53	40.2	23.1	60.7	104.7	42.9	46.5	89.4	135.2
1915	102.7	105.3	20.3	43.8	12.4	50	117.2	100.5	37	74.2	76.8	108
1916	64.4	105.3	51.2	76	126.3	72.8	70.3	80.4	61.7	151.1	95.1	75.6
1917	24.8	46.3	62.4	29.2	83.6	39.2	65.9	229.2	44.3	99.1	63.2	36.8
1918	55.6	95.2	54.2	26.2	51.9	30.3	88.3	60.2	133.9	92	77.7	120.5
1919	70.4	34.7	47.2	38.3	64.1	95.5	45	59.7	65.1	23.3	52.6	132.5
1920	113.1	93.3	71.8	75.5	66.1	30.5	110.4	54	42.9	146.9	76	67.2
1921	94.1	23.4	71.9	20.1	51.1	19.3	101.9	85.4	55.8	67.1	71.5	106.8
1922	71.9	100.2	41.8	57.5	46.9	34.8	66.9	80.6	97.1	29.3	21.3	101.8
1923	74.4	121.4	59.8	73.7	33.8	23.7	71.8	136.5	85	114.1	75	81.1
1924	100.3	31.1	19.7	84.1	107.5	73.2	74.8	95.8	171.5	87.4	103.9	136.2
1925	83.8	133.7	11.9	96.5	120.8	13.9	100.9	46.4	46.8	55.1	54.4	43.8
1926	115.5	55.2	26.3	47.4	65.3	66.2	127	74.4	52.5	55.7	84.8	25
1927	85.9	61.7	87.5	39.1	20.1	70.6	75.3	109.1	124	48.5	63.1	54.9
1928	98.7	98.9	82.3	46.8	55	110.6	53.5	104.1	39.3	137.9	99.4	89.4
1929	37.4	83.5	13.4	23	65.3	42.9	88.2	126	21	103.2	101	165
1930	125	14.1	95	46.5	41.8	45.8	79.8	145	98.1	117.8	74.8	87.6
1931	47	64.2	53.7	77	71.5	101.8	99.5	64.8	63.5	50.1	156.5	55.1
1932	100.1	5.9	32.1	56.4	69.8	14.4	93.8	37.2	94.3	83.8	32.6	110.6
1933	72.6	59	84.3	25.1	51.3	63.7	79.2	59.2	35.6	53.6	29.2	49
1934	112.7	4.2	73.9	48.1	50.7	49	45.8	116.2	127.6	88.1	34.7	130.5
1935	31.4	76.6	34.6	44.9	26.5	121.4	23.9	82.1	143.9	98.4	102.3	37.5
1936	100.5	45.3	39	58	25	75.2	156	48.8	118.5	49.5	77.9	79.6
1937	113.7	105.5	52.3	67.5	69.7	52	97.8	84.6	101.7	48.9	37.3	49.3
1938	111.6	36.7	34.4	3.9	92.2	87.5	170.3	103.9	51.7	184.9	118.8	84
1939	127.7	69.6	68.5	27.4	33.8	57.9	91.3	36.8	57.1	22	187.8	56.4
1940	62.9	98.1	53.8	63.9	23	27.3	85.9	12.8	53.6	157.9	106.3	89.1
1941	56.1	93	58.4	42.4	66.7	19.1	70.8	78.6	24.7	67.9	123.3	58.7
1942	105.8	24	71	47.1	88.8	7.7	98.2	138.2	111.6	63.6	16.7	95.1
1943	127.6	44.7	21.4	38.3	81.9	76.4	50.8	112.9	63.5	95.7	69.1	56.1
1944	101.4	35.1	14	39.7	81.2	44.7	77.5	96.7	110.9	113	128.7	98.2

1945	51.1	79.4	43.1	33.4	82.4	92.6	106.8	59.5	91.8	73.9	17	105.6
1946	125.3	132	36.7	26.6	51.4	90.2	117.4	171.4	133.5	33.4	91.7	122.9
1947	89.7	48	115.6	98.2	117	113.8	73.5	21.2	95	96.4	110.2	73.2
1948	178	55.2	71.8	51.8	60.6	97.8	51.2	72.8	83.7	95.9	74.1	144.9
1949	50.6	66	57.6	58.1	44.5	18.2	74.4	98.3	25.7	161.7	82.2	103
1950	32.4	100.5	42.9	66.3	31	47.2	136.6	112.3	138.1	79.9	70.6	57.2
1951	95.1	64.9	97.9	45.6	44.8	35.2	41.3	103.5	115.6	49.3	78.8	144.6
1952	112.9	21.9	28.4	49.2	96.6	56.3	40.7	73.9	53.8	131.4	51.5	74.8
1953	40.2	39.4	10.9	73.2	43.8	25.1	83.5	121.2	68.6	78.7	69.1	71
1954	54.8	103.7	59.7	30.4	101.5	62.1	90.5	104.4	124.3	125.9	99.7	97.3
1955	67.6	60.2	37.3	69.7	82.6	105	13.5	33.2	88	39.3	64.7	108.9
1956	74.6	21.7	50.2	22.3	33.8	59.6	116.3	128.6	119.4	61.4	48	107
1957	105.7	77.7	93	40.2	52.1	21	115.4	43.9	86.8	107.4	17.9	69.5
1958	95.6	86.9	39.5	37.5	101.2	85.1	100.2	153.3	101	46.1	51.6	88.7
1959	53.3	28.5	55.7	87.9	45.6	58.2	65.5	18.4	36.1	142.7	81.4	179.9
1960	84.7	44.6	42	59.3	68.9	78.7	145.4	112.5	130.1	67.1	151.7	127.6
1961	132.4	77.4	13.4	119.5	57.9	48.1	97.8	63.6	95.4	83.9	58.3	59.3
1962	87.1	32.8	54.8	49.5	68.6	36.4	52.8	115.4	147.2	32.4	76.9	76.4
1963	9.3	30.8	84.6	44	56.7	56.9	62.5	80.2	51.1	119.2	115.1	23.8
1964	43.6	24.8	76.3	73.6	70.3	52.1	72.8	101.2	48.1	76.3	57.7	137.5
1965	111.3	7.9	89.6	68.8	90.2	78.7	94.4	88.3	68.2	33.9	82.8	117.1
1966	72	75.5	42.9	94.3	77.8	113.3	44.4	99	68.5	137.8	45.4	84.9
1967	61.6	89.2	38.3	32.5	115.8	20	35.4	70.4	92.5	144.8	64.5	54.6
1968	106.1	13.8	62.5	51.9	73.8	57.3	24.6	85.2	109.8	82.9	102.4	126.4
1969	104.4	32.9	41.1	57.8	46.8	54.2	31.7	31.3	25.8	34.1	83.5	76.3
1970	47.4	88.5	37.7	98.5	30.2	40.9	75.9	51.7	91.8	70.7	134.7	34.1
1971	43.3	48	59.7	39.7	60	51.7	44.2	57.3	29.6	69.3	70.3	44
1972	81.6	44.4	63.7	62.6	88.6	53.4	64.1	48.5	10.8	44.1	104.4	73.1
1973	55.7	39.8	23.2	40.6	66.2	18	96.2	90.2	76.9	64.3	119	62.3
1974	144.4	55.8	28.7	29.8	59.8	46.6	98.1	89.1	119.9	50.5	59.5	76.7
1975	132.2	36.5	26.7	39.2	28.6	7.1	75.7	27.8	124	82	47	42.5
1976	70.4	42.7	56.2	26.4	69	29.5	54.4	6.2	80.3	129.7	62.1	56.4
1977	50.6	117.4	58.5	72.4	22.9	77	35.7	106.9	49.8	95.7	76.9	70.7
1978	73	51.7	77.7	49.8	14.8	50.1	66.7	61.1	41.9	45.7	79.5	111.1
1979	47.1	41.8	65.6	78.3	94.8	46.5	27	104.6	40.5	90.1	93.2	116
1980	54.7	68.1	80.6	36.1	27.7	48.7	103.2	70.8	98.9	91.7	68.8	87.6
1981	38.4	58.2	87.1	13.4	116	64.4	56.5	23.2	112.7	82.7	59.4	60.1
1982	66.7	64.4	84.9	23.8	51.6	85.7	14.9	110	62.2	115.6	106.9	92.2
1983	100.5	40	90.9	65.7	121	51.5	52	64.6	101.4	99.4	26.5	126.7
1984	128.6	55.7	58.9	35.6	18.3	26.9	36.3	98.6	81.5	78.6	94.4	85
1985	23.2	25.4	61.8	50.2	71.5	68.1	100.4	178	54.6	59.9	46.4	87.1
1986	80.3	2.4	88.1	55.4	102.1	101	55.4	139.5	2.3	100.5	94.1	127.1
1987	27.3	47.1	55.4	62.6	12.8	115.8	25.2	54.7	95	92	64.2	48.9
1988	123.1	60.3	100.4	11.6	77.5	47.3	96	87.9	54.7	84.8	43.1	37.4
1989	60	74.5	96.1	52.8	20.5	60	12.3	90	62.2	86.8	27.9	57.4
1990	104.8	168.9	15.2	48.3	24.1	62.2	55.4	43.8	20.5	142.5	62.3	97
1991	77.5	60.9	54.6	105.6	4.4	91.2	63.9	74.1	50.1	97.4	88.1	33.2

1992	65.4	41	86.8	75.7	50.2	32.5	65.1	116.2	85.5	49.1	84.3	68.5
1993	80.2	13.6	43	110.2	85.8	108.6	49.6	35.8	91.9	35.7	58.2	155
1994	107.7	79.5	96	100.4	57.9	42.2	64	64.4	84.7	54.5	59	139.2
1995	149.5	113.7	68.7	29.2	37.6	17.7	59	35	44.8	140.7	84.8	47.9
1996	78	90.2	100	61.9	54.8	26.2	52.2	96.7	28.1	138.1	85.5	26
1997	26.6	123.5	17.5	39	75.1	115.2	76.9	170.9	33.4	116.1	77.6	71.5
1998	101.2	26	84.9	88	25.3	164.8	79.1	50.8	62.5	130.5	98.4	91.6
1999	111.9	33.3	56.3	48.5	56	66.9	38.2	42.3	136.5	48	91.1	165.8
2000	54.3	97.3	31.3	46.5	56.7	40.8	63.7	67.7	99.8	137.6	131.8	75
2001	27.9	40.9	65.6	86	40	57.9	36.7	94.1	53.3	89.6	41.2	30.9
2002	113.1	125.1	42.6	72.6	109.6	101.2	65.8	51.6	23.5	123.8	130.2	77
2003	42.9	25.6	36.5	44.6	101.3	70.1	72.1	8.2	38.3	30.3	63.9	55.9
2004	81.1	27.7	57.9	50.7	29.9	50.1	41.9	71.5	70.8	145.1	56.9	78
2005	116.3	41	63.2	73.9	53.5	29.1	84.6	52.5	58	96.9	71.1	49.2
2006	32.3	37.3	120.7	45.9	85.1	26.6	65.7	115.7	107.7	133.4	101.7	120.8
2007	76.3	63.4	61.4	9.6	46.7	190	169.6	107.3	24.6	32.1	87.4	85.5
2008	186.2	33.8	82.7	13.6	13.7	54.8	123.7	204.8	107.1	108.8	53.2	59.8
2009	80.2	23.4	38.5	83.9	75	46.2	126.3	122.5	40.8	54.7	164.7	52.4
2010	75.9	58.7	71.1	36.9	32.4	44.9	148.3	44.4	131.7	62.8	145.1	12.4



This Birr Windrose indicates prevailing winds from SSE 12%, S 12%, SSW 12%, WSW 12% , W 11% covering circa 59% of the wind.

The NS alignment of the wind turbines indicated above shows that turbulence, noise & wake effects will be exacerbated beyond the data provided by the Applicant to downwind property owners.

The prevailing winds are from the W/SW directions. This means that the Wake will primarily be to the East/Northeast, which has a huge impact on the low-lying farmlands to the East. These include a lowering of the ground temperature by 3^0 Centigrade together with turbulent air that restricts flying birds. Additionally, this Wake would create a barrier to migration Iceland to the Wexford slobs. This barrier would interfere with foraging for food & would create massive displacement to the detriment of a range of at risk species & protected species.
This drop in temperature will have an effect on the food source for birds in association with an economic cost on all existing houses, with increased heating costs & colder enjoyment values.

It should be noted that the proposed turbines are located at the boundary of the site. The climate impacts from the Wake are then on lands plus properties not owned or under the control of the Applicant.

1) The recent High Court decision in relation to the effect of Noise on health & property devaluation [Phase 2], plus the Victoria Supreme Court decision in Australia are ignored, while historical data, pre 2015 is quoted.

2) The health & property value reports submitted are pre-2016 & have no relevance. Turbines were much smaller in that period.

Reference Number 1 .15: Commercial wind turbines and residential home values: New evidence from the universe of land-based wind projects in the United States Eric J. Brunner, Ben Hoen, Joe Rand, David Schwegman, Energy Policy 21 September 2023 www.elsevier.com/locate/enpol

Reference Number 1.16: Influence of onshore wind turbines on land values Jan von Detten, Johann V. Seebaß, Jan C. Schlüter, Florian Hackelberg. 4 May 2023. Springer. https://doi.org/10.1365/s41056-023-00067-5

Reference Number 1.17: The impact of wind farm visibility on property values: A spatial difference-in-differences analysis. Yasin Sunak, Reinhard Madlener. Energy Economics Volume 55, March 2016, Pages 79-91. https://doi.org/10.1016/j.eneco.2015.12.025

Reference Number 1.18: Clean Energy Wire, Journalism for the energy transition. Benjamin Wehrmann 21 Jan 2019.

Reference Number 1.19: Impact Analysis of the Niyol Wind Farm on Surrounding Rural Residential and Agricultural land Values in Logan County Colorado. June 11, 2020. FORENSIC APPRAISAL GROUP 116 E. Bell Street Neenah, WI 54956 ph (920) 558-4638 www.forensic-appraisal.com.

Reference No 2.1: The recent EU **Court of Justice** decision on the **Scope of Birds Directive** applies to this site.

The Court of Justice delivered an important judgment clarifying the scope of protection for wild bird species in the EU under the Birds Directive (Directive 2009/147) in case C-784/23- OÜ Voore Mets and AS Lemeks Põlva

The Court confirmed that all wild birds, regardless of the population status, are protected from deliberate killing or capture and their nest and eggs are protected from deliberate destruction. This includes not only intentional acts but also activities where the possibility of harm is accepted, such as forestry, construction and farming activities. On the other hand deliberate disturbance is only prohibited where it would be significant at a population level.
This will have significant implications for consents involving activities such as tree felling and hedgerow clearance both in terms of the level of characteristation needed and whether the competent authority will need to grant derogations under the strict conditions of Article 9 of the Birds Directive.

The Court's analysis focused on several key aspects of the Birds Directive's interpretation.

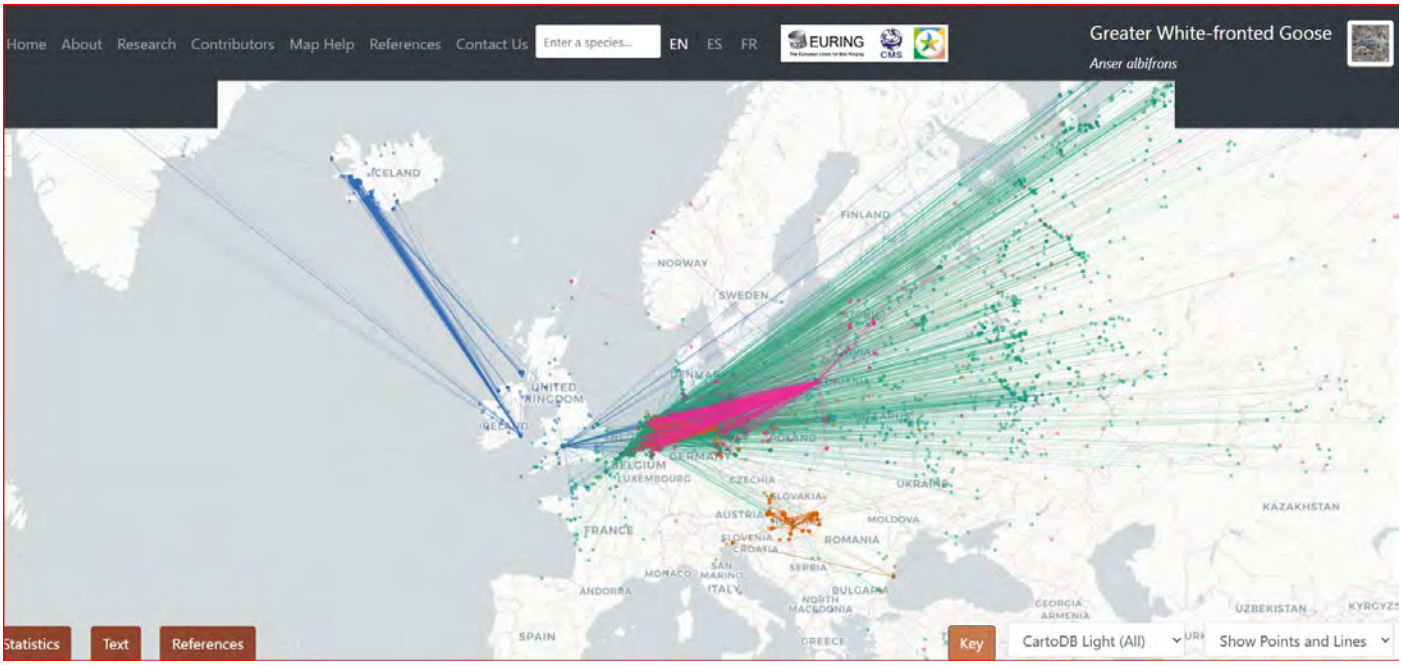
First, regarding the concept of "deliberate" actions under Article 5, the Court held that this encompasses not only intentional acts but also situations where the actor accepts the possibility of protected birds being killed or disturbed, or their nests damaged. This interpretation aligns with the Court's previous interpretation of similar provisions in the Habitats Directive.

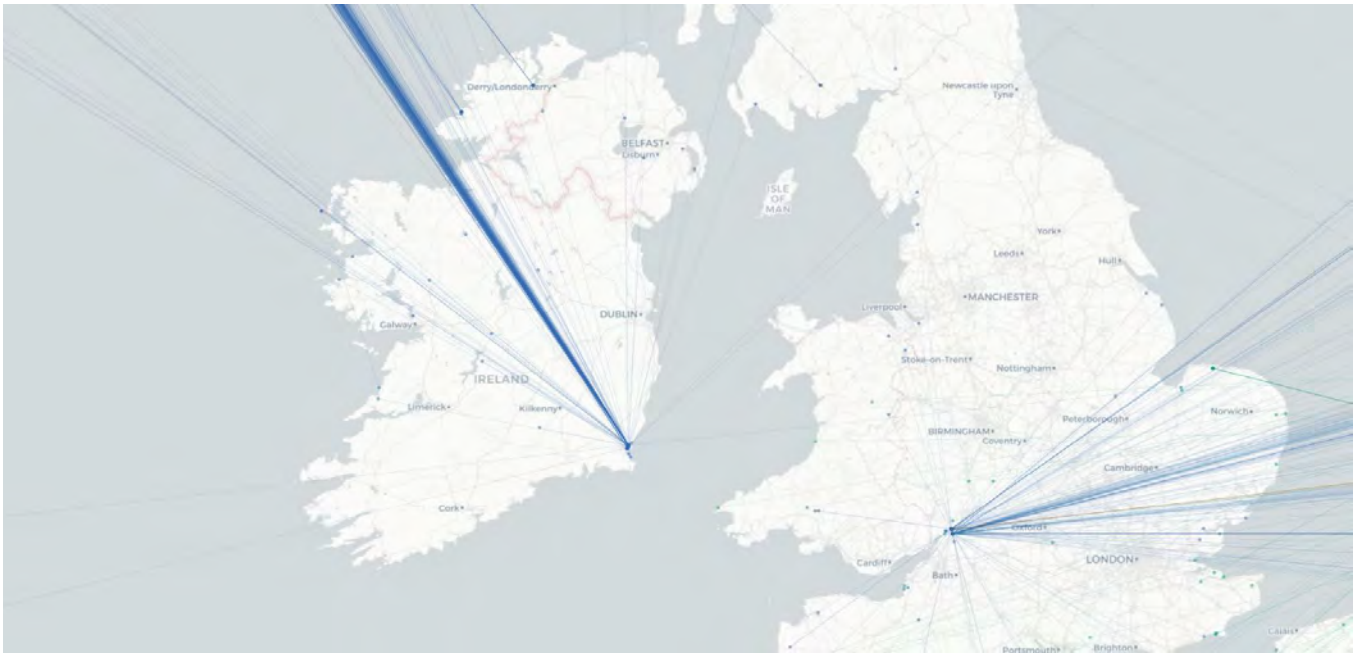
The Court emphasised that the Birds Directive's protections apply to all wild bird species, not merely endangered ones. This broad application reflects the directive's fundamental purpose of protecting all naturally occurring wild birds in EU territory.
A significant distinction was drawn between different prohibitions within Article 5.

The Court held that Article 5(d), concerning deliberate disturbance, only applies where such disturbance would significantly affect the objective of maintaining bird populations at satisfactory levels. However, the prohibitions in Article 5(a) and (b), regarding killing and nest destruction, apply regardless of population impact.

The Court confirmed that scientific data and field observations provide a sufficient basis for establishing bird presence and applying protective measures, consistent with the precautionary principle enshrined in EU law. The fact that no endangered species were present does not affect the application of these protections.

Reference No 2.2: Greenland White Fronted Goose





Reference No. 2.3: Red & Amber Bird Species

Birds of Conservation Concern in Ireland 2020-2026

Amber-list species (medium conservation concern)

Breeding
Goosander
Garganey
Spotted Crake
European Storm-petrel
Fulmar
Manx Shearwater
Gannet
Shag
Little Ringed Plover
Common Sandpiper
Mediterranean Gull
Little Tern
Roseate Tern
Common Tern
Arctic Tern
Sandwich Tern
Great Skua
Black Guillemot
Common Guillemot
Short-eared Owl
Marsh Harrier
Hen Harrier
Goshawk
Kingfisher
Merlin
Chough
Skylark
Bearded Reedling
House Martin

Breeding continued
Swallow
Sand Martin
Willow Warbler
Starling
Spotted Flycatcher
Northern Wheatear
Goldcrest
House Sparrow
Tree Sparrow
Greenfinch
Linnet
Pied Flycatcher
Western Yellow Wagtail

Passage
Cory's Shearwater
Ruff
Spotted Redshank
Wood Sandpiper
Little Gull
Black Tern
Wryneck
Tree Pipit

Wintering
Brent Goose
Barnacle Goose
Greylag Goose
Greater White-fronted Goose

Wintering continued
Smew
Pintail
Black-throated Diver
Great Northern Diver
Bittern
Turnstone
Brambling

Breeding and Wintering
Mute Swan
Whooper Swan
Red-breasted Merganser
Shelduck
Tufted Duck
Gadwall
Wigeon
Mallard
Teal
Great Crested Grebe
Coot
Red-throated Diver
Cormorant
Ringed Plover
Black-headed Gull
Common Gull
Lesser Black-backed Gull
European Herring Gull

rspb giving nature a home

BirdWatch Ireland

For more information, please see Gilbert G, Stanbury A and Lewis L (2021), "Birds of Conservation Concern in Ireland 2020 -2026". Irish Birds 9: 523—544

The categorisation of species as breeding, wintering etc. refers to the populations against which BoCCI criteria were applied

Figure 12 Key potential cumulative impacts on biodiversity from wind and solar and transmission infrastructure *Source: TBC*

Key

1) Fixed offshore wind farms can have cumulative and even ecosystem-level impacts to the composition of the seabed, marine species assemblages, nutrient flows and ocean circulation.
2) In addition to other marine activities like fishing, sports, and military activity, wind energy can add additional construction noise and disturbance to marine ecosystems.
3) Collision and displacement of seabirds is a major impact of increasing offshore wind energy, with floating wind farms now expanding to areas that were previously technically unfeasible.
4) Subsea cables from offshore wind will have a terrestrial impact and combine with other forms of nearshore energy like tidal power.
5) Solar power has a cumulative impact on land use, in addition to other requirements like agriculture, protected areas, real estate and transport infrastructure.
6) Associated renewable energy infrastructure expands the number of distribution and transmission lines needed, incurring greater electrocution risks, especially across vulnerable and migratory species' ranges.
7) Onshore wind energy infrastructure incurs greater collision risks, especially across vulnerable and migratory species' ranges.
8) Expansion of renewable energy has an implication for mining with increased demand for rare earth minerals and metals.
9) Other forms of renewable energy like hydropower will have an impact on freshwater environments and can add cumulative impacts to the water requirements of solar energy for cleaning and cooling panels.
10) Associated renewable energy infrastructure expands the number of distribution and transmission lines needed, incurring greater electrocution risks, especially across vulnerable and migratory species' ranges.

HEN HARRIER AMBER CONSERVATION STATUS

Irish Name: Cromán na gCearc Scientific name: Circus cyaneus

Bird Family: Raptors Status

Breeds in the uplands and bogs of Ireland. Identification Size between Montagu's Harrier and the larger Marsh Harrier. Females and juveniles similar- brown with white rump and dark rings on the tail, hence often referred to collectively as 'ringtails'. Females are bigger than males. Males very distinctive, appearing strikingly pale below, with blue grey upper parts and jet black wing-tips. Hen Harriers have somewhat of an owl-like face, particularly accentuated in female birds. Voice Usually only heard in the breeding season near the nest site. Quick, chattering calls in alarm and display and whistling calls from female to male, when receiving food. Diet Small birds and mammals, which are caught by surprise. Will sometimes use cover, such as woodland edges and bushes, to surprise prey. Breeding Breeding birds are confined largely to heather moorland and young forestry plantations, where they nest on the ground. Hen Harriers are found mainly in Counties Laois, Tipperary, Cork, Clare, Limerick, Galway, Monaghan, Cavan, Leitrim, Donegal and Kerry. The species has declined, probably due to the loss of quality moorland habitat due to agricultural changes, and maturing forest plantations. Hen Harriers mainly hunt over moorland whilst breeding where they take small ground nesting birds and mammals. Wintering Spends winter in more coastal and lowland areas throughout Ireland hence most easily seen on the coast in the winter months. Good sites include the North Slob Nature Reserve and Tacumshin Lake in County Wexford, as well as the East Coast Nature Reserve in Co. Wicklow. Monitored by BirdTrack and the Hen Harrier Roost Survey.

6.1 Characteristics The Hen Harrier is a medium sized raptor with long wings and tail. It possesses a hooked bill suitable for eating meat, like all raptors, and usually flies close to the ground with its wings held in a shallow 'V' above its back. Males are generally smaller than females while male and female adult plumage varies considerably. Adult males are blue-grey above and on the head and breast and white below. Additionally, males have broad black wing tips to both upper and lower wings and show white upper-wing coverts like female birds. Female birds are largely brown with fine markings and have white upper-wing coverts. The female tail is barred with dark bands and the body is streaked brown on a whitish background, especially on the breast. Juvenile birds resemble females but have darker secondary flight feathers, a rusty colour to the breast and less barring. This species is most similar to the Marsh Harrier (Circus aeruginosus).

6.2 Range in Ireland The Hen Harrier has an extremely large range globally, stretching across the majority of the Palearctic from eastern Siberia to Ireland and south as far as North Africa and South East Asia (BirdLife International 2014). In Ireland, however, this species is a scarce summer visitor to uplands and bogs in western Ireland, as well as a scarce winter visitor to lowlands throughout Ireland. The predominance of this species distribution is found in Munster (notably the counties of Cork, Limerick and Kerry), southwest Leinster and the border counties, while more scarce winter roosts are mainly located in coastal regions of the south and east (Irwin et al. 2011).

6.3 Conservation status The Hen Harrier is currently Amber-listed in Ireland due to a decline in the breeding population and continued persecution (Colhoun & Cummins 2013). Similarly, the UK population has been Red-listed (Hayhow et al. 2014). The European population of this species has been evaluated as Depleted due to a large historical decline and relatively low current population (less than 59,000 pairs). Though this decline has slowed in recent years, its population remains significantly lower than pre-decline assessments (BirdLife International 2004). This species is also listed under Annex I of the EC Council Directive on the Conservation of Wild Birds (2009/147/EC), with several Special Protection Areas (SPAs) designated for directed Hen Harrier protection. Internationally, the Hen Harrier is considered to be of Least Concern, owing to its extremely wide distribution despite recent taxonomic splits (BirdLife International 2014).

6.4 Population trend Though the population of this species has stabilised in most of its European distribution since 2000 (BirdLife International 2004), it was once almost extinct in the wild in Britain and Ireland as a result of persecution (Watson 1977). This was followed by a large decline across it European distribution between 1970 and 1990 (BirdLife International 2004). There are currently an estimated 128 – 172 pairs in the Republic of Ireland (Ruddock et al. 2011) with a further 59 in Northern Ireland (Hayhow et al. 2013). Although, this figure represents an increase from a maximum of 129 pairs in 1998-2000 (Norris et al. 2002), substantial differences in surveying effort are thought to confound these estimates as more recent subsampling across surveys has revealed declines in some regions, particularly within several SPAs (J. Lusby pers. comm., 17th Apr. 2015). The UK and Isle of Man population of this species is estimated to have experienced an 18% decrease since 2004, with notable decreases in Scotland and the Isle of Man, likely as a result of habitat change and persecution (Hayhow et al. 2013). Changes to preferred uplands through afforestation and agricultural intensification (and particularly the availability of habitat and food) likely continue to threaten populations of this species (Irwin et al. 2011). It is thought that the carrying capacity of this species' breeding range is the most prominent limitation to current population levels (Norris et al. 2002).

6.5 Breeding ecology 136 Breeding Hen Harriers are confined to moorland and young forestry plantations, where they nest on the ground. In the spring, Hen Harrier pairs lay 1- 6 eggs (Irwin et al. 2011). These are incubated for 34 days and fledge after an additional 37-42 days post-hatching, most of which has occurred by August (Irwin et al. 2011). Following this, individuals predominantly disperse to milder lowland and coastal areas for the winter, although some remain in upland breeding areas (Irwin et al. 2011). Pairs remain monogamous for the duration of breeding, apart from rare recordings of polygynous pairs (Scott 2010; Picozzi 1984). Adult survival is high in this species, at 0.81 annually. However, a longitudinal breeding biology report revealed that fledging success of Irish Hen Harriers, at 2.4 chicks per successful breeding attempt, was lower than that of UK populations (Irwin et al. 2011). Though low, this is still regarded as being higher than the minimum effective replacement rate for this species.

6.6 Habitat requirements Hen Harriers mainly hunt over moorland during the breeding season where they take ground nesting birds and mammals, which are caught by surprise using cover such as woodland edges and bushes. In particular, unmanaged grassland has been identified as important habitat for Hen Harrier feeding (Amar & Redpath

2005; Wilson et al. 2009). In general, Irish observations suggest that areas containing higher proportions of improved grassland are avoided (Wilson et al. 2009). Despite this and the assumed preference for open or younger-growth forestry, more recent assessments suggests that Hen Harrier feeding and breeding has been adapted to utilise older-growth forestry where necessary (Wilson et al. 2009). Time spent feeding differed between male and female birds and was significantly determined by vegetation height and proportion of managed grassland within a territory (Amar & Redpath 2005). It was thought that intensive sheep grazing, associated losses of heather (Calluna vulgaris) with increases in improved pasture and reductions on sward height have resulted in a contraction in suitable Hen Harrier feeding habitat.

6.7 Site fidelity Though Hen Harriers may exhibit strong site fidelity, it is thought that persecution and continually changing forestry patterns may be reducing habitat predictability across breeding seasons and forcing more dispersed annual breeding. Whitfield and Fielding (2009) – in a study of Welsh Hen Harrier dispersal – found natal philopatry (the tendency to breed in a bird's place of birth) to be low, with average natal dispersal of 18.4 km for females and 12.1 km for males. The direction of this dispersal seemed universally towards areas of more suitable habitat. However, dispersal between breeding seasons exhibited much lower distances, with females dispersing significantly less than males and often breeding at the same site in consecutive years (Whitfield & Fielding 2009). Other observations have found that failed breeding attempts drive more distant breeding dispersal in subsequent years (Picozzi 1984).

6.8 Sensitivity to development of wind energy In general, highly sensitive raptors (such as Hen Harriers) are regarded as being threatened by wind energy development through disturbance displacement and collision (Langston & Pullan 2003). However, limited research exists on the direct effects of wind energy infrastructure on populations of this species, particularly in an Irish context. In terms of collision, the common flight height of Hen Harriers while feeding has been measured at a mean of 10-20 m above the ground, largely ruling out the possibility of collision with active turbines. One study revealed that between 60 – 80% of a Hen Harrier's flight was less than 2 m (Whitfield & Madders 2006). This species may be at greater risk, however, during display flights and inexperienced fledgling flight (Madders 2004). A recent assessment of the effects of a wind farm on an existing population of breeding Hen Harriers reported regular flights at close proximity to turbine bases, some of which were at rotor height (Madden & Porter 2007). This same report revealed that, although reductions in flight activity around turbines were observed during the construction phase, the activity of bird populations quickly returned to pre-construction levels. Aside from collision risk, turbine avoidance by Hen Harriers observed at one wind farm installation extended to within 250 m of turbines (PearceHiggins et al. 2009). Though this study found a halving of flight activity within 500 m of a wind energy array, it found no significant modification in flight height near turbines, although this study also predicted a 52% reduction in breeding population within 500 m of a wind energy array. Madden and Porter thus posit that Hen Harriers will continue to use wind farm 137 sites post-construction, at least in the short-term (Madden & Porter 2007). Further, a recent assessment of Scottish bird populations and their sensitivity to wind energy development found that over 10% of estimated Hen Harrier range already overlaps with existing wind energy installations (Bright et al. 2008). Having said this, in an Irish context, concern has been expressed surrounding the wide ranging behaviour of Hen Harriers, potentially resulting in overlap of more than one wind farm (Percival 2003).

6.9 Zone of Sensitivity
Within Scottish SPAs, Male harriers travel up to 9km from nesting sites, though home-range size was estimated as 8km2 compared to female home-range of 4.5km2 . Despite this, most hunting by males and females was carried out within 2 and 1km from nests, respectively (Arroyo et al. 2014). From engagement with Irish Hen Harrier experts, observations have shown breeding home ranges up to a radius of 12-15km (O'Donoghue, unpublished satellite tracking data). Across various studies (Clarke et al. 1997; Watson 1977) these Irish ranges are not assumed to be either constant or circular in nature. Therefore, imposing very large circular zones of sensitivity around wintering roosts or breeding locations may devalue such protection measures, especially given that most activity is believed to occur within a central "core" area. Previous sensitivity mapping projects in relation to bird populations have imposed a buffer of 2 km around known Hen Harrier breeding sites (Bright et al. 2009). Further, a safe working distance from nesting Hen Harriers has been delineated at 500 – 1000 m by the Forestry Commission of Scotland (Forestry Commission Scotland 2006). Consequently, a conservative zone of sensitivity of 2km has been delineated around the summer breeding point locations of this species. However, given the sensitive nature of these roost locations, these have been obscured through the random offsetting of an expanded zone of sensitivity, following the protocol outlined in Appendix 3 of this document. 6.10 Data sources Data for this assessment has been obtained from the results of

extensive national Hen Harrier surveys conducted every 4-5 years in conjunction with the National Parks and Wildlife Service, the most recent of which was conducted in 2010 (Ruddock et al. 2011).

GOLDEN PLOVER RED CONSERVATION STATUS

Irish Name: Feadóg bhuí Scientific name: Pluvialis apricaria Bird Family: Plovers
Status Summer visitor from France & Iberia (though possibly some remain year-round in Ireland) & winter visitor from Iceland. Most in Ireland between October & February Identification Smaller than Grey Plover, with narrower, more pointed wings. Golden brown upperparts, which look grey at close range. Males in summer have more black below than females- extends from throat, towards each eye, and ventrally under neck, chest and belly. In winter, males and females similar in appearence, with no black underparts. Voice Flat whistle 'puu' in flight or when alarmed. Rythmic song 'pu-pee-oo' repeated in display flight, often followed by a repeated 'perpurrlya' when alighting, or when on the ground.
Diet Feed on a variety of soil and surface-living invertebrates, principally beetles and earthworms, but also on plant material such as berries, seeds and grasses. They regularly feed in association with Lapwing & Black-headed Gulls.
Breeding Breed in heather moors, blanket bogs & acidic grasslands. Distribution limited to the uplands of northwest counties in Ireland. Wintering Throughout the winter, Golden Plovers are regularly found in large, densely-packed flocks, and in a variety of habitats, both coastal and inland. Their distribution is widespread in Ireland.

Monitored by Irish Wetland Bird Survey. Breeding

4.1 Characteristics The Golden Plover is a medium-sized stout breeding wader, with narrow, pointed wings and mottled golden brown upperparts which, in winter, look grey at close range. Males in summer have more black below than females, which extends from the throat towards each eye and ventrally under the neck, chest and belly. In winter, males and females are similar in appearance, with no black underparts.

4.2 Range in Ireland
This species is a partially migratory summer visitor from France and Iberia, though some occasionally remain year-round in Ireland, moving to the coast or suitable inland areas in winter. At this time, between October & February, the Irish population is significantly inflated by the arrival of migrants from Iceland. The breeding (summer) distribution in Ireland is limited to the uplands of western and north-western counties in Ireland (Cummins et al. 2003; Cummins et al. 2004). Though this breeding distribution is sparse, notable localities include the isolated uplands of Donegal, western Mayo and south-western Galway. More recent resurveying of formerly occupied coastal machair sites of Sligo have resulted in these being lost from this species' breeding distribution since surveys of 1996 (Suddaby et al. 2010; Madden et al. 1998). At several of these sites, no evidence of breeding success was observed. More recent surveys of the Connemara Bog Complex SPA are currently underway, as part of National Parks and Wildlife Service monitoring efforts.

4.3 Conservation status The Golden Plover is Red-listed in Ireland, as it has been for some time (Lynas et al. 2007; Colhoun & Cummins 2013), due to large declines in its breeding population and breeding range and more recent declines in wintering populations. The European population is considered Secure. Though declines were recorded in several populations in Western Europe, this was compensated for by increases in its Finnish population and stability elsewhere (BirdLife International 2004). This is further regarded as being of Least Concern internationally by the IUCN (BirdLife International 2012). Given its significant regional declines, this species is also listed under Annex I of the EC Council Directive on the Conservation of Wild Birds (2009/147/EC). It is thought that the southern extremities of its European breeding range (including populations in Ireland and the UK) have been in decline since the 19th Century (Tucker & Heath 1994).

4.4 Population trend Currently, estimates of the Irish population of Golden Plover stand at circa. 120 pairs (Colhoun and Cummins 2013). In Ireland, this species has experienced a 40% population reduction in the last 20 years, while declines of up to 73% have been recorded in the breeding population between 1988/91 and 2008 (Lauder & Donaghy 2008). Similar declines in Britain have been attributed to afforestation and agricultural intensification (Boobyer 1992) which is likely a common driver of loss in Ireland also. A recent resurvey of 32 suitable machair sites within the Golden Plover's known range revealed a complete absence of breeding pairs, including a disappearance from formerly occupied Sligo machair (Suddaby et al. 2010), although Machair is not this species primary breeding habitat. This report warns that this current downward trend risks local extinction of this species as a breeding population. This same

report did, however, find Golden Plover to be the most numerous species at other sites, though these large aggregations were thought to be passage migrants. Adult survival is low in comparison to other species at 0.73 (Sandercock 2003), meaning that any recovery of this species with improved habitat protection or restoration will be slow.

4.5 Breeding ecology Golden Plovers nests consist of a shallow scrape on bare ground, usually in areas of low vegetation. This species is not a colonial nester though pairs may nest within 100m of each other. Nesting densities are conventionally much lower than this, however. A single clutch of 3-4 eggs is usually laid from April – May and is incubated for 28 – 31 days (Snow & Perrins 1998). Hatching success of these eggs was in other studies affected by predation by Carrion Crows (Corvus corone), Common Gull (Larus canus), American Mink (Mustela vison) and Foxes (Vulpes vulpes) (Parr 1993), while the breeding of Irish waders in general are thought be impacted by similar predation effects (Suddaby et al. 2010) . Adult foraging while nesting is widely dispersed, between 6- 8 km during daylight and 2-3 km nocturnally (Pearce-Higgins & Yalden 2003).

4.6 Habitat requirements
During the breeding season, this species requires areas of heather (Calluna vulgaris) moors, blanket bogs & acidic grasslands for nesting, favouring those areas with shorter vegetation (Snow & Perrins 1998). Their selection and use of habitat seems strongly correlated with prey abundance and availability, and not necessarily with lower levels of disturbance experienced at these sites (PearceHiggins & Yalden 2003). Arable fields were predominantly used as feeding ground during breeding, with a strong preference shown for shorter grassland areas of this range. Nesting birds will forage several kilometres around these sites on a variety of invertebrates, principally beetles & earthworms, but also on plant material such as berries, seeds & grasses (Pearce-Higgins & Yalden 2003). A study on Golden Plover chick habitat selection found that they neither select for exclusively heather- or grass-dominated habitats, but favour areas of mixed cover consisting of heather and grass or mire dominated by bog-cotton (Eriophorum vaginatum) (Whittingham et al. 2001). Again, availability of suitable prey was found to be the main determinant. Additionally it was concluded that vegetation structure, including concealment from predators, may influence habitat use. Though areas of calcareous grassland contained higher densities of suitable invertebrates, their exposed nature reduced this habitats utilization (Whittingham et al. 2001).

4.7 Site fidelity Given the Golden Plover's already limited distribution, remaining suitable habitat within its current range is of high priority. Though little research has been done on this aspect of the Golden Plover's ecology, limitations associated with habitat availability likely result in high site fidelity. The high specificity of breeding and feeding site selection of both adults and young (Snow & Perrins 1998; Whittingham et al. 2001) suggests that restriction to within these areas will remain so in the future. Though site selection of this species is narrow, disturbance within these sites as a result of wind energy developments was found to be very low in a recent assessment (Douglas et al. 2011), in contrast to the behavioural disturbance caused by walking tourists observed across a longitudinal study of a British Golden Plover population (Finney et al. 2005).

4.8 Sensitivity to development of wind energy In general, breeding waders were identified by an EU assessment of wind energy impacts as being particularly susceptible to disturbance displacement and barriers to movement (Commission 2011). Collision risk for waders is generally deemed to be low, due to a relatively low cursory flight path, coupled with high flight manoeuvrability. A review of pan-European collision assessments revealed much lower Golden Plover collision records than other species, though this was not controlled for survey effort or corpse recovery rates (Hötker et al. 2006). An assessment of disturbance to Golden Plover nesting sites by walking tourists revealed substantially reduced habitat use with 200 m of unimproved paths and to within 50 m of improved paths which contained tourists more effectively. Generally, reduced use of suitable habitat surrounding operating turbines, to within 200 m of the turbine base, has been recorded (Pearce-Higgins et al. 2009). Additionally, a review of 29 other studies suggests Golden Plover will approach wind turbines to an average distance of 175 m in non-breeding season (Hötker et al. 2006), with turbine height positively correlated with displacement distance. Further, modelling of wind energy developments and potential Golden Plover habitat found a negative relationship between wind farms and predicted populations of this species (Pearce-Higgins et al. 2008). However, a recent paper by Douglas et al. (2011) revealed that the installation of wind farms had no observable effect on populations or distributions of breeding Golden Plover up to three years after the completion and operation of turbines. Conversely, disturbance effects observed by Hötker et al. (Hötker et al. 2006) were found in 72% of Golden Plover sites, though these data pertained to non-breeding birds only. This is supported by a longitudinal study of British Golden Plover in the Pennines which

revealed that, though birds were disturbed often, reproductive performance did not fall (Finney et al. 2005). Furthermore, post-construction monitoring at 15 upland wind farms showed no significant decline in populations (Pearce-Higgins et al. 2012). Most disturbance effects were measured during the construction phase of these projects. Thus, current research indicates that care be taken in the planning of turbine height and with due diligence during construction of wind farms, especially when positioned on habitat known to support breeding Golden Plovers.

4.9 Zone of Sensitivity Avoidance of wind turbines and associated infrastructure by breeding Golden Plovers has been observed at distances of at least 200 m (Pearce-Higgins et al. 2008; Finney et al. 2005), with strong correlation between turbine height and disturbance displacement (Hötker et al. 2006). Previous sensitivity mapping assessments have used no zone of 149 sensitivity around Golden Plover habitat, instead demarcating Special Protected Areas (SPAs), within which this species occurs, as an indication of potential distribution. Additional to displacement, collision and barriers effects while migrating for forage up to 10km from nesting sites (Pearce-Higgins & Yalden 2003), as well as consideration of expert opinion, have resulted in the zone of sensitivity for this species being assigned a radius of 800 m around known breeding sites. Though this exceeds smaller recommended distances, the assigned radius allows for ranging around point locations and accounts for increased disturbance. In addition, Irish breeding populations of waders are at greater threat generally through habitat loss and disturbance.

4.10 Data sources Data for this assessment was obtained from the Upland Bird Survey (Cummins et al. 2004; Cummins et al. 2003), the Resurvey of breeding wader populations of machair and associated wet grasslands in north-west Ireland, as commissioned by the National Parks and Wildlife Service (Suddaby et al. 2010)and the Irish Wetland Bird Survey (Boland & Crowe 2012).

Reference Number 3.16: BLACK-HEADED GULL AMBER CONSERVATION STATUS

Irish Name: Sléibhín Scientific name: Larus ridibundus Bird Family: Gulls Status
Resident along all Irish coasts, with significant numbers arriving from the Continent in winter. Breeds in small numbers on islands in larger lakes in western Ireland. Identification A small gull, slightly smaller than Common Gull. Adults are pale grey above and white below. Adults are easily told apart from other Common Gull species by the thick white leading edge to outer wing, which can be seen at some distance. A blackish area bordering the white leading edge of the underwing is also evident. Pointed wings, and a small tail and head in proportion to the body, along with a long neck give a distinctive profile compared to other gulls. Adults have red legs, and in summer plumage, a dark brown hood on the head; in the winter, the hood in absent and is replaced by a dark spot behind the eye. Black-headed Gulls have two age groups, and attains adult plumage after one year when it moults into adult winter plumage. Young birds just out of the nest are finely patterned on the upperparts in ginger and brown and show a black tail band. First winter and first summer birds retain the wing and tail markings of the juvenile bird, but show grey on the mantle and in the first summer, a hood with a variable amount of white mixed in with the brown. Just after the bird is one year old it moults into adult winter plumage. Voice Strident, down slurred call. Can be very noisy at colonies.

Diet Feeds on insects especially in arable fields. Will also exploit domestic and fisheries waste. Breeding Breeds both on the coast and inland where they will often nest in colonies. Usually, nests on the ground in wetland areas, such as bogs and marshes and will also use man made lakes. Numbers breeding inland have declined dramatically, probably due to predation by the American Mink, which is an able swimmer and is able to access previously inaccessible nesting areas. The largest colonies in Ireland are in Northern Ireland on Lough Neagh. Colonies in the Republic are not widespread, the largest are found inland in Counties Galway, Monaghan and Mayo and at coastal sites in Counties Wexford and Donegal Wintering Irish birds are augmented by wintering birds from northern and eastern Europe and are widespread on both on the coast and inland.

Monitored by Wintering birds are monitored through the Irish Wetland Bird Survey. Breeding seabirds are monitored through breeding seabird surveys carried out every 15-20 years.

10.1 Characteristics The Black-headed Gull is a small gull, slightly smaller than a Common Gull (Larus canus). Adults are pale grey above with white below and are easily told apart from other common gull species by the thick white leading edge to the upper surface of the outer wing, which can be seen at some distance. Pointed wings, and a short tail and head in proportion to the body, along with a long neck, give a distinctive profile compared to other gulls. Adults have red legs and in summer plumage a dark brown hood on the head. In the winter, the hood is absent and is replaced by a dark spot behind the eye.

10.2 Range in Ireland The Black-headed Gull is a widespread Palaearctic species, ranging from Western Europe to Japan. In Ireland, this species can be found along all coasts, with significant numbers arriving from mainland Europe in winter. Though once a common bird, it now exists at much lower numbers across much of its Irish range and has experienced closely recorded declines in the recent past (Boland & Crowe 2012). This species now breeds sparsely across the midlands, though more prominent breeding sites in the Republic can be found at large lakes in the west in counties Galway and Mayo. Coastal sites in counties Wexford and Donegal are also important for this species breeding population.

10.3 Conservation status
Though significant populations exist elsewhere in the Palaearctic, Black-headed Gulls have been placed on the Red-list of Birds of Conservation Concern in Ireland since 2007, owing to a rapidly declining and localised breeding population (Lynas et al. 2007; Colhoun & Cummins 2013). The European population of this species is regarded as Secure, despite declines in several countries (BirdLife International 2004). The aggregate global population of this species has been assessed as Least Concern (BirdLife International 2012).

10.4 Population trend Winter populations of this species are augmented by wintering birds from northern and eastern Europe (Wernham et al. 2002). Though once a common and widespread species with a considerable resident population, numbers breeding inland have declined dramatically. This is probably due to predation by the American Mink which, as an able swimmer, can access previously inaccessible nesting areas. Though declines are difficult to estimate given the irregularity of surveys and their wide distribution, some studies estimate that the species has experienced a 50% decline in overall mean and annual peak numbers (Boland & Crowe 2012). Other studies have identified a particular decline in coastal breeding numbers (Mitchell et al. 2004). Of note, populations in the Dublin Bay area declined by almost 60% in just under a decade, from 1995- 2004 (Merne et al. 2009).

10.5 Breeding ecology Black-headed Gulls predominantly nest colonially, between April and July, often with other species of gulls and terns (Snow & Perrins 1998), preferring inland breeding sites over coastal locations. These include temporarily flooded, well-vegetated wetlands such as lake margins, river banks, lagoons, estuaries and tussocky marshes. This species is also known to use manmade structures and habitats as a nesting ground, such as gravel pits, sewage ponds and canals. Nests are ground-level and consist of rough vegetation on a shallow scrape on vegetation mats, reeds, grass and International 2014). Pairs will usually lay clutches of 2-3 eggs, which are incubated for 23-26 days. Though juvenile survival for this species is low at 0.447 (Balmer & Peach 1997), adult survival is extremely high at over 90% (Prévot-Julliard et al. 1998). Therefore, survival within the first two years for this species seems key to population stability.

10.6 Habitat requirements Black-headed Gulls use a wide variety of wetlands, either on the coast or inland. These areas include the banks of slow-flowing rivers, lake edges, mudflats, tidal inshore waters, estuaries and lagoons, though may also be found in anthropogenic habitats such as parks, agricultural land, sewage ponds and landfills (Snow & Perrins 1998). In coastal areas this may further include inlets with sandy or muddy beaches, though rocky or exposed shores are avoided. Within these preferred habitats, this species is an opportunist, using a variety of food sources. During the breeding season, when natural food is abundant, aquatic and terrestrial invertebrates are preferred, small rodents and grain. During the winter when natural forage is scarce, Black-headed Gulls rely strongly on sources originating from humans, including refuse tips, fish discards and urban waste (BirdLife International 2014).

10.7 Site fidelity
Though the Black-headed Gull shows a seemingly low level of site fidelity given the wide suite of habitats occupied compared to other species and its opportunistic feeding behaviour, this species displays a strong preference for nesting near erect vegetation within its preferred habitat (BirdLife International 2014). In addition, decreases in population numbers as a result of ecosystem threats (including mink depredation) suggest that the species' willingness to change breeding habitat to avoid such stresses is lower than expected. 158

10.8 Sensitivity to development of wind energy. Adult annual survival of this species is high compared to other species at 90% (Prévot-Julliard et al. 1998), thus exposing individuals to the potential effects of collision mortality across numerous years (Garthe & Hüppop 2004). Contrary to this, Winkelman (1992) found no disturbance of Black-headed Gull feeding and roosting by the presence of operational wind farms. In fact, previous studies have found increases in

populations of this species around wind energy installations (Winkelman 1989), possibly through ecological release of resources due to reduced competition. Further, the flight height of Black-headed Gulls below 15 m has been shown to reduce their susceptibility to collision with operating wind turbine rotors (Still et al. 1996). Despite this, measurements at Zeebrugge in Belgium (Everaert et al. 2002) found that Herring, Lesser Blackbacked and Black-headed Gulls all exhibited significantly higher mortality by collision than other species present. This report also showed a significant reduction in flights of Black-headed Gulls between the rotor heights of turbines present (36-85 m). Furthermore, the risk of collision was found to be significantly higher at night than during the day (Everaert 2002).

10.9 Zone of Sensitivity The high mortality of the Black-headed Gull as a result of wind turbine collision (Everaert 2002), combined with the steep observed drop in the species' population within Ireland (Boland & Crowe 2012; Mitchell et al. 2004), justifies a zone of sensitivity being imposed around its current distribution. This is defined by several important breeding colonies at coastal and inland lakes of the Republic of Ireland, with frequent feeding flights across and around potential locations for wind turbines. Given observed flying heights and associated higher risk of collision than other species, a zone of sensitivity of 1km was imposed for this species.

10.10 Data sources Data for this assessment were obtained from the most recent Irish Wetland Bird Survey (Boland & Crowe 2012) and Seabird 2000 (Mitchell et al. 2004), which was undertaken between 1998 & 2002 (Black-headed Gull records collected from '99 – '02).

COMMON GULL AMBER CONSERVATION STATUS

Irish Name:	Faoileán bán
Scientific name:	*Larus canus*
Bird Family:	Gulls

Status

Local breeding species on islands in larger lakes in western Ireland. Winter visitor to all Irish coasts, with significant numbers arriving from central and northern Scotland, Scandinavia and the Baltic.

Identification

Similar to Herring Gull. In adult plumage, has light grey upperparts and white underparts. Common Gull is much smaller than Herring Gull, with a slighter bill (yellow in adults), and adults have yellow-green legs and often show larger mirrors at the wing tips. Common Gull is also a more delicate Gull with a more rounded head and quicker movements. Like adult Herring Gulls the head is pure white in the summer and streaked in the winter. The species has three age groups and attains adult plumage after two years when they moult into adult winter plumage. Juveniles have dark, strongly marked upperparts, tail band and dark pink legs. First year birds retain the dark heavily marked upperwings and tail band, but have a grey mantle as adults birds do. Second year birds more closely resemble adult birds but show more black markings in the outer wing feathers and only a small mirror.

Voice

Insects and other invertebrates, fish and fisheries waste.

Diet

Terrestrial and aquatic insects and invertebrates, fish.

Breeding

Nests on the ground in a wide variety of situations, including, islands, cliffs and shingle banks. Breeds on the coast and inland in the west of Ireland, from Dingle to Malin Head, with most colonies in Co. Galway, Co. Mayo and Co. Donegal. Inland it can breed on islands in lakes where it has declined. These declines, like those of inland breeding Black-headed Gulls, have been attributed to predation by American Mink, reaching previously safe nesting areas

CORMORANT AMBER CONSERVATION STATUS

Irish Name: Broigheall Scientific name: Phalacrocorax carbo Bird Family: Cormorants Status

Resident, some immigration during the winter Identification Large, mainly all dark seabird, often stands with wings out stretched drying. Long body and neck, long strong hooked bill. Dark webbed feet. Swims low in the water with bill raised. Often seen inland, unlike the similar looking Shag, where it breeds in trees. Adult breeding bird is black with a green, bronze and blue gloss to its plumage, white feathering and yellow bare flesh at the base of the bill and a white

thigh patch. Cormorant lacks crest, instead having a sloping forehead which gives it a wedge shaped profile. Adult in non-breeding plumage lacks white thigh patch. Juvenile bird has very pale, even white, underparts and dark brown upperparts. Sub-adults have a variable amount of white in the underparts. Voice Deep guteral call when at the colony. Diet Fish. Breeding Breeds in colonies mainly around the coast of Ireland, with some birds breeding inland. Most of the larger coastal colonies in Ireland are on the south and north west coasts with big colonies also in Co. Dublin. Birds on the coast breed on cliffs whilst those inland, in trees. Wintering Winters at sea and inland Monitored by Breeding seabirds are monitored through seabird surveys carried out every 15-20 years

WHOOPER SWAN AMBER CONSERVATION STATUS

Irish Name: Eala Ghlórach Scientific name: Cygnus cygnus Bird Family:

Swans Status

Winter visitor to wetlands throughout Ireland from October to April. Identification Similar to Bewick's Swan, but larger, with longer neck. Yellow and black bill, with the yellow projecting below the nostril. Voice Vocal bugling or honking. Diet Aquatic vegetation, but they are commonly found grazing on agricultural grasslands and fields where there is spilled grain, as well as potatoes from cultivated land. Breeding The Whooper Swans that are present in Ireland each winter nest in Iceland during the summer. Each year a small number of Whoopers stay in Ireland for the summer and there have been occasional breeding records on lakes in the midlands and north-west. Wintering Most on lowland open farmland around inland wetlands, regularly seen while feeding on grasslands and stubble. Monitored by Irish Wetland Bird Survey (I-WeBS), and a special swan census is carried out every five years, most recently in 2020. The census takes place in January and aims to count and gather data on every Whooper Swan in Ireland. The census is coordinated in the Republic of Ireland by our I-WeBS team.

Breeding grounds in Iceland and Northern Europe. Relatively widespread winter migrant, especially north and west of a line between Limerick and Dublin. Lough Swilly (Donegal), Lough Foyle (Donegal/Derry), Wexford Harbour & Slobs, Lough Gara (Sligo) and Donegal Bay all support greatest numbers (350- >2,000 birds).

14.1 Characteristics The Whooper Swan is a very large and conspicuous bird. Adults are uniformly white and have a yellow and black bill, showing more yellow than black, with the yellow generally projecting below the nostril towards the bill-tip. Whooper Swans are larger than the Bewick's Swan (Cygnus columbianus) – the other yellow-billed swan that occurs in Ireland- with a longer neck and longer bill-profile. Whoopers can be distinguished from Ireland's resident Mute Swans (Cygnus olor) as they lack the knob and orange colour of the latter, and the necks of the yellow-billed swans tend to be held more erect than the graceful S-bend formed by the Mute Swan.

14.2 Range in Ireland Whooper Swans have an extensive international distribution, ranging from Iceland across the majority of the Palearctic to eastern Russia. In Ireland, these birds are winter visitors to wetlands throughout the country from October, peaking in November, December and January before departing by April (Boland & Crowe 2012). Of the five distinct populations of Whooper Swans globally, it is exclusively the Icelandic-breeding population that winters in Ireland (Robinson et al. 2004). Whilst in Ireland, this species is relatively widespread, occurring in as many as 270 sites, especially north and west of a line between Limerick and Dublin. Important sites within this distribution are Loughs Erne, Foyle, Swilly, Oughter and Iron, Wexford Harbour and Slobs and the Callows of the Shannon, Brosna, Suck and Blackwater rivers (Boland et al. 2010). Most recent surveys have suggested a general shift in this species' winter distribution to the southeast (Hall et al. 2012).

14.3 Conservation status 190 Whooper Swans are currently Amber-listed in Ireland due to the hosting of more than 20% of the European wintering population, the majority of which winter at ten or less sites (Colhoun & Cummins 2013). Furthermore, this species relies on a very small breeding population internationally. Consequently, this species is listed under Annex I of the EC Council Directive on the Conservation of Wild Birds (2009/147/EC). BirdLife International has, however, assessed the European population of this species as Secure owing to its extensive range and large numbers which have experienced a recent increase (BirdLife International 2004). Similarly, this species has been listed as Least Concern by (BirdLife International 2012).

14.4 Population trend

Despite some declines in Balkan populations of Whooper Swans, aggregate European populations of this species are increasing (BirdLife International 2004). Within Ireland, numbers of this species have increased at a mean rate of 2.6%

annually since 2001 (Boland & Crowe 2012), from 14,079 in 2005 (Worden et al. 2009) to 14,981 in 2010 (Boland et al. 2010), and the island of Ireland now supports more than 50% of the flyway population of the Icelandic breeding population (Boland & Crowe 2012; Hall et al. 2012). Of this most recent count, 10,452 birds were counted in the Republic of Ireland (Hall et al. 2012). Despite some flux in the importance of specific overwintering sites, there has been no significant change in the number of internationally-important sites on the island of Ireland (n = 14) (Boland et al. 2010). Of the numerous sites at which this species occurs in Ireland, 16 are now of national importance (Boland & Crowe 2012). Previous surveys did note, however, that these increasing numbers (8%) are found in a decreasing number (-9%) of sites (Worden et al. 2009).

14.5 Breeding ecology The Whooper Swan breeds in open shallow water, by coastal inlets, estuaries and rivers of Iceland and north-eastern Europe. The population occurring in Ireland breeds exclusively in Iceland (Boland & Crowe 2012). This species lays a single clutch each year of 4-5 eggs, which are incubated for 31-42 days (Brazil 2003). Though estimates of juvenile mortality are unavailable, adult survival in this species is estimated at 0.801 (Brazil 2003).

14.6 Habitat requirements This species winters at lakes, rivers, marshes, lagoons and sheltered inlets across Ireland and is increasingly found in lowland open farmland, grassland and stubble. A recent survey indicated that the use of improved dry pasture by this species has increased markedly since previous surveys (2005 and 2000), while occupation of lakes and rivers has dropped in the same period (Boland et al. 2010). Indeed, the majority of observations in recent surveys have positioned Whooper Swans in pasture and arable agricultural land (Worden et al. 2009; Boland et al. 2010). The diet of Whooper Swans was formerly restricted to aquatic vegetation within 1m of the surface, but this species is increasingly recorded grazing on grass in pasture and spilt grain, as well as roots, shoots, leaves, rhizomes and tubers of tillage land (Boland et al. 2010).

14.7 Site fidelity Given the growing threat to migratory birds internationally and the increasing population of this species in Ireland, the importance of nationally- and internationally-important sites is generally growing (Worden et al. 2009). However, the recent adaptation to farmland of varying types indicates that this species has a reasonably broad habitat preference (Boland et al. 2010). In addition, the recently observed flux of sites indicates that this species may not remain loyal to specific areas of suitable habitat (Boland & Crowe 2012; Boland et al. 2010).

14.8 Sensitivity to development of wind energy In general, this species has been identified as being at particular risk of disturbance displacement and collision as a result of wind energy development (Langston & Pullan 2003). In particular, exclusion from habitat around wind turbines has been identified (Larsen & Clausen 2002), in some cases up to 300 m from wind energy installations (Percival 2003). Observations of swan nonbreeding activity from 8 European studies have given a mean minimum distance of 150 m from the base of wind turbines (Hötker et al. 2006), while other studies have shown a reduction of 1-2.5% in available habitat through disturbance displacement (Larsen & Clausen 1998). Whooper Swans have the highest recorded migratory flight height of any species of bird, at up to 8km above sea level (Elkins 1983). However, while moving between roosting and feeding sites, most flocks travel at between 5 and 30 m, putting this species at a much higher risk of collision with medium and large turbines, especially when the size and reduced manoeuvrability of this species is considered (Larsen & Clausen 2002). Though Whooper Swans can avoid turbines and have been known to habituate to these (especially resident birds) their risk of collision is much greater than that of other species. In addition to collisions with turbines themselves, swans have a high observed collision rate with overhead power lines, which may be associated with these installations (Langston & Pullan 2003). Despite this, observed collision rates for Whooper Swans have remained low around the wind energy installations of Europe (Hötker et al. 2006). It is therefore claimed that Whooper Swans are most susceptible to collision with medium sized turbines (10 – 50 m blade height) in the low light conditions of mornings and evenings during winter (Larsen & Clausen 2002). There may also be seasonal variation in this exposure, as flight times have been shown to vary across over-wintering periods (Larsen & Clausen 2002).

14.9 Zone of Sensitivity Given the high risk of collision with wind turbines in comparison to other species and the observed disturbance to occupied habitat up to 300 m (Percival 2003), Whooper Swans have been assigned a zone of sensitivity of radius 600 m around occupied I-WeBS subsites. A more conservative approach has been taken in this instance given the international importance of the Irish distribution of this species.

14.10 Data sources Data for this assessment was obtained from the Irish Wetland Bird Survey (I-WeBS) (Boland & Crowe 2012), and the International Swan Census of January 2010 (Boland et al. 2010; Hall et al. 2012). IWeBS is co-

ordinated by BirdWatch Ireland and funded by the National Parks and Wildlife Service of the Department of the Arts, Heritage and the Gaeltacht. The International Migratory Swan Census is organised every five years and is carefully co-ordinated over one weekend in January in Ireland by the I-WeBS Office and the Irish Whooper Swan Study Group, in Britain by the Wildfowl and Wetlands Trust (WWT) and in Iceland by the Icelandic Institute of Natural History, with overall co-ordination by WWT and the Wetlands International/ IUCN SSC Swan Specialist Group. BirdLife International, 2004.

KINGFISHER AMBER CONSERVATION STATUS
Irish Name: Cruidín Scientific name: Alcedo atthis Bird Family:

Kingfisher Status
Resident on Irish streams, rivers and canals. Identification Very distinctive when seen well with its brightly-coloured plumage. The underparts are a bright orange-red, while the wings and back of the head are dark blue. The back, rump and tail are a bright, almost "electric" blue and usually draw attention to a flying bird. Despite these bright colours, can be easily overlooked perched motionless on a branch beside a stream or river on the look-out for fish. During the breeding season, females have a small red patch at the base of the bill, which is not shown by adult males.

Voice A shill whistled “chee-kee”, frequently repeated. It is usually one first signs that a Kingfisher is present along a stream or river.

Diet Various species of small fish (Stickleback, Minnow, and Chub) and larger aquatic insects caught by plunge-diving from a perch or while hovering. Breeding Kingfishers breed in tunnels dug in vertical banks along streams and rivers.

Wintering A very sedentary species, Kingfishers rarely move from their territories. However, some may move to lakes and coasts during extended spells of poor weather. Monitored by Waterways Bird Survey.

GREENLAND WHITE-FRONTED GOOSE AMBER CONSERVATION STATUS

Irish Name:	Gé Bhánéadanach
Scientific name:	*Anser albifrons flavirostris*
Bird Family:	Geese

Status

Scarce winter visitor to wetlands in Wexford and western Ireland from October to April.
Identification

Medium-sized grey goose, with orange legs, a long orange-yellow bill with a prominent blaze around the base of the bill (adults).
Voice

High-pitched, musical in quality (not nasal). Usually disyllabic.
Diet

Grazes on a range of plant material taking roots, tubers, shoots and leaves. Grasses, clover, spilt grain, winter wheat and potatoes are popular foods. Forages over peat bogs, dune grassland, and occasionally salt marsh, with the use of agricultural grassland increasing in recent years.
Breeding

Breeds on lowland tundra, often by lakes and rivers. Nests are widely scattered, though loose colonies may be formed.

13.1 Characteristics

The Greenland White-fronted Goose is a medium-sized grey-brown goose, with orange legs and an orange-yellow bill. Adults have a prominent blaze around the base of the bill and black barring on the belly. This species is similar to the larger Greylag Goose (Anser anser), though is distinguished from this by a white patch above the bill.

13.2 Range in Ireland

The Greater White-fronted Goose (Anser albifrons) has an extremely large range globally, extending throughout the Arctic while breeding and in various regions at lower latitudes during the winter, from China to Western Europe and coastal North America (BirdLife International 2014). The Irish and British migratory population originates from Greenland and is regarded as a subspecies (A. a. flavirostris). In Ireland, this subspecies is a scarce winter visitor to a limited number of sites, between October and April. Whilst here, this species is highly gregarious and mainly gathers in three internationally important sites (at the Wexford Slobs, Lough Swilly and the Little Brosna Callows). Additionally, this species occurs at 3 sites, Lough Iron, Dunfanaghy New Lake and Cahore marshes, in nationally important numbers.

13.3 Conservation status

A large proportion (63%) of the global population of Greenland White-fronted Geese was counted in Ireland in spring 2014 (Fox et al. 2014). This subspecies is currently Amber-listed in Ireland as the majority of the internationally important population winters at less than ten sites (Colhoun & Cummins 2013).

13.4 Population trend

The population has experienced a marked decline, from an estimated 35,600 individuals in 1999 to 20,797 in spring 2014 (Fox et al. 2014). In Ireland, this equates to an average annual decline of 2.4% (Boland & Crowe 2012), though the substantial population found at the Wexford Slobs has undergone a much lower annual decline (0.9%). It is thought that this decline is a result of continued perilously poor productivity in its Greenland breeding grounds, as a result of environmental factors (Fox et al. 2006; Boyd & Fox 2008) and inter-specific competition (Kristiansen & Jarrett 2002).

13.5 Breeding ecology

This subspecies' breeding range is confined to western Greenland, where it nests in lowland tundra, often by lakes and rivers. While here, a single clutch is laid annually, although only a small proportion of birds may actually breed. This clutch consists of 5-6 eggs which are incubated for 27- 28 days. Nests – usually consisting of a mound of vegetation on sand or clay – are widely scattered, though loose colonies may be formed (Snow & Perrins 1998).

13.6 Habitat requirements In its wintering range,

Greenland White-fronted Geese require undisturbed foraging and roosting areas, and sites with multiple foraging areas to allow for local movements in response to disturbance (Stroud et al. 2012). Roost sites occur adjacent to salt marshes, on mud flats and on some inland freshwater lakes (BirdLife International 2014). It traditionally forages over peat bogs, dune grassland, and occasionally salt marshes though it is now increasingly found feeding on intensively managed grasslands (Mayes et al. 2009; Fox et al. 2006). This species grazes on a range of plant material, taking roots, tubers, shoots and leaves. In particular, grasses, clover, split grain, winter wheat and potatoes are preferred forage. More detailed investigations of White-fronted Goose feeding found that habitat preference is strongly linked to the availability of this preferred vegetation, in addition to environmental factors such as frost and snow cover (Owen 1971) and local drainage regimes (Mayes et al. 2009).

13.7 Site fidelity

The fact that this species returns to the same set of nationally and internationally important wintering sites annually, indicates strong site fidelity. Given the low reproductive output (Fox et al. 2006), the decline in numbers reaching the limited number of Irish wintering sites is likely to continue, increasing the importance of remaining sites. A longitudinal study of an isolated flock in Ireland revealed strong affinity to a wetland area during a decline towards, and subsequent to, the site becoming unsuitable for wintering individuals (Mayes et al. 2009).

13.8 Sensitivity to development of wind energy In general,

Greenland White-fronted Geese are regarded as being threatened by wind energy development through disturbance displacement and collision (Langston & Pullan 2003; Stroud et al. 2012). In some studies, disturbance displacement of

this species has been observed up to 600 m, with significantly lower feeding closer to turbines (Kruckenberg & Jaene 1999). Avoidance of roads has also been noted for this species (Mooij 1982), suggesting that infrastructure associated with turbines may also negatively impact this species. Similarly, although collision and disturbance effects are poorly recorded for this species, a recent assessment of goose feeding found that significantly fewer birds were observed grazing within 40-80 m of low level power lines, though this effect was not observed with higher voltage lines mounted at greater heights (Ballasus & Sassinka 1997). A review of more generalised collision risk with turbines was inconclusive, though examples of flocks flying within large turbine rotor heights have been recorded, particularly in coastal regions (Langston & Pullan 2003). As a result, in a recent species action plan (Stroud et al. 2012) collision with turbines and power lines has been highlighted as a significant threat to the conservation of Greenland Whitefronted Geese.

13.9 Zone of Sensitivity

Little research has been conducted on the disturbance distances of this species. However, reduced numbers of this species have been observed feeding up to 600 m from wind turbines (Kruckenberg & Jaene 1999). Additionally, a review of various assessments by Langston and Pullan (2003) indicated that distances of up to 600 m should be used in any exclusion for geese. The zone of sensitivity for this species has thus been set at 600 m, demarcated around the Special Protected Areas (SPAs) within which the major flocks of wintering Greenland White-fronted Geese are found.

13.10 Data sources

Data for this assessment has been obtained from the Irish Wetland Bird Survey (Boland & Crowe 2012) and from a dedicated annual survey coordinated by the National Parks and Wildlife Service and the Greenland White-fronted Goose Study, the most recent of which was conducted in 2014 (Fox et al. 2014).

Reference Number 3.1 : Offaly County Development Plan

DMS-97 Safe Sight Distances required for access onto National, Regional and Local Roads	The following safe sight distances, shall be provided from vehicular entrances on the road network; • Local Tertiary Roads: 60 metres; • Local Secondary Roads: 90 metres; • Local Primary Roads: 120 metres; • Regional Roads: 150 metres; and • National Roads: 230 metres. As set out by design standards detailed in TII publications, sight distances shall be measured from a point 2.4 metres from the road edge at the proposed access to a point at the near edge of the approaching carriageway. The standard for local roads is at the discretion of the Planning Authority and may be reduced where it would not give rise to a specific traffic hazard.

DMS-105 Traffic and Transport Assessments and Road Safety Audits	Developers will be required to provide a detailed Transport and Traffic Assessment (TTA), as carried out by competent professionals in this field, where new developments will have a significant effect on travel demand and the capacity of surrounding transport links in accordance with the thresholds set out in Tables 2.1, 2.2 and 2.3 of Traffic and Transport Assessment Guidelines (Transport Infrastructure Ireland, 2014). When preparing the TTA's regard should be had to the provision of the; • Traffic and Transport Assessment Guidelines (2014); • Design standards detailed in TII publications; and • Traffic Management Guidelines (Dublin Transportation Office and Department of Transport, 2019). Where a Transport and Traffic Assessment identifies necessary on and off-site improvements for the development to be able to proceed, the developer will be expected to fund the improvements by entering into a formal agreement with the Council. A Road Safety Audit shall be required for significant developments in accordance with the Road Safety Audit Guidelines (TII Publication).

13.9.13 Energy and Communications

DMS-109 Wind Farms	When assessing planning applications for wind energy developments the Council will have regard to; • the Wind Energy Development Guidelines for Planning Authorities, DoEHLG, (2006) and any amendments to the Guidelines which may be made; and • the Wind Energy Strategy Designations Map from the County Wind Energy Strategy showing areas identified as 'Areas Open for Consideration for Wind Energy Developments' and 'Areas not deemed suitable for Wind Energy Developments', and specific policy for wind development in these areas as outlined in Section 8 of the County Wind Energy Strategy;
	In addition to the above, the following local considerations will be taken into account by the Council in relation to any planning application; • Impact on the visual amenities of the area; • Impact on the residential amenities of the area; • Scale and layout of the project, any cumulative effects due to other projects and the extent to which the impacts are visible across the local landscape; • Visual impact of the proposal with respect to protected views, scenic routes and designated scenic landscapes and proposed Wilderness Areas as detailed in Chapter 4 of this Plan; • Impact on nature conservation, ecology, soil, hydrology, groundwater, archaeology, built heritage and public rights of way; • Impact on ground conditions and geology; • Consideration of falling distance plus an additional flashover distance from wind turbines to overhead transmission lines; • Impact of development on the road network in the area; • Impact of the development on radio observatories and broadcast communications in the area; and • Impact on human health in relation to noise disturbance (including consistency with the Word Health Organisations 2018 Environmental Noise Guidelines for the European Region), shadow flicker and air quality. This list is not exhaustive and the Council may consider other requirements contained in the chapter on a case by case basis with planning applications should the need arise. Where impacts are predicted to arise as a result of the development proposed, suitably detailed mitigation measures shall be proposed.

Table 8.4 Restricted Regional Routes in County Offaly

Restricted Regional Route	Location	Reason
R356	Cloghan to Banagher	Carrying Capacity
R400	Rhode to county boundary toward Rochfortbridge, link to M6	Carrying Capacity
R402	Ballina Cross to Edenderry	Carrying Capacity
R420	Tober to Tullamore	Carrying Capacity
R420	Tullamore to Portarlington	Carrying Capacity
R436	Ferbane to county boundary toward Kilbeggan	Carrying Capacity
R439	Birr to Banagher	Carrying Capacity
R445	Dunkerrin through Moneygall to county boundary	Carrying Capacity
R446	Horseleap to the county boundary towards Moate	Carrying Capacity
R440	Birr through Kinnitty to county boundary towards Mountrath	Amenity
R357	Cloghan to Shannonbridge	Amenity
R421	Tullamore to Kinnitty	Carrying Capacity and Amenity
R357	Cloghan to Blueball	Carrying Capacity and Amenity

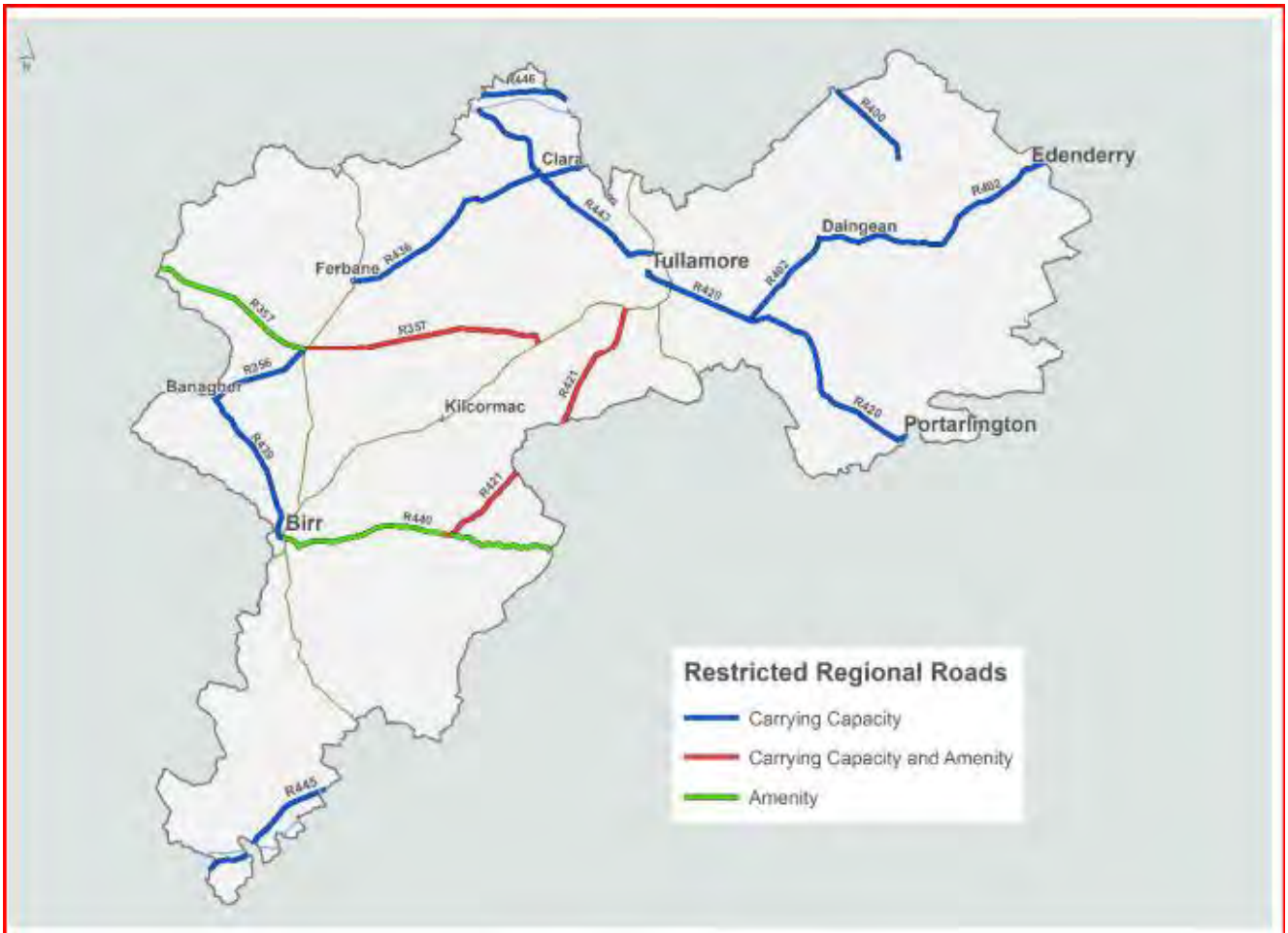


Figure 8.10 Restricted Regional Routes

3.3 Visibility

For safety, road users shall be able to see any potential hazard in time to slow down or stop comfortably before reaching it. It is necessary therefore to consider the road user's line of vision in both the vertical and horizontal planes and the stopping sight distance for the vehicle or ATU at the relevant design speed. Visibility requirements for the different junction types are included in the relevant chapters of this standard.

4.3 Design Vehicle

The use of computer software to predict the swept path of large vehicles is mandatory in the design of all junction types. The vehicle type used shall be appropriate to the predicted use of the junction or direct access. The vehicle tracking software should be capable of allowing vehicle speed to be measured. The Designer shall ensure that the junction design can accommodate a driver negotiating the junction at a minimum speed of 5km/hr for direct accesses and 15km/hr for priority junctions. At all other junctions, Designers shall demonstrate using tracking software that the design vehicles included in Appendix A can travel at the design speed set out in this standard.

All of the geometric parameters outlined in this standard for the design of priority junctions have been developed to cater for a 16.5m long articulated vehicle, whose turning width is greater than the vehicle dimensions permitted in the existing Road Traffic (Construction, Equipment and Use of Vehicles) Regulations, or likely to be permitted in the near future. In cases where hard strips are present, the design vehicle may encroach on these while turning, and at some simple junctions with local roads, the design vehicle may encroach into opposing traffic lanes.

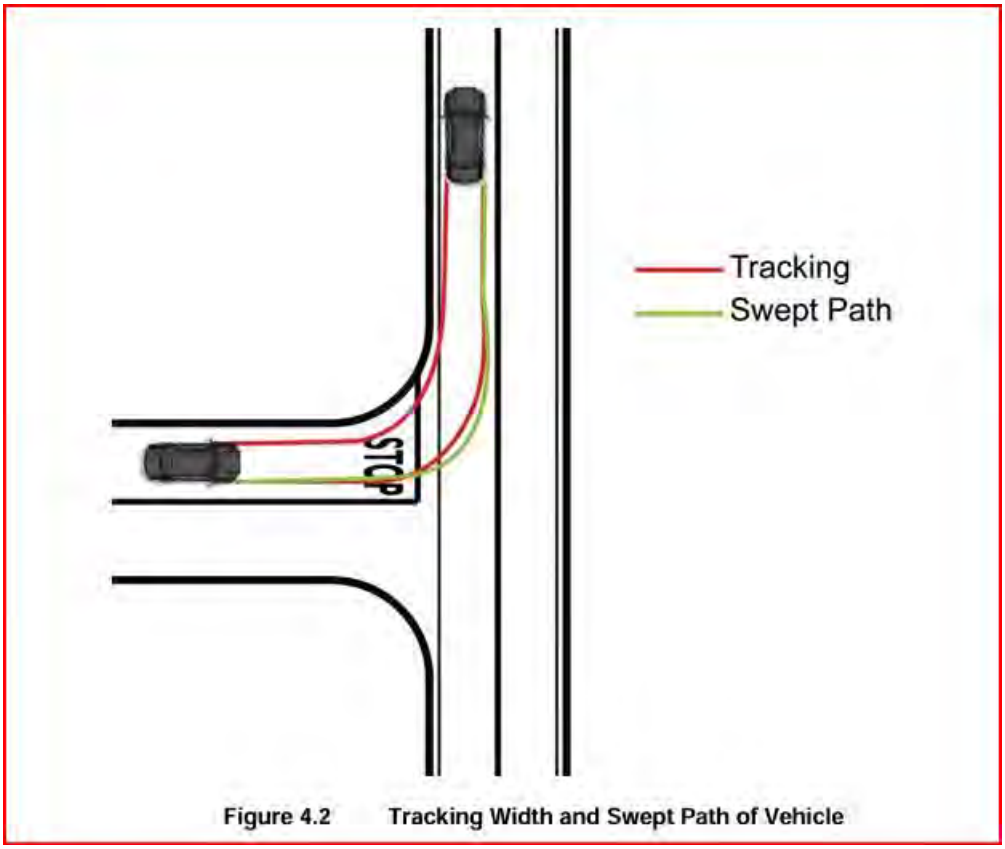


Figure 4.2 Tracking Width and Swept Path of Vehicle

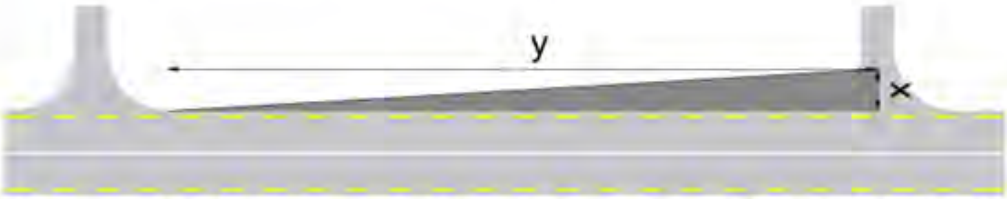
5.2.4 Visibility

At driver's eye level, there shall be a clear view from the junction or access over the immediate area of the junction or access and its connection to the national road.

Direct accesses shall only be sited where they do not encroach on the visibility requirements of adjoining direct accesses or junctions in regular use – see Figure 5.4. This will determine the minimum spacing of new accesses. However, a minimum staggered distance of 20m shall be always provided.

Signs, street furniture and planting should be located and designed so as not to obstruct visibility.

Direct Access located within the visibility envelope of the adjacent access



Wider spacing of accesses results in unobstructed sight distance from the adjacent access

Note:
'x' distance is given by Table 5.4
'y' distance is given by Table 5.5

Figure 5.4 Examples of minor road alignment at junctions

5.6.2 Visibility

5.6.2.1 General

Traffic from either a minor road or direct access has to join or cross the major road when there are gaps in the major road traffic streams. It is therefore essential that drivers emerging from a minor road or direct access shall have adequate visibility in each direction to see the oncoming major road traffic in sufficient time to permit them to make their manoeuvres safely. The visibility requirement for drivers emerging from a minor road or direct access is to the high object (1.05m) on the major road as defined in DN-GEO-03031. This concept also applies to major road traffic turning right into the minor road or direct access.

Table 5.4 'x' Distances on the minor road for visibility measurements

Major road use	Minor road use	Standard	'x' Distance(m)
All roads	All junctions and accesses, Stop control	Desirable Minimum	3.0
All roads	Cycle Route	Desirable Minimum	4.0
National roads	Simple Junctions, Stop control	Relaxation	2.4*
Regional & Local Roads	All junctions and accesses, Yield control (where there are no relaxations associated with the junction layout)	Desirable Minimum	Max. 9.0
Regional & Local Roads	Accesses, Lightly trafficked	Relaxation	2.0
All roads	All junctions and accesses	Desirable Maximum	9.0

From the point "x" metres back from the major road a driver approaching the junction along the minor road shall be able to see clearly points to the left and right on the nearer edge of the major road running carriageway at a distance given in Table 5.5, measured from its intersection with the centreline of the minor road. This is called the 'y' distance and is defined in Figure 5.11a and 5.11b.

Table 5.5 'y' Visibility distances from the minor road

Design Speed of major road(km/h)	'y' Distance(m)
42	50
50	70
60	90
70	120
85	160
100	215
120	295

5.6.4 Corner Radii

It is recommended that the minimum circular corner radius at simple junctions in rural areas where no provision is made for HGVs should be 10m. Where there is frequent use by large commercial vehicles (e.g. near a quarry or industry frequently accessed by large vehicles), the minimum circular corner radius shall be as follows:

a) For vehicles entering the minor road, the corner radii shall be 13m followed by a 1:10 taper for a distance of 25m measured along the line of the minor road from the nearside edge of the major road.

b) For vehicles entering the major road from the minor road, the corner radii shall be 13m followed by a 1:10 taper for 25m measured along the line of the major road from the corner line of the minor road. This is shown in Figure 5.13.

c) 13m at ghost island junctions with tapers of 1:6 over a distance of 30m.

d) 13m at simple staggered junctions, with tapers of 1:8 over a distance of 32m.

e) 20m radius for left-in/left-out priority junctions, except on Type 2 Divided Roads where the minimum exit radius off the mainline shall be 40m.

f) 40m exit radius off the mainline and 20m entry radius onto the mainline for left in-left out priority junctions forming part of a compact grade separated junction. Refer to Chapter 8 for details.

The values in a) to d) above are minimum values and a swept path analysis shall be carried out in accordance with Chapter 4 at all at-grade junction locations to establish circular corner radii for the junction appropriate for its use.

9.2.5 Sight Distances

For Compact Connector roads of low radii where it is necessary to provide for vehicle restraint systems, an obstruction in Stopping Sight Distance to the 0.26m object height may occur. In this case a relaxation to Stopping Sight Distance to the 0.26m object may be provided but SSD shall be maintained above the vehicle restraint system to the 1.05m object height.

Guidance on sight distance and visibility standards are given in Chapter 5 of this standard for the connections to the major and minor roads. In the case of compact grade separation these shall be taken as mandatory.

1. Design Speed

The road alignment shall be designed so as to ensure that standards of curvature, visibility, superelevation, etc. provide for a Design Speed which shall be consistent with the anticipated vehicle speeds on the road. Design speed is related to road characteristics and is not directly related to mandatory speed limits. A relatively straight alignment in flat country will generate higher speeds, and thus produce a higher Design Speed than a more sinuous alignment in hilly terrain, or amongst dense land use constraints. There is always an inherent economic trade-off between the construction and environmental costs of alternative alignments of different Design Speeds, and their user benefits.

2. Sight Distance

2.1 Stopping Sight Distance

Table 1.3 shows the Stopping Sight Distance (SSD) appropriate for each Design Speed.

Stopping Sight Distance shall be measured from a driver's eye height of between 1.05m and 2.00m, to an object height of between 0.26m and 2.00m above the road surface, as shown in Figure 2.1. It shall be checked in both the horizontal and vertical planes, between any two points within the visibility envelope shown in Figure 2.1. The check shall be carried out along a line in the centre of the lane on the inside of the curve (for each carriageway on Dual Carriageways / Divided Roads).

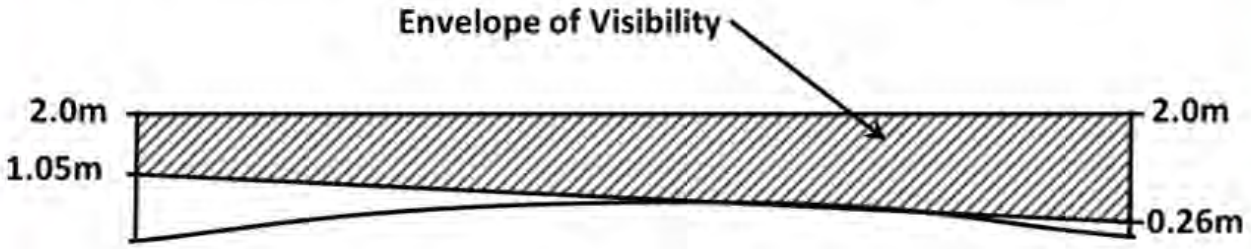


Figure 2.1 Measurement of Stopping Sight Distance

And the Design Manual for Urban Roads and Streets (DMURS) and TII Standard DN-GEO- 03084 'The Treatment of Transition Zones to Towns and Villages on National Roads' where appropriate.

• In the case of single houses in the countryside such standards should not be achieved by the extensive removal of hedgerows, ditches, embankments, trees or old walls, and should be in accordance with Section 2.8 of the Rural Design Guide13.

• All significant development proposals will be required to have transport and traffic assessments carried out in accordance with the publication Traffic Management Guidelines14 and the Traffic and Transport Assessment Guidelines15 (where the development affects a national road).

• Planning applications involving a new access or significant changes to an existing access to a national road, will be required to include a Road Safety Audit.

13.22.1 Access and Sight Lines

The applicant must demonstrate that safe vehicular access to and from a proposed site is provided in terms of visibility from a proposed entrance, but also in terms of impact on road traffic on the adjoining public road, through generation of turning and stopping movements by vehicles leaving and entering the proposed site. Applicants must adhere to the TII document Design Manual for Roads and Bridges (DMRB) and TII Standard DN-GEO-03060 Geometric Design of Junctions when assessing planning applications and the Design Manual for Urban Roads and Streets (DMURS) and TII Standard DN-GEO-03084 'The Treatment of Transition Zones to Towns and Villages on National Roads' where appropriate. Site entrances should be located so as to require the least amount of hedgerow removal in accordance with DMRB requirements. Excessive hedgerow removal will be resisted where setback is considered significant or roadside definition is compromised. Hedgerow removal will also be resisted where several entrances have over time denuded the extent of mature hedgerow along a particular stretch of road. All hedgerows that are required to be removed to achieve sightlines should be reinstated behind the applicable sightlines and maintained so as not to cause any reduction in the extent of sightlines achievable over time.

Reference Number 3.3 : EIAR submission on Roads

Note that the detailed drawings in this application do not comply with the Development Standards of the Kilkenny/Laois County Development Plan or with the TII Standards as referenced in same. This indicates that the lands required for the Sight Distance Triangles is not in the ownership of the applicant. The Sight Distance Triangle requirements are based on default Speedlimits or 85% effective speeds. No data is provided for same. It should also be noted that no vertical section, as required, is included to indicate compliance.

As a result of this non-compliance at every junction, this Application should be refused on County Development Plan breaches & Road Safety issues.

The N77 close to Ballyragget & the Regional & Local Roads are not owned by Kilkenny County Council. They are public Rights-of-Way. The adjoining landowners own the lands under the public Rights-of-Way to the centre of the road. Public Utility Companies have the right to lay services under such public Right-of-Ways, but private developers do not. Reference previous Court Decisions: Kenny J in Holland v Dublin County Council (1979) 113 ILTR, Baker J in Daly v Kilronan windfarm (2017) IEHC 308.

Granting approval to the use of the Local Roads for the grid connection would be facilitating trespass or allowing a public utility contractor as proposed, to construct private works to do same to avoid the existing legal process is challengeable under Judicial Review.

The haul route & access required to transport components is noted to require 3rd party lands both for widening, removal of fences, walls, trees, tree/hedge pruning, etc, & on occasion to allow over sail requirements. The application documents are contradictory & do not appear to contain the necessary consents from 3rd Party Landowners for any works necessary to carry out the necessary road improvements.

Before retirement, I was employed as Senior Engineer Roads & Transportation. Road ownership is variable.

- Most of the roads evolved as public Rights of Way from long term usage. This Right of Way only permits the public to pass & repass over the surface. The adjoining landowner is the registered owner to the centre of the road.
- A second situation involves the Local Authority purchasing lands under a form of dedication of a Right of Way to the Local Authority. Again, the adjoining landowner retains ownership of the soil under the Right of Way.
- A third situation involves the Local Authority purchasing the lands through CPO via a Bord Pleanala decision. In this case the Local Authority owns the road.

The Local Roads comes under the first & second bullet points. No developer has rights to use the lands under these roads without the landowner's permission. Bord Pleanala do not have the authority to grant permission over 3rd party lands & doing so could be claimed as facilitating trespass.

It should be noted that the Applicant does not own the public road proposed for the grid connection or passing bays, neither does Offaly County Council. The public road confers a Right to pass and repass over the surface of the roadway. The soil under the public road is owned by the adjoining Registered owner. The Applicant does not have ownership or control of said roadways & is not allowed to include same as if it were in his ownership or part of his site.

MWP

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Ref: CO/23882
Date: 3rd September 2025

National Environmental Health Service,
Health Service Executive,
Midland Regional Hospital
Tullamore,
Arden Road,
Co. Offaly,
R35 HP73

Re: Planning Application for Strategic Infrastructure Development under Section 37E of the Planning and development Act (As Amended)

Dear Sir/Madam,

We are engaged by Ballinla Wind Farm Ltd. (applicant) for the preparation of the design, planning and EIAR for a proposed Wind Energy Project within the townlands of Leitrim, Ballyfore Big, Ballyleakin, and Ballina (Geashill By), Co. Offaly.

The project has been the subject of a Pre-application Stage consultation for Strategic Infrastructure with An Coimisiún Pleanála (Ref: ABP-318203-23). An Coimisiún Pleanála has determined that this proposed project falls within the Strategic Infrastructure Development consent process under Section 37A(2)(a) and (b) of the Planning and Development Act 2000, as amended. In confirming that this project is a Strategic Infrastructure Development project it has identified 18 prescribed bodies that have to be notified of the application for the proposed development. Accordingly, we are notifying you that the application has been lodged with An Coimisiún Pleanála.

The following sets out the description of the proposed development:

- Seven Wind Turbine Generators (blade tip height 185m).
- Seven Wind Turbine foundations and hardstand areas.
- One electrical substation (110kV) including independent power producer (IPP) substation and wind farm operations compound with associated ancillary buildings, security fencing and all associated works.
- One LiDAR station based on the ground.
- Two new site entrances from the L5010.
- New and upgraded internal site access tracks.
- All associated underground electrical and communications cabling connecting the proposed turbines to the proposed onsite substation.
- The TDR including temporary works on sections of the public road network and private lands along the turbine delivery route on the L-5006 and the junction of the R-402 and R-420.
- One temporary construction site compound and additional mobile welfare unit.
- One spoil deposition area.
- Landscaping.

ENGINEERING AND ENVIRONMENTAL CONSULTANTS

Directors: Peter Fay BSc CEng MEI MStructE FConsEI | Paul Collins BE CEng MEI MStructE | John Lee BE HDip5HWW CEng FEI | Brian Sayers BE MSc CEng MEI | Ian Brosnan BE CEng MEI MICE MStructE

Technical Directors: Ken Fitzgerald BSc Surv Dip CEcon PG Dip Planning EIA CZM | David Ahern BE CEng MEI MCIBSE

Associate Directors: Tim Hurley BEng MEngSc CEng MEI | Michael Fenton BE CEng MEI | Caitriona Fox BA MSc

Registered in Ireland as Melachy Walsh & Company Limited
Company Registration Number: 133445 VAT Number: 4726135H
Registered Office: Park House, Bessboro Road, Blackrock, Cork, Ireland

- Associated surface water management systems.

The applicant is seeking a ten-year permission and an operational period of no less than 35 years from the date of commissioning of the entire Wind Farm. The substation and associated infrastructure is permanent.

An Environmental Impact Assessment Report (EIAR) and a Natura Impact Statement (NIS) have been prepared in respect of the proposed development and accompanies this application. The EIAR and NIS were completed with the added element of a proposed 8km grid connection to the Philipstown 110kV Substation, to be submitted into planning separately and in the future. The proposed grid connection will be within the townlands of Leitrim, Lumville, Ballinla, Clarkeville, Ballyfore Big, Ballyfore Little, Ballyeakin and Ballykilleen, in (Coolestown By) Co. Offaly.

A copy of the application may be viewed/downloaded on the following dedicated SID project website **ballinlawindfarmsid.ie** commencing on the (5th September 2025). A hard copy of the application can be made available if required.

You are advised that the An Coimisiún Pleanála may in respect of an application for permission decide to:

(a) (i) grant the permission, or (ii) make such modifications to the proposed development as it specifies in its decisions and grant permission in respect of the proposed development as so modified, or (iii) grant permission in respect of the proposed development (with or without specified modification of it of the foregoing kind), and any of the above decisions may be subject to or without conditions,

or

(b) refuse to grant the permission

Submissions or observations may be made only to An Coimisiún Pleanála, 64 Marlborough Street, Dublin 1 relating to:

i. the implications of the proposed development for the proposer planning and sustainable development, and
ii. the likely effects on the environment of the proposed development, and
iii. the likely significant effects or adverse effect on any European site, if the development is carried out.

Any submissions/observations must be received by An Coimisiún Pleanála not later than **5.30pm** on the (24th October 2025).

Should you have any queries in relation to the enclosed please contact the undersigned.

Yours sincerely,

Graeme Thornton

Graeme Thornton
for MWP

ENGINEERING AND ENVIRONMENTAL CONSULTANTS

Reference Number 4.1: HSE submission for similar Application to Clare County Council

An tSeirbhís Sláinte Comhshaoil
Feidhmeannacht na Seirbhíse Sláinte,
Ionad 6, Páirc Ghnó Bothar Chuinche,
Inis, Co. An Chlár.

Environmental Health Service,
Health Service Executive,
Unit 6, Quin Road Business Park,
Ennis, Co. Clare.

☎ (065) 6706660

CLARE CO. COUNCIL
18 APR 2023
PLANNING SECTION

Planning Department
Clare County Council,
New Road,
Ennis, Co. Clare

Date: 13-4-23
ID3085
Planning ref: 23-148
Applicant: RWE Renewables Ireland Limited

ection Purposes

An tSeirbhís Sláinte Comhshaoil
Feidhmeannacht na Seirbhíse Sláinte,
Ionad 6, Páirc Ghnó Bothar Chuinche,
Inis, Co. An Chlár.

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☎ (065) 6706660

CLARE CO. COUNCIL
18 APR 2023
PLANNING SECTION

Planning Department
Clare County Council,
New Road,
Ennis, Co. Clare

Date: 13-4-23
ID3085
Planning ref: 23-148
Applicant: RWE Renewables Ireland Limited

The following HSE stakeholders were consulted on the application on the 22nd March 2023:

- Emergency Planning – Kay Kennington
- Estates – Helen Maher/Stephen Murphy
- Director of National Health Protection – Eamonn O' Moore
  CHO – Maria Bridgeman

A visit to the proposed development site and surrounding area was carried out by Mr Rory O'Dea, Senior Environmental Health Officer, on the 28th March 2023.

The following are the observations of the EHS. For clarification on the content of this submission contact should be made, in the first instance, with Gerard Leen, Principal Environmental Health Officer at the above address.

Yours faithfully,

Gerard Leen

Gerard Leen
Principal Environmental Health Officer

Inspection Purposes Only

Noise

The EHS has considered Chapter 7 of the EIA titled Noise.

Construction Phase

Exposure to construction noise and construction activities should be controlled by conditioning hours of activity, if permission is granted. The absolute noise exposure levels given in table 7.1 are not reasonable to protect sleep and normal land use in a rural area such as the proposed development area.

WHO have identified noise as a significant risk to health particularly where it disturbs sleep:

https://www.who.int/europe/health-topics/noise#tab=tab_1

The background level in the vicinity is around 30dB as reported in the EIAR. To then permit noise levels of 55dB up to 11pm at night (change of 20dB) for cat A during an 18 month construction period is not a reasonable protection of health. It is also not reasonable protection of health to permit levels of 65 dB for cat A to commence at 7.00am within an existing noise environment such as the development site. It is accepted that construction activities cause noise, but by limiting all activities to a conditioned time there can be adequate protection of Public Health during this phase.

It should be noted that the Supreme Court have made it clear that compliance with a license or planning condition does not negate the fact that any activity cannot create a Statutory Nuisance ([1999] IESC 64 Supreme Court). This extends to compliance with any Guidance or Standard.

It is the opinion of the EHS that continued exposure to the noise levels in Table 7.1 of the EIAR, derived from BS5258, over an 18 month period up to 11pm at night would meet the criteria of section 108 of the Environmental protection Agency 1992, in that it would be a Statutory Nuisance.

Operation Noise

Measured background from EIAR

Table 7-4: Prevailing Background Noise during Daytime Periods (110m hub height)

Location	Prevailing Background Noise $L_{A90,10min}$ (dB) at Standardised 10 m Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
RWID_2	34.1	34.7	35.5	36.5	37.7	39.0	40.5	42.1	43.9	43.9§
RWID_11	31.7	32.5	33.5	34.7	36.2	37.9	39.8	42.0	44.4	44.4§
RWID_13	25.8	27.0	28.3	29.8	31.6	33.5	35.7	38.0	38.0§	38.0§
RWID_17	27.5	27.9	28.6	29.8	31.5	33.5	35.9	38.8	42.1	42.1§
RWID_46	33.5	34.1	34.9	35.9	37.1	38.4	39.9	41.5	41.5	41.5§
RWID_49	28.3	28.3	28.6	29.4	30.5	32.1	34.0	36.3	36.3§	36.3§
RWID_52	29.9	30.1	30.5	31.2	32.1	33.3	34.6	36.2	36.2§	36.2§
RWID_123	28.6	29.0	29.6	30.7	32.0	33.7	35.7	38.1	38.1§	38.1§
RWID_211	33.8	34.1	34.7	35.5	36.5	37.8	39.3	41.0	43.0	43.0§

§ - noise level restricted to the highest derived point

Inspection Purposes Only

The evaluation criteria for daytime noise exposure has been taken from the 2006 Guidance which permits an absolute noise exposure limit of 35 to 40 dB LA90 . There is no advice within the guidelines on how to choose the noise limit from within this range.

The EIAR has decided to use the higher criteria (more noise exposure to sensitive locations) based on the following rationale:

"An appropriate balance must be achieved between power generation and noise impact." From the 2006 Guidance
And from ETSU R-97 (written in 1996)
ETSU-R-97 which recommends that the following three factors be considered when determining the fixed limit:
1) Number of dwellings in neighbourhood of the wind farm.
2) The effect of noise limits on the kWh.
3) Duration and level of exposure.

From the EIAR page 20 section 7
The IOA GPG states the following with respect to the ETSU-R-97 criteria... "It can be argued that assessing these factors do not represent an acoustic consideration but ultimately a planning consideration."
The first factor to be considered is the "Number of dwellings in neighbourhood of the wind farm". ETSU-R-97 describes this factor as balancing the benefits from a wind energy project with the local environment impact

"The more dwellings that are in the vicinity of a wind farm the tighter the limits should be as the total environmental impact will be greater. Conversely if only a few dwellings are affected, then the environmental impact is less and noise limits towards the upper end of the range may be appropriate."
The number of noise sensitive locations (includes planning permissions) within the 35dB LA90 study area is 41. A noise limit of 40 dB LA90 is appropriate.

The second factor is the effect of noise limits on the power output of the wind farm. Similarly, to the first factor, this balances the planning merit of the project against the local impact. The proposed project has 8 turbines. If the limit is lowered, then, based on the noise modelling results, curtailment would be required. Since this project is considered to have merit in assisting Ireland in meeting its renewable energy targets, the upper end of the limit range is appropriate.
The final ETSU factor relates to the duration and level of exposure. The prevailing background noise levels are described in detail in Section 7.4.1 and Appendix 7.1. In terms of the location of the properties within the study area, these are mainly located east, south and west of the proposed site. There is one property located downwind of the prevailing, south westerly wind.

The EHS makes the following comments:

a) The 'common good' identified in the EIAR to justify a higher noise exposure for the noise sensitive locations because there are 'only' 41 of them has no basis in Environmental Assessment. The EIA has to legally assess 'the likely significant effects'. Whether these likely significant effects meet a criteria for proper planning and sustainable development, whilst protecting public health, under Planning Legislation is not a role for the EIA or the EIAR accompanying a planning application. It is not the role of the EIA to form an opinion on the balances required in planning decisions.

b) The EIAR should inform on the likely significant effects from the proposed development. It is perfectly reasonable and rationale for the EIAR to inform all stakeholder, including local residents and their Environmental Health Service and their Planning Service of the significance of predicted noise against a health protection standard set at the lower noise criteria. The implications of using a lower power output to meet noise requirements should have been considered in the 'alternatives' section of the EIA process. The same applies for the rationale of 'to have merit'. The final element of the rationale 'level and duration' is not quantified in the reasoning for adopting the higher noise level criteria.

c) The reasonable course of action in the EIA process is to report at every criteria between 35 and 40 DB LA90, which then informs the Planning Authority who can then decide on the balance between the need for the development, the merits of the development and the predicted environmental impacts as per their statutory functions.

d) It is noted in tables 7.18 onwards that if the lower level from ETSU R 97 was adopted then none of the NSL would meet the criteria at the higher wind speeds. Even at the highest adopted criteria there are still NSL that will be exposed to higher levels of noise than the adopted criteria to the south west of the development site.

e) The rationale for setting a higher noise limit due to it not being viable to run the development at lower power should not be used to ignore assessment of the more stringent health protection standard of the lower noise limit.

f) It is also noted that the EIAR does not report the predicted change in the noise environment which is a 'likely significant effect' but just compares the predicted against the absolute noise exposure criteria adopted at the highest level under the 2006 Guidance.

g) The adopted higher level of 43 dB LAQ90 for night time noise in ETSU-R-97 is contra to the excepted position that there should be higher protection from noise at night. In practice, the theoretical attenuation of noise at night from everyone being inside with windows and doors closed as detailed by ETSU R -97, does not happen. Particularly in rural areas as per the proposed development. This criteria is permitting night time noise increases of up to 20 to 25 dB from the existing noise environment during the night. Even with a theoretical 10 dB attenuation the increase in noise is predicted to be up to 15 dB.

From the EIAR:

'The predicted noise levels comply with the daytime and night-time limits at the majority of noise sensitive locations. However, an exceedance is observed at receptors south east of the site, the nearest of which is R13 during daytime periods at standardised 10m height wind speeds 6m/s for both the upper and lower envelopes.
The noise modelling assumed that this receptor is downwind of all wind turbines. In practice, this will not occur all the time and the actual noise levels at the receptor will be lower when the receptor is upwind or cross wind of the wind farm. The receptors where the exceedance occurs are south east and so upwind of the prevailing wind. Mitigation measures are outlined in Section 7.6.2.'

And in 7.6.2

'The predicted noise from the proposed wind farm meets the daytime and night-time noise limits at the closest locations to the proposed windfarm, and therefore no mitigation is required..'

The EHS is of the opinion that the EIAR does not adequately assess the likely significant effects from noise. This opinion has been formed for the following reasons:

1. **The adoption of the higher level of 40 dB LAQ90 criteria in low background areas is based on a rationale that authors of EIARs have no competency to make,**
2. **The EIAR should therefore inform the Planning Authority of the likely significant effect at the lowest and highest noise level criteria to enable an informed decision to be made on the likely significant effects,**
3. **The EIAR does not clearly state the change in noise environment at NSLs as a 'likely significant effect'**

Shadow Flicker

The EHS has considered Chapter 12 of the EIAR on predicted shadow flicker from the proposed development.

The 2006 Wind Energy Guidance document is generally accepted as outdated and not fit for assessment of the size of the current turbine heights and proximity to housing and facilities. It has been subject to a review process over a number of years. Whilst the new guidance and/or legislative base for wind farm development has not yet been adopted, a proposed draft approach has been published along with draft Wind Energy Development Guidance in 2019.
https://assets.gov.ie/46097/6e68ea81b8084ac5b7f9343d04f0b0ef.pdf

Section 5.8 of the draft:

The planning authority or An Bord Pleanála should impose condition(s) to ensure that no existing dwelling or other affected property will experience shadow flicker as a result of the wind energy development subject of the planning application and the wind energy development shall be installed and operated in accordance with the shadow flicker study submitted to accompany the planning application, including any mitigation measures required.

Planning Authority - Inspection Purposes Only

The EIAR section 12.2.1.4 states:

'The 2019 revised guidelines are currently at draft stage and were subject to consultation and liable to change before the final version is issued. As such, until the 2019 Draft guidelines are finalised and published, the currently adopted WEDG 2006 guidelines will continue to be considered for the assessment of shadow flicker at the proposed development.'

This statement and the subsequent use of the 2006 standard is disingenuous in that:

a) The size and nature of wind energy development has change significantly since the 2006 guidance was published (drafted approaching 20 years ago) and it is generally accepted by developers, regulators and communities subject to the development projects that they are not fit for purpose anymore,

b) The technology to shut turbines down during shadow flicker events has progressed significantly along with the body of knowledge on the health effects of shadow flicker exposure and why it should be eliminated,

c) The 2006 Guidance has been subject to a prolonged review process over a number of years resulting in consultation submissions, publication of a preferred draft approach and draft new guidance. Final publication being delayed due to a number of circumstances and reasons, but since the technology to identify shadow flicker events and shut the turbine down during events has commonly existed, there has been no serious debate that this should not be the case for all future commercial wind energy development. The likelihood of the zero shadow flicker approach changing in the final guidance is extremely low. Note the draft guidance is prescriptive in this area to planning authorities conditioning zero shadow flicker, which in itself is rare in Irish published guidance in the planning process so there is a consensus that is highly unlikely to change.

d) The EIAR then states that there will be mitigation to ensure zero shadow flicker exposure. Zero shadow flicker is a health protection standard that technology can implement at a reasonable cost and has become standard for other wind energy development.

Andrew Sulley
Senior Environmental Health Officer

Rory O'Dea
Senior Environmental Health Officer

Reference number 4.2:

A laboratory study on the effects of wind turbine noise on sleep: results of the polysomnographic WiTNES study Michael G. Smith, Mikael Ogren, Pontus Thorsson, Laith Hussain-Alkhateeb, Eja Pedersen, Jens Forssen, Julia Ageborg Morsing and Kerstin Persson Waye. *SLEEPJ*, 2020, Vol. 43, No. 9

A greater number of people will likely be exposed to wind turbine noise (WTN) at home. Environmental noise is recognized as a public health concern by the World Health Organization (WHO), which estimates that sleep disturbance constitutes the majority of the disease impacts of environmental noise in Europe, with the annual loss of over 900,000 healthy life years. Adequate sleep is vital for maintaining good health and wellbeing, and chronic short or interrupted sleep duration is associated with an increased risk for obesity, diabetes, hypertension, cardiovascular disease, and all-cause mortality. To protect sleep, the WHO recently recommended nighttime noise limits for road, rail, and air traffic in Europe, but concluded that the quality of evidence of nighttime exposure to WTN was too low to allow a recommendation. Therefore, studies on potential effects of WTN on sleep are needed. Amplitude modulation (AM) is a broadband, rhythmic change in the level of WTN corresponding to the rotational frequency of the turbine blades. AM has been reported as a particularly unpleasant and annoying characteristic of WTN. Local meteorological conditions at the turbine, for instance wind speed gradient across the rotor area, wind shear, and turbulence, affect the acoustical character of the AM. This effect is strongest during the stable atmospheric conditions typical of nighttime, with strong AM "beats" in the 400–2,500 Hz range as a consequence. Furthermore, the

stable atmospheric conditions at night are favourable for the propagation of low-frequency noise, such as that emitted by wind turbines, over longer distances than in the daytime. A larger number of dwellings could therefore be exposed to WTN at sound pressure levels relevant for disturbance. Combined with lower nocturnal anthropogenic noise, and lower ambient noise levels due to more stable meteorological conditions, there could be increased audibility of WTN and AM at nearby dwellings during the night.

A series of recent epidemiological studies by Poulsen et al. did not find significant associations between calculated short- or long-term WTN and cardiovascular or metabolic outcomes including stroke and myocardial infarction, antihypertensive medication redemption, or diabetes. The same authors did however find that 5-year average outdoor WTN was associated with increased use of sleep medications among people aged at least 65 years, although there were no significant associations for people aged younger than 65 years or between sleep medication use and indoor average WTN across all age groups. There is some limited evidence from two previous studies that living within 2 km of wind turbines is associated with lower perceived sleep quality, lower health related quality of life, and reduced energy levels, compared to in demographically similar areas.

A single night of WTN exposure shorterm Rapid Eye Movement sleep. No effects of WTN on other measured physiologic outcomes could be detected, including autonomic activation, arousals, awakenings, salivary cortisol, SOL, sleep time, or deep sleep. Despite the low sound pressure level of 32 Db LAEq,indoor,night, the findings show that continuous environmental noise with AM may impact sleep. Self-reported sleep data support these results, with WTN exposure leading to lower sleep quality and restoration in the morning, which was true for populations who both were and were not habitually exposed to WTN.

Reference Number 4.3:
NOISE ACTION PLAN 2024-2028 – DUBLIN AGGLOMERATION

NOISE POLICY STATEMENT

Dublin City Council, Dún Laoghaire-Rathdown County Council, Fingal County Council, South Dublin County Council, Kildare County Council and Wicklow County Council will adopt a strategic approach to managing environmental noise from road traffic, rail traffic, airports and industrial activity sites, including ports, within its functional area, including the following:

1. *Prevention – manage the risk of additional members of the community being exposed to undesirable noise levels where it is likely to have significant adverse impact on health and quality of life.*

2. *Protection – protect areas which are desirably quiet, or which offer a sense of tranquillity through a process of identification and validation followed by formal designation of 'Quiet Areas'.*

3. *Mitigation – identify and prioritise appropriate mitigation measures to reduce noise levels where they are potentially harmful.*

The Environmental Noise Directive ('END') (2002/49/EC) is a European Union legal instrument vital for protecting public health and the environment by addressing the adverse effects of environmental noise.

The END was transposed into Irish Law by the Environmental Noise Regulations 2006 (S.I. 140/2006) (the 'Regulations'). The Regulations were revised by the European Communities (Environmental Noise) Regulations 2018 (S.I. 549/2018) and amended through the European Communities (Environmental Noise) (Amendment) Regulations 2021 (S.I. 663/2021).

The requirement for SEA for plans and programs is outlined in European Directive 2001/42/EC ('SEA Directive'). In the context of transport sector plans (which could include a Noise Action Plan), this directive is implemented in Irish law through the European Communities (Environmental Assessment of Certain Plans and Programmes) Regulations, 20045 (S. I. 435/2004). This legislation has been amended by the European Communities (Environmental Assessment of Certain Plans and Programmes) (Amendment) Regulations 20116 (S.I. 200/ 2011).

Strategic noise maps should have been prepared in respect of the calendar year 2023 for noise from the following sources:

- *Road traffic – all roads and major roads (sections of road with a flow threshold of 3,000,000 vehicle passages per year).*

- *Industrial activity sites – Industrial Emission (IE) sites as regulated by the EPA under the IPPC Directive 96/61 EC.*

For the noise action planning process, the Regulations require that;
"Each action plan or revision of an action plan shall address priorities which may be identified on the basis of exceedances of any relevant noise limit value or other relevant criteria established by the Agency [EPA] in accordance with subparagraph (3), and
(ii) shall, in the first instance, address the most important area or areas, as the case may be, established by strategic noise mapping."

Furthermore, the Regulations require each APA to "determine the measures to be included in an action plan." Finally, the action plan must "have as its objective that of also protecting quiet areas in an agglomeration". This Noise Action Plan therefore includes the identification of existing noise emissions, the identification of priority important areas based on an assessment of harmful effects and details of noise management measures for consideration and evaluation at implementation stage. The Noise Action Plan also includes the identification of Candidate Quiet Areas for consideration as Quiet Areas at the implementation stage.

Noise Indicators

The Regulations specify two main noise indicators which much be used in the preparation of the strategic noise maps:

- *Lden – the annual average noise level for the day, evening and night periods and is designed to indicate overall annoyance; and*

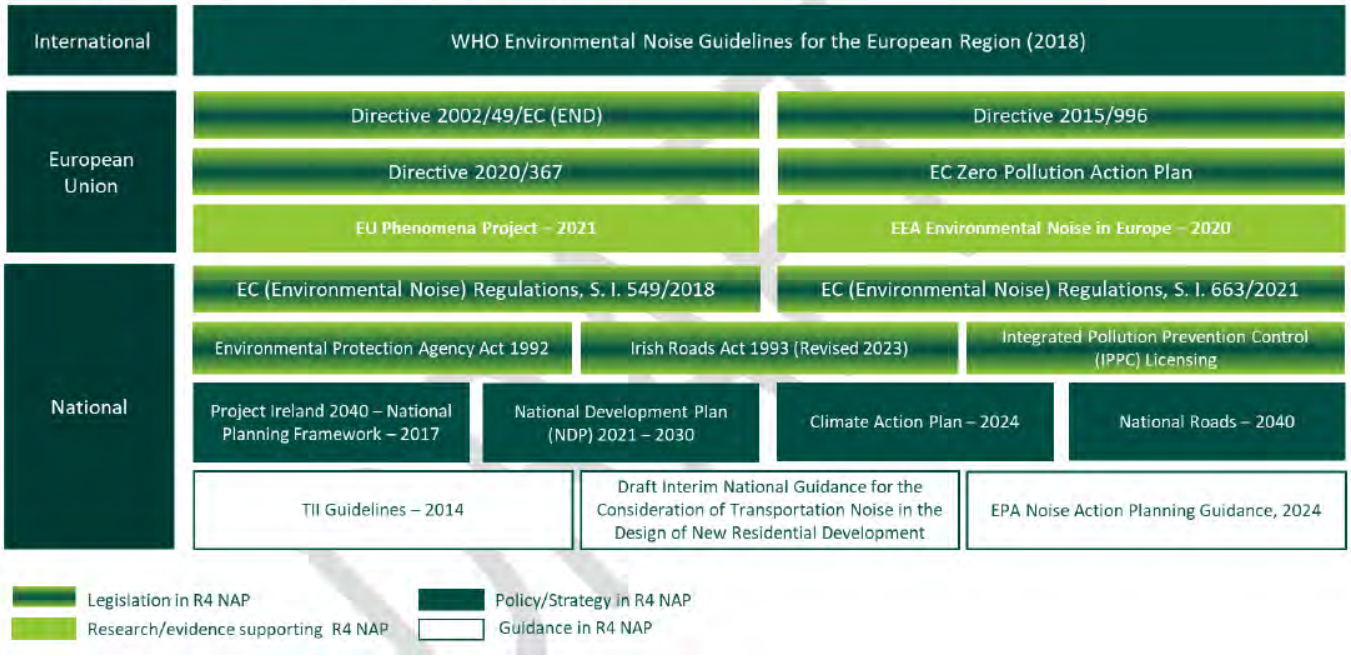
- *Lnight – the annual average noise level for the night-time periods, from 23:00 – 07:00 hours and is designed to indicate sleep disturbance.*

Calculations of supplementary noise indicators have also been undertaken, namely the Laeq, 16hr (the annual average noise level for the daytime/evening periods, from 07:00 – 23:00 hours), which has been approved by the EPA as the appropriate noise indicator to inform the identification of Candidate Quiet Areas.

Reference Number 4.4:

Noise and Effects on Health and Quality of Life : Environmental Noise Guidelines (World Health Organization, WHO), 2018

Figure 2: Existing Noise Management Legislation and Guidance



Noise can have a significant and disruptive effect on everyday life. Since the implementation of the Regulations, there have been extensive studies into the links between environmental noise exposure and health.

The World Health Organization (WHO) in its publication 'Environmental Noise Guidelines for the European Region 2018 and 'Night Noise Guidelines for Europe 2009 has also presented several key health outcomes including: noise annoyance; sleep disturbance; cardiovascular health; mental health, wellbeing, and quality of life; and children's learning.

The Environmental Noise Guidelines for the European Region provides recommendations for protecting human health from exposure to environmental noise originating from various sources including road traffic, railway and aircraft noise.

The recommendations include guideline values using Lden and Lnight metrics in terms of the onset of health effects. However, no single noise metric best correlates with all adverse health outcomes associated with environmental noise effects, and health effects can be correlated with more than one metric. . The noise metrics which are generally considered to best correlate with the different health effects, and are the subject of this Noise Action Plan, are set out in Table 4.

Table 4: Noise Metrics and the Associated Health Effects

Noise Metric	Health Effects
L_{den}	Cardiovascular disease, Cognitive impairment, and Annoyance
L_{night}	Sleep disturbance and Wellbeing

Harmful Effects Assessment

The European Communities (Environmental Noise) (Amendment) Regulations 2021 (S.I. 663/2021) sets out the assessment methods for harmful effects, which considers ischaemic heart disease (IHD), high annoyance (HA) and high sleep disturbance (HSD).

Ischaemic heart disease is calculated for road traffic noise only, whereas high annoyance and high sleep disturbance are calculated for road traffic, railway and aircraft noise.

The exposure of harmful effect is assessed independently for each source. Where the same people are simultaneously exposed to different noise sources, the harmful effects may not, in general, be cumulated, however can be compared to identify proportional significance.

The method determines harmful effects on population within an assessment area, rather than an accurate assessment of possible health effects at any specific building or location.

Whilst the Regulations set out the equations to be used for calculating harmful effects, it does not define noise thresholds above which health effects should be calculated for, nor does it stipulate the assessment bands that should be used (0.1 Db, 1 Db or 5 Db), these have been provided by the EPA, and are as follows:

- *The calculations for harmful effects should be undertaken in 1 Db assessment bands.*
- *The assessment of harmful effects should be undertaken above the following thresholds which are in line with WHO Guidelines:*
- *Road traffic noise: 53 Db Lden, 45 Db Lnight*

Harmful effects have therefore been calculated from population exposure statistics in 1 Db bands for the noise level thresholds set out above using the calculation methodology set out in the Regulations.

Table 20: BS 8233 Recommended Internal L_{Aeq} Target Levels for Overall Noise in the Design of a Building

Location	$L_{Aeq, 16hr}$ (0700-2300 hrs)*	$L_{Aeq, 8hr}$ (2300-0700 hrs)*
Living Rooms	35 dB	-
Dining Rooms	40 dB	-
Bedrooms	35 dB	30 dB

*see BS 8233:2014 for caveats and notes

The above Noise Standards are in the process of being adopted in the Dublin Authorities & East Leinster. And the applicant for the windfarm indicates far higher threshold values.
The level indicated at 30Db is far lower than the levels indicated in the applicants submission.

Reference Number 4.5:

Influence Of Atmospheric Conditions On Measured Infrasound From Wind Turbines, Sarah D'amico, Timothy Van Renterghem, Dick Botteldooren, *Ghent University, Department Of Information Technology, Waves Research Group, Technologiepark 126, B 9052, Gent, Zwijnaarde, Belgium.* Journal Of Wind Engineering & Industrial Aerodynamics 225 (2022) 105021. Available Online 7 May 2022

Dominant predictors for the infrasound production were mean wind speed, turbulence intensity and turbulent vertical heat flux.

Pressure fluctuations resulting from wind turbines in the infrasonic range lead to both discrete frequencies and broadband components. For modern large horizontal axis wind turbines, the first discrete frequency occurs at the blade passing frequency, typically below 1 Hz. Its harmonics typically predominate in the whole infrasound range. The blade passing frequency (BPF) levels define the acoustic signature of the wind turbine. The broadband component, generally indicated as inflow noise, covers the full infrasound frequency range as well, down to extremely low frequencies, and enters the lower part of the audible frequency range. In this article, the term infrasound is used for frequencies below 20 Hz. The audible frequency range exceeds 20 Hz. The term "low frequency" is used in a more generic way throughout the manuscript, referring to sounds that remain approximately below 100 Hz.

The aerodynamic Interaction between the rotating blades and the tower is the most accredited cause for Blade Passing Frequency levels. For upwind wind turbines, a reduction in the inflow velocity appears in front of the tower since it obstructs the incoming wind flow. This local velocity deficit produces a change in the angle of attack of the passing blade, thus a periodical change in its aerodynamic loading, resulting in a discrete pressure level at the BPF (van den Berg, 2005). Recently, Yauwenas et al. (2017) and Zajamsek et al. (2019) hypothesized that the blade-tower interaction noise could be attributed to the aerodynamic disturbances generated by the blades and impacting on the tower. Through numerical simulations, they could identify the tower as the dominant pressure generation point of BPF noise. Other sources of BPF levels can be identified in the atmospheric turbulences, the cross-winds and the wind shears leading to periodical aerodynamic changes on the rotating blade as well (Goldstein, 2017). Although the latter theory is less cited than blade-tower interaction phenomena, the BPF noise generation mechanism is still not completely clarified.

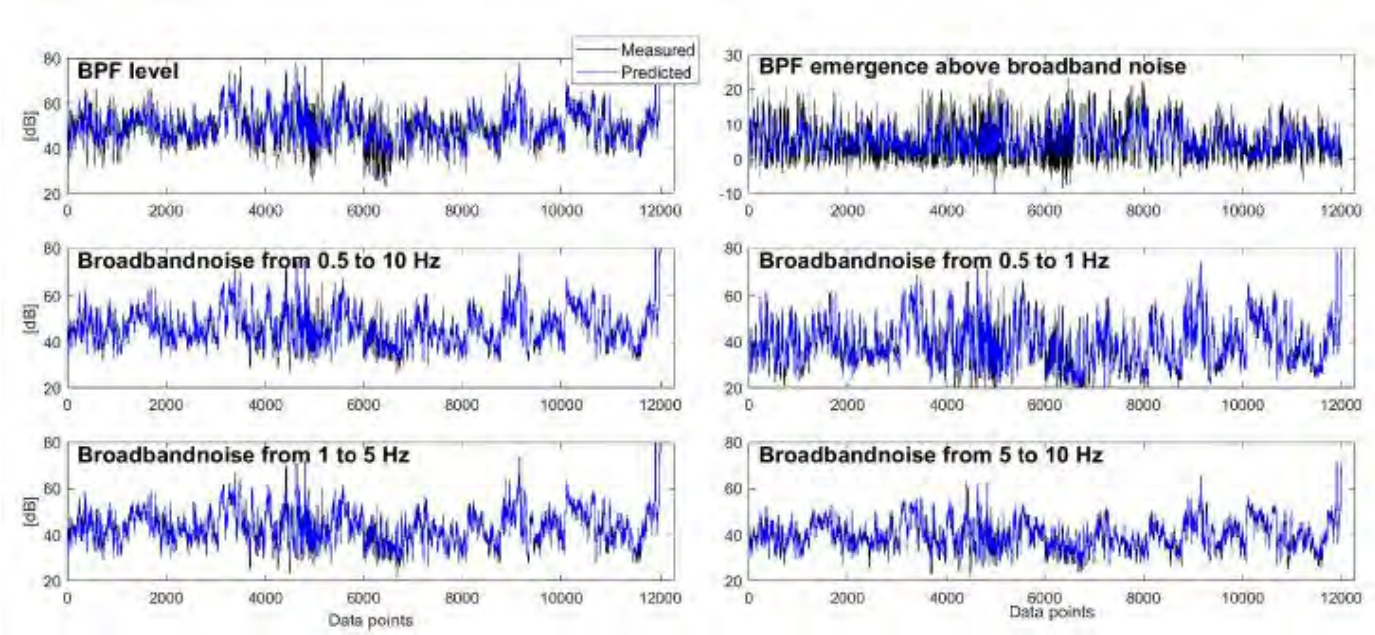
Wind turbine inflow noise is generated by the interaction between the wind turbine rotating structures and the inflow turbulences present in the atmospheric boundary layer. In particular, large inflow turbulences are the cause of infrasound inflow noise. When eddies much lager that the mean blade chord are convected towards the rotating blades, the latter undergo a sudden change in their loading which produces broadband infrasound (Wagner et al., 1996) at a frequency related to the dimension of the turbulent eddy and of the blade chord. For large modern wind turbines, this mechanism affects the lowest part of the infrasound range. For inflow turbulence eddies smaller that the blade chord, the pressure fluctuations are locally generated by the eddies on the surface of the blade (Wagner et al., 1996) and can appear in the remaining part of the infrasound spectra up to the lowest part of the audible frequency range. Wind shear and cross-wind conditions can also provoke a change in the aerodynamic loading of the rotating blades (Zajamsek et al., 2016). In the last decades, research mostly focused on the study of inflow noise through numerical or semi-empirical models. However, such models are restricted to the lower part of the audible frequency range only (Lowson, 1994) (Lee and Chong, 2014) (Klein et al., 2018).

Measuring wind turbine noise emissions in the infrasonic frequency range is not trivial due to its co-occurrence with high levels of wind-induced microphone noise outdoors. Although the BPF levels could in theory be easily distinguishable from the broadband noise, wind-induced microphone noise can completely mask both contributions to the wind turbine infrasound, even at low mean wind speeds (D' Amico et al., 2021).

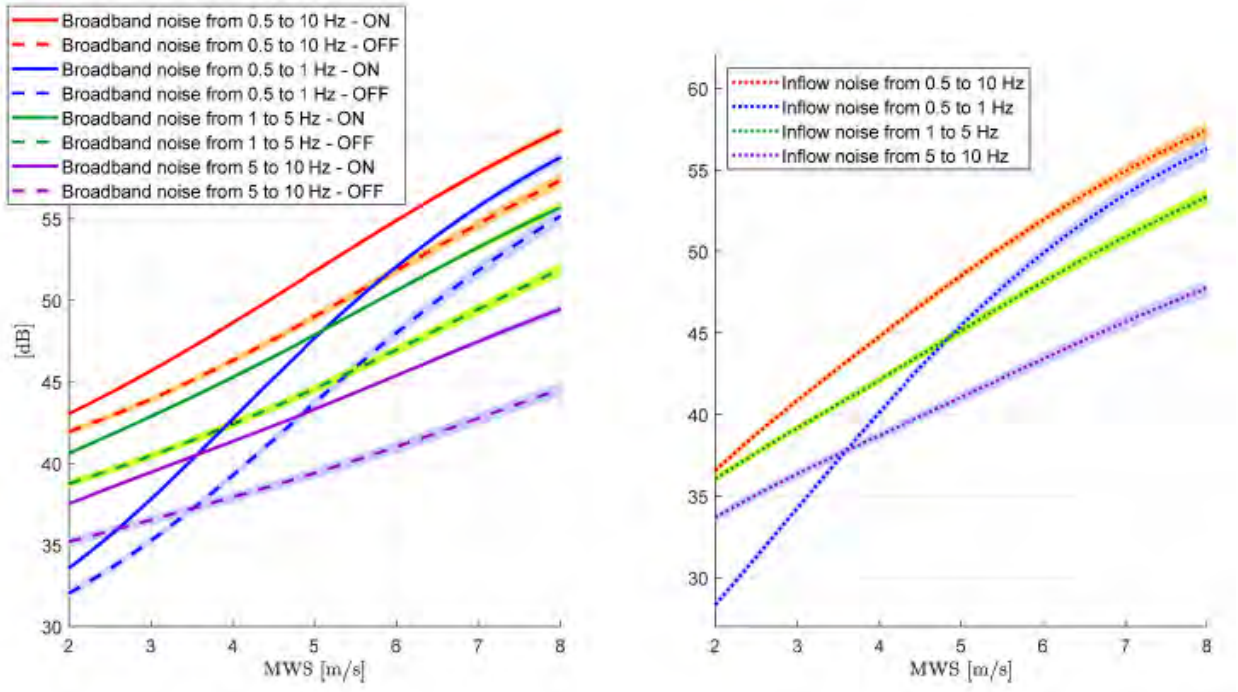
Little work has been published on actually measured wind turbine noise under various weather conditions (Hansen and Hansen, 2020) and studies reporting comprehensive assessment of wind turbine infrasound in different meteorological and wind conditions are even more limited. Zajamsek et al. (2016) related the long-distance propagation of BPF noise at a few dwellings to different atmospheric parameters to investigate the factors that influence their propagation outdoors. That study was able to identify BPF peaks indoors during periods of stable atmospheric conditions. Buck et al. (2016) related measured wind turbine inflow noise to local turbulence determined from the rotor blade vibration, finding a positive correlation at low frequency. Nevertheless, the latter study was limited to the audible frequency range only. No studies were found allowing to predict the generation of infrasound based on (inflow) atmospheric parameters.

The measurement campaign was performed at the Melle Wind Farm on the terrain of Ghent University from August 2019 to December 2019 and from March 2020 to November 2020. Sound pressure levels emissions were measured simultaneously with meteorological data. The wind farm at the measurement location consists of three Enercon E82 turbines of 2.3 MW each, positioned at a distance of approximately 450 m from each other in the NW-SE direction. The three wind turbines are three-bladed and pitch-controlled with hub heights of 108 m and 82 m rotor diameters. The wind turbines reach the rated power at 14 m/s mean wind speed at hub height and have a cut-in wind speed of 2 m/s.

The surrounding environment Is characterized by fully flat agricultural terrain with some sparse buildings located at a distance of 200 m from the microphones and a main motorway at approximately 250 m.



Measured and modelled BPF levels (upper, left), BPF emergence above broadband noise (upper, right), broadband noise from 0.5 to 10 Hz (center, left), broadband noise from 0.5 to 1 Hz (center, right), broadband noise from 1 to 5 Hz (lower, left) and broadband noise from 5 to 10 Hz (lower, right) for each valid data point. Results are expressed in decibel. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)



Predicted broadband noise levels using the ANN for varying the Mean Wind Speed from 2 to 8 m/s. Right: Predicted mean values of the inflow noise levels using the artificial neural network (ANN) and Equation

$$L_{Inflow} = 10\log_{10}\left(10^{\frac{L_{Broad_{ON}}}{10}} - 10^{\frac{L_{Broad_{OFF}}}{10}}\right)$$

for Mean Wind Speed from 2 to 8 m/s and positive signal-to-noise ratio. 95% confidence intervals are calculated with the bootstrapping technique assuming no particular data distribution and are presented as shaded areas; averaged values are depicted as full, dashed and dotted lines. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

The vertical turbulent heat flux has a strong Influence on inflow noise especially in the lowest frequency range considered. Positive turbulence heat fluxes lead to an increased amount of inflow noise from the wind turbines, indicating a predominance of turbulence generated noise in the frequency range from 0.5 to 1 Hz.

Reference Number 4.6:
Draft Wind Energy Guideline. Department of Planning and Environment dpie.nsw.gov.au. Technical Supplement for Noise Assessment November 2023

Decibel (dB)	A measure of sound level. The decibel is a logarithmic way of describing a ratio. The ratio may be power, sound pressure, voltage, intensity or other parameters. In the case of sound pressure, it is equivalent to 10 times the logarithm (to base 10) of the ratio of a given sound pressure squared to a reference sound pressure squared.
Decibel (A-weighted; dB(A))	Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
Decibel (C-weighted)	C-weighting is an adjustment made to sound-level measurements that takes account of low-frequency components of noise within the audibility range of humans.

The assessment of noise impacts arising from wind energy development is unique in three key ways.

- *Firstly, wind turbines operate under very different conditions to other industrial noise sources. Wind turbines only function when there is wind, and the noise level from each wind turbine rises as the wind speed increases. The increase in wind speed also results in an equal or greater increase in the background noise level due to aerodynamic and foliage noise which can mask turbine noise. The increase in background noise with wind speed is generally site specific and needs to be determined in the assessment process.*

- *Secondly, the height of the noise source centre (the machinery inside the enclosure at the top of the tower, called the nacelle) is highly elevated compared to other noise sources such as roads, railways, mines and most industrial facilities. As a result, there is less opportunity to mitigate or shield the propagation of wind turbine noise.*

- *Lastly, activities in rural areas, such as farming and agricultural practices, can generate significant noise resulting from sources including road traffic and farm machinery. Whilst noise from wind turbines is not likely to be dominant, the characteristics of wind turbine noise may be perceived as being different to these existing noise sources.*

Noise limits for residential receivers

The predicted equivalent noise level (LAeq,10 minute)[1], adjusted for tonality and low frequency noise in accordance with these guidelines, should not exceed **35 dB(A)** or the **background noise (LA90(10 minute)) by more than 5 dB(A)**, whichever is the greater, at all relevant receivers for wind speed from cut-in to rated power of the wind turbine generator and each integer wind speed in between.

Note: While the noise criteria is established on the basis of a 24-hour period, noise readings are taken at 10 minute intervals.

Figure 1 shows the average distances at which compliance with different noise standards is expected to occur, using other Australian and International standards as examples.

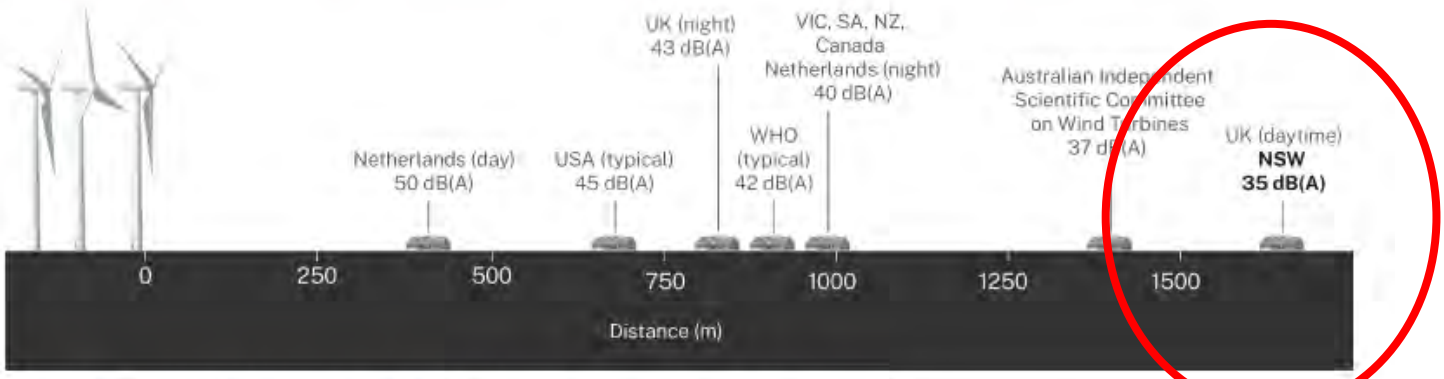


Figure 1 – Distances at which a range of residential noise limits may be achieved[2]

2:- Comparison of inter-jurisdictional wind energy noise criteria is complex. The setback distances are indicative only and do not account for site-specific conditions which may increase or decrease the noise level, such as topography. Modelled using ISO 9613.2 algorithm for three typical 6 MW turbines (with a hub height of 170 m) directly upwind of receivers

Special noise characteristics

While the main noise assessment criteria for wind energy projects is the base noise level, there are alternate special noise characteristics which need to be considered as part of the noise assessment process of any wind energy project.

Tonality

In addition to sound pressure level (measured in decibels, Db), the way sound is perceived is partially determined by its pitch or frequency (measured in Hertz, Hz). Human hearing covers frequencies from 20 Hz to 20,000 Hz and is less sensitive at low and high frequencies. Sounds which have unusually high levels of energy in a relatively narrow band of frequencies may be referred to as being tonal.

Audible tonal sounds from wind turbines are generally related to rotational equipment in the turbine nacelle and can have a specific pitch dependent on the speed of rotation. This can cause the noise to be more noticeable. These tonal characteristics (as defined below) typically do not occur in well designed and well-maintained wind turbines. If present, they are usually caused by a turbine maintenance issue3.

The SA Guideline suggests that the tonality assessment procedure detailed in the International Standard IEC 61400–11 is appropriate for measurement in close proximity to a turbine or that it can be modified for assessing wind farm associated tones at distant receivers. However, the NSW EPA assesses tonality with reference to the ISO 1996.2 standard.

For consistency in NSW, assessment, prediction and compliance of tonality objectives should be undertaken in accordance with ISO 1996.2: 2017 Acoustics — Description, measurement and assessment of environmental noise — Part 2: Determination of sound pressure levels using measured or similar representative data. The survey method described in Annex K (comparison of 1/3rd octave levels) assessed at integer wind speeds provides an acceptable screening test. It defines tonality as when the level of a one-third octave band4 exceeds the level of the adjacent bands on both sides by:

- *5 Db or more if the centre frequency of the band containing the tone is in the range 500 Hz to 10,000 Hz;*
- *8 Db or more if the centre frequency of the band containing the tone is in the range 160 Hz to 400 Hz; and/or*
- *15 Db or more if the centre frequency of the band containing the tone is in the range 25 Hz to 125 Hz.*

If tonality is found to be a repeated characteristic of the wind turbine noise, 5 Db(A) should be added to measured noise levels from the wind energy project. *The tonal characteristic penalty applies only if the tone from the wind turbine*

is audible at the relevant receiver. Absence of tone in noise emissions measured at an intermediate location is sufficient proof the wind energy project noise is not tonal at a receiver location. The assessment for tonality should only be made for frequencies of concern from 25 Hz to 10,000 Hz and for sound pressure levels above the threshold of hearing (as defined in ISO 389.7:2019 Acoustics – Reference zero for the calibration of audiometric equipment – Part 7: Reference threshold of hearing under free-field and diffuse-field listening conditions).

Low frequency noise

Low frequency noise is present in all types of environmental noise and is particularly difficult to measure in the presence of wind due to the increased level of background noise. Analysis of wind turbine spectra shows that low frequency noise is typically not a significant feature of modern wind turbine noise when it complies with the A-weighted criteria outlined in Section 3.1.

In the unlikely event that excessive low frequency noise is found to be a repeated characteristic (i.e. noise from the wind project would be repeatedly greater than 60 DbI) of the wind turbine noise, 5 Db(A) should be added to the predicted or measured noise level from the wind energy project.

However, at the discretion of the applicant, a more detailed assessment can be carried out to demonstrate that low frequency noise is not a repeated characteristic. This assessment must be undertaken using Fact Sheet C of the Noise Policy for Industry (NSW EPA, 2017). Minor modifications to this approach are required for wind energy projects. The modified approach is:

• the assessment must be undertaken for a 24-hour period, rather than the trichotomy of day/evening/night reported in the Noise Policy for Industry.

• where any of the one-third octave noise levels in Table C2 (reproduced below) are exceeded by up to and including 5 Db and cannot be mitigated, ***a 2 Db(A) positive adjustment to measured/predicted A-weighted levels applies.***

• where any of the one-third octave noise levels in Table C2 (reproduced below) are exceeded by more than 5 Db and cannot be mitigated, ***a 5-Db(A) positive adjustment to measured/predicted A-weighted levels applies.***

Table C2: One-third octave low frequency noise thresholds

Hz/dB(Z)	One-third octave $L_{Zeq,15minute}$ threshold level												
Frequency (Hz)	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB(Z)	92	89	86	77	69	61	54	50	50	48	48	46	44

Health impacts

In 2018, the World Health Organization (WHO) released their Environmental noise guidelines for the European Region which comprised a suite of recommendations including "reducing noise levels produced by wind turbines below 45 Db Lden, as wind turbine noise above this level is associated with adverse health effects." The WHO recommended level of Lden 45 Db(A) is a minimum of 3.5 Db higher than the base NSW criterion and would typically be expected to equate to a level measured in NSW of around Leq 42 – 50 Db(A).

The NSW Government's position on potential health impacts of wind energy projects continues to be informed by the scientific findings of the NHMRC and the advice of NSW Health. The National Wind Farm Commissioner and the Independent Scientific Committee on Wind Turbines was established by the federal government in 2015 to provide advice on the potential impacts of wind turbine sound on health and the environment.

This work resulted in several publications including Wind turbine sound limits: Current status and recommendations based on mitigating noise annoyance (2018). ***THIS CONCLUDES THAT A LEVEL OF LA90,10 MIN (EQUAL TO 37 DB), IS AN APPROXIMATE MAXIMUM LEVEL OF NOISE TO WHICH RESIDENTS SHOULD BE EXPOSED. These measurements are averaged over 10 minute periods & exclude the higher noise emissions.***

The criteria adopted in this guideline is significantly lower than the WHO recommended level and slightly below the levels recommended by the Independent Scientific Committee on Wind Turbines.
The NSW Government will continue to monitor contemporary scientific research outcomes to ensure its position reflects robust evidence on any health effects.

Reference number 4.7:
Effects of wind turbine noise on songbird behavior during nonbreeding season Yael Lehnardt, Jesse R. Barber, Oded Berger-Tal Conservation Biology. DOI: 10.1111/cobi.14188. Accepted: 7 September 2023
Anthropogenic noise is one of the fastest growing, globally widespread pollutants, affecting countless species worldwide. Despite accumulating evidence of the negative impacts of wind turbines on wildlife, little is known about how the noise they generate affects ecological systems. Songbirds may be susceptible to noise pollution due to their reliance on vocal communication and thus, in this field study, we examined how songbirds are affected by wind turbine noise. We broadcasted noise produced by one wind turbine in a migratory stopover site during the nonbreeding season. Throughout the study, we repeatedly monitored
the acoustic environment and songbird community before, during, and after the noise treatments with passive acoustic monitoring and mist netting. We employed generalized linear mixed effects models to assess the impact of experimental noise treatment on birds' behaviour and likelihood ratio tests to compare models with variables of interest with null models. The daily number of birds in the presence of wind turbine noise **decreased by approximately 30%** compared with the before and after phases. This reduction had a significant spatial pattern; the largest decrease was closer to the speaker and on its downwind side, fitting measured sound propagation. Although we found no impact on species diversity, two out of three most common species showed clear avoidance behaviour: 45% and 36% decrease in abundance for the lesser whitethroat (*Sylvia curruca*) and Sardinian warbler (*Sylvia melanocephala momus*), respectively. In the after phase, there were lingering effects on the lesser whitethroat. The age structure of the lesser whitethroat population was affected because only juvenile birds showed avoidance behavior. No difference in avoidance extent was found between migratory and nonmigratory species, but the impacts of displacement on migrants during stopover are especially troubling from a conservation perspective. Our results stress the need to address the impacts of noise pollution on wildlife when planning noise-generating infrastructures, such as wind turbines, to allow for sustainable development without threatening already declining songbird populations.

Reference Number 4.8:
Wind turbine blade damage detection based on acoustic signals Chenchen Yang, Shaohu Ding & Guangsheng Zhou www.nature.com/scientificreports. (2025) 15:3930 | https://doi.org/10.1038/s41598-025-88276-x
When the wind turbine blade rotates, it radiates sound which mainly includes aerodynamic sound and mechanical sound to the surrounding environment. Aerodynamic sound is produced by the interaction between the blade and the wind blowing in the face. Mechanical sound mainly originates from the noise generated by the work of gearboxes, transmission bearings and other parts. In addition, defective blades produce abnormal sounds that mix with the sound radiated into the environment to form
complex wind turbine sounds containing damage signals. For example, in a study by Traylor et al. wind turbine blades with and without cracking defects were experimentally analysed. It was observed that for the blades with cracks on the trailing edge, the noise from the wind turbine unit was accompanied by a distinctive acoustically sharp whistling sound. Another study by Chen et al. proposed that the detection of defects in the drainage holes of the wind turbine blades is associated with a unique event of whistle sound. Thus, a specific defect generates a corresponding sound event.

Reference Number 4.9:
Impact of a two-dimensional steep hill on wind turbine noise propagation Jules Colas1, Ariane Emmanuelli1, Didier Dragna, Philippe Blanc-Benon, Benjamin Cotté, and Richard J. A. M. Stevens. Wind Energ. Sci., 9, 1869–1884, 2024 https://doi.org/10.5194/wes-9-1869-2024. Published: 7 October 2024.
This study demonstrates that terrain topography can significantly affect wind turbine sound propagation. In the case of a wind turbine on a hilltop, both the sound levels and the AM are greatly enhanced downwind compared to the flat case. This could result
in increased annoyance and is mainly an effect of mean flow field modification. In all cases, the far-field AM downwind is created by the wind turbine's wake. When the turbine is placed in front of the hill, we observed that, despite a

strong shielding effect from the terrain, SPL just after the hill is comparable to that of the flat case. This is due to focusing induced by the hill's wake, which also increases AM at this location.
For a turbine on a hilltop, the sound emitted is higher than in the flat case due to increasing wind speed. For a turbine upstream of a hill, the sound emitted is slightly lower due to the decrease in wind speed before the hill. Finally, we find that the sound-focusing effect becomes more pronounced and closer to the turbine with increasing wind speed and that most of the propagation effects are directly behind the wind turbine (close to t = 0). However, this might be because our study used an N x2D approach, which does not consider the full 3D sound propagation through the wake. Also, turbulence in the atmosphere can scatter the sound and reduce the focusing effect we observed, but further research is needed to determine to what extent this happens.

Reference Number 4.10:

PSYCHOACOUSTIC EVALUATION OF MODELLED WIND TURBINE NOISE Josephine Siebert Pockele and Roberto Merino-Martinez . 30th International Congress on Sound and Vibration.

Current validation of wind turbine noise models primarily focuses on sound levels averaged over time, typically expressed in metrics such as the equivalent A-weighted sound pressure level (LA,eq). Whereas valid for regulatory purposes, these methods are not sufficient for psychoacoustic research, as time-averaged levels alone do not fully explain the measured noise annoyance. Therefore, this research aims to establish whether psychoacoustic sound quality metrics (SQMs) provide additional value when analysing wind turbine noise models. This work employs the Horizontal Axis Wind turbine simulation Code 2 (HAWC2) to generate noise source spectrograms, which are propagated through the atmosphere with a Gaussian beam-tracing approach. The final sound signals are retrieved through an inverse Short-Time Fourier Transform (Istft). This methodology is applied to a case study featuring a stall-controlled, horizontal-axis, Nordtank NTK 500/41 wind turbine. The results are evaluated against measurements by considering LA,eq, SQMs, and a comparative listening experiment. The LA,eq metric shows a consistent underprediction of the simulations with respect to measurements, which is partly explained by a ground reflection modelling error. In the high-frequency range, stall noise is known to be significantly underpredicted by the aero-acoustic simulation model. This usually translates in increasing discrepancies between measurements and models as the wind speed increases. The comparative listening experiment confirms that participants experience the simulations and the measurements as significantly different. The difference ratings show a good agreement with the differences in the psychoacoustic annoyance and loudness metrics. It is more difficult to relate the results from the listening experiment to LA,eq. These findings confirm that an evaluation with psychoacoustic metrics next to conventional methods provides additional value in validating wind turbine noise models for human perception research.

Reference Number 4.11:

The multiple understandings of wind turbine noise: Reviewing scientific attempts at handling uncertainty. 2024. Julia K. Kirkegaard, Tom H. Cronin, Sophie Nyborg, Daniel N. Franzten. DTU Wind and Energy Systems, Technical University of Denmark, Roskilde, 4000. Denmark https://doi.org/10.5194/wes-2024-34

Sound and noise are measured in the same acoustic unit, that is, the decibel (or Db), that was originally coined for audio levels in telephone cables back in the early 1900s (Garret 2020, p. 466 on the Bell Labs). As the human ear is not equally sensitive to all frequencies (first measured by Fletcher and Munson, 1933), then a method of averaging (or weighting scale) has been developed and is now governed by the international standard ISO 226 (International Standardization Organization). While the so-called A weighting (Db(A)) inevitably masks the individual frequencies of the original sound, it is by far the most commonly used metric.

When propagating and traveling to our ears, sound vibrations cause the vibration of the 160 human ear drum, which in turn are translated into impulses that the brain perceives as sound (Gunther, 2012, p. 306). Pure sound (e.g. a musical note where air particles vibrate in a neat/regular and predictable, and thus calculable, fashion) is hereby a very tangible and physical phenomenon. The vibrations are always depicted graphically by waves, much the same as electricity, and something that can relatively easily be shown to "obey" the natural laws of wave physics such as superposition (Gunther, 2012, p. 205).
It is when sound vibrations become uncontrollable and unpredictable, that sound is referred to not as musical but as noise in the technical epistemic community: "Although noises are sometimes not entirely unmusical, and notes are

usually not quite free from noise, there is no difficulty in recognising which of the two is the simpler phenomenon. There is a certain smoothness and continuity about the musical note" (Rayleigh, 1945, p. 4). In contrast to pure sound, noise is more difficult to simulate/calculate: while noise still obeying the laws of physics, it is difficult to demonstrate through equations/calculations that it does so, as it "does not so easily yield to conventional mathematical analysis" (Garret, 2020, p. 26). In general, noise is thus considered a sound that is unwanted, not useful or indicating that something is wrong, and the physics of air particles reflects this (Lee and White, 1998).

The noise emanating from a turbine Is mostly aerodynamic noise, that Is, air flowing over the blades resulting in turbulence and rapid vibration of air particles (Wagner, 1996). The design of a wind turbine blade has historically concentrated on optimising power production and is key to this epistemic community, but these blade design considerations are entangled with questions around noise. The principal fundamentals of air flowing over the blades of a wind turbine go back to the 1920s with research in the aviation industry because of the similar requirements of an aircraft wing needing the force of lift to keep the aircraft flying up in the air, and the need for the force of torque to turn the rotor of a wind turbine. So, when wind turbine blade design development started in the 1970s, the research topic of aerofoil design was already established (Bak, 2021). Particularly important reference work was carried out by NASA in the 1950s who produced a catalogue of aerofoil designs, each tested in their wind tunnel (Abbott and von Doenhoff, 1959). The reason for the aircraft designers and wind turbine designers being interested in aerofoil design are similar: efficiency of the air flowing over the aerofoil. The more efficient an aircraft wing is, the more lift force is generated to keep it in the air, and the more efficient a wind turbine blade
is, the more torque Is generated t" tur' the rotor, the more energy can be extracted from the kinetic energy of the wind and converted into electrical energy. This is the energy that is then sold to produce revenue for the wind turbine owner.

However, whilst noise from aircraft is mostly from the engines, noise from wind turbines is an important constraint in wind turbine blade design. Much of the engineering driver for working on wind turbine noise and its reduction is the belief that the public's perspective on sound is 'annoying noise' (Deshmukh et al., 2018). Work by Pedersen and Waye (2004) is often quoted relating perception and annoyance due to wind turbine noise (see Health section) and that a reduction of the noise level (the dose) at the human ear is a desirable goal as "noise is one of the major hindrances in the development of wind power industry" (Dai et al., 2015) as people "experience annoyance" when they live in the vicinity of wind turbines. Indeed, research by acousticians using listening tests and "idealised wind turbine sounds" (von Hünerbein, 2010) have tried to
establish "audibility thresholds and equal annoyance contours" in order to quantify an impact. However, a reduction in noise generation often comes at a price: a reduction in power produced (Wagner, 1996, p. 164).

The aerodynamics of the blades has been a consistent object of research for noise generation research. When the airflow passes over the wind turbine blade "at the trailing edge", it becomes turbulent (unruly), producing a scattering mechanism which makes up the main part of aerofoil noise (Wagner, 1996, p. 67). In terms of the shape of the aerofoil, various "fixes" or adaptations have been applied, such as trailing edge serrations (or "dinotails") in order to reduce the noise from the back edge of turbine blades (Fuglsang and Oerlemans, 2012). With these devices, typically, noise reductions of about 2-3 decibel (Db) in overall A-weighted sound levels have been achieved, even if the exact mechanism is not yet understood and is still today the subject of wind tunnel testing (e.g. Ryi et al., 2014).

The study of the relationship between Infrastructure developments and health can be traced back to around the beginning of the 20th century where noise figured as one amongst many environmental hazards or risks. In a study from 1910, the impacts of noise on the work efficiency of industrial workers were observed for the first time (Wynne, 1930). Since the 1960s, 'risk' studies (Kasperson et al., 1988), constituting noise in the environment as a health concern (and risk), has become established as a field in itself (foreword, ICBEN, 1973). Importantly, health is defined not just as a matter of absence of disease, but a matter of complete physical, mental, and social well-being (WHO, 1946). Therefore, the World Health Organisation (WHO) considers (noise) annoyance as a health issue resulting from noise exposure, along with e.g. sleep disturbance, mental health, diabetes and heart disease (WHO, 2018). Annoyance is one of the most prevalent health effects of noise (Guski et al., 2017) but is moreover hypothesised to mediate a range of other 'physical' health effects (e.g. stress, anxiety, sleep disturbance, metabolic and cardiovascular disease) (WHO, 2018; Van Kamp and Van den Berg, 2018, 2021, Michaud, 2016, Taylor and Klenk, 2018). While traffic, industry and 'neighbourhood noise', for instance, have been investigated since at least the 1950s (Stevens et al., 1955), the health impact of wind turbine noise has only been an issue in the last decades (WHO, 2018, Pedersen and Waye,

2004). Annoyance, though, continuously comes forward as the most important health consequence of wind turbine sound (Van Kamp and Van den Berg, 2021).
Low frequency and infra sound from wind turbines is also a topic of public and political concern, with concerns that these lower, inaudible sound frequencies may lead to other health effects than audible sounds, such as the "Wind Turbine Syndrome" caused by Vibroacoustic disease (VAD) (vibration of the body, nausea or dizziness). However, there is no evidence that these lower frequencies have any health effects, nor that they lead to extra annoyance (Van Kamp and Van den Berg, 2021).

This epistemic community focuses on self-reported health effects (e.g. annoyance, stress or sleep disruption) in survey studies as well as in laboratory experiments (e.g. Müller et al., 2023; Hübner et al., 2019; Boorsma and Schepers, 2017), which also include objective measurement of bodily reactions, for instance polysomnography to detect sleep disturbance.
Epidemiological studies on the population include self-reported health effects in surveys, but a couple of studies also use more objective data. The Canadian Community Noise and Health Study by Michaud et al. (e.g. 2016), for instance, used hair cortisol concentrations to complement self-reported data. The Danish Health Study on the health-impacts of wind turbine noise (Poulsen et al., 2019) used wind turbine location data and modelled noise levels together with medical register data in order to study the relationship between wind turbine noise and a range of medical conditions on the population.

A formative study in the 1950's by Stevens et al. (1955, p. 64) developed the "Composite Noise Rating" approach whereby people's reaction to noise could be predicted, so that a "realistic criterion" or limit for neighbourhood noise. This was based on the recognition that levels, or doses, of noise – measured in decibels (Db(A)) – could elicit a certain human response way below that which can damage hearing, namely influencing the wellbeing and health of the general public. However, annoyance studies today build on a seminal paper on noise annoyance published in 1978 by Theodor Schultz (Schultz, 1978). He developed a model which rested on the conviction that both the noise dose and the response can be standardised and quantified and plotted in a graph that shows visually the particular relation between sound dose and response ("% highly annoyed") for different noise sources.
The dose-response model emerged from a need to be useful for planning, regulation and policy, the raison d'être for the health-based epistemic community: In 1978, the hitherto limited agency of science to produce 'facts' for policy and planning was problematized by Professor Paul Borsky (Columbia University). In a paper presented at an environmental noise conference, Borsky argued that the "lack of agreement on standardized units of measurement and comparable methods for obtaining and analysing objective data" in the scientific community was one of the main reasons "why community noise abatement has made such slow progress" (Borsky, 1978, p. 453).

To overcome this seeming lack of influence on policy, Schultz's overarching aim with his dose-response paradigm, which was supported in part by the U.S. Department of Housing and Urban Development (Schultz, 1978, p. 403), was to find a stable model that could better inform policymaking on land use and planning and offer "guidance for regulatory decisions about noise" (1978, p. 403; also see Fidell, 2003; Miedema and Vos, 1998, p. 3434). To do so, Schultz changed the main metric from median response (resembling an "average response" of a community) which was the common approach at the time, to "percent highly annoyed" plotted against noise exposure. The argument was that this approach would provide a more stable (universal) model, since "the median response is much more difficult to translate from one annoyance scale to another, in everyday terms that are understood by politicians and policy makers" (Schultz, 1978, p. 379). Moreover, if the person was highly annoyed, he hypothesized the response would be strongly correlated to the sound itself, providing a more "useful indication of acceptable community noise exposure" (Schultz, 1978, p. 379). Further, without providing further evidence, Schultz (1978, p. 389) commented that restricting the percentage of the 310 population being 'highly annoyed' to 10% would be a "desirable condition". Noise limits should in other words meet that target. Pedersen and Waye (2004) conducted the first – and now seminal – annoyance dose-response study for wind energy in 2004 to explore "acceptable exposure levels". "There is clearly a need for field studies to investigate the impact of wind turbines on people living in their vicinity And to further explore the presence of disturbances. In particular, Dose–response relationships should be investigated to achieve a more precise knowledge of acceptable exposure levels" (Pedersen and Waye, 2004, p. 3461).

They concluded that wind turbine noise is a particularly annoying noise source as, despite lower doses, it produced higher annoyance rates than other noise sources at the same dose level. (See Figure). The idea that different types of noise sources (aircraft, road traffic, train, etc.) would result in varying degrees of annoyance at similar noise levels was

already put forward by Miedema and Vos (1998). Such comparative studies on different noise sources have helped to demonstrate that wind turbine noise may have particularly annoying characteristics (e.g. the "swishing" or "thumping" sound character, technically referred to as amplitude modulation) that can be perceived at "low dose levels", but which are not often captured by the measuring methodology in regulation (Janssen et al. 2011, Haggett, 2012).

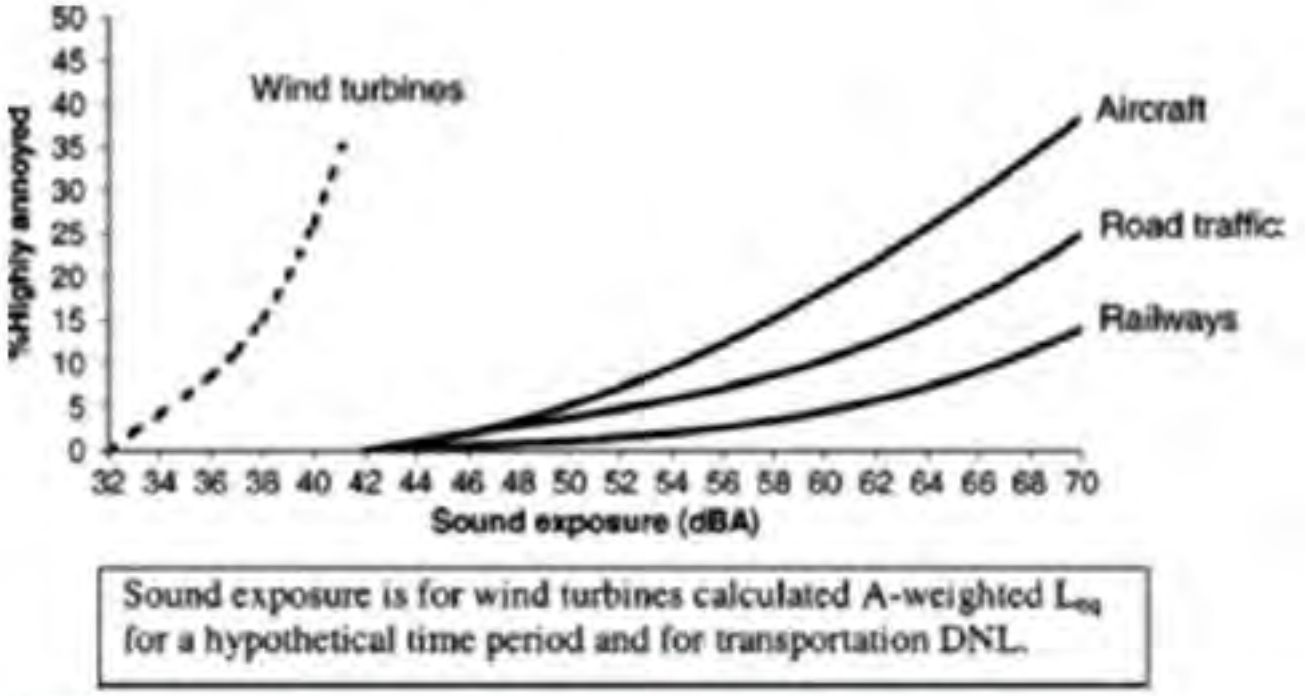


Figure 2: Pedersen and Waye's dose-response model (2004, p. 3468)

Another key example of inconclusive attempts at taming the unruly nature of the epistemic object of wind turbine noise are the publications that came out of the Danish health study on wind turbine noise (e.g. Poulsen et al., 2018). Funded by the Danish government with high hopes that the study could provide "objective proof" on (the lack of) health impacts (cardiovascular disease and other diseases related to stress and sleep deprivation), the study was in the end unable to establish with certainty either that there were or there were not health effects from wind turbine noise, and the researchers behind the study recommended further research (Danish Agency of Public Health (Sundhedsstyrelsen), 2019; Poulsen et al., 2019). Thus, in a sense, the cancer study has produced evidence, or, rather "arguments" both for proponents of and opponents to wind power, sparking even more controversy.

It Is therefore worth summarising the communities' understandings here, to crystallise their differences: For the technical community, noise is something that can be measured and modelled, with the expectation that its impact on people can be reduced to a quantifiable estimate of Db(A). Hereby, there is the assumption that by quantifying and reducing the noise level, the risk of opposition to wind energy as well as revenue loss, is reduced.
For the health community, a statistical approach translates the noise Db(A) level into the risk of a certain percentage of highly annoyed people, enabling the setting of a limit that can be relied upon for informing policy and regulation, providing a quantifiable threshold below which the risk of adverse health effects is reduced to an acceptable level.
Comment: This level of uncertainty invokes the Precautionary Principle & refusal of development.

Reference Number 4.12 :
Environmental noise in Europe — 2020 No 22/2019 EEA Report

- *Long-term exposure to environmental noise is estimated to cause 12 000 premature deaths and contribute to 48 000 new cases of ischaemic heart disease per year in the European territory. It is estimated that 22 million people suffer chronic high annoyance and 6.5 million people suffer chronic high sleep disturbance.*

- *As a result of aircraft noise, 12 500 schoolchildren are estimated to suffer learning impairment in school.*

- *These significant health impacts are most likely to be underestimated, with new WHO evidence demonstrating effects at levels below the obligatory END reporting thresholds. In addition, the END does not comprehensively cover all urban areas, roads, railways and airports across Europe.*

- *Exposure to environmental noise does not affect everyone equally. Socially deprived groups, as well as groups with increased susceptibility to noise, may suffer more pronounced health-related impacts of noise.*

Description of the main non-auditory adverse health effects of noise

Annoyance	*It is one of the most prevalent responses to noise, and it is described as a stress reaction that encompasses a wide range of negative feelings, including disturbance, dissatisfaction, distress, displeasure, irritation and nuisance. The individual response to noise depends not only on exposure levels but also on contextual, situational and personal factors. It can initiate physiological stress reactions that, if long-term, could trigger the development of cardiovascular disease.*
Sleep disturbance	*Sleep serves to facilitate vital functions in our body. Noise fragments sleep, reduces sleep continuity and reduces the total amount of sleep time, which can have impacts on alertness, performance at work and quality of life. Sleep restriction causes, among other things, changes in glucose metabolism and appetite regulation, impaired memory consolidation and a dysfunction in blood vessels. Long-term sleep disturbance can also lead to cardiovascular health issues.*
Cardiovascular and metabolic effects	*Noise is an important risk factor for chronic diseases. Noise exposure activates stress reactions in the body, leading to increases in blood pressure, a changing heart rate and a release of stress hormones. In addition, the cardiovascular and metabolic effects related to noise exposure may also be a consequence of a reduction in sleep quality, caused by noise exposure during the night, among other additional or interrelated mechanisms. These chronic effects can lead to premature mortality.*
Cognitive development in children	*Noise in classrooms affects children in many ways, including lowering their motivation, reducing speech intelligibility, listening comprehension and concentration, producing annoyance and disturbance, and increasing restlessness. As a result, children exposed to noise at school may experience poorer reading ability, memory and performance. Cognitive impairment could also be linked to noise exposure at home during night-time hours, which can cause low mood, fatigue and impaired task performance the next day. Noise at home may also be linked to hyperactivity and inattention problems, which can cause lower academic performance.*

Noise annoyance, sleep disturbance and their relation to health and well-being

Although noise annoyance and sleep disturbance may be short lived in some situations, in this report and according to the World Health Organization (WHO) environmental noise guidelines (WHO, 2018), noise annoyance and sleep disturbance refer to those affecting people long-term/chronically. In terms of severity, WHO (2018) based its results on the percentage of the population giving the highest ratings for long-term, self-reported noise annoyance and sleep disturbance, namely the 'percentage of the population highly annoyed' and the 'percentage of the population highly sleep disturbed'. Therefore, throughout this assessment, we refer to 'high annoyance' and 'high sleep disturbance' to describe the long-term impacts of noise on annoyance and sleep disturbance.

The WHO environmental noise guidelines (WHO, 2018) consider long-term annoyance and sleep disturbance due to noise to be important health outcomes. According to the WHO definition of health, which is 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (International Health Conference, 2002)', documenting only physical health does not present a complete picture of general health. Therefore, being undisturbed by noise in all activities, including sleep, constitutes an asset worthy of protection (WHO, 2018). The importance of considering both annoyance and self-reported sleep disturbance as health outcomes is further supported by evidence indicating that they may play a part in the causal pathway of noise-induced cardiovascular and metabolic diseases (Eriksson and Pershagen, 2018; WHO, 2018).

Recommendations from the WHO environmental noise guidelines

Reducing noise below these levels is strongly recommended

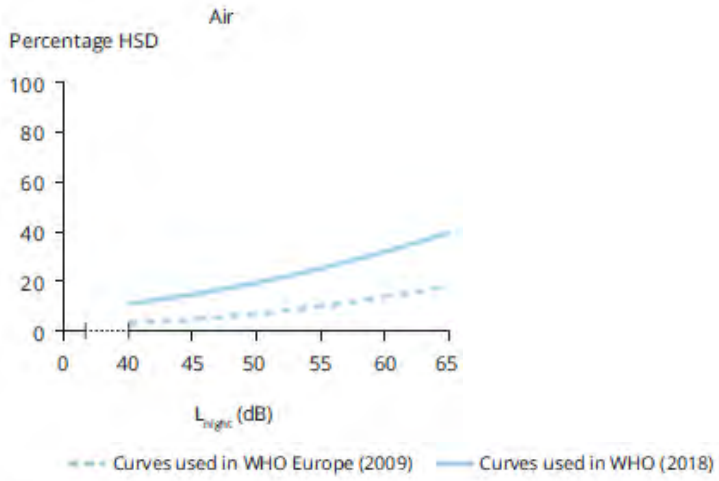
Noise indicator	*Road*	*Rail*	*Air*
Lden	*53 Db*	*54 Db*	*45 Db*
Lnight	*45 Db*	*44 Db*	*40 Db*

Estimated percentage of people in the category 'Highly Annoyed (HA) by noise for air, road and rail traffic' according to the WHO environmental noise guidelines

Note: Dashed lines show the previous curves used by the EU from Miedema and Oudshoorn (2001).

Source: Guski et al. (2017).

Estimated percentage of people in the category 'Highly Sleep Disturbed (HSD) by noise for air, road and rail traffic' from the WHO environmental noise guidelines



Note: Dashed lines show previous curves from *Night-Noise Guidelines for Europe* (WHO Europe, 2009).

Source: Basner and McGuire (2018).

Other health effects of noise

Although current guidance from the WHO mainly focuses on direct links between noise levels and priority health effects such as annoyance, sleep disturbance, cognition impairment, cardiovascular outcomes and hearing impairment, given the disease-inducing mechanisms of noise, i.e. stress and the disturbance of night-time sleep, noise may have wider impacts on people's health and well-being.

For example, it has recently been suggested that exposure to transport noise may be involved in the development of some types of breast cancer (Sørensen et al., 2014; Hegewald et al., 2017; Andersen et al., 2018). It is also hypothesised that psychological stress caused by noise may exacerbate respiratory disease (Recio et al., 2016). Noise causes stress and annoyance and has also been linked to serious mental health problems such as depression and anxiety (Beutel et al., 2016; Orban, et al., 2016).

Other studies have shown the indirect impacts of living in noisy areas. For instance, transport noise may, through sleep disturbance, lead to physical inactivity (Foraster et al., 2016; Roswall et al., 2017). Other associations between traffic noise and lifestyle factors such as smoking, alcohol consumption or medication intake have also been reported (Bocquier et al., 2014; Roswall et al., 2018).

Environmental noise impacts on vulnerable groups

Group	*Vulnerability*	*Adapted from*
Children	*Exposure to aircraft noise in schools affects children's cognition. Compared with adults, children are in an important learning and developmental phase and may therefore be disproportionately affected by noise. Children also may lack coping strategies and have less control over environmental noise than adults. As children also spend more time in bed, they may be exposed more to night noise levels.*	*WHO Europe, 2009; Clark and Paunovic, 2018a*
Elderly	*Since sleep structure becomes more fragmented with age; elderly people are more vulnerable to sleep disturbance. Elderly people may also be more prone to suffering cardiovascular effects due to noise than younger adults. The risk of suffering health conditions related to the heart and circulatory system increases with age. In addition, the elderly typically spend more time at home or have lived in a property exposed to noise for many years.*	*WHO Europe, 2009; Tobias et al., 2014; Halonen et al., 2015*
Shift workers	*Shift workers may be at an increased risk of experiencing negative impacts from exposure to environmental noise, because their sleep structure is under stress. Shift workers may also need to sleep during the day, when environmental noise levels are higher.*	*WHO Europe, 2009*
Pre-existing health conditions	*People suffering from chronic diseases may have a higher cardiovascular risk due to noise than those without such pre-existing conditions.*	*Babisch, 2006*
Noise sensitive	*People considered to be noise sensitive (e.g. people who pay more attention to noises, discriminate more between noises, find noises more threatening and out of their control, and react to and adapt to noises slowly) are generally more susceptible to sleep disturbance as well as psychological effects due to noise.*	*Stansfeld, 1992; Marks and Griefahn, 2007*
Pregnant women	*The sleep structure of pregnant women becomes more fragmented. Environmental noise may also increase the risk for pre-term birth and low birth weight.*	*WHO Europe, 2009; Nieuwenhuijsen et al., 2017*
Socio-economically disadvantaged	*Lower socio-economic groups may be exposed to higher levels of noise. Those living in more deprived locations have less access to quiet areas. Deprived populations may experience the worst effects of noise pollution as a result of poorer housing, pre-existing health conditions or fewer opportunities for coping with noise.*	*EEA, 2018c; Dreger et al., 2019; WHO, 2019*

Effects of noise on biodiversity

- *Anthropogenic noise not only affects species sensitive to noise, but has impacts on a wide range of terrestrial and aquatic species that inhabit very different ecosystems.*

- *Anthropogenic noise causes a range of physiological and behavioural responses in terrestrial and marine wildlife, which can lead to reduced reproductive success, increased mortality risk and emigration, resulting in decreased population densities.*

- *Although the responses to noise are very much species dependent, effects can start to appear at levels as low as 40 Db(A) for terrestrial animals. In addition to levels of noise, impacts may also depend on noise frequency and type.*

- *At least 19 % of nature protection areas covered by Natura 2000 are located in areas where noise levels are above the Environmental Noise Directive reporting thresholds because of roads, railways and aircraft.*

Effects on terrestrial wildlife due to general background, transport and industrial noise

Terrestrial	Birds		Changes in singing and communication behaviour
			Changes in spatial distributions and movements
			Reduced breeding
			Effects on physiological development
			Increased stress levels
			Reduced reproductive success
			Decline in species diversity
			Changes in distribution and abundance.
			Changes in community species
	Mammals		Changes in vocal and communication behaviour
			Reduced foraging
			Increased stress levels
			Reduced reproductive success
	Reptiles and amphibians		Changes in vocal and communication behaviour
			Difficulties in locating mates
	Invertebrates		Changes in mate attraction behaviour

	Physiological response
	Behavioural response
	Impact on fitness
	Consequences for population and communities

Sources: Adapted from Francis and Barber (2013) and Shannon et al. (2016).

Reference Number 4.13:
Recent Advances in Wind Turbine Noise Research Colin Hansen 1, and Kristy Hansen. Acoustics 2020, 2, 171–206; doi:10.3390/acoustics2010013 www.mdpi.com/journal/acoustics

Special Characteristics of Wind Farm Noise
Some special characteristics of wind farm noise can be accounted for by adding a penalty in Dba to the measured A-weighted sound pressure level before comparing the measured A-weighted level to the allowed level. Other characteristics may be accounted for by specifying an allowable limit for a particular measurement that quantifies that particular characteristic. However, research is still needed to determine how regulations can best address all characteristics of wind farm noise at the typical range of distances between the nearest turbine in a wind farm and potentially affected residences. Characteristics of wind farm noise that are potentially annoying to residents are listed and explained below.

(a) ***Amplitude modulation (AM)*** *which is the periodic variation in wind farm noise level. Allowed levels should be expressed in terms of a single parameter that is proportional to the annoyance and magnitude of the modulation. A suitable modulation metric as well as its suitable value are both subjects of current research. The single parameter could then be used as a basis for an AM penalty (decrease in*

allowed A-weighted sound pressure level as a function of a suitable modulation metric). It may also be necessary for the magnitude of the AM penalty to be a function of the A-weighted noise level.

(b) ***Low-frequency noise (LFN).*** *This is currently addressed in some regulations that do consider it, in a number of ways by specifying one or more of the following:*

(i) an allowed maximum C-weighted noise level ;
(ii) an allowed maximum decibel difference between the C-weighted level and the A-weighted level
(iii) allowed overall maximum indoor noise levels in a specified frequency range (see, for example, which specifies, in Danish regulations, an allowed 20 Dba in the range 10–160 Hz for wind speeds at hub height between 6 and 8 m/s); and
(iv) allowed maximum indoor noise levels for each 1/3-octave band in the frequency range 20–200 Hz (Swedish and Finnish regulations according to Sørensen and Kishore and DEFRA criteria according to Moorhouse et al. or 5–80 Hz

A limitation of the methods presented above is their use in isolation. For instance, considering the overall C-weighted level or Dbc minus Dba exclusively will result in false positives in the results. On the other hand, comprehensive spectral analysis can be complex for compliance assessment purposes.
After reviewing the approaches to LFN assessment and regulation used in various international jurisdictions, Downey and Parnell proposed a new approach that uses a three-stage assessment of LFN:
(i)simple initial screening so that assessment proceeds only if the C-weighted level minus the A-weighted level (Dbc-Dba) exceeds 15 Db;
(ii) comparison of 1/3-octave band levels between 10 and 160 Hz with allowed 1/3-octave band levels; and
(iii) assignment of a penalty to the measured A-weighted level, depending on the extent by which the measured 1/3-octave band levels exceed the allowed levels.
As wind turbines become larger, the likelihood of annoyance from excessive infrasound and LFN becomes greater, due to the shift to lower frequencies of the wind turbine noise spectrum. On the other hand, some would argue that, if turbines become sufficiently high, the noise reaching dwellings would be reduced, but this remains very speculative. Research is needed to determine whether or not existing regulations are applicable to turbines larger than those existing in wind farms at the time that the regulations were drafted, and whether satisfaction of the various different requirements in different regulations adequately protects residents from LFN annoyance.

(c) ***Tones.*** *It is well known that tones add to the annoyance of wind farm noise. The international standard, IEC61400 describes how to determine tonal prominence for noise measured close to a wind turbine. As discussed, the procedure is not appropriate for determining the extent of tonality at a dwelling located some distance from the nearest turbine in a wind farm. In addition, results of round robin tests in various laboratories show inconsistencies in identification of the same tone, probably due to inconsistencies in interpretation of the standard by different research groups. These inconsistencies in interpretation of IEC61400, probably as a result of the high complexity of IEC61400, will need further research to resolve. It is important that any new standard for wind farm noise specifies appropriate frequency-dependent and sound pressure level-dependent tonal penalties that can be used in regulations.*

(d) ***Infrasound.*** *A single number rating for the level of infrasound is currently the G-weighted level (Dbg). The G-weighting network has a maximum response at 20 Hz that rolls off in a similar way to the response of the ear as the frequency is decreased to 2 Hz. Above 20 Hz, the weighting is not zero but rolls off at a rate such that the weighting at 2 Hz is similar to that at 63 Hz. It needs to be established whether this is a suitable descriptor to be used in regulations for wind farm noise and, if so, what would be an appropriate allowed Dbg level. The appropriate level would have to be based on the outcomes of further research on the effects of infrasound on annoyance and sleep disruption.*

Ground Vibration

It is generally accepted that seismic vibration generated by wind turbines is sufficiently small that it cannot be detected by residents living more than 2 km from the nearest turbine in a wind farm. In fact, it is highly unlikely that vibrations would be detectable by residents living even closer than this. However, vibration levels generated by wind farms are sufficiently high that they can interfere with stations set up to monitor atomic bomb testing, earthquakes and volcanoes. For this reason, wind farms are generally excluded within 30–50 km of military establishments or seismic monitoring stations.
Recently, questions have arisen concerning the ability of seismic waves generated by wind farms to generate significant levels of acoustic infrasound, but work by Nguyen et al. would suggest that this is unlikely to be the case. Although they found that vibration levels on the floor in dwellings were unlikely to be due to infrasound, they did find that vibration levels on the window were well correlated with the wind farm acoustic signature (not the ground vibration). However, more extensive studies of wind farm vibration levels in dwellings closer than 1 km to the nearest turbine in a wind farm are warranted.
Although it is generally accepted that ground vibrations due to turbines do not have a detectable effect on humans, more research effort is needed to quantify the effect of wind farms on ground vibration and the distance they should be from sensitive seismic measurement stations used for detection of volcanoes, earthquakes and atomic testing.

Local Native Wildlife and Agriculture
Quite a few studies have been undertaken to evaluate whether or not wind farms cause wildlife to leave their vicinity (see for example. In cases where this is true, it is difficult to determine whether the reason was turbine noise, construction activity, or the visual presence of a huge tower with rotating blades.
Studies have also been undertaken on the effect of wind turbines on livestock (see, for example, and on wildlife (see, for example. These studies have shown that wind turbine noise may affect communication between animals, which may affect breeding, and/or contribute to increased cortisol, indicating a stress response that could make the animals more susceptible to infection and disease.
Although it is relatively easy to show that wildlife tend to leave wind farm areas, it is not clear whether this is due to the noise emission or other effects such as the turbine presence or shadow flicker.

Reference Number 4.14:
Long-term wind turbine noise exposure and the risk of incident atrial fibrillation in the Danish Nurse cohort. Elvira V. Brauner, Jeanette T. Jorgensen, Anne Katrine Duun-Henriksen, Claus Backalarz, Jens E. Laursen, Torben H. Pedersen, Mette K. Simonsen, Zorana J. Andersen. Environment International 130 (2019) 104915
The results from this first nationwide, prospective cohort study of Danish female nurses assessing the relationship between WTN exposure and AF offer suggestive evidence of an association. We used a large nationwide prospective cohort with a representative distribution of present and historical addresses around entire Denmark and benefited from objective assessment of AF incidence based on high quality Danish registries with near 100% coverage (Helweg-Larsen, 2011; Lynge et al., 2011; Schmidt et al., 2015),
as well as detailed information on AF risk factors. This assessment implies minimal possibility of recall and information bias and no selection bias. We furthermore benefited from the state-of-the-art high resolution validated exposure models for WT and road traffic noise (Backalarz et al., 2016; Kragh et al., 2001; Sondergaard et al., 2009) as well as air pollution (Kakosimos et al., 2010; Ketzel et al., 2011), which were based on geocodes and also accounted for all address changes, meteorological conditions as well as the size and the type of WTs.
We found a significant effect of exposure to WTN above 20 Db compared to<20 Db at night. We acknowledge that noise levels below 20 Db and probably not able to cause sleep disturbance, but if real this implies that night exposure to WTN is important in the causal pathway. This is plausible as the second mechanism involved in the effects of noise exposure relate to indirect noise-induced sleep disturbances, which are proposed pathways implicated in the development of metabolic changes (Munzel et al., 2017a, 2017b, 2017c).
Sleep has a regulatory influence on the immune system (Ali and Orr, 2014; Gomez-Gonzalez et al., 2012) and disturbed sleep has been associated with systemic impairment of the immune system. Sleep disturbances are similarly associated with impairment of the immune system, including changes in circulating white blood cells and increases in pro-inflammatory molecules (Aho et al., 2013; Irwin et al., 2016) that are on the causal pathway to AF. Notably, our results suggesting a strong association between nighttime WTN and AF, are supported by a recent study of noise annoyance and AF, where the authors report that annoyance due to noise at night was most strongly associated with AF prevalence (Hahad et al., 2018).

We found suggestive evidence of an association between long-term exposure to WTN and AF amongst in women above age 44. This should be interpreted with caution as levels of WTN exposure were low and direct auditory effects leading to AF are not expected.

Reference Number 4.15:
PHYSICAL AND PERCEPTUAL PREDICTION OF WIND TURBINE NOISE. Andrea P. C. Bresciani 2023. ISBN: 978-90-365-5954-6.DOI: 10.3990/1.9789036559546
The increasing demand for renewable energy has led to a surge in wind turbine installations. However, the noise emitted by wind turbines is hampering their deployment close to inhabited places because of the annoyance caused to the residents. Despite lower sound levels than other common sources, wind turbine noise ranks as the most annoying sound source compared to wind, road, and rail noises.
Wind turbines emit mechanical and aerodynamic noise. Sources of mechanical noise are the drivetrain and the gearbox. Aerodynamic noise is caused by the interaction of the moving wind turbine blades and the air. The dominant noise sources in the audible frequency range (20 Hz to 20 kHz) are aerodynamic, mainly trailing- and leading-edge noise. Trailing-edge noise is caused by the interaction of the turbulent boundary layer on the blade with the trailing edge of the blade itself, while leading-edge noise is generated by the interaction of the turbulence in the inflow with the leading edge of the blade. This research focuses on developing a wind turbine noise model, accounting for trailing- and leading-edge noise sources, atmospheric propagation, and creating audible sound files (auralization) from a numerical workflow. Furthermore, the impact of terrain and atmospheric conditions on noise emission, propagation, and perception is investigated. Using analytical and empirical methods, the study prioritizes fast computational turnaround methods that can be used in a real environment and practical applications. The methods should be robust, delivering accurate results for various conditions and turbine geometries.
The acoustic emissions from a wind turbine can be categorized Into two primary sources: mechanical and aerodynamic noise. The mechanical noise is usually tonal and associated with the vibrations of the gearbox that are transmitted to the nacelle and tower. The aerodynamic noise is generated by the blades passing through the air. Horizontal-axis turbines rotate at a relatively low speed and, hence, tonal peaks caused by the blade loading will appear in the infrasound region (frequencies lower than 20 Hz). In the audible frequency region (frequencies between 20 Hz and 20 kHz), the airfoil noise is considered the dominant noise source.
Several noise mechanisms could contribute to the total airfoil noise, including trailing-edge noise, leading-edge noise, tip-vortex noise, blunt trailing-edge noise, and separation-stall noise. However, for wind turbines, the trailing-edge noise caused by the turbulent boundary layer and the leading-edge noise caused by the turbulent inflow are believed to be the main noise sources in design operating conditions.
Besides the characteristics of acoustic emissions, the atmosphere and the ground strongly influence the noise perceived by the listener. The levels at the listener position can be increased or reduced with respect to free-field propagation depending on the frequency range, ground type, and atmospheric conditions. The most important physical phenomena are ground reflection, atmospheric absorption, and refraction.
The sound propagating in a turbulent atmosphere fluctuates in amplitude and phase. This phenomenon, known as acoustic scintillation, is caused by random fluctuations in the acoustic refractive index of the air induced by atmospheric turbulence. Auralization techniques should consider this phenomenon to increase the realism of the synthetic sound.
A sound wave propagating in a turbulent medium encounters variations in the acoustic refractive index caused by random fluctuations in temperature and velocity. As a result, the wave is randomly distorted, causing changes in its amplitude and phase. For example, for a pure tone emitted by a static source, a listener sufficiently far will perceive a fluctuation (around the nominal, undisturbed values) in amplitude and frequency.

The cumulative Noise impact from Wake effects, plus friction effects/noise from insect detritus on the wind blades on residences from the South-West/West prevailing winds & shear winds are not provided. The N/S axis of the turbines indicate increased noise at the north-eastern boundary adjoining the existing houses.

Reference Number 4.16:
Balz Anor-v- An Bord Pleanala Supreme Court judgement [2016] [IESC 124]

While the 2019 guidelines remain in draft form, Note the Balz Anor-v- An Bord Pleanala Supreme Court judgement [2016] [IESC 124] which states that the Board, in deliberating on an application, should have some regard to the

guidance set out therein. The preferred approach as set out in the Section 5.7.4 of the 2019 draft guidelines is for noise limit restriction limits consistent with World Health Organisation guidelines of 5 Db(A) above existing background noise within a range of 35 to 43 Db(A) with 43 Db(A) being the maximum noise limit permitted day or night. This criteria is below that permitted under the 2006 guidelines. As noted the predicted noise levels do not comply with same.

Reference Number 4.17:

2024 TNEI Wind Farm Judicial Review Case Overview – Wind Turbine Noise

As we approach May, we highlight an interesting Judicial Review case that TNEI was involved with last year in the Republic of Ireland. The case related to a consented wind farm whose approval was challenged by a local objector group (the Applicants). A number of challenges were presented, including the suggestion that the decision to consent the wind farm by An Bord Pleanála (the Board) had not properly considered all of the information presented to them i.e. the information that had been previously submitted by the Applicants and other objectors; the argument that the current Wind Energy Development Guidelines are out of date; and, the argument that there was a lack of consideration and assessment of Amplitude Modulation (AM).

To summarise a long case, the Applicant argued that the Decision made by the Board;

- Lacked relevant consideration of other material relating to wind turbine noise, other than the currently adopted Wind Energy Development Guidelines (WEDG) 2006;
- Failed to consider submissions arguing the WEDG 2006 were / are out of date and no longer represent best scientific knowledge as regards wind turbine noise; and
- Failed to consider / assess amplitude modulation (AM), and therefore erred in law.

The Judge ultimately decided that the Board did consider submissions made by the Applicant and other material outside that of the WEDG2006, including the more recent draft WEDG2019 (which are currently being revised), consideration of several other guidance documents (including British Standard 4142, and WHO guidelines).
The Judge also decided that AM was sufficiently considered, following contributions by TNEI's Jim Singleton (originally the Applicant contended that a planning condition to control AM should be imposed, but Jim noted that imposing an AM planning condition is at odds with the advice stated in the Institute of Acoustics (IOA) 'A Good Practice Guide to the Application of ETSU R 97 for the Assessment and Rating of Wind Turbine Noise'). It was noted that, currently, whilst there is a method to measure and quantify AM, further work is required to develop a robust mechanism for controlling AM that could be incorporated into a planning condition.
The Applicant submitted Information "elati'g to a huge range of issues and objections over the course of a 700+ page submission, each of which demanded certiorari (grounds to quash a decision). It was noted that the objections lacked detail and were perhaps more *quantity than quality*, and in the end the Judge ordered the proceedings to be dismissed.
The need to thoroughly consider potential impacts associated with wind turbine noise remains an essential part of the wind farm design and consenting process. Whilst an update to the WEDG is expected this year it is essential that noise continues to be properly considered in the meantime to protect wind farm neighbours, to help inform decision makers and to provide certainty to wind farm developers.

Reference Number 4.18:

A planning condition for wind turbines. *.Andy McKenzie, Matthew Cand, Dick Bowdler, Mark Jiggins, Gavin Irvine, Michael Reid, Richard Perkins, Michael Lotinga, Malcolm Hayes and Andrew Bullmore,* Acoustics Bulletin November/December 2017, Vol 42 No 6.

Introduction

This article sets out a proposed wording for a planning condition on noise for wind farms or individual wind turbines. Whilst local authorities and developers have waited for a planning condition that could be applied to newly consented wind farms, or to those already consented but with a suspensive condition, the report Wind Turbine AM Review (WTAMR) by WSP/Parsons Brinckerhoff for DECC arguably did not provide that. In addition there have been a number of comments on WTAMR that we consider should be addressed. The introductory sections and the conditions text represent the broad consensus view of those whose names appear below, following a period of discussion, compromise and agreement. This approach is proposed based on the current state of understanding but may be subject to modification in light of new research and further robust information.

Copies of the condition only in Word format are available from the following websites:
www.hayesmckenzie.co.uk/uploads/A_Planning_Condition_for_Wind_Turbines_Sept_2017.docx
www.dickbowdler.co.uk/content/publications/

Proposed wording condition: The annex contains the condition wording which takes fairly typical wording for a planning condition on wind farm noise, including adjustments for tonal penalties if relevant, and adds a mechanism for adding a penalty for AM. Consistent with the recommendations of the WTAMR, the AM penalty is applied in addition to the tonality penalty. But how to calculate an AM penalty in practice is not clear from the WTAMR report.
WSP researchers in their subsequent *Acoustic Bulletin* article have discussed this aspect further: the penalty "should be applied to each individual 10-minute period assessed, and the rated levels separated into wind speed integer 'bins' for the purposes of comparison with the condition limits". They explain that to "aggregate the AM penalty" values would give an equivalent result to adding the penalty to each 10-minute period and then averaging the resulting "rated" levels, which is our experience in practice. In contrast, as they note, averaging the AM ratings and deriving an AM penalty on that basis would in many cases lead to different results.
The proposed condition has therefore been drafted on the basis of aggregating the AM penalties obtained, and applying this to the overall noise levels. This is considered to be a pragmatic way to represent the frequency/intensity of AM typically observed in relevant weather conditions. The condition explains that this averaging should only be done in relevant subsets of conditions which are determined in each case based on the observed complaints (if relevant), data analysis results or practitioner judgment. Analysis in wind direction bins or plotting the amplitude modulation as a polar plot may be important in determining the appropriate subset. An example is shown in Fig 1 which is a polar plot of AM values as a function of wind direction and speed.

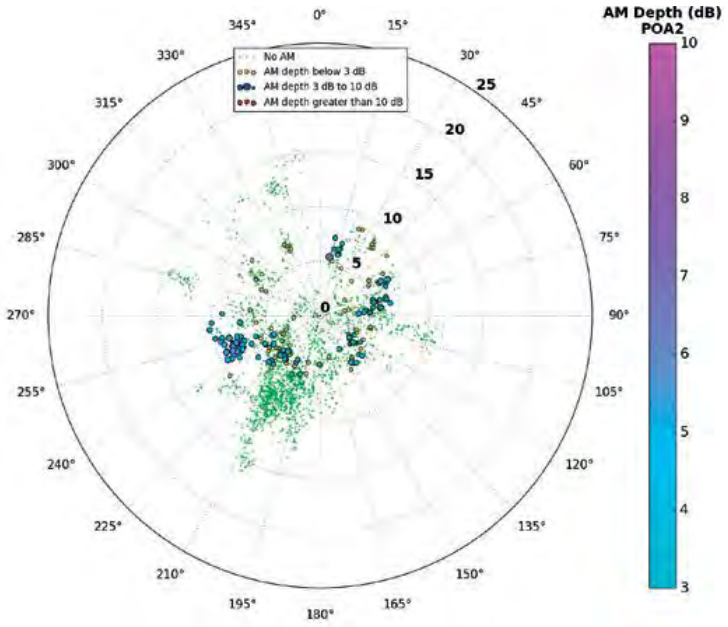


Fig 1 – plot of calculated AM ratings (dots) as a function of wind direction (circular direction) and wind speed (radial direction).

M penalty – general aspects.
As various people before us have discovered, the derivation of a penalty is not easy. There is not sufficient reliable research to be confident that a penalty system would always provide a fair indication of the impact of AM. However, to do nothing would be unfair on those wind farm neighbours adversely affected by AM and, in any case, there seems to be general agreement amongst many stakeholders on all sides of the debate that a robust condition including AM is required.
There are a significant number of people who have reservations about the penalty scheme proposed in the WTAMR report and this has been discussed in some detail by interested parties. The conclusion is that the penalty graph needs further research to establish whether it should be amended to take account of rotational speed and the difference between Leq and L90 (which increases as AM increases) and that this should be progressed as soon as possible. Meanwhile we have included the WTAMR graph in this condition. It is intended for medium to large scale turbines with a rotational speed up to 32 rpm.

A note on the night time limit

There has been criticism from some quarters of the method the WTAMR report proposed for an additional penalty to be applied at night to take account of the difference between the night-time and day-time limits; specifically, where the night-time limits are higher. With a few exceptions (where suspensive conditions for AM have been applied, typically as a scheme to be agreed) the condition we are discussing here applies only to new consents. That means that, in the majority of cases, it will be applied as part of a complete set of noise limits. In such cases, the night-time and day-time limits can be set appropriately in accordance with the circumstances of the case. It should be noted that, if the nighttime limit is higher than the day time limit this could mean that an AM penalty would take the wind farm over the limit during the day but not at night. Where a suspensive condition for AM has been applied, the AM penalty would have to be tailored to the individual case unless an application were made to amend the conditions as a whole.

Annex

Proposed planning conditions on noise for **** Wind Farm: The rating level of noise emissions from the combined effects of the wind turbines hereby permitted (including the application of any tonal penalty and amplitude modulation (AM) penalty), when determined in accordance with the attached guidance notes, shall not exceed the values for the relevant integer wind speed set out in or derived from Table 1 attached to these conditions and:

A) Within 21 days from receipt of a written request of the planning authority, following a complaint to it alleging noise disturbance at a dwelling, the wind farm operator shall, at its expense, employ an independent consultant and provide a written protocol to be approved by the planning authority. The protocol shall describe the procedure to assess the level and character of noise emissions from the wind farm at the complainant's property in accordance with the procedures described in the attached guidance notes. The written request from the planning authority shall set out as far as possible the time or meteorological conditions to which the complaint relates and time or conditions relating to tonal noise or AM if applicable. Measurements to assess compliance with the noise limits shall be undertaken in accordance with the assessment protocol which shall be approved in writing by the planning authority.

B) The wind farm operator shall provide to the planning authority the independent consultant's assessment of the rating level of noise emissions undertaken in accordance with the protocol within two months of the date of the approval of the protocol by the local authority unless otherwise agreed by the planning authority. The assessment shall include all data collected for the purposes of undertaking the compliance measurements and analysis, such data to be provided in a format to be agreed with the planning authority. Certificates of calibration of the equipment shall be submitted to the planning authority with the report.

C) Where a further assessment of the rating level of noise emissions from the wind farm is required pursuant to Guidance Note 5 of the attached Guidance Notes, the wind farm operator shall submit a copy of the further assessment within 21 days of submission of the independent consultant's initial assessment unless otherwise agreed by the Planning Authority.

[It is acknowledged that there may be other parts of the current IOAGPG conditions which require inclusion here, such as the clause discussing limits which apply at non named locations etc. The text included above aims to show how rating of AM scheme fits within the normal WF compliance approach.]
(Insert here the table or tables relevant to the specific planning condition)

Guidance notes for noise condition

These notes are to be read with and form part of the planning condition on noise. The measured data is to be split into bins as described below. The rating level in each bin is the arithmetic sum of the wind farm noise level, any tonal penalty applied in accordance with Note 3 and any AM penalty applied in accordance with Note 4. Reference to ETSU-R-97 refers to the publication entitled "The Assessment and Rating of Noise from Wind Farms" (1997) published by the Energy Technology Support unit (ETSU) for the Department of Trade and Industry (DTI). IOAGPG is "A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise" or any update of that report current at the time of measurement. The IOA Metric is "A Method for Rating Amplitude Modulation in Wind Turbine Noise" dated 9th August 2016 or any update of that current at the time of measurement.

Note 1 – Data collection

A) Values of the LA90,10-minute noise index should be measured in accordance with the IOAGPG. Measurements shall be undertaken in such a manner to enable a tonal penalty to be calculated and to allow an AM penalty to be calculated for selected periods where a tonal or AM assessment is required.

B) To enable compliance with the conditions to be evaluated, the wind farm operator shall continuously log arithmetic mean wind speed in metres per second (m/s) and arithmetic mean wind direction in degrees from north in each successive 10-minutes period in a manner to be agreed in writing with the planning authority. The wind speed at turbine hub height shall be "standardised" to a reference height of 10 metres as described in ETSU-R-97 at page 120 using a reference roughness length of 0.05 metres. It is this standardised 10 metre height wind speed data which are correlated with the noise measurements determined as valid. The wind farm operator shall continuously log arithmetic mean nacelle anemometer wind speed, arithmetic mean nacelle orientation, arithmetic mean wind direction as measured at the nacelle, arithmetic mean rotor RPM and whether each wind turbine is running normally during each successive 10-minutes period for each wind turbine on the wind farm. All 10-minute periods shall commence on the hour and in 10-minute increments thereafter synchronised with Universal Time (UT).

Note 2 – Data analysis

4. The independent consultant shall identify a subset of data having had regard to:-

• the conditions (including time of day and corresponding wind directions and speeds) at times in which complaints were recorded.
• the nature/description recorded in the complaints if available.
• information contained in the written request from the local planning authority.
• likely propagation effects (downwind conditions or otherwise);
• the results of the tonality/AM analysis where relevant.

In cases where it is possible to identify patterns of clearly different conditions in which complaints have arisen additional subsets may be considered provided this does not introduce unreasonable complexity in the analysis and can be justified by the independent consultant.

5. Within each of the subset(s) of data identified, data shall be placed into separate 1 m/s wide wind speed bins.

Note 3 – Tonal penalty

A) Where, in accordance with the protocol, the noise contains or is likely to contain a tonal component, a tonal audibility shall be calculated for each ten-minute period using the following procedure.

B) For each 10-minute period for which a tonal assessment is required this shall be performed on noise emissions during two minutes of each 10-minute period. The two-minute periods should be spaced at10-minute intervals provided that uninterrupted uncorrupted data are available ("the standard procedure").

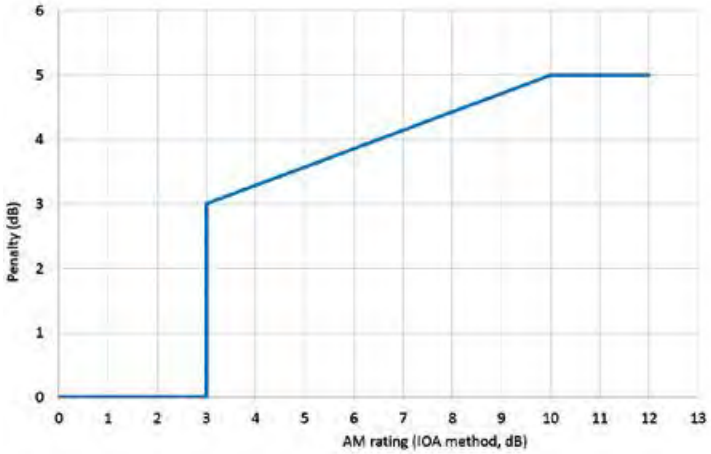
C) For each of the two-minute samples the tone level above audibility shall be calculated by comparison with the audibility criterion given in Section 2.1 on pages 104-109 of ETSU-R-97. Samples for which the tones were below the audibility criterion or no tone was identified, a value of zero audibility shall be substituted. Where data for a ten-minute period are corrupted, that period shall be removed from the tonal analysis.

D) The tone level above audibility for each 10-minute period shall be placed in the appropriate data subset and wind speed bin.

Note 4 – AM penalty

A) Where, in accordance with the protocol, the noise contains or is likely to contain AM, an AM penalty shall be calculated for each ten-minute period using the following procedure.

B) For each 10-minute interval for which an AM assessment is required this shall be performed in accordance with the IOA Metric. The value of AM for each ten-minute period shall be converted to a penalty in decibels in accordance with the graph below and the penalty shall be placed in the appropriate data subset and wind speed bin. Where a penalty is zero it should be placed in the bin in the same way.



Technical Penalty graph

Note 5 – Calculation of rating level

A) The LA90 sound pressure level for each data subset and wind speed bin is the arithmetic mean of all the 10-minute sound pressure levels within that data subset and wind speed bin except where data has been excluded for reasons which should be clearly identified by the independent consultant. The tonal penalty for each bin is the arithmetic mean of the separate 10-minute tonal audibility levels in the bin converted to a penalty in accordance with Fig 17 on page 104of ETSU-R-97. The AM penalty for each bin is the arithmetic mean of the AM penalties in the bin. The assessment level in each bin is normally the arithmetic sum of the bin LA90, the bin tonal penalty and the bin AM penalty except where the AM penalty and the tonal penalty relate to the same characteristic (e.g. amplitude modulated tones) when the sum of both penalties may overly penalise the characteristics of the noise. Such cases should be identified and only the larger of the AM or tonal penalty should be applied.

B) If the assessment level in every bin lies at or below the values set out in the table(s) attached to the conditions, then no further action is necessary. In the event that the assessment level is above the limit(s)set out in the tables attached to the noise conditions in any bin, the independent consultant shall undertake a further assessment of the rating level to correct for background noise so that the rating level relates to wind turbine noise emission only. Correction for background noise need only be undertaken for those wind speed bins where the assessment level is above the limit.

C) The wind farm operator shall ensure that all the wind turbines in the development are turned off for such periods as the independent consultant requires to undertake the further assessment. The further assessment shall be undertaken in accordance with the following steps:-

i. Repeating the steps in Note 1, with the wind farm switched off, and determining the background noise (L3) in each bin as required in the protocol. At the discretion of the consultant and provided there is no reason to believe background noise would vary with wind direction, background noise in bins where there is insufficient data can be assumed to be the same as that in other bins at the same wind speed.

ii. The wind farm noise (L1) in each bin shall then be calculated as follows where L2 is the measured level with turbines running butwithout the addition of any tonal nor AM penalty:

$$L_1 = 10\log\left[10^{L_2/10} - 10^{L_3/10}\right]$$

iii. The rating level shall be calculated by adding the tonal and AM penalties to the derived wind farm noise L1 in that bin.

iv. If the rating level after adjustment for background noise contribution and adjustment for tonal and AM penalties in every bin lies at or below the values set out in the Tables attached to the condition at all wind speeds then no further action is necessary. If the rating level at any integer wind speed exceeds the values set out in the Table(s) attached to the condition then the development fails to comply with the planning condition in the circumstances represented by that bin.

Reference Number 4.19:

Institute of Acoustics Statement in Respect of Wind Farm Noise Assessment. December 2024

The Institute of Acoustics (IOA) is the UK's professional body for those working in acoustics, noise and vibration. It engages widely with other professional bodies in related fields, and members are active in UK, European and International Standards development. Members also work in many sectors including consultancy, research and development, local and central UK Government, as well as for developers of, and objectors to, wind turbines, where they get involved with wind farm noise assessments.

ETSU-R-97

Published in 1996, ETSU-R-97 'The Assessment and Rating of Noise from Wind Farms' contains a methodology for generating noise limits for a wind turbine, and wind farms, and is currently referenced by the UK Government as a guidance document. The UK Government has endorsed ETSUR- 97 in various policy documents / statements since its publication, and it is the UK Government (that is responsible for planning policy) who decide the noise limits in ETSU-R-97. IOA Good Practice Guide

At the invitation of the Department for Energy and Climate Change (DECC), the IOA agreed to produce a Good Practice Guide (GPG) to the application of ETSU-R-97, considering the technical elements only. The GPG was published in 2013, with additional supplementary guidance notes published in 2014. This remains current guidance endorsed for use until such time as an updated version is published.

Amplitude Modulation

'Amplitude Modulation' (AM) is a feature of the character of wind farm noise caused by the cyclical nature of the blades. An understanding of the causal mechanisms has been gained in recent years, along with control methods to help assist with sites where AM can lead to complaints. An IOA endorsed metric was published in 2016 and can be found at: [http://ioa.org.uk/publications/windturbine- noise]. A sample planning condition was proposed by IOA members which was published in the IOA bulletin (November-December 2017 issue).

Infrasound

The IOA is aware that there is some information presented at planning inquiries suggesting the potential for physiological health effects from infrasound from wind turbines. **It is current advice to members that there is no need to assess infrasound as part of the noise impact assessment process**, as the absolute levels are well below those reported to trigger physiological health effects based on peer reviewed research to date.

Low Frequency Noise

The IOA is aware that there is some information presented at planning inquiries suggesting the potential for physiological health effects from low frequency noise from wind turbines. **It is current advice to members that there is no need to assess low frequency noise as part of the noise impact assessment process**, as the absolute levels, whilst potentially audible at typical receptor distances, are well below those reported to trigger physiological health effects based on peer reviewed research to date.

Vibration
Vibration from operational wind turbines has been measured by extremely sensitive measurement equipment such as seismic arrays. But in terms of human perception, measured vibration levels are well below perception thresholds even on the actual wind turbine sites. There is, therefore, no need to assess vibration affecting people for operational wind turbine developments.

Summary
The IOA has a responsibility to provide guidance on technical matters within its sphere of activity. The GPG and the IOA metric are endorsed by IOA Council to give advice to members on how to apply ETSUR- 97. It will continue to advance the understanding of AM through its renewable energy advisory group and update its advice when new evidence emerges.

The article includes the comment "to do nothing would be unfair on those wind farm neighbours adversely affected by AM and, in any case, there seems to be general agreement amongst many stakeholders on all sides of the debate that a robust condition including AM is required."

I thought it interesting because the blog was quoting the IOA's Good Practice Guide is dated May 2013 !!

https://www.tneigroup.com/news_event/2024-tnei-wind-farm-judicial-review-case-overview-wind-turbine-noise/

"The Judge also decided that AM was sufficiently considered, following contributions by TNEI's Jim Singleton (originally the Applicant contended that a planning condition to control AM should be imposed, but Jim noted that imposing an AM planning condition is at odds with the advice stated in the Institute of Acoustics (IOA) 'A Good Practice Guide to the Application of ETSU R 97 for the Assessment and Rating of Wind Turbine Noise'). It was noted that, currently, whilst there is a method to measure and quantify AM, further work is required to develop a robust mechanism for controlling AM that could be incorporated into a planning condition."

Below is evidence from an environmental health officer in Scotland which mentions the IOAs planning condition. I believe Dick Bowdler's testimony said that particular condition doesn't work very well. If he did, he'd be right, I've been told it's very clear to see the flaws in the code.

But the point is... the IOA working group said... it would be unfair not to impose a planning condition.

To be honest, I've spent my time looking at noise predictions etc I don't know enough about planning conditions but if I was looking for best practice, New South Wales guidance is the first place I'd look. And New Zealand, they looked at ETSU R 97, way back when and decided not to use it.

Reference Number 4.20:
ENVIRO ACOUSTIC RESEARCH *ENIA – Koup 1 Wind Energy Facility*

Effect of Wind
Wind alters sound propagation by the mechanism of refraction, that is, wind bends sound waves. Wind nearer to the ground moves more slowly than wind at higher altitudes, due to surface characteristics such as hills, trees, and man-made structures that interfere with the wind. This wind gradient, with faster wind at higher elevation and slower wind at lower elevation, causes sound waves to bend downward when they are traveling to a location downwind of the source and to bend upward when traveling toward a location upwind of the source. Waves bending downward means that a listener standing downwind of the source will hear louder noise levels than the listener standing upwind of the source. This phenomenon can significantly impact sound propagation over long distances and when wind speeds are high. Over short distances wind direction has a small impact on sound propagation as long as wind velocities are reasonably slow, i.e., less than 5 m/s.

Wind speed frequently plays a role in increasing sound levels in natural locations. With no wind, there is little vegetation movement that could generate noises and faunal noises (normally birds and insects) dominate, however, as wind speeds increase, the rustling of leaves increases which subsequently can increase sound levels. This directly depends on the type of vegetation in a certain area. The impact of increased wind speed on sound levels depends on

the vegetation type (deciduous versus conifers), the density of vegetation in an area, seasonal changes (in winter deciduous trees are bare) as well as the height of this vegetation. This excludes unanticipated consequences, as suitable vegetation may create suitable habitats and food sources attracting birds and insects (and the subsequent increase in faunal communication).
Generally, noises from wind turbines:

- could be significant within 500 m, with receptors3 staying within 500 m from operational WTG subject to noises at a potentially sufficient level to be considered disturbing.

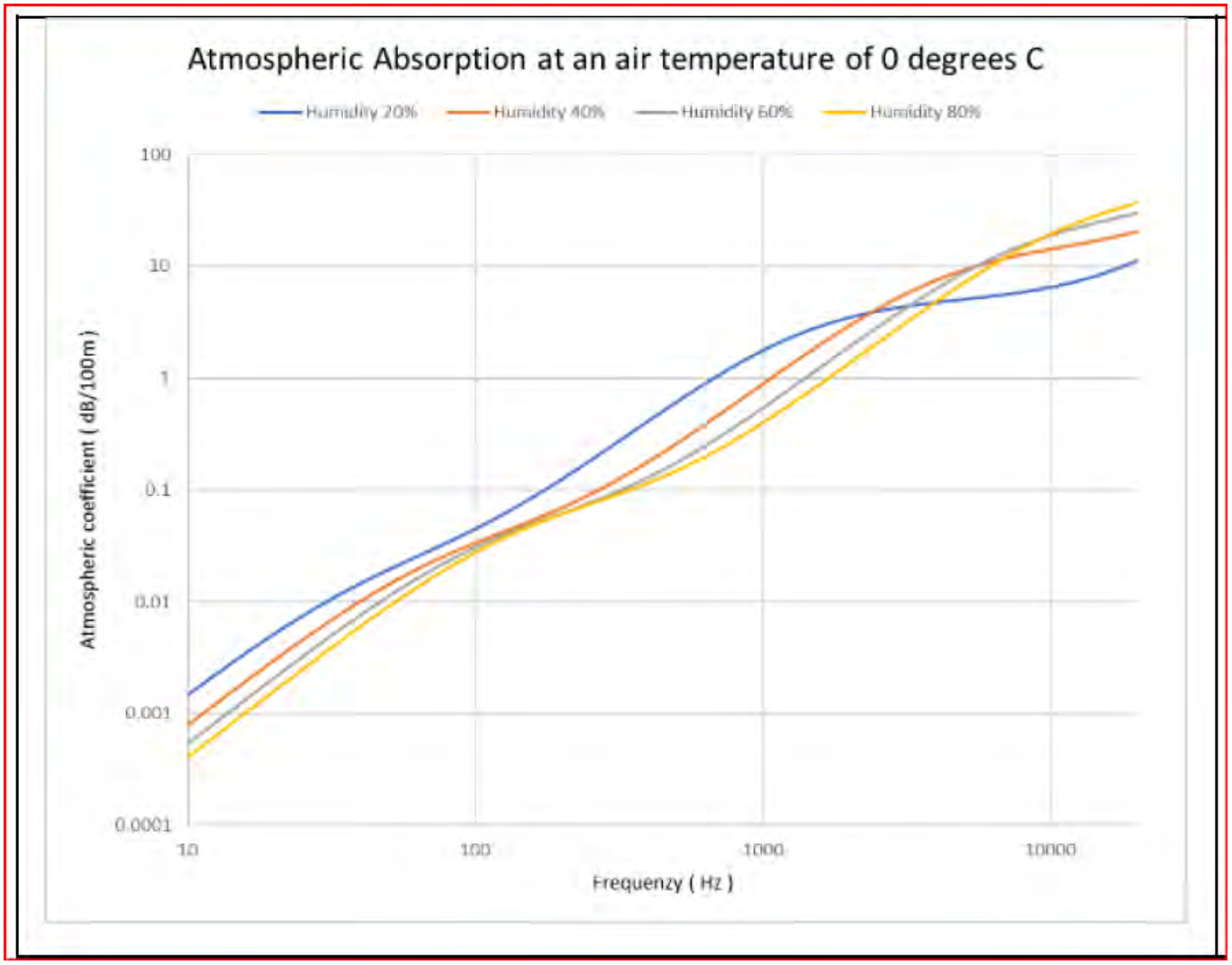
- are normally limited to a distance of approximately 1,000m from operational wind turbines (subject to WTG layout, as the WTG cumulatively contribute to noise levels with 2,000m from WTG). Night-time ambient sound levels could be elevated and the potential noise impact measurable; and

- likely to be audible up to a distance of 2,000m at night. Noises from the WTG are of a low concern at distances greater than 2,000m, although the sound of the WTGs may be audible at greater distances during certain meteorological phenomena (sound levels are generally very low at distances greater than 2,000m).

- Effect of Humidity and Temperature

- Generally, sound propagate better at lower temperatures (down to 10^0 C), and with everything being equal, a decrease in temperature from 32^0 C to 10^0 C could increase the sound level at a listener 600 m away by ±2.5 Db (at 1,000 Hz).

- The effect of humidity on sound propagation is quite complex, but effectively relates to how increased humidity changes the density of air. Lower density translates into faster sound wave travel, so sound waves travel faster at high humidity. With everything being equal, an increase in humidity from 20% to 80% would increase the sound level at a listener 600 m away by ±4 Db (at 1,000 Hz at 20^0 C).
- Together, the impact of temperature and humidity (together with air pressure – to a minor extent) are complex and highly dependent on the frequency composition of the noise.


Atmospheric Absorption at an air temperature of 0 degrees C
Humidity 20%
Humidity 40%
Humidity 60%
Humidity 80%
100
10
1
0.1
0.01
0.001
0.0001
Atmospheric coefficient (dB/100m)
10
100
1000
10000
Frequenzy (Hz)

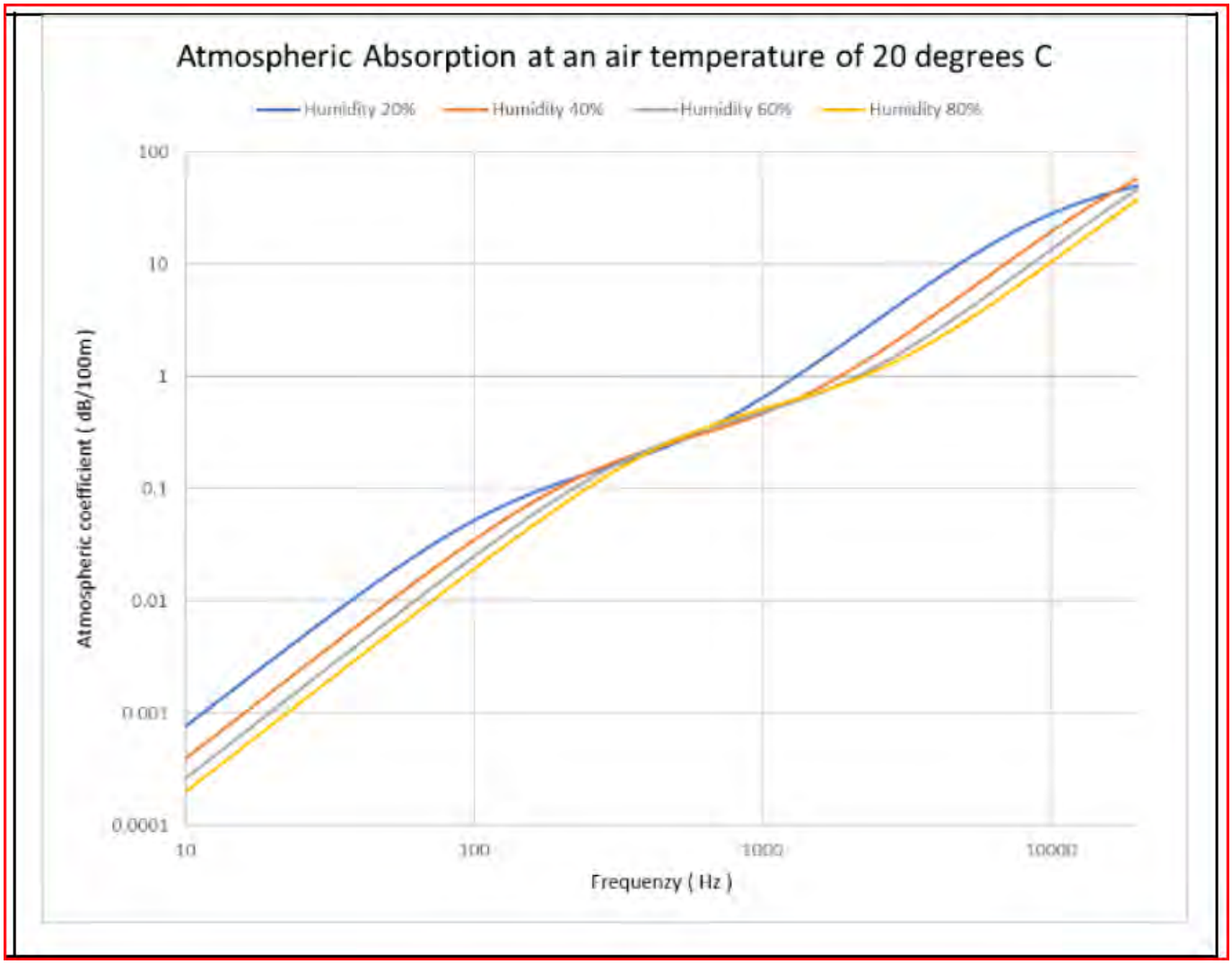


Figure: Effect of Temperature and Humidity on propagation of Sound

Equipment Description[21]	Impact Device?	Maximum Sound Power Levels (dBA)	Operational Noise Level at given distance considering potential maximum noise levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modeling only considering distance) (dBA)											
			5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Backhoe	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Compactor (ground)	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Compressor (air)	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Concrete Batch Plant	No	117.7	92.7	86.7	80.6	72.7	66.7	63.1	60.6	57.1	52.7	49.2	46.7	40.6
Concrete Mixer Truck	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Concrete Pump Truck	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Crane	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Drill Rig Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Drum Mixer	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Dump Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Excavator	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Flat Bed Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Front End Loader	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Generator	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Generator (<25KVA)	No	104.7	79.7	73.7	67.6	59.7	53.7	50.1	47.6	44.1	39.7	36.2	33.7	27.6
Grader	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Impact Pile Driver	Yes	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6
Jackhammer	Yes	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Man Lift	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Mounted Impact Hammer	Yes	124.7	99.7	93.7	87.6	79.7	73.7	70.1	67.6	64.1	59.7	56.2	53.7	47.6
Pickup Truck	No	89.7	64.7	58.7	52.6	44.7	38.7	35.1	32.6	29.1	24.7	21.2	18.7	12.6
Pumps	No	111.7	86.7	80.7	74.6	66.7	60.7	57.1	54.6	51.1	46.7	43.2	40.7	34.6
Vibratory Concrete Mixer	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Vibratory Pile Driver	No	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6

Equipment Description	Equivalent (average) Sound Levels (dBA)	Operational Noise Level at given distance considering equivalent (average) sound power emission levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
		5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Air compressor	92.6	67.6	61.6	55.6	47.6	41.5	38.0	35.4	31.9	27.3	23.6	20.9	14.2
Bulldozer CAT D10	111.9	86.9	80.9	74.9	66.9	60.8	57.3	54.7	51.2	46.6	42.9	40.2	33.5
Cement truck (with cement)	111.7	86.7	80.7	74.7	66.7	60.6	57.1	54.5	51.0	46.4	42.7	40.0	33.3
Crane	107.5	82.5	76.5	70.5	62.5	56.4	52.9	50.3	46.8	42.2	38.5	35.8	29.1
Diesel Generator (Large - mobile)	106.1	81.1	75.1	69.1	61.1	55.0	51.5	48.9	45.4	40.8	37.1	34.4	27.7
Dumper/Haul truck - Terex 30 ton	112.2	87.2	81.2	75.2	67.2	61.1	57.6	55.0	51.5	46.9	43.2	40.5	33.8
Excavator - Hitachi EX1200	113.1	88.1	82.1	76.1	68.1	62.0	58.5	55.9	52.4	47.8	44.1	41.4	34.7
FEL (988) (FM)	115.6	90.6	84.6	78.6	70.6	64.5	61.0	58.4	54.9	50.3	46.6	43.9	37.2
General noise	108.8	83.8	77.8	71.8	63.8	57.7	54.2	51.6	48.1	43.5	39.8	37.1	30.4
Grader - Operational Hitachi	108.9	83.9	77.9	71.9	63.9	57.8	54.3	51.7	48.2	43.6	39.9	37.2	30.5
Road Truck average	109.6	84.6	78.6	72.6	64.6	58.5	55.0	52.4	48.9	44.3	40.6	37.9	31.2
Rock Breaker, CAT	120.7	95.7	89.7	83.7	75.7	69.6	66.1	63.5	60.0	55.4	51.7	49.0	42.3
Vibrating roller	106.3	81.3	75.3	69.3	61.3	55.2	51.7	49.1	45.6	41.0	37.3	34.6	27.9
Substation (one transformer)	85.2	60.2	54.2	48.2	40.2	34.1	30.6	28.0	24.5	19.9	16.2	13.5	6.8
Water Dozer, CAT	113.8	88.8	82.8	76.8	68.8	62.7	59.2	56.6	53.1	48.5	44.8	42.1	35.4
Wind Turbine: Acciona AW125/3000	108.5	83.5	77.5	71.5	63.5	57.4	53.9	51.3	47.8	43.2	39.5	36.8	30.1
Wind Turbine: Goldwind GW165 6.0	112.6	87.6	81.6	75.6	67.6	61.5	58.0	55.4	51.8	47.3	43.6	40.9	34.2
Wind Turbine: Goldwind GW182 7.2	112.2	87.2	81.2	75.2	67.2	61.1	57.6	55.0	51.5	46.9	43.2	40.5	33.8
Wind Turbine: Nordex N163 / 5.X	109.2	84.2	78.2	72.2	64.2	58.1	54.6	52.0	48.5	43.9	40.2	37.5	30.8
Wind Turbine: Vesta V66, ave	110.4	85.4	79.4	73.4	65.4	59.3	55.8	53.2	49.7	45.1	41.4	38.7	32.0
Wind Turbine: Vestas V162-7.2MW	107.1	82.1	76.1	70.1	62.1	56.0	52.5	49.9	46.4	41.8	38.1	35.4	28.7

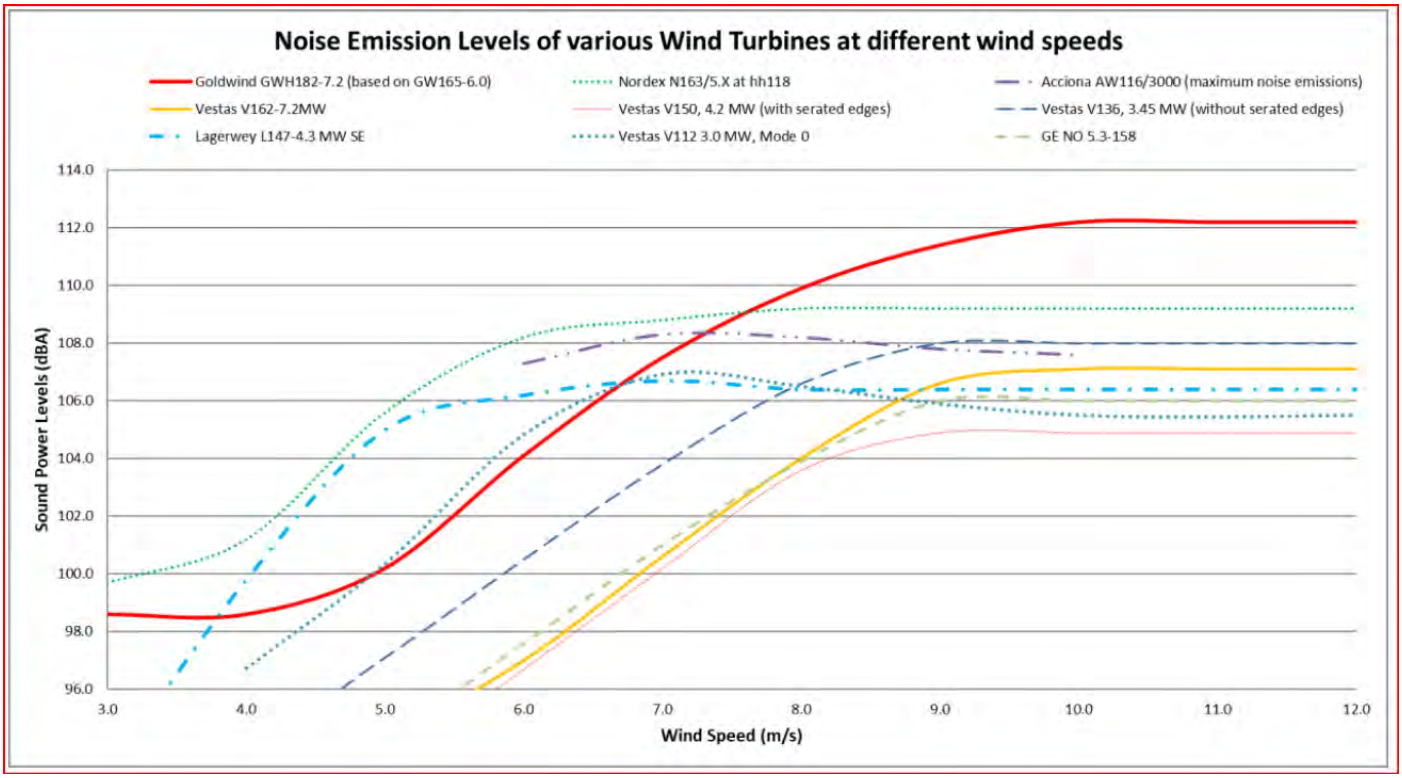
Potential equivalent noise levels generated by various equipment. Without proof from the Noise Model, it is assumed that a radius of 750m & 40.2dBa was used for various maps. These numbers are wind tunnel calculations for singular wind turbines & do not reflect the cumulative noise at a windfarm for turbulence from wake effects.

Wind Turbine Noise: Aerodynamic sources

Aerodynamic noise is emitted by a wind turbine blade through a number of sources such as:

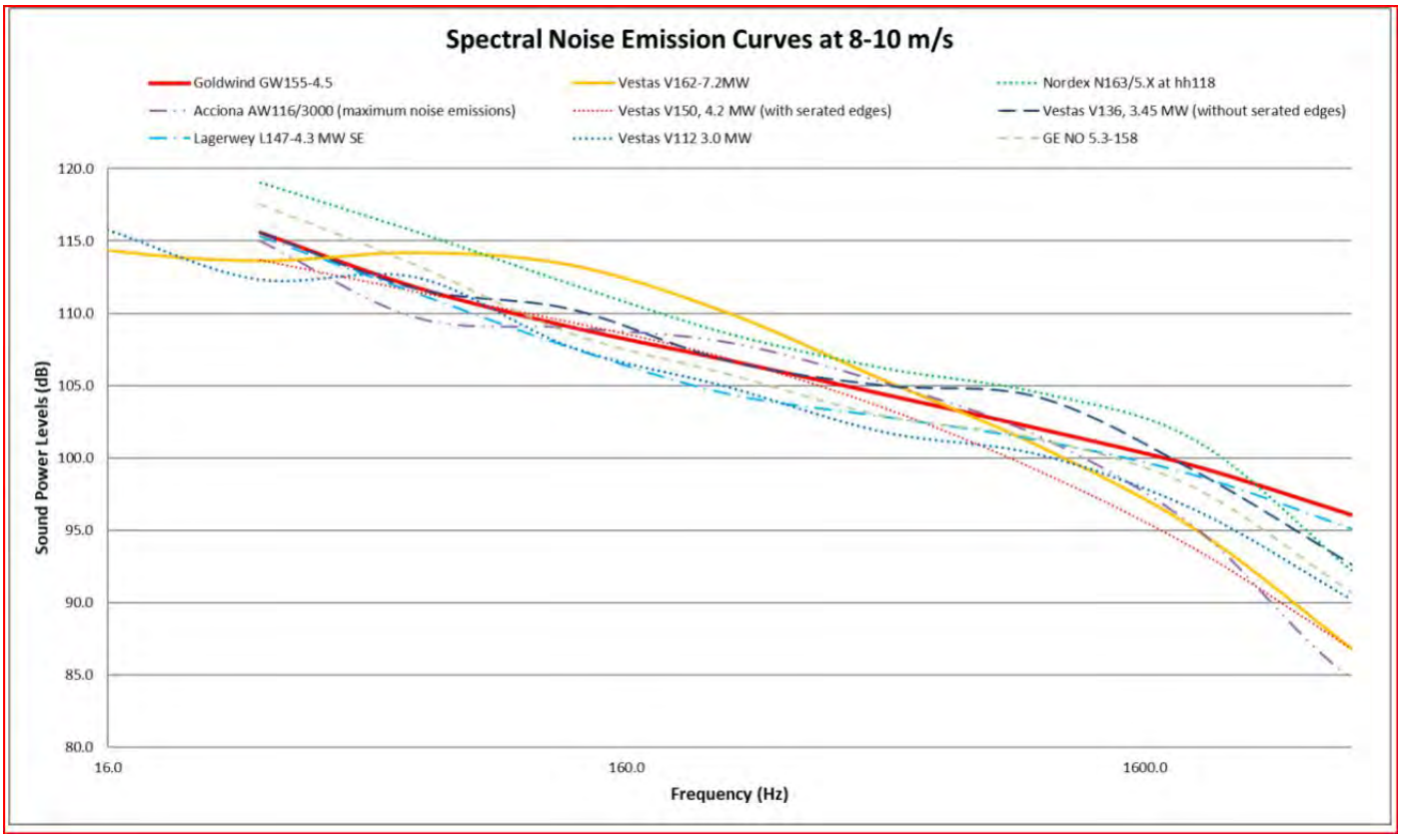
1. Self-noise due to the interaction of the turbulent boundary layer with the blade trailing edge.
2. Noise due to inflow turbulence (turbulence in the wind interacting with the blades).
3. Discrete frequency noise due to trailing edge thickness.
4. Discrete frequency noise due to laminar boundary layer instabilities (unstable flow close to the surface of the blade).
5. Noise generated by the rotor tips.

Therefore, as the wind speed increases, noises created by the wind turbine also increase. At a low wind speed the noise created by the wind turbine is generally (relatively) low, and increases to a maximum at a certain wind speed when it either remains constant, increase very slightly or even drops.



Noise Emissions Curve of a number of different wind turbines

The propagation model also makes use of various frequencies, because these frequencies are affected in different ways as it propagates through air, over barriers and over different ground conditions providing a higher accuracy than models that only use the total sound power level.



Octave sound power emissions of various wind turbines

Noise from Mechanical sources

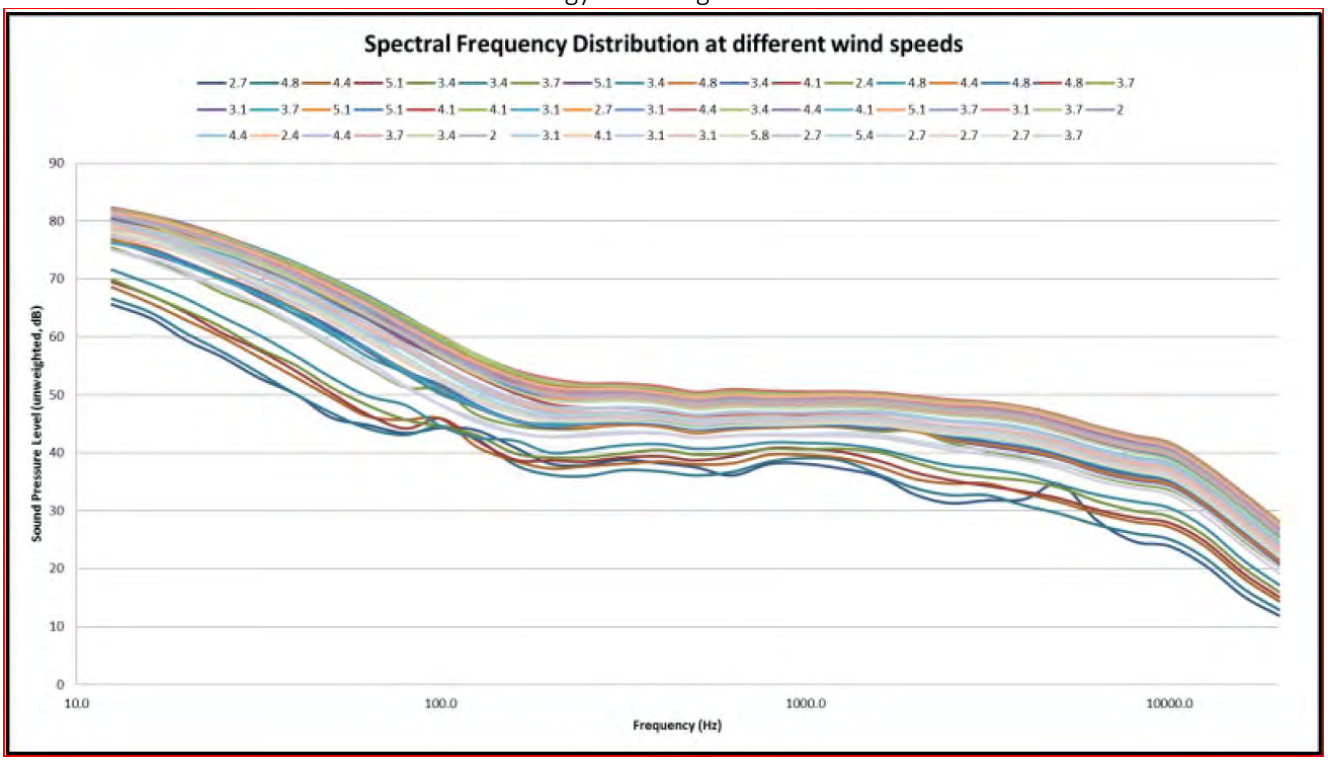
Mechanical noise is normally perceived within the emitted noise from wind turbines as an audible tone(s) which is subjectively more intrusive than a broad band noise of the same sound pressure level. Sources for this noise are normally associated with:

- the gearbox and the tooth mesh frequencies of the step-up stages;
- generator noise caused by coil flexure of the generator windings which is associated with power regulation and control;
- generator noise caused by cooling fans; and
- control equipment noise caused by hydraulic compressors for pitch regulation and yaw control.

Tones are noises with a narrow sound frequency composition (e.g., the whine of an electrical motor). Annoying tones can be created in numerous ways: machinery with rotating parts such as motors, gearboxes, fans and pumps often create tones. An imbalance or repeated impacts may cause vibration that, when transmitted through surfaces into the air, can be heard as tones. Pulsating flows of liquids or gases can also create tones, which may be caused by combustion processes or flow restrictions. The best and most well-known example of a tonal noise is the buzz created by a flying mosquito.

Noise from Low Frequency Noise

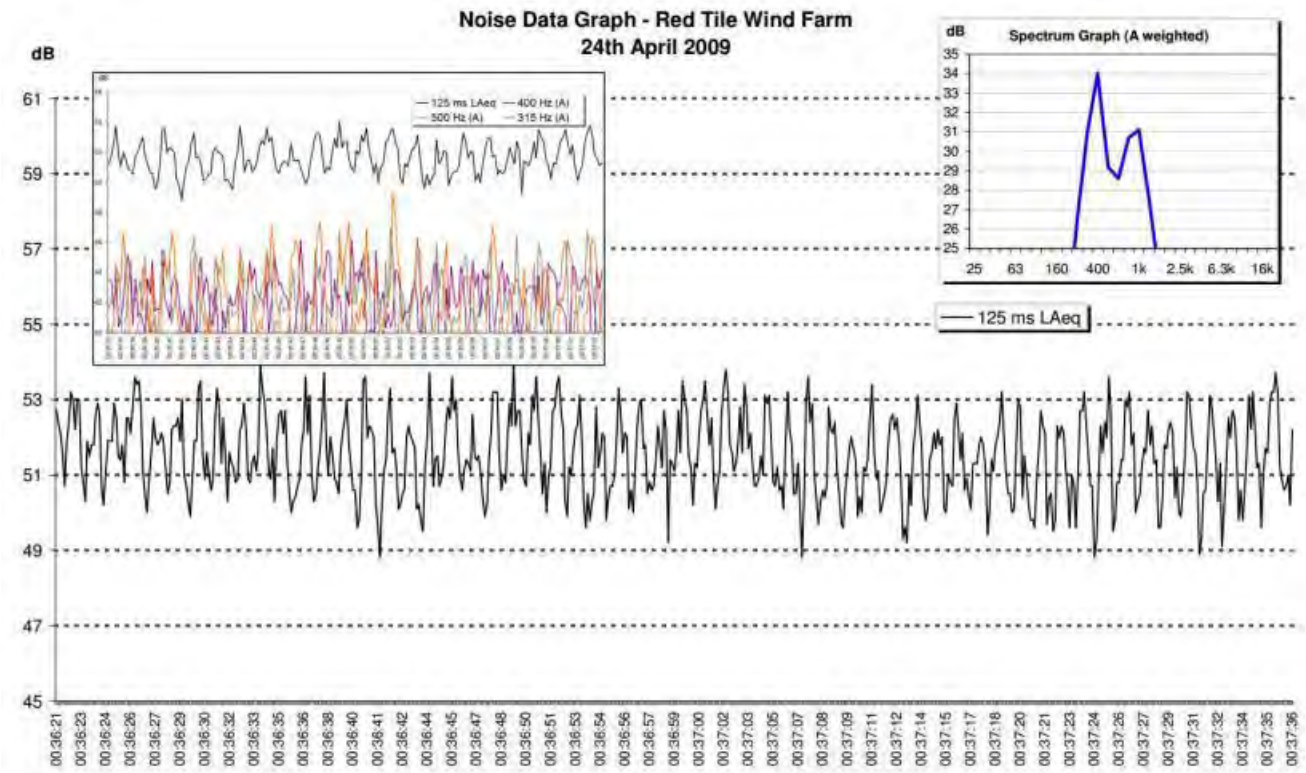
Low frequency sound is the term used to describe sound energy in the region below ~200 Hz. The rumble of thunder and the throb of a diesel engine are both examples of sounds with most of their energy in this low frequency range. Infrasound is often used to describe sound energy in the region below 20 Hz.



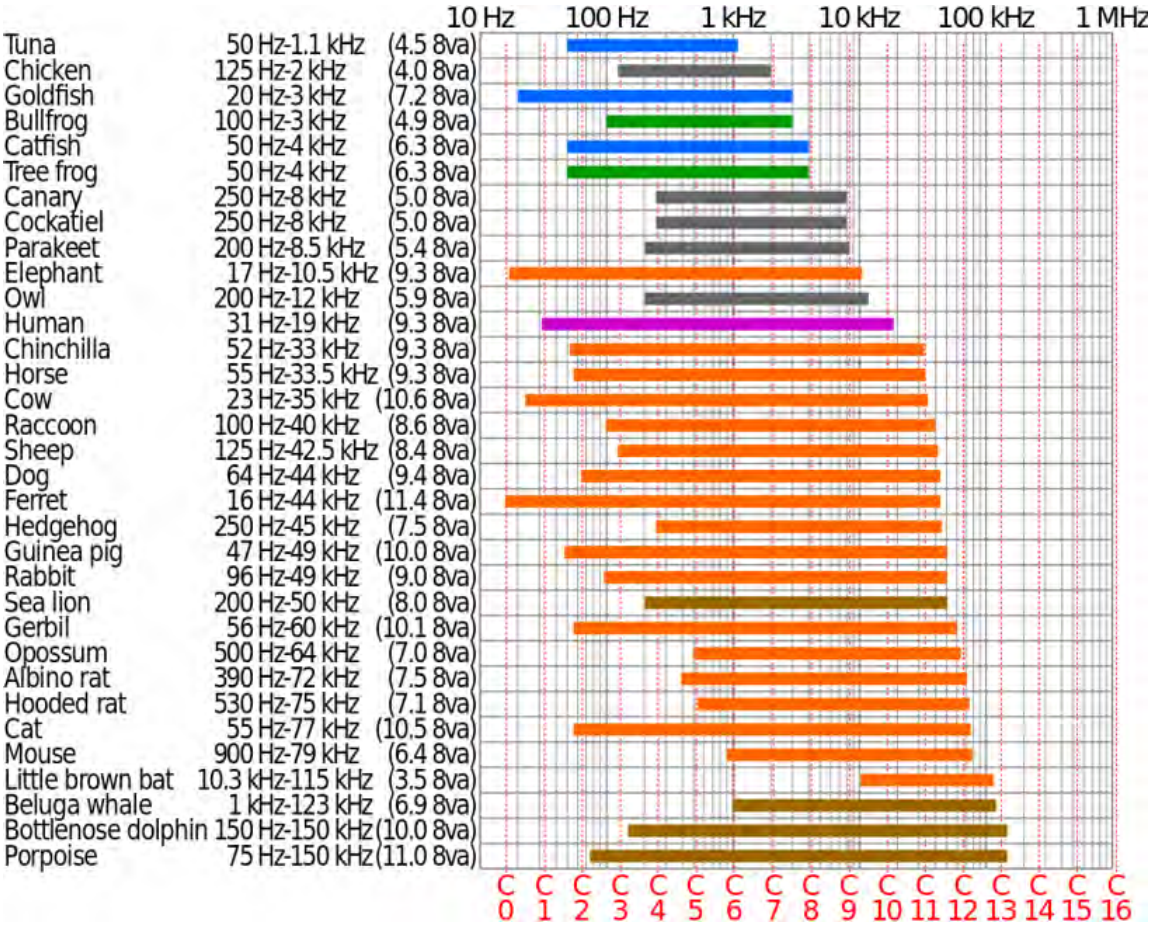
Third octave band sound power levels at various wind speeds at a location where wind induced noises dominate

Noise from Amplitude modulation

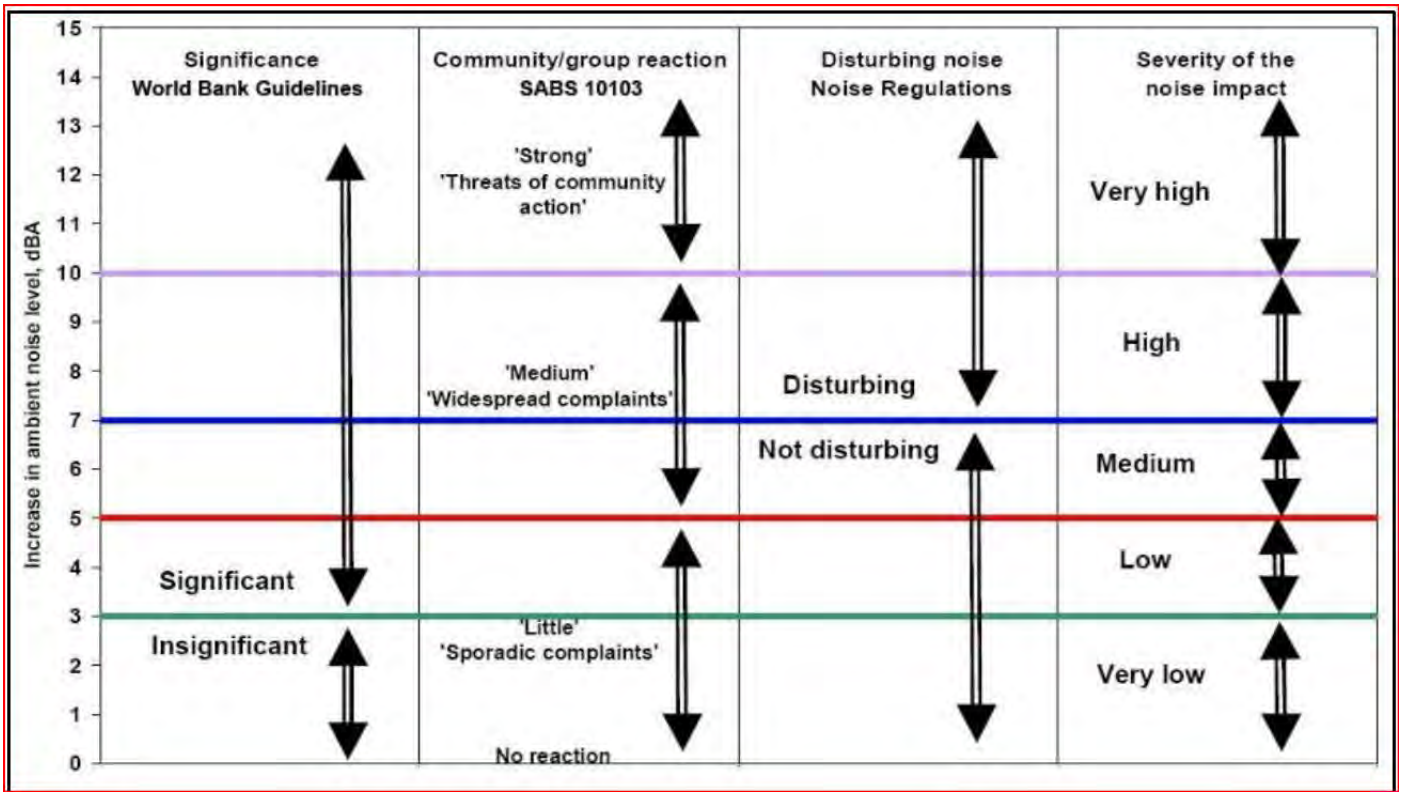
The amplitude modulation (AM) of the sound emissions from the wind turbines creates a repetitive rise and fall in sound levels synchronized to the blade rotational speed, sometimes referred to as a “swish” or “thump”.



Example time-sound series graph illustrating AM as measured by Stigwood (2013)



Logarithmic Chart of the Hearing Ranges of Some Animals



Criteria to assess the significance of impacts stemming from noise

1	2	3	4	5	6	7
Type of district	Equivalent continuous rating level ($L_{Req,T}$) for noise dBA					
	Outdoors			Indoors, with open windows		
	Day/night $L_{R,dn}$ [a]	Daytime $L_{Req,d}$ [b]	Night-time $L_{Req,n}$ [b]	Day/night $L_{R,dn}$ [a]	Daytime $L_{Req,d}$ [b]	Night-time $L_{Req,n}$ [b]
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts with one or more of the following: workshops; business premises; and main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

Acceptable Zone Sound Levels for noise in districts (SANS 10103:2008)

Reference Number 4.21:

Laboratory Validation of 3D Model and Investigating Its Application to Wind Turbine Noise Propagation over Rough Ground James Naylor and Qin Qin. Wind 2024, 4, 363–375. https://doi.org/10.3390/wind4040018 https://www.mdpi.com/journal/wind

In an investigation into how wind turbine noise interacts with the surrounding terrain, its propagation over rough ground is simulated using a parabolic equation code using a modified effective impedance model, which

characterizes the effects of a three-dimensional, rigid roughness within a relatively long wavelength limit (ka ≤ 1). The model is validated by comparison to experiments conducted within an anechoic chamber wherein different source–receiver geometries are considered. The relative sound pressure level spectra from the parabolic equation code using the modified effective impedance model highlight a sensitivity to the roughness parameters. At a low frequency and far distance, the relative sound pressure level decreased as the roughness coverage increased. A difference of 4.9 Db has been reported. The simulations highlight how the roughness shifts the ground effect dips, resulting in the sound level at the distance of 2 km being altered. However, only the monochromatic wave has been discussed. Further work on broadband noise is desirable. Furthermore, due to the long wavelength limit, only a portion of audible wind turbine noise can be investigated.

Large wind turbines are quite serious sources of noise, making the acoustic impact one of the major hindrances to the public's acceptance of the technology. Conclusions from a government-commissioned analysis of the current guidance for wind turbine noise control in the UK indicate that the current framework is outdated in light of the large volume of new research and technologies spanning decades after the initial publishing of the document.
Reviews on the effects of wind turbine noise indicate that, at a minimum, wind turbine noise is a cause for annoyance, and despite the levels being modest compared to other sources like traffic noise, the wind turbine noise seems more annoying.
This paper focuses on the reflections and scattering of the noise from the rough terrain that often surrounds wind turbines. It is well understood that roughness can have a significant effect on the propagation of sound, such that considering its effect in the context of wind turbine noise is worthwhile. It is valuable to understand how this noise propagates through the environment toward the homes of those living near wind turbines.

Reference Number 4.22:

Characterization of wind turbine noise using psychoacoustical indicators Manish Manohare, Eoin King, Eugene MC Keown. Proceedings of INTER-NOISE 2024

Wind energy is widely recognized as a promising source of renewable energy. However, the noise generated by wind turbines poses a significant concern for residents living in close proximity to these installations. The rotor blades of wind turbines emit noise levels ranging from 98 to 104 Db(A) at an average wind speed of 8m/s, translating to 33-40 Db(A) at a distance of 500 meters from dwellings. While these noise levels might not be considered problematic in comparison to road traffic or industrial noise, the distinctive swishing sound produced by wind turbines can be perceived as highly annoying by nearby residents due to its rhythmic modulation, primarily driven by the rotor blades. Extensive research has been conducted on the perception of wind turbine noise (WTN), with a focus on assessing the levels of annoyance and associated stress. Studies indicate that exposure to WTN levels exceeding 35 Db(A) can lead to increased annoyance and disturbances in sleep patterns. Consequently, regulations and standards have been established to guide acceptable levels of WTN, with parameters such as LA90 and Laeq (equivalent continuous noise level) being a primary consideration. These standards typically account for factors such as wind speed, noise-sensitive areas, and background noise levels. For example, in Denmark, maximum allowable WTN levels range from 42-44 Db in general and 37-39 Db in noise sensitive
areas with an average wind speed of 8 m/s].

Reference Number 4.23: WHO 2018 Evidence base

Based on the overall scope and key questions the current guidelines review the relevant literature in the area of environmental noise and health in order to incorporate significant research undertaken since the publication of previous guidelines. The process of evidence search and retrieval involved several steps. These include the identification, retrieval and synthesis of the evidence, followed by a systematic review and assessment (described in section 2.4).
2.3.1 Identification, retrieval and synthesis of evidence
As a first step, the GDG identified key health outcomes associated with environmental noise. Next, it rated the relevance of these health outcomes according to the following three categories:
• critical for assessing environmental noise issues
• important, but not critical for assessing environmental noise issues

• unimportant.
The GDG rated the relevance based on the seriousness and prevalence of the outcomes and the anticipated availability of evidence for an association with noise exposure. The following health outcomes were selected as either critical or important for developing recommendations on the health impacts of environmental noise.

Critical health outcome	Important health outcome
Cardiovascular disease	Adverse birth outcomes
Annoyance	Quality of life, well-being and mental health
Effects on sleep	Metabolic outcomes
Cognitive impairment	
Hearing impairment and tinnitus	

Reference Number 4.24 : Computational Modelling of the Effects of Rain on Wind Turbine Performance. Aishwerya Gahlot, Lakshmi Sankar Auraluck Pichitkul Suranaree. Proceedings of ASME Turbo Expo 2022 Turbomachinery Technical Conference and Exposition GT2022 June 13-17, 2022, Rotterdam, The Netherlands GT2022-82500

Wind turbines often operate under misty or rainy conditions. There is a considerable body of experimental evidence on the adverse effects of rain on wind turbine power production. Physical understanding of these effects, guided by quantitative modelled, is necessary to fully understand the effects of rain power production.

2-D viscous flow simulations are presented for a representative wind turbine airfoil for several angles of attack under wet and dry conditions. Regression fits of these drag polars have been used in a combined blade element- momentum analysis for the NREL Phase VI rotor. The calculations indicate a loss of 30% to 40% in power production, attributable to rain, over a range of wind speeds

Moisture and rain cause two noticeable effects on wind turbine performance – surface erosion, and deterioration of aerodynamic performance caused by the formation of a water layer over the rotor surface.

There are several hypotheses that may be proposed for the loss of airfoil performance while operating in rain, as measured by the lift-to-drag ratio:

1. As stated earlier, erosion of the blade surface may trip the boundary layer and cause the blade section drag to dramatically increase, even though the blades were designed using laminar flow airfoils. This effect is modelled by some researchers by tripping the boundary layer at user-specified locations in the vicinity of the blade leading edge, within a Reynolds Averaged Navier-Stokes analysis or an interactive boundary layer analysis. In the present study, the flow is assumed to be fully turbulent.
2. Secondly, the wavy surface of the thin water film over the airfoil may trigger the transition in a manner similar to surface roughness. This would require a more sophisticated analysis that accurately resolves the interaction between the water layer and the external airflow. Verification of this hypothesis has not been attempted in the present study.
3. Thirdly, the extra displacement thickness of the water layer over and above the aerodynamic boundary layer, and the loss of airflow momentum caused by the Stokes reaction forces exerted by water droplets on the airflow, would substantially alter the pressure field over the airfoil. An interactional aerodynamics numerical simulations liking the water droplet transport to the aerodynamic flow would allow this hypothesis to be tested. This is the approach used in this study.

As stated earlier, exposure to rain over a period of time would cause erosion of the blade surface causing the flow to be turbulent even under dry conditions.

As expected, there is some deterioration in power production when the airfoil is assumed to be rough, caused by the increase in sectional drag in a fully turbulent flow. It is also seen that the power production for the wet rotor is well below the values for the dry rotor. At 9 m/s, the highest speed modelled using the Blade Element Momentum (BEM) analysis, the baseline rotor with laminar flow airfoil data generates 9.1 KW of power, while the wet rotor generates only 6.6 KW of power, a 25% loss in power.

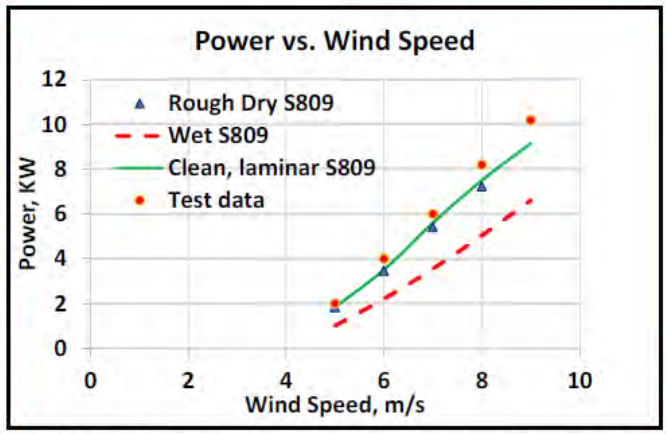


FIGURE 12. EFFECT OF SURFACE ROUGHNESS AND RAIN ON NREL PHASE VI ROTOR PERFORMANCE

Reference Number 4.25: Vesta documents showing that effects of rain on power curves are not considered.

RESTRICTED

Document no.: 0067-7063 V01
Document owner: Platform Management
Type: T05 - General Description

Performance Specification V117-4.0/4.2 MW 50/60 Hz
Operational Envelope and Performance Guidelines

Date: 2017-07-10
Restricted
Page 6 of 15

3.3 Operational Envelope – Conditions for Power Curve and Ct Values (at Hub Height)

Consult Section 6, p. 10 for power curves and C_t values.

Conditions for Power Curve and C_t Values (at Hub Height)	
Wind Shear, *α*	0.00-0.30 (10 minute average)
Turbulence Intensity, *I*	6-12% (10 minute average)
Blades	Clean
Rain	No
Ice/Snow on Blades	No
Leading Edge	No damage
Terrain	IEC 61400-12-1
Inflow Angle (Vertical)	0 ±2°
Grid Voltage	Nominal Voltage ±2.5%
Grid Frequency	Nominal Frequency ±0.5 Hz
Grid Active Power (at LV-side of turbine transformer)	As per tabulated values in Sections 6 and 7
Grid Reactive Power (at LV-side of turbine transformer)	Power Factor 1.0

Table 3-4: Conditions for power curve and Ct values

Reference number 4.26

Mapping of Meteorological Observations over the Island of Ireland to Enhance the Understanding and Prediction of Rain Erosion in Wind Turbine Blades JamesW. K. Nash, Iasonas Zekos and Margaret M. Stack

One of the most prevalent factors is the presence of rain and the subsequent rain erosion of the leading edge of wind turbine blades. Damage caused by impacts from other projectiles, including hail, sand insects and birds, also contributes to the degradation. However, they are less understood and particularly site specific, with early research on

hail erosion displaying little erosion damage, insects preferring warm humid air for flight, sand being mainly present in dry, arid areas or certain coastal sites and turbine siting and development aiming to minimise bat or bird strikes. Extreme weather and rainfall have increased over recent years in northern latitudes. With the increasing size of turbines and therefore tip speed, one can assume that rain erosion is set to become a dominating issue for the sector, highlighting the need to find a solution. In some cases, severe erosion can occur in as little as 2 years.

Typically, the leading edge of a wind turbine blade is protected using some form of polymeric coating or tape, referred to as a leading-edge protection system (LEP). LEPs are susceptible to environmental conditions during erosion. Temperature sensitivities are particularly common in polyurethane (PU) coatings, with their low glass transition temperatures. In recent solid particle erosion tests, PU coatings have exhibited varying erosion behaviours at a range of temperatures (30–100 _C). This performance is largely dependent on coating composition and, although some of the temperatures used were outside of typical operational values during rain events, these results exemplify their temperature sensitivities. Thermal cycling and ageing can also affect mechanical properties, further highlighting the need to understand the impact conditions.

During rain events, the relative humidity is often high. This atmospheric moisture can interact with polymers to a varying degree. Degradation from humidity fluctuations through water ingress and hydrolysis can temporarily or permanently change mechanical properties. Hydrothermal ageing is well documented too within pure composites. However, to the authors acknowledge, there have been no investigating the influence of humidity or hydrothermal ageing. Furthermore, as wind turbine blade surfaces contain two or more different polymers (at least one LEP layer and the composite), even if the top layer is not affected by humidity, another LEP layer or the composite beneath may potentially absorb water, leading to swelling, which could delaminate or fatigue the interface between layers.

Impurities in rain can also lead to chemical reactions and, with the prevalence of acid rain in northern Europe and sea salt aerosols in coastal and offshore sites, this contribution to the erosion process requires further investigation. In northern Europe, sulphuric and nitric acids are the most common, typically from burning fossil fuels or agricultural sources, respectively. Sea salt aerosols are predominantly composed of chloride (Cl^-), sodium (Na+), sulphate ($SO2^{4-}$), magnesium (Mg2+), calcium (Ca2+), and potassium (K^-). Salt concentrations are typically much higher than acidic pollutants and are of interest in situations where materials (including polymers) are prone to corrosion. Recent evidence suggests enhanced degradation due to the presence of sea salt, acidity or at sites in close proximity to quarries. The influence of salt will be more pronounced at sites near the coast or offshore. Exposure to other pollutant concentrations, such as particulate matter and air pollution, is irregular, site specific and changes over time in relation to the pollution from factories, vehicles and other sources. Without the appropriate data, addressing these other pollutant influences becomes difficult.

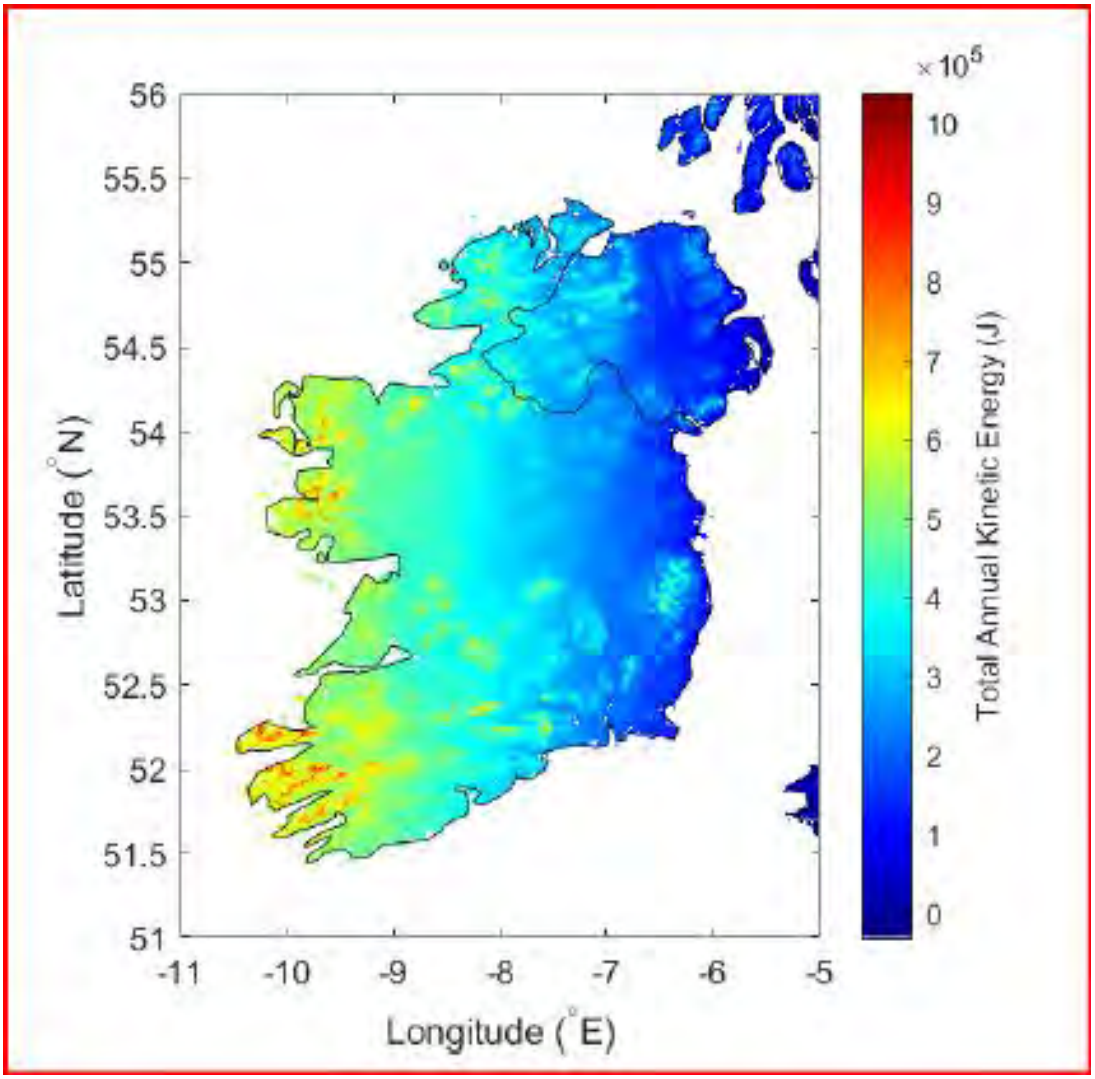


Figure. A total annual kinetic energy map of the island of Ireland.

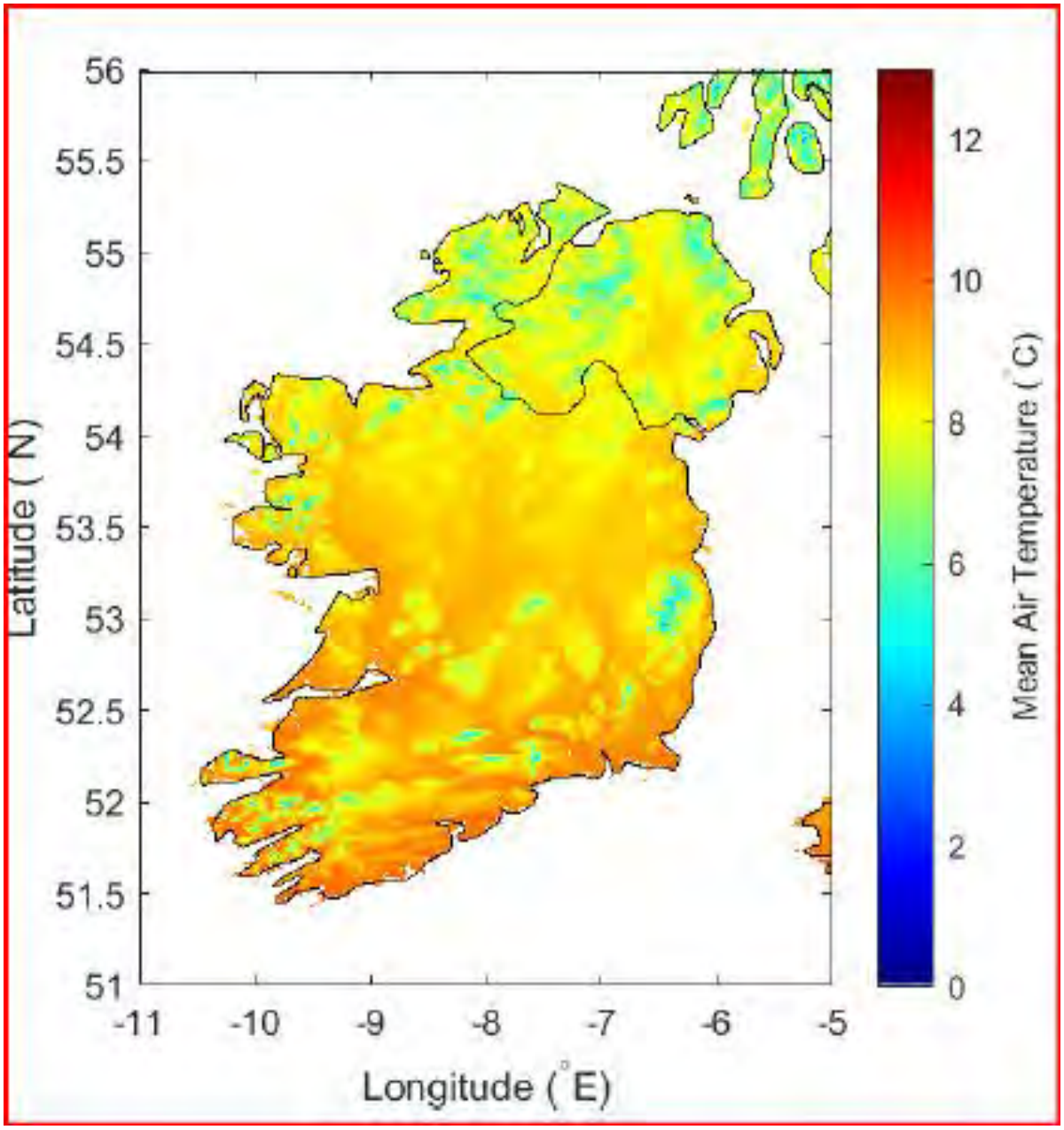


Figure. A mean air temperature map of the island of Ireland

Temperature strongly influences the mechanical properties of temperature sensitive polymers. Impacts generating localized heating and fluctuations in air temperature during rainfall may well lead to accelerating the aging process. As discussed by Pugh et al., Polymeric materials typically used as coatings may have glass transition temperatures in the range of 0–30 _C. In practice, this means the behaviour of coatings will change over the operational range of a wind turbine.

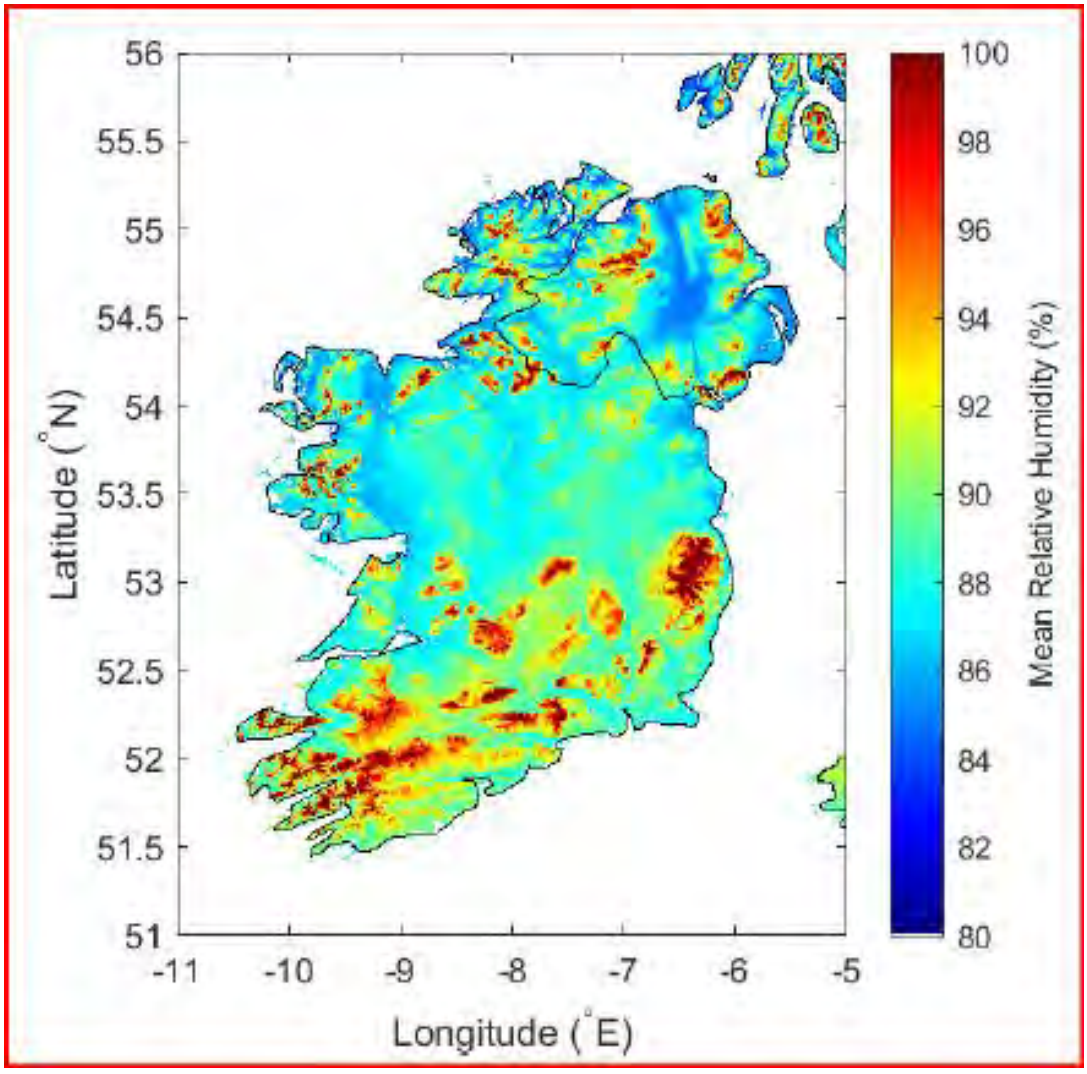


Figure. A mean relative humidity map of the island of Ireland

During impacts from projectiles, heat is generated in the target material. Humidity can enhance the heat transfer from materials into the surrounding air, influencing the erosion process, particularly with high impact rates. Humidity is a problem for polymers, causing degradation through hydrolysis and water ingress. This process can be catalysed by salts, reducing the mechanical properties of wind turbine blade materials and enhancing erosion damage. Seasonal variations in both rain kinetic energy, temperature, humidity and chemical composition indicate that erosion occurs differently depending on the time of year.

Rainfall amounts are significantly reduced in the summer and enhanced in the winter in terms of rain events. Rainfall intensities peak in the summer; however, this is usually with suboptimal wind speeds. The majority of rainfall intensities are low and, according to the analysed data, rated speed, high intensity events, at >10 $mmhr^{-1}$, are unlikely to occur, especially in winter. At rated speed, temperatures and humidities are often much lower during winter than summer, which will influence material performance. Sea salt aerosols are much more prevalent during winter months, which, when combined with the decreased humidity at rated speeds, could lead to increased depositions and therefore enhance damage processes. The results here indicate that the erosion process is much more severe during winter.

All of these erosion issues increase friction & noise

Reference Number: 4.27

Eolization 2024 : A project on spatial auralization of wind farm noise Jules Colas, Loïc Alexandre. INTER-NOISE and NOISE-CON Congress and Conference Proceedings · October 2024 DOI: 10.3397/IN_2024_4225

Results

First, the results from the propagation simulations are briefly presented for the scenarios studied. In Fig. , the overall sound pressure level (OASPL) fields average over one rotation are plotted in the plane z = 2 m for the two cases. For a single wind turbine (Fig. 5a), the OASPL presents a dipolar shape which is characteristic of a wind turbine. Cross-wind extinction zones (on the line x = 1500 m) and an upwind shadow zone (x < 1000 m) are observed and a small focusing induced by the wake downwind (x > 2000 m) is also discernable. When two wind turbines are present (Fig. 5b) the same features are present but superimpose on each other. No additional refraction patterns that could be induced by the wake of the turbines are visible in this case. The average OASPL is typically low in wind turbine noise application and amplitude modulation (AM) must also be considered as it is responsible for annoyance at resident locations. Fig. 6a shows the AM field at z = 2 m for one wind turbine. AM is defined as the difference between minimum and maximum OASPL computed during one rotation of the rotor. For the single wind turbine case some classical features are again recovered with this method. In the cross-wind direction (x = 1500 m) high amplitude modulation is found due to the blade approaching and receding from the receiver. Upwind, at the limit of the shadow zone (x = 1000 m), AM also increases as already shown by various authors [11, 19]. AM also increases downwind (x > 3000 m) due to the wake effect [14, 20]. As sound sources move inside the wake the refraction pattern is modified and the amplification at the ground changes. The same features are present in the two wind turbine case (Fig. 6b) but AM decreases slightly downwind and crosswind because of the source superposition.

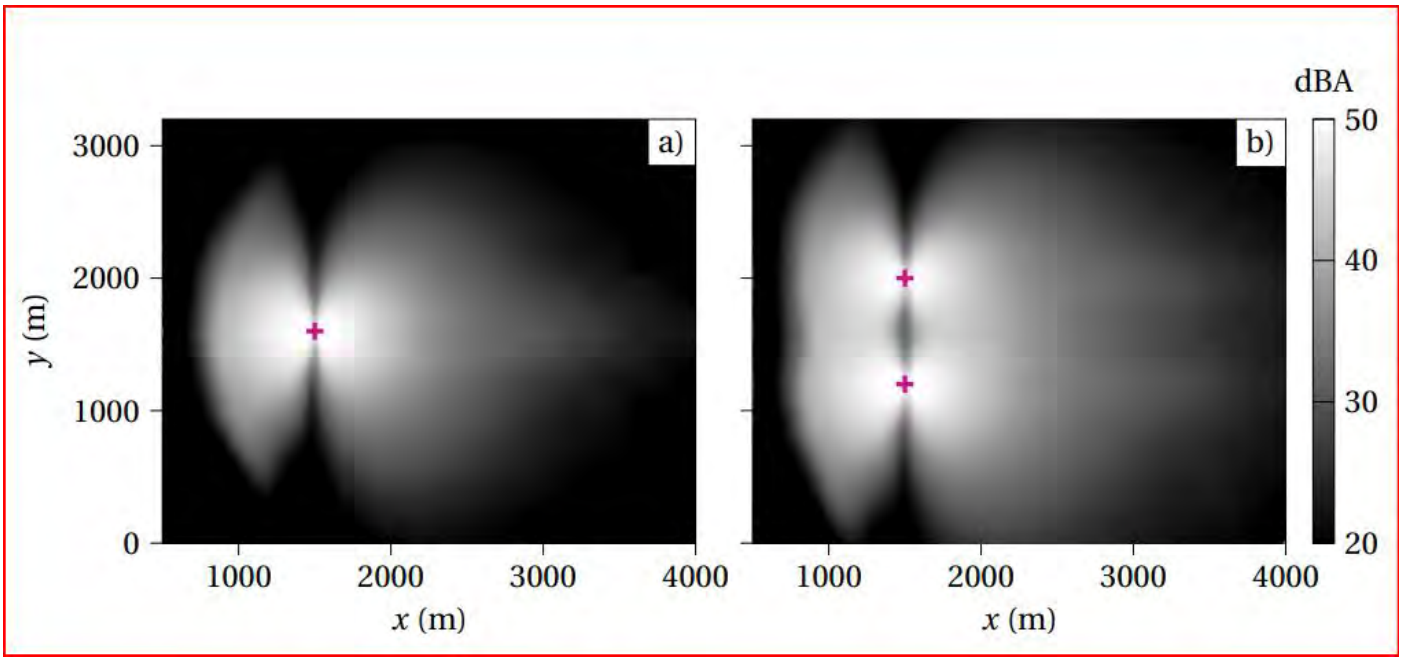


Figure 5 : Average OverAll Sound Pressure Level (ASPL) over one rotation at z = 2 m for a) single wind turbine case and b) two wind turbine cases. Wind turbine hub positions are indicated with crosses.

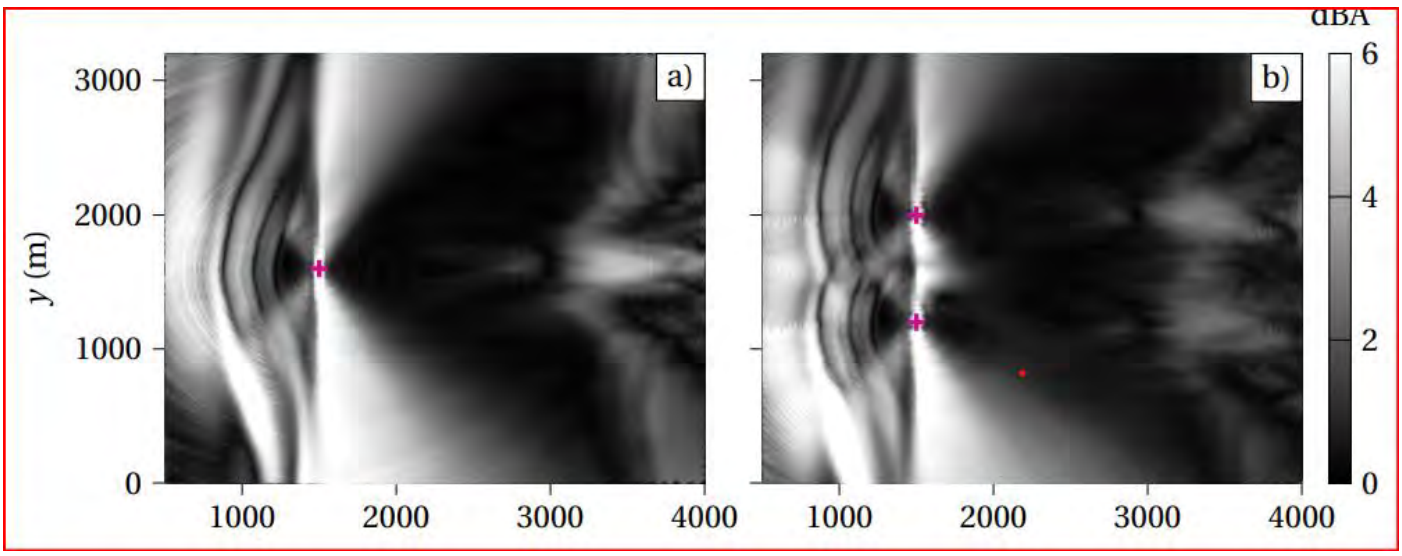


Figure 6: AM at z = 2 m for a) single wind turbine case and b) two wind turbine case. Wind turbine positions are indicated with crosses. and (x, y) = (2500 m,1600 m) for the two scenarios considered.

Reference No. 4.28: Characterizing the Wake Effects on Wind Power Generator Operation by Data-Driven Techniques. Astolfi, D.; De Caro, F.; Vaccaro, A., Energies 2023, 16, 5818. https://dx.doi.org/10.3390/en16155818

Wake interactions between nearby wind turbines represent the most important cause of producible energy loss in an operating wind farm. It is well known that the wind intensity downstream of a rotor gets reduced and that, **if nearby wind turbines are not sufficiently spaced**, the velocity deficit does not completely recover, thus affecting power production. In particular, on the one hand for offshore installations, it is convenient to maintain the layout of a wind farm as sufficiently compact to reduce Operation and Maintenance (OandM) costs but, on the other hand, if the layout is too compact the wake losses might reach 10–20% of the Annual Energy Production (AEP)

Reference No. 4.29: Auditory and non-auditory effects of noise on health. The Lancet. Volume 383, Issue 9925p1325-1332April 12,-2014
Dr Mathias Basner, MD basner@upenn.edu, Wolfgang Babisch, PhD, Prof Adrian Davis, PhD, Mark Brink, PhD, Char lotte Clark, PhD, Sabine Janssen, PhD, Prof Stephen Stansfeld, PhD.

Noise is pervasive in everyday life and can cause both auditory and non-auditory health effects. Noise-induced hearing loss remains highly prevalent in occupational settings, and is increasingly caused by social noise exposure (eg, through personal music players). Our understanding of molecular mechanisms involved in noise-induced hair-cell and nerve damage has substantially increased, and preventive and therapeutic drugs will probably become available within 10 years. Evidence of the non-auditory effects of environmental noise exposure on public health is growing. Observational and experimental studies have shown that noise exposure leads to annoyance, disturbs sleep and causes daytime sleepiness, affects patient outcomes and staff performance in hospitals, increases the occurrence of hypertension and cardiovascular disease, and impairs cognitive performance in schoolchildren. In this Review, we stress the importance of adequate noise prevention and mitigation strategies for public health.

The effects on public drinking water, sandstone surface from:

a) The erosion of microplastics from the wind turbine blade coatings & discharge into aquifer is not included. Blades from a 4.2MW turbine could emit 62kg of microplastic material annually,
b) Suspended Solids from excavation, cable installation, road works during construction, is not included
c) Cement contamination of groundwater,
d) Release of Hydrocarbons,
e) Release of Wastewater,
f) The effect of vibration on the sandstone is not addressed.
g) The effect of excavation with the use of explosives or pile drilling on the groundwater is not addressed.
h) The potential collapse of underground conduits from vibration & the weight of the foundations plus turbines is not considered.
i) The use of detergents to wash insect detritus off the blades is not considered.

3) The seismic effects & infrasound from the sandstone vibrating is not addressed.

Reference Number 5.1:
Wind farms and groundwater impacts, A guide to EIA and Planning considerations, Version 1.1 / April 2015. Northern Ireland Environment Agency

Why is it important to protect groundwater?

Groundwater has three major uses in Northern Ireland:

- *Abstractions for agricultural and industrial purposes, food and beverage production (including bottled water);*
- *Public and private drinking water supply; and*
- *Maintenance of flow and water levels in rivers, lakes and wetlands, particularly during times of low rainfall.*

The protection of groundwater from the risk of possible contamination is important because pollutants could cause health problems in human beings, reduce the quality of agricultural products, make water unsuitable for certain industrial processes, and pose a threat to our countryside and environment including their suitability for recreational purposes. In summary, the contamination of groundwater can not only have health and environmental impacts, but also serious economic consequences.

What impact can a wind farm have on groundwater?

The development of a wind farm has the potential to impact on groundwater quality, groundwater quantity and/or the established groundwater flow regime. Figure 1 overleaf shows the scale and extent of the foundation of a single wind turbine which could potentially impact on the aquatic environment. Changes to the local water environment can affect receptors such as wells/boreholes, springs, wetlands and waterways, and can also have implications for groundwater dependent ecology and/or land stability

Potential impacts on groundwater from wind farms.

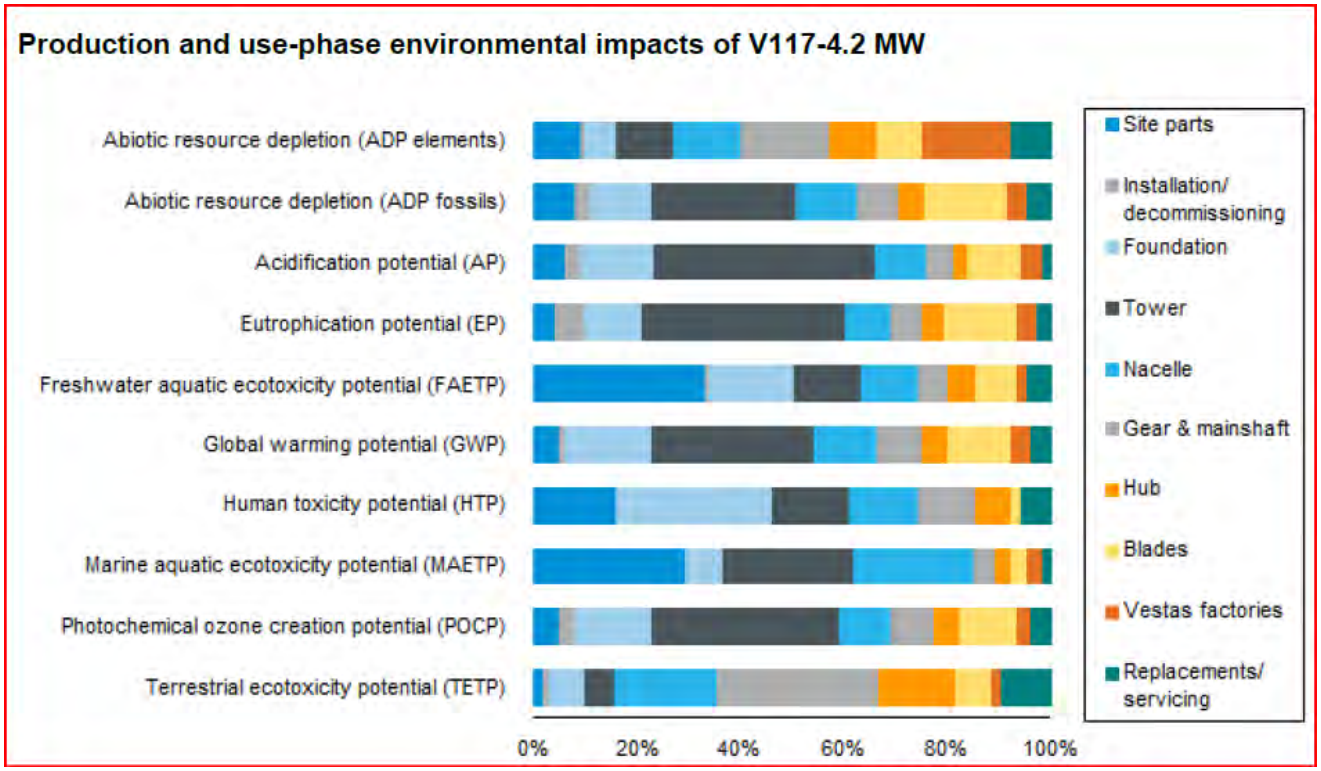
	Construction Phase	Operational Phase	Decommissioning Phase
Groundwater Flow Regime	**Earthworks and site drainage:** ▪ Reduction in water table if dewatering is required for turbine foundation construction or borrow pits; ▪ Changes to groundwater distribution and flow.	**Physical presence of turbines and tracks:** ▪ Possible changes to groundwater distribution; ▪ Reduction in groundwater storage. **Reduction of forestry in site area:** ▪ Changes to infiltration and surface runoff patterns, thereby influencing groundwater flow and distribution.	**Physical presence of former turbines and tracks:** ▪ Possible changes to groundwater distribution; ▪ Reduction in groundwater storage.
Groundwater Quality	**Earthworks:** ▪ Disturbance of contaminated soil and subsequent groundwater pollution. **Materials Management:** ▪ Pollution from spills or leaks of fuel, oil and building materials.	**Materials Management:** ▪ Pollution from spills or leaks of fuel or oil.	**Use of vehicles and machinery to remove infrastructure:** ▪ Pollution from spills or leaks of fuel or oil.

Reference Number 5.2: Life cycle assessment of electricity production from an Onshore V117-42MW wind plant. Priyanka Razdan, Peter Garrett Version: 1.1 Date: 01.11.2019

Whole-life environmental impacts of V117-4.2 MW plant (shown in g, mg or MJ per functional unit of 1kWh)

Environmental impact categories:	Unit	Quantity
Abiotic resource depletion (ADP elements)	mg Sb-e	0.05
Abiotic resource depletion (ADP fossils)	MJ	0.06
Acidification potential (AP)	mg SO2-e	16
Eutrophication potential (EP)	mg PO4-e	2.0
Freshwater aquatic ecotoxicity potential (FAETP)	mg DCB-e	33
Global warming potential (GWP)	g CO2-e	4.4
Human toxicity potential (HTP)	mg DCB-e	3857
Marine aquatic ecotoxicity potential (MAETP)	g DCB-e	553
Photochemical oxidant creation potential (POCP)	mg Ethene	1.3
Terrestrial ecotoxicity potential (TETP)	mg DCB-e	29

Note: impact indicators are based on CML impact assessment method Version 2016 (CML, 2016)



Sulphur hexafluoride (SF6) gas

Sulphur hexafluoride is a very potent greenhouse gas which is used in switchgears for medium- and high-voltage applications. The gas acts as an electrical insulator for the operation of the switchgear. Each turbine contains switchgear, and they are also used onsite for connecting the turbines and transformer substation. For the switchgear application this usually only becomes an issue if the gas is released into the environment during a blow-out. Occurrences of blow-outs are extremely rare and have not been modelled in this study. During normal operation the turbine switchgear may potentially release up to 0.1% w/w of the sulphur hexafluoride per year, accounting for a potential 2% w/w total release over 20 years of operation. The potential effect of a blow-out is assessed in the sensitivity analysis, as shown in Section 6.7.

At end-of-life the switchgears are collected, and the sulphur hexafluoride gas is reclaimed for reuse in new equipment. Vestas has established procedures and is working in partnership with customers and suppliers to assure the safe disposal of switchgears used in Vestas power plants. Based on supplier data it is estimated that a maximum of 1% w/w of the SF6 gas may be released to atmosphere during the reclamation and recycling process at end-of-life. Vestas estimates that 95% of all switchgears will be returned for reclamation at end-of-life. The remaining 5% are assumed to have all the sulphur hexafluoride gas released to atmosphere at end-of-life.

Reference number 6.1:
The High Court [2024] IEHC 136 [2018 8457 P] Margaret Webster & Keith Rollo v Meenacloghspar (Wind) Ltd
Phase 2 of the High Court proceedings will deal with compensation.

From page 164 in HC Decision:

Issue 12: Are Mr. Rollo and Ms. Webster entitled to an award of damages for personal injuries?

I am satisfied on the balance of probabilities that Mr. Rollo has suffered personal injury in the form of a recognisable psychiatric illness. I also find that this injury was caused by the sleeplessness caused by the WTN, and so caused by the nuisance in suit.

From page 174 in HC Decision:

The question of whether damages for personal injury were recoverable for the tort of private nuisance does not appear to have been argued in Hanrahan. It will fall to the Supreme Court in an appropriate case to consider whether, as a matter of principle, damages for personal injuries should be awarded for a property based tort. However, one can say that the outcomes of Hanrahan and Patterson suggest that the answer to this question is in the affirmative. It seems that such general damages can include compensation for loss of amenity, property damage, damage to capital value, loss of rent, temporary relocation costs, damage to human, animal health and plant life, damages for diminution in enjoyment, (which can include e.g. sleeplessness, lack of ability to rest and enjoy the property and mental distress

The Precautionary Principle applies to such health issues & Planning Permission must be refused.

Reference Number 6.2:
Victorian Supreme Court in *Uren v Bald Hills Wind Farm Pty Ltd* [2022] VSC 145 (Uren)

Key takeouts

(i) The loss of amenity for a surrounding landowner due to wind turbine noise can form the basis of a successful claim in private nuisance. This is the first time a successful claim has been made on these grounds against a wind energy facility operator in Australia.

- *Correctly understanding and applying applicable noise standards is a critical component of managing overall legal risk. For the first time, judicial guidance has been provided on how to interpret and apply various aspects of a noise standard that is applicable in Victoria.*

- *Compliance with applicable noise standards will reduce, but not eliminate, all legal risk. Additional risk mitigation strategies may also be required, such as developing social licence to operate, using neighbour agreements, properly interrogating consultant reports, independently verifying regulator statements of compliance, and appropriately responding to landowner complaints.*

A recent decision of the Victorian Supreme Court in Uren v Bald Hills Wind Farm Pty Ltd [2022] VSC 145 (Uren) relating to wind turbine noise has a number of significant implications for the wind industry.

In February 2020, two neighbouring residents to the Bald Hills wind farm commenced proceedings in the Supreme Court against the wind farm operator, alleging private nuisance. A successful claim in private nuisance requires a substantial and unreasonable interference with a person's use or enjoyment of their land.

Extensive evidence was given on both sides in relation to these issues, but ultimately the Court decided that noise from certain wind turbines at the wind farm caused a substantial, albeit intermittent, interference with both plaintiffs' use and enjoyment of their land. The Court ordered:

- *an injunction preventing the wind energy facility (WEF) operator from continuing to permit noise from certain wind turbines at night and to take necessary measures to abate the nuisance;*
  and

- *payment of $260,000 to the plaintiffs, which included an award of aggravated damages.*

Even if Bald Hills had been able to establish compliance with the noise conditions in the permit at the plaintiffs' houses, this would not have been determinative of reasonableness. The noise limits under the permit and the Environment Protection Regulations are at the higher end of the range applied in Australia. Significantly, while the NZ Standard and condition 19(a) limit the extent to which continuous underlying noise levels are increased by wind turbine noise, they are not directed to intermittent loud noise from wind turbines, and provide no means of determining whether a wind farm produces unreasonably annoying noise in certain weather conditions, or on a particular night … I would also have taken into account that it is a matter of judgment whether 40 Db or 35 Db is an acceptable noise limit for rural dwellings at night, and that Victoria is the only Australian state that has adopted the higher limit.

Reference Number 6.3:
Decision of the French Council of State No. 465036 of 8 March 2024

On 8 March, the French Council of State issued a historic decision by making illegal permits for onshore wind turbines and fleet renewal rules. In a statement, the Fédération Environment Durable *and fifteen associations, which had lodged the application, stated that "the Council of State has annulled all the provisions concerning the three successive versions of the noise nuisance protocol which is supposed to protect the health of local residents."*
Ongoing projects must start all over again

Projects under instruction or not yet built "require a complete environmental assessment", welcomes the Federation, while stating that "all wind farms built on the basis of now-illegal by-laws should normally no longer be allowed to operate as they are."
Beyond that, the Council of State noted that the ministerial noise measurement orders had not been subject to an environmental assessment, "which constitutes a violation of the law". He also stressed that decisions to approve the acoustic protocol "have not been subject to public participation, thereby violating the principles of participation and transparency."
Decision of the Council of State No. 465036 of 8 March 2024

Reference Number 6.4:
Commercial wind turbines and residential home values: New evidence from the universe of land-based wind projects in the United States Eric J. Brunner, Ben Hoen, Joe Rand, David Schwegman, Energy Policy21 September 2023
www.elsevier.com/locate/enpol

While the majority of U.S. studies have found small negative and insignificant effects of proximity to wind turbines on property values, the evidence from studies that use data from European countries typically finds that proximity to wind turbines reduces residential property values.

For example, using data from Denmark, Jensen et al. (2014) estimate that homes where residents can see a turbine decline in value by 3%, and these homes decline by an additional 2% if residents can hear the turbines when compared to those properties outside of visible or auditory range. They also find effects fade as distance increases.

Gibbons (2015) finds that English and Welsh homes with a visible wind energy project within 2 km experience approximately a 5%–6% decline in value relative to homes without a view and those located farther away.

From the Netherlands and using a difference-in-differences identification strategy, Droes and Koster (2016) find a 1.4% reduction in home prices for homes located within 2 km of a wind turbine with the effects being larger for homes located near turbines in urban areas and for larger turbines.

Similarly, using data from Germany, Sunak and Madlener (2016) and Sunak and Madlener (2017) find that turbine visibility and close proximity to wind turbines reduces residential home values by approximately 9%–20% respectively.

Jensen et al. (2018), Droes and Koster (2021) and Eichholtz et al. (2023), using data from Denmark, the Netherlands, respectively, find that close proximity to wind turbines reduces residential property values by between 3%, 6% and 7%.

The stark difference in findings between studies conducted in the U. S. and those conducted in Europe raises an important question: why do European studies nearly universally find that wind turbines reduce residential property

values (and in many cases by a considerable magnitude), while studies from the U.S. typically find small and statistically insignificant effects? While the existing literature provides no definitive answer to that question, there are several possibilities. First, the population density of Europe is approximately 3.5 times higher than that of the U.S. Furthermore, that figure represents average population density and most wind turbines in the U.S. are located in the less densely populated areas of the Midwest and Southwest. Thus, it is simply harder to site wind turbines farther away from residential locations in Europe than in the U.S. Second, and relatedly, European studies tend to have significantly more residential sale transactions in close proximity to a wind turbine. For example, Droes and Koster (2016) observe 149,939 transactions within 2 km of a wind turbine while in the largest U.S. study to date, Hoen et al. (2015) observe approximately 1200 homes within 1 mile of a turbine.

Reference Number 6.5:

Influence of onshore wind turbines on land values Jan von Detten, Johann V. Seebaß, Jan C. Schlüter, Florian Hackelberg. 4 May 2023. Springer . https://doi.org/10.1365/s41056-023-00067-5

The economic consequences of wind turbines on property prices and land values are a widely discussed political and social issue. In this study, in addition to the previous research on the impact of wind turbines on property prices, the influence of wind turbines on standard land values was examined for the first time. The study thus provides new insights, particularly with regard to the debate on distance areas and financial compensation payments for residents. The chosen investigated area is located in Northern Germany and comprises three coastal districts in the state Schleswig-Holstein with a total of 1382 land zones and a high density of wind turbines. Using ordinary least squares models, the significant influence of wind turbines on the standard land values could be shown within a radius of up to 9km. Using an exemplary municipality for the study area, an average change in the standard land value of 7.33% per 1000m distance could be determined. Overall, the standard land values of less densely populated areas were affected more than urban areas.

Jensen et al. (2018) examined around 40% of Denmark's total area in their study and found that, within a radius of 3km around a wind turbine, property prices are negatively influenced. In addition, they demonstrated a correlation between the number of wind turbines and the amount of price decrease. Studies from the Netherlands and England also found that the visibility of the plant has a decisive influence (Gibbons 2015; Dröes and Koster 2014). Gibbons (2015) found that properties with visible wind turbines within a radius of 2km have a 5–6% decrease in value. This effect depended largely on the height of the wind turbines. For Greece, Skenteris et al. (2019) applied various hedonic pricing models to evaluate the visual impact of wind farms on dwelling prices. Depending on their modelling setup, they found either no significant effects or a negative correlation within 2km radius. Westlund and Wilhelmsson (2021) found reductions in the value of Swedish properties in vicinity to wind turbines, which exponentially decrease in distance. Moreover, their results indicate that not only the sheer existence of such turbines but also their number and their height impacts value changes.

Sunak and Madlener (2016) took disturbing variables into account, the authors found that their difference-in-difference approach had a significant effect of 9–14% on the offer prices when a wind turbine has a clear visual impact on the property. The most recent study is provided by Frondel et al. (2019), who have evaluated more than 2.7 million offer prices over the years 2007 to 2015 using an OLS model. An average negative influence of 7.1% was found for properties located within one kilometre of a wind turbine. The influence decreases steadily up to a distance of 8–9km from the plant, after which no further effect could be determined. With up to 23.0%, wind turbines have a particularly high influence on the supply prices of old and rural properties, whereas no significant effect was observed in urban areas. The results of Sunak and Madlener (2016), who applied augmented spatial models on German data, imply that sheer distance to wind turbines is of less importance than the actual visual impact on a specific dwelling or property.

Reference Number 6.6:

The impact of wind farm visibility on property values: A spatial difference-in-differences analysis. Yasin Sunak, Reinhard Madlener. Energy Economics Volume 55, March 2016, Pages 79-91. https://doi.org/10.1016/j.eneco.2015.12.025

Today's investment decisions in large-scale onshore wind *projects in* Germany *are no longer determined only by the investment's economic benefit, but also by concerns associated to social acceptance. Despite a mostly positive attitude towards the expansion of wind power, local public concerns often stem from the belief that the proximity to large-scale* wind farms *may lead to a decrease in* property prices*. In particular, the change in landscape caused by the*

construction of a wind farm may have an adverse impact on the view from some properties, and thus may negatively affect their price. To investigate the potential devaluation of properties in Germany *due to* wind farms*, we use a quasi-experimental technique and apply a spatial difference-in-differences approach to various wind farm sites in the federal state of North Rhine-Westphalia. We adopt a quantitative visual impact assessment approach to account for the adverse environmental effects caused by the wind turbines. To properly account for spatial dependence and unobserved variables biases, we apply augmented spatial* econometric models*. The estimates indicate that the asking price for properties whose view was strongly affected by the construction of wind turbines decreased by about 9–14%. In contrast, properties with a minor or marginal view on the wind turbines experienced no devaluation.*

Even if wind turbines are visible from distances of up to 30 or 40 km under certain circumstances, usually the significance of a visual impact can be expected to drop substantially beyond distances in excess of two to three kilometers (Bishop, 2002, Sullivan et al., 2012).

Reference Number 6.7:
Clean Energy Wire, Journalism for the energy transition. Benjamin Wehrmann 21 Jan 2019.

German homeowners could see the value of their property fall if wind turbines are built in their vicinity, according to a study *by research institute RWI. The value of a one-family house falls by an average of 7 percent when a wind turbine begins operation within 1 kilometre of the property, RWI estimates, based on a review of close to 3 million offers on an online real estate website. The effect disappears at a distance of 8 to 9 kilometres, RWI says, adding that the drop in value is down to potential noise pollution and the turbines' aesthetic impact on the landscape. The study found that the value of older houses in rural areas dropped by up to 23 percent, while almost no devaluation was observed for houses built on the outskirts of larger towns. "Wind power may be important for the success of the energy transition but* implications for property owners can be severe *in some cases," RWI researcher Manuel Frondel said.*
Several regional governments in Germany have imposed strict minimum distances *from residential areas for new* onshore wind *turbines, but critics argue this could pose a significant challenge to meeting the country's* renewable power targets*. According to a study commissioned by* WWF *in October 2018, available land will become* "the new currency" *of Germany's energy transition.*

Reference Number 6.8:
Impact Analysis of the Niyol Wind Farm on Surrounding Rural Residential and Agricultural land Values in Logan County Colorado. June 11, 2020. FORENSIC APPRAISAL GROUP 116 E. Bell Street Neenah, WI 54956 ph (920) 558-4638 www.forensic-appraisal.com.

- *The Landsink (Ontario, CA) study found a loss range of -8.85% to -50%, with a loss average of -39% for residential homes within 664ft to 2,531ft of a wind farm.*
- *The Appraisal Group One Wisconsin Study found a typical loss of 1-10 acre residential lots within ½-mile of wind turbines to be -19% to -40%.*
- *The Clarkson University upstate New York study of both residential and agricultural properties found a loss ranging from -15.6% to -31% within 1-3 miles of a wind farm.*
- *The Forensic Appraisal Coral Springs (WY) study of large residential lots (35 acres) which would be abutting a proposed wind farm suffered a value impact of -25% to -44%.*
- *The McCann study (IL) of residential properties found an average impact of -25% within 2-miles of a wind farm.*
- *The Forensic Appraisal Big Sky (IL) study found a loss range of -12% to -25% of residences within 0.31mi to 1.72mi of a wind turbine, with an average impact of -19% at an average distance of 0.65 miles to a wind turbine.*
- *The Twin Grove II Wind Farm (McLean County, IL) study of a 198MW wind farm comprised of 120 turbines being 397ft in height over an 11,000 acres area.*
  A paired sales analysis of residential property within the influence of the wind farm found the improved property is negatively impacted by the presence of wind turbines. The impact measured ranged from -46.6% to -7.7%, with the higher impact closest to the wind turbines and the impact diminishing as the distance is increased. The distances measured ranged 1,483ft to 5,481ft away from a residence.

The Twin Grove II Wind Farm also found an overall impact of -6.63% to -8.5% for vacant agricultural properties within the wind farm zone.
Properties within the Wind Farm Footprint= -35% impact on property value

Properties : 1-Mile outside of the Wind Farm Footprint = -22%
impact on property value : Agricultural Properties within the Wind Farm Footprint= 8.5% impact on property value
Application of these estimated losses to the client's property value is:

Niyol Wind Farm Loss to Property Value Estimate			
	Total assessed value	*impact*	*value loss*
Properties within the foot print	*$6,948,960*	*-35%*	*-- $1,405,051*
Properties 1-mile outside of the Footprint	*$4,014,430*	*-22%*	*-$1,528,771*
			-$2,933,822

Reference Number 6.9:
Wind Turbines and House Prices Along the West of Ireland: A Hedonic Pricing Approach. Gillespie T, McHale P (2023), Centre for Economic Research on Inclusivity and Sustainability (CERIS) Working Paper Series, 2023/01.

Despite the benefits associated with wind energy, wind turbines impose undesirable externalities on residents mainly through aural and visual pollution. In this paper, I perform a preliminary evaluation on the effect of wind turbines on listed house prices in Ireland. I employ a unique dataset of exact turbine locations with housing and amenity data in seven counties along the west and southern coast of Ireland. With this I conduct a hedonic pricing analysis incorporating spatial and temporal fixed effects. The analysis finds a robust and significant reduction in property value of -14.7% within 1km of a turbine. The effect increases with turbine height, count, and level of urban influence. However, there is evidence that the price effect decays over time, becoming insignificant after 10 years. Furthermore, exhibited effects likely persist beyond 1km, although they are not significant in this analysis. In short, the results presented in this paper are consistent with existing European studies, enforcing the recommendation that turbines should be constructed in highly remote areas to minimise impacts on residents.
The estimated effects from proximity to a wind turbine on house price for dwellings In three of the six area classes: rural areas with high urban influence, rural areas with moderate urban influence, and highly rural/remote areas. Cities, satellite towns, and independent urban towns are not reported due to sample size concerns. There are fewer than 10 observations within 1km of a turbine and no more than 60 observations within 1-2km across all three urban classes combined. Proximity to a wind turbine has a significant negative effect across all three rural classes with the greatest estimated effects in rural areas with moderate urban influence at −20.1%.

One of the most recent scientific papers on Wind wake indicates effects to a distance downwind of 22diameters. Thus, wind turbines have a wake effect on properties & land for at least 3.3km downwind. Placing wind turbines close to application boundaries without the consent of said downwind farmers & property owners for this 3.3klm, who will suffer a temperature drop of 3^0 Degrees Centigrade & consequential crop losses & household heating costs. This effect is included in the ABP FI query of 6th March 2025 Laurclavagh Clause 10.1.

4) The Wake effect on Climate where ground temperatures are lowered by 3degrees centigrade, leading to lower crop yields over the 40-50km envelope.
5) The Wake effects on downwind turbines & associated noise due to turbulent air is not identified.
6) The increasing turbine noise levels, over time with bearings wear, is not identified.
7) The turbine noise numbers provided have no reference & are stated to be assumed & would seem to be wind tunnel values for a singular turbine.
8) The attraction of insects to wind turbines & the attraction of bats to the insects is not addressed.
9) The seismic effects on frogs, worms & herbivores, such as badgers are not addressed.
10) The recent High Court decision in relation to the effect of Noise on health & property devaluation [Phase 2], plus the Victoria Supreme Court decision in Australia are ignored, while historical data, pre 2015, is quoted.
11) The health & property value reports submitted are pre-2016 & have no relevance. Turbines were much smaller in that period. References to reports from central America with sparse houses is not relevant.

Reference Number 7.1:
The proposed development is not in compliance with [2023/2413: DIRECTIVE (EU) 2023/2413 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652]

Reference Number 7.2:
Effect of wind turbine wake turbulence on offshore helicopter operations in and around wind farms. *HFDM analysis and consultation with helicopter operators.* April 2020 . Ministry of EZK and Rijksdienst voor Ondernemend Nederland (RVO).

"A better understanding of the effects of wind turbine wake turbulence on helicopters could reduce the uncertainty in the current recommended distances and could help in defining adequate wind turbine stop-procedures.
" The only relevant and valid document produced by CASA is related to the National Airports Safeguarding Framework12. Guideline D13 to this framework entitled Managing the Risk to Aviation Safety of Wind Turbine Installation (wind farms) / Wind monitoring Towers addresses the issues in the withdrawn AC as well as obstacle issues and, in brief, turbulence. The guideline states that wind turbine turbulence may be "noticeable" up to 16 rotor diameters from the turbine. The document
continues, "At this time, the effect of this level of turbulence on aircraft in the vicinity is not known with certainty".
The Wake effect on bird navigation in the context of the proposed site being located in the centre of the Lough Corrib/Clare River SPA/SAC, creates a turbulent air flight barrier for birds up to a height of c800m OD, over a 4km width & over a 40km Wake & its effects on foraging, fragmentation & habitat loss are not identified. The proposed site location is located in the centre of the Lough Corrib/ Clare River SAC/SPA/Natura 2000 site.

Reference Number 7.3: Mitigating Wind Turbine Radar Interference: USA Wind Energy Technologies Office

The U.S. Department of Energy's (DOE) Wind Energy Technologies Office (WETO) supports interagency efforts to identify and deploy technology and process improvements to mitigate impacts of wind farms on radars. DOE undertakes this work along with the Department of Defense (DOD), the Department of Homeland Security (DHS), the Federal Aviation Administration (FAA), the National Oceanic and Atmospheric Administration (NOAA), and the Bureau of Ocean Energy Management (BOEM).
As wind development continues to grow and expand to new areas of the country, the likelihood that some turbines will be located within the line of sight of radar systems also increases. Wind turbines can cause interference for radar systems *because their large towers and moving blades reflect electromagnetic radiation.*

Reference Number : 7.4

A Review on State-of-the-Art Reviews in Wind-Turbine- and Wind-Farm-Related Topics : Sawant, M.; Thakare, S.; Rao, A.P.; Feijóo-Lorenzo, A.E.; Bokde, N.D. Energies 2021, 14, 2041. https://doi.org/10.3390/ en14082041

WA Wind Turbine extracts wind's kinetic energy and converts it into mechanical energy. During this process, the WT reduces the wind speed behind the rotor, which creates a wind shadow or wakes effect, as shown in Figure 9.

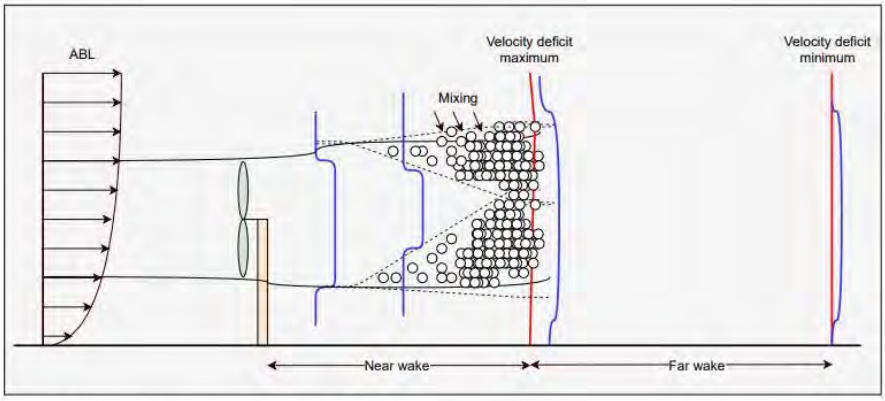


Figure 9. The velocity profile behind WT [85].

Due to the wake effect, the downstream WTs receive wind with lower speed and higher turbulence level, which reduces the energy yield . In Figure 10, uo is the direction of wind, T1 to T7 are WT locations, and it is clear that the downstream WTs receive modified wind; hence, it affects the energy yield.

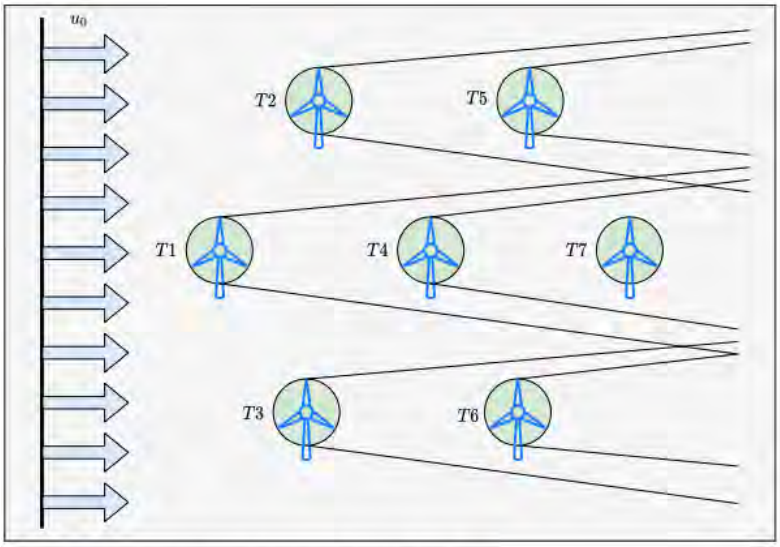
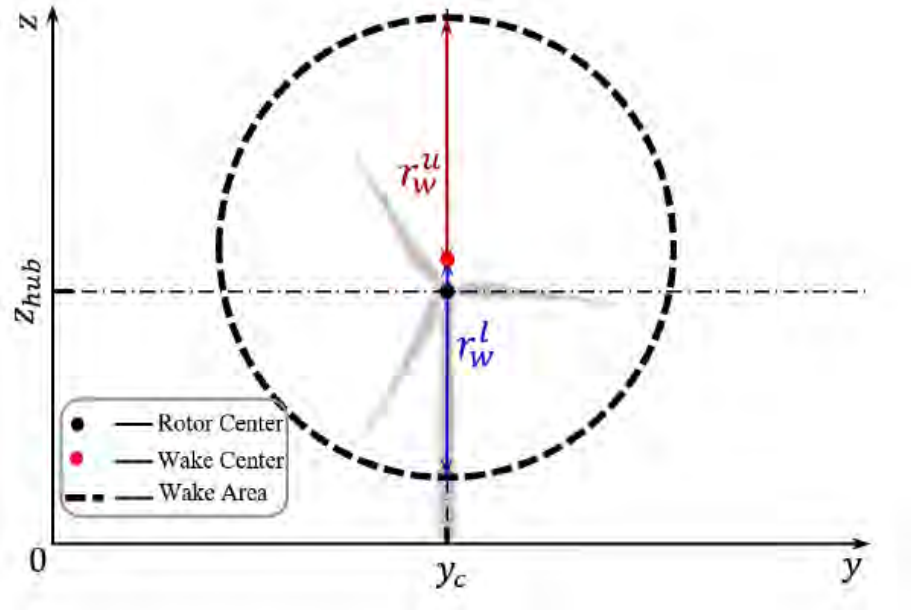


Figure 10. Wake effect in a wind farm (WF) [73].

The parameters that influence the wake effect are Wind Farm size and layout, number and size of WTs, wind speed and direction, and turbine blade design . General impacts of the wake generated by WTs are a mechanical failure, extra maintenance cost, and reduction in power.

Reference Number 7.5 :
Upward Shift of Wind Turbine Wakes in Large Wind Farms. Zewei Wang and Xiaolei Yang.
https://doi.org/10.3390/en16248051. Published: 14 December 2023 Energies 2023, 16, 8051.

Larger upward shifts of the wake center are observed for wind turbines in further downstream rows and wind turbines installed on the ground with higher roughness, for which the wake expands at a higher rate.
Regarding turbulence intensity, it is higher around the top tip of the turbine compared to the bottom tip at intermediate wake locations



Schematic of the wake area in the streamwise plane, which are indicated as wider & higher than the blades. The potentially 100m higher levels above the blades bring much colder air down to ground level.

Reference 7.6:
Impacts of wind turbine characteristics on wake turbulence Shifeng Wang, Sicong Wang. *Energy Storage and Conversion* 2025, 3(1), 1956. https://doi.org/10.59400/esc1956.

The enhanced wake turbulence generated by wind turbine has remarkable effects on the power generation and fatigue loads of wind farm and the environment. The turbulence can sustain strength and distance for several miles before fully dissipating.

Reference Number 7.7 :
Wind turbine impact on near-ground air temperature, Renewable Energy Volume 123, August 2018,
David Moravec , Vojtěch Barták , Vladimír Puš , Jan Wild . https://doi.org/10.1016/j.renene.2018.02.091

"Impacts on local climate are especially crucial in situations where allocating more turbines is justified by reducing carbon emissions, because these effects could have subsequent impacts on the carbon cycle in the affected area. Wind farms can affect local climates in two main ways. The first is by extracting kinetic energy, which slows wind flow. The second is by further heightening turbulence flow downwind. Turbulence can be generated in the wake of rotors and also by the shear between the non-affected faster air layer below the turbine and the upper air layer slowed by the turbine .

The generated turbulence has a secondary effect by enhancing vertical mixing of air. Several studies showed that enhanced turbulence produced by wind farms has impact on heat and moisture exchange between the surface and the atmosphere. In stable atmospheric conditions, when a warm air layer is present above cooler air, increased turbulence results in a warming near the surface by transferring thermal energy from higher levels to the lower. On the other hand, when unstable atmospheric conditions are present, i.e. cool air lying above a warmer layer, enhanced turbulence leads to mixing the layers and provides a cooling effect on the ground. These impacts depend on the ratio of natural turbulence to turbulence generated by the wind turbine. The stability of atmospheric layers can also influence a wind farm's impacts. The effect of vertical mixing can be 10–15% stronger when a wind turbine is present in the atmospheric boundary layer."

"Theoretical models have been tested in wind tunnel experiments. The outcomes of these experiments have shown that the effect of the wake can be found up to a distance of 20 rotor diameters . A computational study has suggested this to be a shorter still distance of 15 diameters . Maximum turbulence has been found at a distance of 4–4.5 rotor diameters above rotor hub height in neutral cases of atmospheric layers and 3–6 diameters in stable cases. Heightened

turbulence intensity is associated with strong shear of layers and turbulent kinetic energy produced by regional features or wind farm layout ."

For every 1,000ft you ascend, the temperature drops approximately 3.5-5 degrees Fahrenheit.[1.94- 2.77 degrees Centigrade]. The effect of the turbine .The proposed windfarm will reduce temperatures by a minimum of 4 degrees Centigrade & a maximum of 6 degrees Centigrade. The Meterological Maps indicate the effect on the Wake area. Basically pasture lands & crops will be dramatically affected.

Reference Number 7.8 :
Segmented Gurney Flaps for Enhanced Wind Turbine Wake Recovery.Nirav Dangi, Koen Boorsma, Edwin Bot, Wim Bierbooms, and Wei Yu. https://doi.org/10.5194/wes-2023-90 Preprint. Discussion started: 23 August 2023

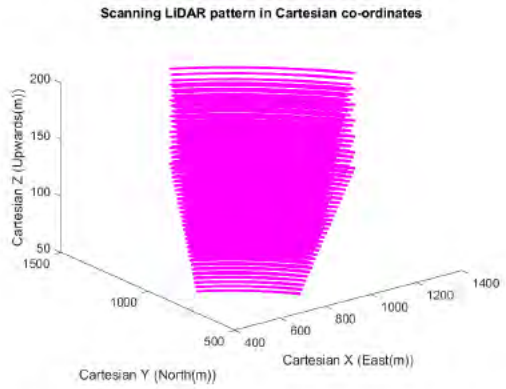


Figure A1: Scanning LiDAR pattern (Cartesian co-ordinates)

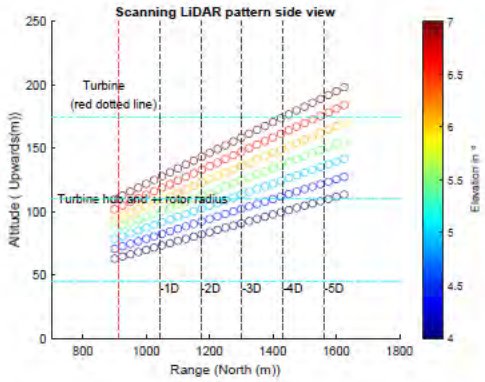


Figure A2: Scanning LiDAR pattern side view

Reference Number 7.9:

Wind farms dry surface soil in temporal and spatial variation. Gang Wang, Guoqing Li, Zhe Liu. MethodsX Volume 10, 2023, 102000 https://doi.org/10.1016/j.mex.2023.102000

Wind farms have been proved to have potential impact on the ecology. As an important ecological factor, soil moisture has a great impact on the ecosystem. Therefore, it is of great significance to explore the effect of wind farms on soil moisture. At present, the remote sensing data can be used to calculate the soil moisture of wind farm conveniently, but its spatial resolution is poor. Moreover, the measured soil moisture can't express the spatial difference. Therefore, through the effective combination of remote sensing data and measured data, this method can accurately judge the impact of wind farm on soil moisture. This method investigated wind farms located in the grasslands of China. Remote sensing images and field data were used to explore the area and extent of influence of wind farms on grassland soil moisture. We use Landsat images and field measurements to derive a linear relationship between the soil moisture and the TVDI, which was calculated based on the land surface temperature and NDVI, was developed in this work. The cor-relation was used to reverse spatial distribution map of soil moisture before and after the construction of wind farms. The diurnal and seasonal variation of the influence of the wind farm on the grassland soil moisture was also judged.

Ecosystem impacts during construction and operation have been widely reported, including the potential to reduce, fragment, or degrade habitat for wildlife, fish, and plants. However, the impacts on local climate, and thus longer-term impacts on ecosystems are less well understood. Soil moisture changes are important for nutrient and energy cycling in ecosystems and have a direct impact on local wildlife. Xie (2015) used the measured data to monitor the effects of wind farms on vegetation and soil in low-water, semi-arid regions. After the wind farm is built, there is no consistent trend in soil moisture based on wind direction or distance from the wind farm (0–100 m) . Armstrong et al. (2016) used observation data from a wind farm in Scotland to judge the impact of wind turbine operation on the local climate in podzolic soil. They found that there was no significant trend in changes in soil moisture (to a depth of 10 cm) caused by the operation of wind turbines, which may be related to the high water table at the wind farm. Tang et al. (2017) used

0.25° × 0.25° climate change initiative (CCI) soil moisture data derived from MODIS data to judge the impact of wind farms on vegetation in Texas and Illinois, USA. By comparing the annual soil moisture difference between the wind farm and non-wind-farm regions, it was found that the wind farm soil moisture reduced by 0.3% after construction in the desert and yellow-brown soils . With remote sensing data, although the soil moisture before and after a wind farm has been built can be calculated, the spatial resolution of the data is low and cannot be effectively combined with field-measured data. Therefore, many difficulties remain in accurately judging the impact of wind farms on soil moisture. Therefore, this paper investigated wind farms located in the grasslands of China. Remote sensing images and field data were used to explore the area and extent of influence of wind farms on grassland soil moisture.

Conclusions

We used remote sensing and field-measured data to analyze changes in soil moisture before and after the construction of wind farms. We found that wind farms significantly reduce soil moisture to different extents according to season and wind direction. We obtained the following main conclusions;

- *(1) Wind farms significantly reduced soil moisture within the wind farms and in the upwind and downwind directions. Compared with the upwind and downwind directions, the decrease in soil moisture within the wind farms was the most, and the annual decrease in soil moisture within wind farms reached 4.4%.*

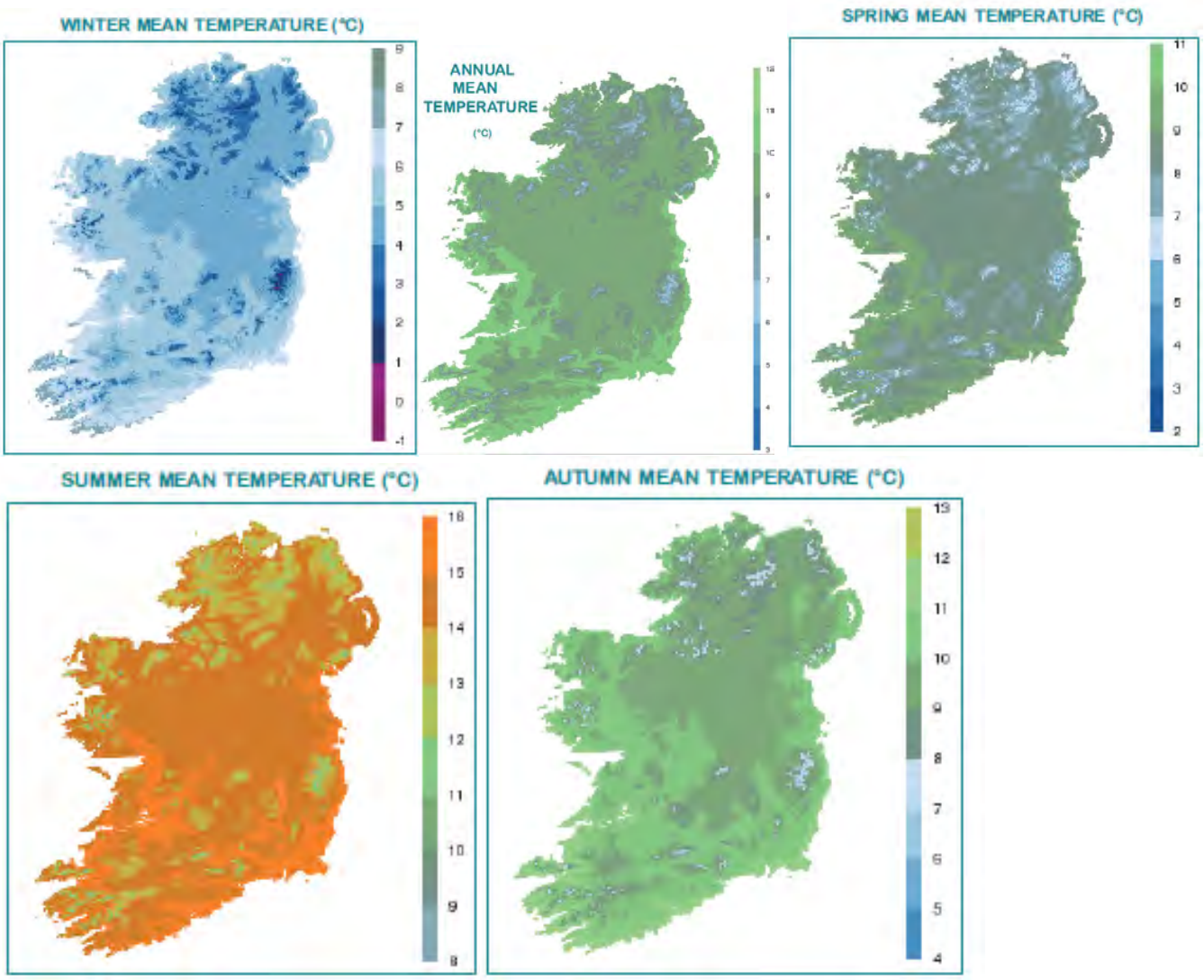
- *(2) Wind farms have different influences on the soil moisture in the upwind and downwind directions in each season. Reductions are greatest in the upwind direction in spring and the downwind direction in summer and autumn.*

- *(3) The wind farm reduced the soil moisture most significantly downwind of the wind farm throughout the day, with an average value of up to 2.85%. The decrease in the soil moisture upwind was the least significant, only by 0.21%.*

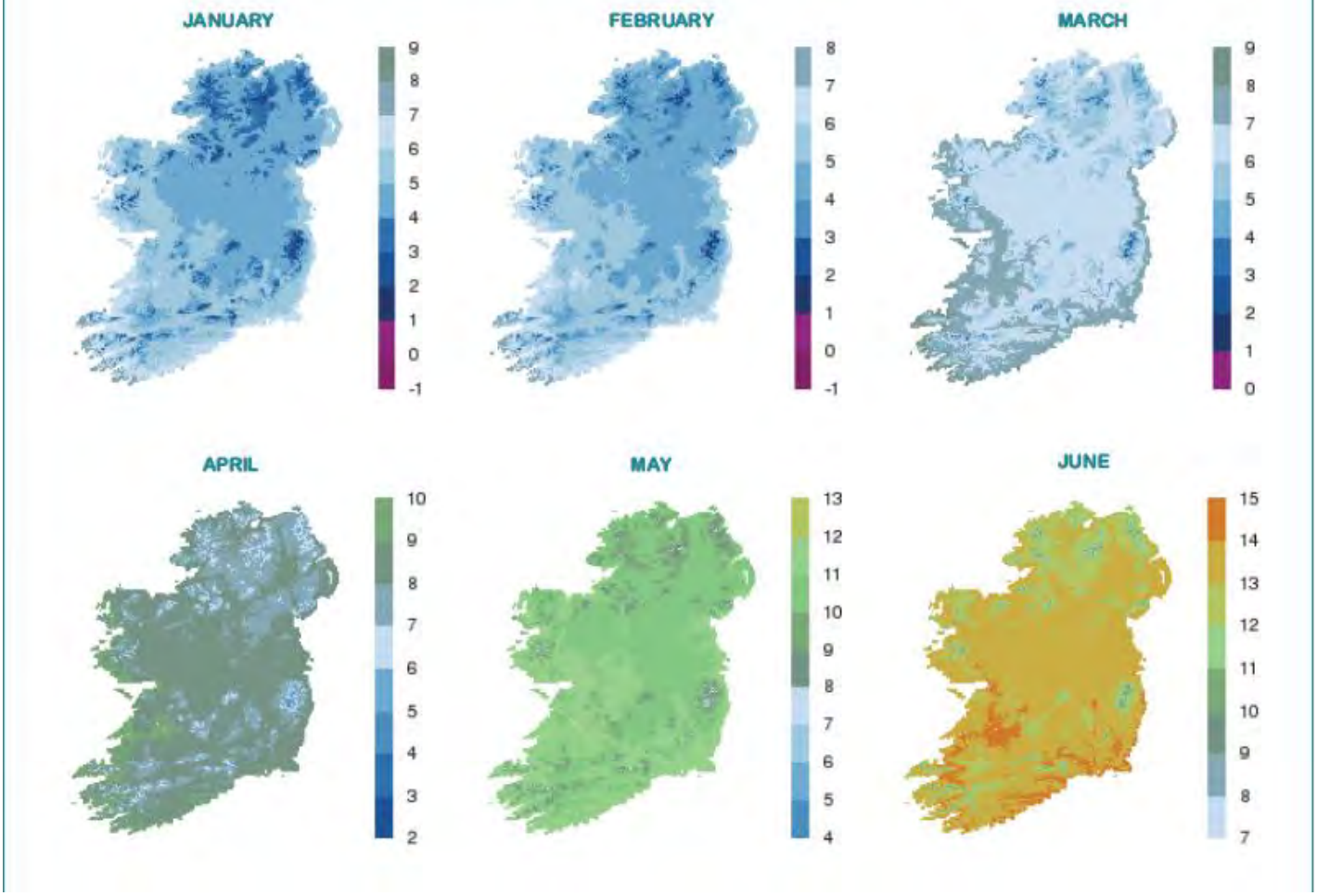
Reference Number 7.10:
Wind Turbines Cause Chronic Stress In Badgers (*Meles Meles*) In Great Britain, Roseanna C. N. Agnew; Valerie J. Smith; Robert C. Fowkes. *J Wildl Dis* (2016) 52 (3): 459–467.Https://Doi.Org/10.7589/2015-09-231

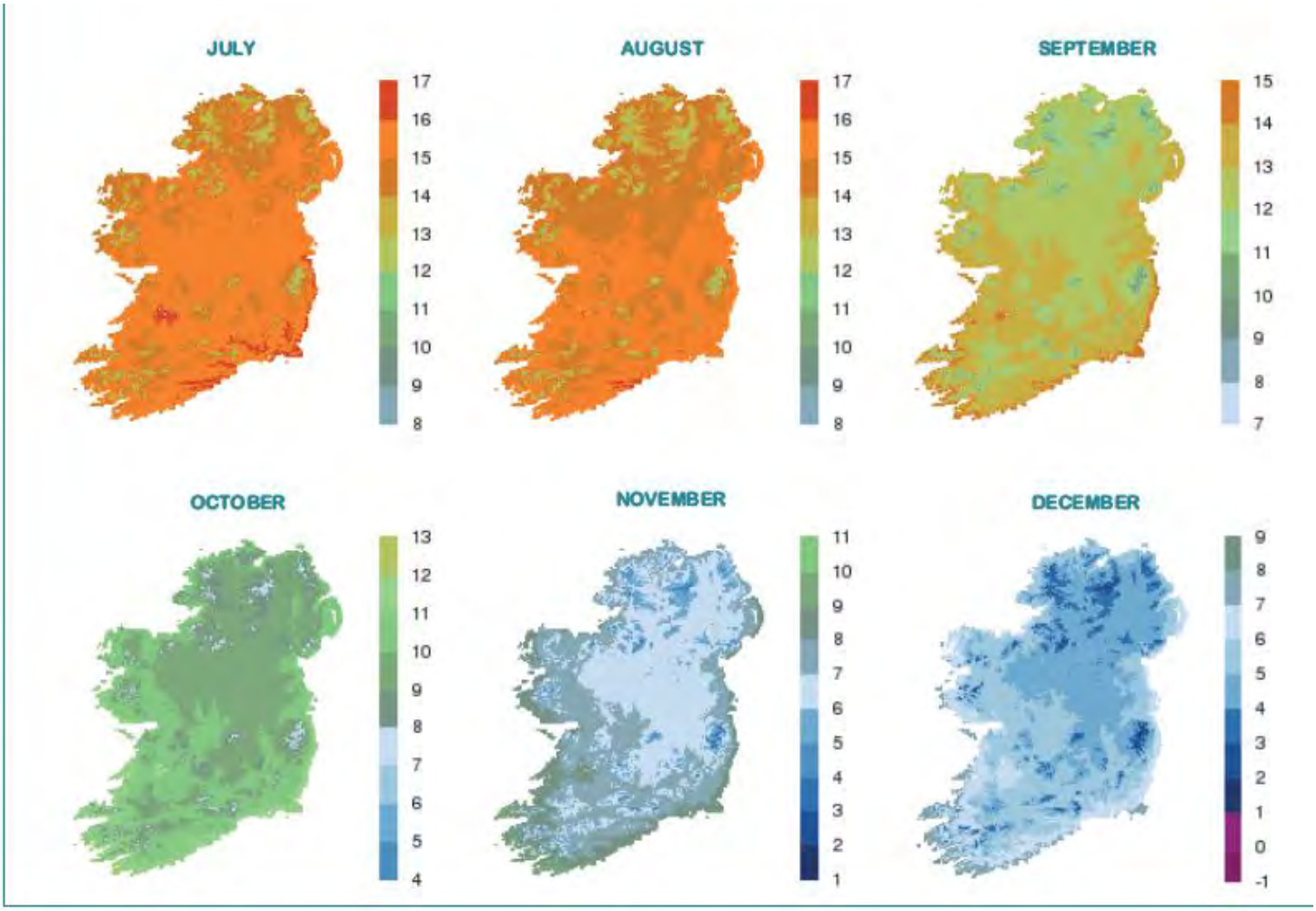
A paucity of data exists with which to assess the effects of wind turbines noise on terrestrial wildlife, despite growing concern about the impact of infrasound from wind farms on human health and well-being. In 2013, we assessed whether the presence of turbines in Great Britain impacted the stress levels of badgers (Meles meles) in nearby setts. Hair cortisol levels were used to determine if the badgers were physiologically stressed. Hair of badgers living <1 km from a wind farm had a 264% higher cortisol level than badgers >10 km from a wind farm. This demonstrates that affected badgers suffer from enhanced hypothalamo-pituitary-adrenal activity and are physiologically stressed. No differences were found between the cortisol levels of badgers living near wind farms operational since 2009 and 2012, indicating that the animals do not become habituated to turbine disturbance. Cortisol levels in the affected badgers did not vary in relation to the distance from turbines within 1 km, wind farm annual power output, or number of turbines. We suggest that the higher cortisol levels in affected badgers is caused by the turbines' sound and that these high levels may affect badgers' immune systems, which could result in increased risk of infection and disease in the badger population.

Reference Number 7.11:
Met Eireann, Climatological Note No.14: A Summary Of Climate Averages For Ireland 1981-2010. Séamus Walshe



MONTHLY MEAN TEMPERATURE (°C)





Reference Number 7.12:
Costs and consequences of wind turbine wake effects arising from uncoordinated wind energy development J. K. Lundquist, K. K. DuVivier, D. Kaffine and J. M. Tomaszewski. Department of Atmospheric and Oceanic Sciences, University of Colorado Boulder, Boulder, CO, USA. National Renewable Energy Laboratory, Golden,CO, USA. University of Denver Sturm College of Law, Denver, CO, USA. Department of Economics, University of Colorado Boulder, Boulder, CO, USA.e-mail: Julie.Lundquist@colorado.edu Nature Energy | www.nature.com/natureenergy

Optimal wind farm locations require a strong and reliable wind resource and access to transmission lines. As onshore and offshore wind energy grows, preferred locations become saturated with numerous wind farms. An upwind wind farm generates 'wake effects' (decreases in downwind wind speeds) that undermine a downwind wind farm's power generation and revenues.
*Here we use a diverse set of analysis tools from the atmospheric science, economic and legal communities to assess costs and consequences of these wake effects, focusing on a West Texas case study. We show that although wake effects vary with atmospheric conditions, they are discernible in monthly power production. In stably stratified atmospheric conditions, **wakes can extend 50+ km downwind**, resulting in economic losses of several million dollars over six years for our case study. However, our investigation of the legal literature shows no legal guidance for protecting existing wind farms from such significant impacts.*

Reference Number 7.13:
Gone with the wind? Wind farm-induced wakes and regulatory gaps Eirik Finserås, Ignacio Herrera Anchustegui, Etienne Cheynet, Cristian Guillermo Gebhardt, Joachim Reuder . Elsevier, Wind Policy 159(2024) 105897. https://doi.org/10.1016/j.marpol.2023.105897

"Wind farm-induced wakes can propagate dozens of kilometres, decreasing the power production and the fatigue lifetime of wind turbines between neighbouring farms.

Recent studies indicate that farm wakes can propagate downwind for distances ranging from 30 km to 55 km , with even longer wakes observed under specific flow conditions.

Wind turbine wakes correspond to the area downstream of wind turbines associated with a reduced mean wind speed and increased turbulence.

The wakes propagate downstream of wind turbines, and as air with higher velocity from above is mixed downward into the wake, the velocity deficit decreases. This process, known as wake recovery, is strongly influenced by the thermal stratification of the atmosphere, which refers to the vertical layering of air with different temperatures and affects air mixing.

In contemporary OWFs, wind turbines are commonly placed at distances of 6–10 times their diameter. For cutting-edge North Sea offshore turbines with a rotor diameter of 164 m, this results in spacing ranging from 1.0 km to 1.6 km between turbines. While increasing the distance between turbines helps reduce wake effects, it can also raise the cost of energy production due to the efficiency loss.

Reference Number 7.14:
Impacts of wind turbines on vegetation and soil cover: a case study of Urla, Cesme, and Karaburun Peninsulas, Turkey
Talha Aksoy, Mehmet Cetin, Saye Nihan Cabuk, Muzeyyen Anil Senyel Kurkcuoglu, Gulsah Bilge Ozturk, Alper Cabuk.
Clean Technologies and Environmental Policy (2023) 25:51–68 https://doi.org/10.1007/s10098-022-02387-x

Wind turbines, similar to many other artificial structures such as communication masts, tall buildings and windows, power lines, and fences, are discussed in the literature as one of the sources of bird fatalities (Drewitt and Langston 2008). However, the effects of wind turbines on bird fatality are associated with various factors such as the location, season, topography, and bird species (Fernandez et al. 2007; Kuvelsky et al. 2007; Farfan et al. 2009; Sovacool 2013; Wang et al. 2015). For instance, Farfan et al. (2009) studied the impact of wind farms with a case study from southern Spain. They concluded that the turbines did not harm passerine birds but had a negative effect on the raptors in the region.

In a study conducted in Mongolia, the vegetation change in the 50 km buffer zones around Wind Power Plants between 2008 and 2014 was monitored and assessed using NDVI analysis (Li et al. 2016). The impact of WPPs on vegetation was reported to be more significant after the operations started compared to the installation period, and the highest rate of change was detected in the 30-km buffer zone around the turbines. *WPPs can have a significant impact on climate-affected vegetation due to the local climate. Tang et al. (2017) analyzed the effects of WPPs on vegetation growth and productivity in summer (June–August) in the Bashang region of North China. WPPs showed a significant inhibitory effect on vegetation growth as evidenced by decreases in leaf area index (LAI), increased vegetation index (EVI), and normalized difference vegetation index (NDVI).*

Shen et al. (2017) evaluated the direct impact on the pasture lands during the construction of WPPs in China using the Landsat 8 satellite and the GF-2 HD satellite imageries. The study concluded that the construction of a single wind turbine damaged approximately 3000 m2 of pasture land, and China's GF-2 HD satellite (GF-2) could accurately detect the damage in the area.

All of the research mentioned above show that wind turbines cause turbulence, wake effect, and temperature change nearby; therefore, measurable impacts on vegetation occur or are likely to occur.

Land principally occupied by agriculture, with significant areas of natural vegetation, experienced the most negative change in the 3–5% slope group. It is 1.76 times higher in the control buffer area compared to the WPP surrounding. The most degradation was observed in the northern facing aspect group, with 2.43 times higher in the control buffer zone compared to the areas closer to WPP in the northern aspect group

In natural grasslands–pasture lands, it was observed that the degradation was high in the 1–2% slope group, and it was 7.61 times higher around the Wind Power Plant compared to the control buffer zone. In addition, the south-facing aspect group experienced the most negative change, with 9.24 times higher change surrounding the WPP than the control buffer zone. So, it was inferred that areas close to the WPP are exposed to more degradation than control buffer areas.

It was determined that the highest degradation in the natural vegetation class is on the 3–5% slope and in the area far from the WPP in the north direction. There could be no analysis since at least two of the groups in the same year did

not have WPP. When the same WPP in different years was examined, the slope groups were found to be 3–5% and had a north-facing aspect. As a result of the study, it is thought that the degradation in agricultural areas with natural vegetation is more prone to damage caused by WPP—in areas with 3–5% slope and north-facing aspect.

The biggest degradation in the pasture lands class was identified on a 1–2% slope and in the area closest to the WPP in the south direction. Examining the WPPs in the same years, which were divided into groups, it was found that the highest deterioration was predominantly on the 0–1% slope, but a common direction could not be determined. When the same WPPs were evaluated in various years, it was discovered that the degradation was concentrated in the 0–1%slope group, with certain groups exhibiting consistency within themselves in terms of aspect.

Turbines change the humidity and temperature in the local area, which creates a positive or negative effect depending on the vegetation type.

Reference Number 7.15:
The wind farm pressure field. Ronald B. Smith, Earth and Planetary Science Department, Yale University, New Haven, CT, 06520, USA. European Academy of Wind Energy. https://doi.org/10.5194/wes-2023-56

The disturbed atmospheric pressure near a wind farm arises from the turbine drag forces in combination with vertical confinement associated with atmospheric stability. These pressure gradients slow the wind upstream, deflect the air laterally, weaken the flow deceleration over the farm and modify the wake recovery.
In a stably stratified atmosphere, the lifting of the air caused by farm drag creates gravity waves aloft whose pressure field acts back on the lower atmosphere.

Reference Number 7.16:
Impacts of wind farms on surface air temperatures Somnath Baidya Roy and Justin J. Traiteur. Department of Atmospheric Sciences, University of Illinois, 105 South Gregory Street, Urbana, IL 61820.

Utility-scale large wind farms are rapidly growing in size and numbers all over the world. Data from a meteorological field campaign show that such wind farms can significantly affect near-surface air temperatures. These effects result from enhanced vertical mixing due to turbulence generated by wind turbine rotors.

Reference Number 7.17:
Do terrestrial animals avoid areas close to turbines in functioning wind farms in agricultural landscapes? Rafał Łopucki & Daniel Klich & Sylwia Gielarek. Environ Monit Assess (2017) 189: 343 DOI 10.1007/s10661-017-6018-z

The reactions of animals were species specific. Herbivorous mammals (roe deer and European hare) avoided wind farm interiors and proximity to turbines. The common pheasant showed a positive reaction to wind turbine proximity. The red fox had the most neutral response to wind turbines. Although this species visited wind farm interiors less often than the control area, there was no relation between fox track density and turbine proximity.

Terrestrial animals can potentially be affected by wind power development in various ways (Lovich and Ennen 2013), but the empirical evidence suggests a lack of such effects during the operational phase of wind farms or a swift habituation of animals to the disturbance, thus suggesting a limited impact (Helldin et al. 2012; Lovich and Ennen 2013; Łopucki and Mróz 2016; Menzel and Pohlmeyer 1999; Walter et al. 2006; Winder et al. 2014a, b). For this reason, we would expect no effect (neither negative nor positive) of wind turbines on the studied species.

However, our study showed that wind farms can significantly alter habitat use of terrestrial animals not only during the construction phase (Helldin et al. 2012), but also during the operational phase.

In our study, terrestrial animals did indeed use the wind farm areas (tracks of all analyzed species were found close to turbines), which is in accordance with the published literature regarding the different animal species (Helldin et al. 2012; Lovich and Ennen 2013; Rabin et al. 2006; Winder et al. 2014a, b), but the frequency of use of areas near wind turbines was different than the use of land far away from turbines. Our results show that wind farm operations affect terrestrial animals both in wind farm interiors (among the turbines), as well as within at least a 700-m buffer zone around each wind farm. The reaction of the studied animals to wind farms, however, is specific and depends on the species.

Herbivorous mammals

Wind farm interiors were less intensively frequented by roe deer and European hare than control areas. Both species also showed a clear linear decrease of track density with decreasing distance to the turbine. Acoustic factors seem to be the most probable reason for the lower presence of these species in the wind farm areas and with decreasing distance to turbines. Permanent and high noise levels may be bothersome enough for these species to visit less frequently and spend less time there (resulting in lower track density) because the noise may cause metabolic stress and be harmful for animals (Du et al. 2010; Kight and Swaddle 2011). However, it is more likely that herbivorous mammals have difficulty perceiving sounds in noisy environments. Human related noise may restrict the habitat use and movement of species and represent a life-threatening hazard in predator-prey interactions, particularly regarding herbivorous mammals (Barber et al. 2010; Chan et al. 2010; Clevenger and Waltho 2005; Rabin et al. 2006). Both the roe deer and the European hare rely more on hearing than other senses, particularly to avoid danger (Molinari-Jobin et al. 2004) and, thus, are susceptible to such a noise effect. Both are also under high predatory pressure in the Carpathian region (Bombik et al. 2014; Kauhala and Kowalczyk 2011).

Herbivorous mammals generally increase their vigilance in environments that are under a high predatory pressure (Laundré et al. 2001; Wolff and Horn 2003). Avoidance of risky habitats is an important part of their anti-predatory strategy (Aulak and Babińska-Werka 1990; Bongi et al. 2008; Klich and Grudzień 2013) that may lead to some areas being depleted of prey due to vigilance rather than predation (Brown et al. 1999).

For roe deer and the European hare, the proximity of turbines may thus represent a risky habitat due to the animals' impaired ability to hear approaching predators. This phenomenon may be more likely during hours of darkness or low light, when both species are most active during winter (Chapman and Flux 2008; Pépin and Cargnelutti 1994; Wallach et al. 2010). Previous studies (Bergen 2002; Menzel and Pohlmeyer 1999) showed no significant difference in roe deer distribution or habitat use in areas with wind farms compared to reference areas without wind power. However, neither roe deer nor the European hare were under high predation pressure that could displace them to other habitats (Keuling et al. 2011; Ludwig et al. 2009).

Reference Number 7.18:
Out of sight of wind turbines—Reindeer response to wind farms in operation. Anna Skarin, Per Sandström, Moudud Alam, *Ecology and Evolution.* www.ecolevol.org 2018;8:9906–9919. 27 July 2018

To meet the expanding land use required for wind energy development, a better understanding of the effects on terrestrial animals' responses to such development is required. Using GPS-data from 50 freely ranging female reindeer (Rangifer tarandus) in the Malå reindeer herding community, Sweden, we determined reindeer calving sites and estimated reindeer habitat selection using resource selection functions (RSF). RSFs were estimated at both second-(selection of home range) and third-order (selection within home range) scale in relation to environmental variables, wind farm(WF) development phase (before construction, construction, and operation), distance to the WFs and at the second-order scale whether the wind turbines were in or out of sight of the reindeer. We found that the distance between reindeer calving site and WFs increased during the operation phase, compared to before construction. At both scales of selection, we found a significant decrease in habitat selection of areas in proximity of the WFs, in the same comparison. The results also revealed a shift in home range selection away from habitats where wind turbines became visible toward habitats where the wind turbines were obscured by topography (increase in use by 79% at 5 km). We interpret the reindeer shift in home range selection as an effect of the wind turbines per se. Using topography and land cover information together with the positions of wind turbines could therefore help identify sensitive habitats for reindeer and improve the planning and placement of WFs. In addition, we found that operation phase of these WFs had a stronger adverse impact on reindeer habitat selection than the construction phase. Thus, the continuous running of the wind turbines making a sound both day and night seemed to have disturbed the reindeer more than the sudden sounds and increased human activity during construction work.

Reference Number 7.19 :
Wake Effects, Wind Rights, and Wind Turbines: Why Science, Constitutional Rights, and Public Policy Issues Play a Crucial Role, Kimberly E. Diamond. William & Mary Environmental Law and Policy Review Volume 40 (2015-2016) Issue 3 Article 5 May 2016

When wind wakes generated from wind turbines on an immediately adjacent neighbour's property extend over a downwind neighbour's land, that land will experience wake-related adverse impacts.

A general description of wind wakes and wake effects is as follows. The term "wind wake" is derived from the wakes moving ships leave behind them in the water. Specifically, there is a v-shaped Kelvin wake that spreads out behind a ship, starting from the ship's hull. A turbulent wake bisects the Kelvin wake, creating a zone of churning, choppy water in a corkscrew-like pattern down the middle of the Kelvin wake. Similar to ships, utility-scale wind turbines create wakes from wind passing through them. Wakes, with respect to wind turbines, refer to the wind speed deficit and reduced energy content wind possesses after leaving a particular utility-scale wind turbine. Once wind flows through a turbine, the volume of air downwind from it has a reduced wind speed and increased turbulence compared to wind flowing in the free stream, or, rather, wind that is travelling at its natural velocity that another obstruction has not impeded or redirected (such as a house, barn, tree, complex terrain including hills or mountains, or other obstacles such as another wind turbine). While atmospheric conditions, including seasonal temperature fluctuations, relative humidity, and other environmental factors, can substantially impact the size, scale, shape, and overall pattern of a wake (known as a "wake rose"), a turbine's blade length and angle at which the blade is attached to the turbine are significant factors in the size and magnitude of the wake, as well as the distance the wake travels.

Scientists still are debating the length to which a wind turbine wake extends. However, the scientific community generally agrees that a wake from a utility-scale commercial wind turbine can extend a minimum distance of eight to ten times such turbine's rotor diameter. In fact, Texas Tech University's Wind Science and Engineering Center conducted a recent study using Doppler radar that shows turbine wakes persisting up to fifteen times the rotor diameter of the wake-generating turbine.

Reference Number 7.20:
A new USGS report shows a link between air disturbed by wind turbines and vegetation patterns By Communications and Publishing September 26, 2022

Denver, CO. — The trails of disturbed air produced by wind turbines—known as wakes—can alter downwind temperatures and humidity, and a new U.S. Geological Survey study has demonstrated for the first time that wakes can impact vegetation in the vicinity.

The study's insight into the effects of wakes from wind turbines on vegetation is an important first step to understanding how wind energy affects terrestrial ecosystems. Wind energy is rapidly and globally expanding, with five-fold increases since 2010 and predictions of up to 10-fold growth over the next 30 years.

"We are just beginning to understand how the wakes from wind turbines affect both the terrestrial and offshore environment," said USGS Research Ecologist, Jay Diffendorfer, "The next step will be to better understand where and why these effects occur."

In the study, scientists modeled wake and non-wake zones around 17 wind facilities across the United States, to test if wakes influenced vegetation condition, which was measured using data from USGS's Landsat satellites. The study was designed to isolate the effects of turbine wakes from other factors that could affect vegetation condition around wind facilities, such as new roads or agriculture.

These wake-induced changes in vegetation condition were found for part or all of the growing season at 10 of the 17 facilities studied. Researchers found that wakes can have both positive and negative effects on vegetation greenness, a measure that is often used in remote sensing to assess vegetation density and crop health, and that the magnitude of the change in greenness depended primarily on earlier precipitation. The changes observed at some facilities were consistent with levels that other studies found can affect breeding bird clutch size, species richness, and ungulate abundance.

As wind energy expands, understanding where and when wind turbines positively or negatively affect vegetation may aid in future decisions about where to site wind energy infrastructure. For example, careful placement may benefit agriculture or grazing while minimizing unwanted reductions to the vegetation greenness in the vicinity.

Widely acknowledged environmental impacts include wildlife deaths from turbine collisions, habitat loss, and behavioural avoidance of wind facilities by some species (Allison et al 2019).

A newly emerging, potential environmental impact may be the effects of turbine wakes ('wakes') on microclimates and vegetation. Wind turbines generate wakes as they remove energy from wind resulting in lower wind speeds and increased turbulence. These wakes are large enough to reduce energy generation at downwind facilities (Lundquist et al 2019). They can also change air, surface, and soil temperatures, as well as humidity (Zhou et al 2012, Armstrong et al 2016, Xia et al 2016, Rajewski et al 2020), but not always (Moravec et al 2018). Field-collected and remotely-sensed surface temperature data show wakes can cause nighttime warming up to 1.5 °C–1.9 °C (Rajewski et al 2013, Smith et al 2013) and cool daytime temperatures (Rajewski et al 2013, Xia et al 2016), although these effects vary with wind conditions and season.

Reference Number 7.21:
Wind turbine wakes can impact down-wind vegetation greenness Jay E Diffendorfer, Melanie K Vanderhoof and Zach H Ancona United States Geological Survey, Geosciences and Environmental Change Science Center, Denver, CO 80225, United States of America *Environ. Res. Lett.* 17 (2022) 104025 https://doi.org/10.1088/1748-9326/ac8da9 26 September 2022

Global wind energy has expanded 5-fold since 2010 and is predicted to expand another 8–10-fold over the next 30 years. Wakes generated by wind turbines can alter downwind microclimates and potentially downwind vegetation. However, the design of past studies has made it difficult to isolate the impact of wake effects on vegetation from land cover change. We used hourly wind data to model wake and non-wake zones around 17 wind facilities across the U.S. and compared remotely-sensed vegetation greenness in wake and non-wake zones before and after construction. We located sampling sites only in the dominant vegetation type and in areas that were not disturbed before or after construction. We found evidence for wake effects on vegetation greenness at 10 of 17 facilities for portions of, or the entire growing season. Evidence included statistical significance in Before After Control Impact statistical models, differences >3% between expected and observed values of vegetation greenness, and consistent spatial patterns of anomalies in vegetation greenness relative to turbine locations and wind direction. Wakes induced both increases and decreases in vegetation greenness, which may be difficult to predict prior to construction. The magnitude of wake effects depended primarily on precipitation and to a lesser degree aridity. Wake effects did not show trends over time following construction, suggesting the changes impact vegetation greenness within a growing season, but do not accrue over years. Even small changes in vegetation greenness, similar to those found in this study, have been seen to affect higher trophic levels. Given the rapid global growth of wind energy, and the importance of vegetation condition for agriculture, grazing, wildlife, and carbon storage, understanding how wakes from wind turbines impact vegetation is essential to exploit or ameliorate these effects.

Reference Number 7.22 :
Vibrational noise from wind energy-turbines negatively impacts earthworm abundance. 2021, Velilla, Estefania; Collinson, Eleanor; Bellato, Laura; Berg, Matty P.; Halfwerk, Wouter Published in: Oikos DOI: 10.1111/oik.08166. www.oikosjournal.org

Human activities often impact the sensory environment of organisms. Wind energy turbines are a fast-growing potential source of anthropogenic vibrational noise that can affect soil animals sensitive to vibrations and thereby alter soil community functioning. Larger soil animals, such as earthworms (macrofauna, > 1 cm in size), are particularly likely to be impacted by the low-frequency turbine waves that can travel through soils over large distances. Here we examine the effect of wind turbine-induced vibrational noise on the abundance of soil animals. We measured vibrational noise generated by seven different turbines located in organically-farmed crop fields in the Netherlands. Vibratory noise levels dropped by an average of 23 ± 7 Db over a distance of 200 m away from the wind turbines. Earthworm abundance showed a strong decrease with increasing vibratory noise. When comparing the nearest sampling points in proximity of the wind energy turbines with the points furthest away, abundance dropped on average by 40% across all seven fields. The abundance of small-sized soil animals (mesofauna, < 10 mm in size) differed between crop fields, but was not related to local noise levels. Our results suggest that anthropogenic vibratory noise levels can impact larger soil fauna, which has important consequences for soil functioning. Earthworms, for instance, are considered to be crucial ecosystem engineers and an impact on their abundance, survival and reproduction may have knock-on effects on important processes such as water filtration, nutrient cycling and carbon sequestration.

Animals rely on different sensory stimuli to acquire and process information from their environment. The ability to acquire this information is essential for an animal's reproductive success and survival (e.g. finding a mate and detecting

a predator) (Dall et al. 2005, Dominoni et al. 2020). Activities tightly linked to human population growth are however interfering with environmental information processing of many animal species, with important population- and community-level consequences (Derryberry et al. 2020, Dominoni et al. 2020, Halfwerk 2020). Sensory pollutants, such as artificial light at night and traffic sounds have been shown to cause negative effects on animal behaviour and physiology, which can translate to reduced survival and reproduction, and ultimately to population declines (Barber et al. 2010, Kight and Swaddle 2011, Francis and Barber 2013).

Human activities are responsible for 50% of the earth's seismic noise levels (Lecocq et al. 2020), but the impact of this sensory pollutant on animals and their communities living in the soil remains largely unknown. **However, vibrational noise of natural and anthropogenic sources has been shown to affect mating interactions, predator prey dynamics and competition in different species** *(Caldwell et al. 2010, McNett et al. 2010, Roberts et al. 2016, Caorsi et al. 2019, Phillips et al. 2020, Velilla et al. 2020).* **A major contributing source of anthropogenic vibrational noise comes from wind energy turbines, which are mainly found in rural or farming areas and sometimes cover a large land surface. The blades, the rotor and the shafts from wind turbines are supported by a tower that is usually anchored to a heavy concrete and steel rebar platform reaching up to nine meters in depth** *(Stammler and Ceranna 2016). These platforms are needed to withstand the weight of the turbine, and although they may additionally reduce some of the vibrational noise created by the turbine, they induce vibrations in the soil, mostly in the low frequency range < 500 Hz (Stammler and Ceranna 2016). So far, we have little knowledge on how wind-turbine generated noise affects soil animals.*

The potential impact of noise on animals may depend on the overlap between an animal's body size and the spectral distribution of the vibrations that travel through the soil. Vibrations generated by wind energy turbines are typically low in frequency (< 500 Hz) and small-bodied animals (mesofauna, < 10 mm in size) might not be able to perceive, or even experience any strain from these low-frequency waves. Larger soil animals (macrofauna, > 1 cm in size), however, might be able to perceive low-frequency vibrations and can therefore be impacted by turbine noise through a perceptual mechanism. Among macrofauna, earthworms are particularly sensitive to low-frequency vibrations as they use vibrational cues to detect approaching predators (Catania 2008, Farina 2014). Earthworms are crucial ecosystem engineers (Jones et al. 1997) that are well known to influence soil structure, hydrology and nutrient quality as well as plant production (Clements et al. 1991, Van Groenigen et al. 2014, Bertrand et al. 2015). Vibratory noise from turbines may either mask, or mimic vibratory cues produced by approaching predators, such as moles, and earthworms may surface in response (Catania 2008, Dominoni et al. 2020). An increased perception of predation pressure, or decreased response to predatory cues could both lead to a decline in earthworm abundance in areas with high vibrational noise, consequently affecting soil structure, water infiltration, nutrient cycling, carbon sequestration and more (Blouin et al. 2013, Bertrand et al. 2015).

In the current study we assessed the effect of wind turbine-induced vibrational noise on earthworm abundance, and on the abundance of soil mesofauna. We hypothesized that vibrational noise would have a body-size dependent effect on soil animals and therefore expected a negative impact on earthworm abundance and no direct impact on the smaller mesofauna (although they could still be affected indirectly through an impact on earthworms). To test our predictions, we selected seven turbines stationed in agricultural fields in the Netherlands. We measured vibrational noise induced by wind turbines along a 14 transects and related these noise levels to earthworm and mesofauna abundance.

Earthworm abundance was negatively related to vibrational noise

We found that, on average, the number of earthworms decreased by 40% at the point furthest away from the turbines compared to the closest point to the turbines where we measured (128 m versus 8 m). Our results confirm that earthworm abundance decreased substantially as the amplitude of vibrational noise increased. The maximum amplitude difference over the range at which we surveyed earthworms was on average 13 Db. We therefore predict the impact of vibratory noise to be even bigger when measured over the whole transect, as vibrational noise levels near the base of the turbine are up to 30 Db higher than at our furthest sites (> 200 m from the turbine). We did not survey earthworm densities close to the turbine base as the composition of the soil differed substantially between the nearest points (2 m and 4 m) and remaining points of the transect. While we accounted for variation in soil compaction and crop type, neither of these factors was related to earthworm densities. Soil compaction and crop type also did not co-vary with distance to the wind turbines (Supporting information). Although vibration-specific receptors have not been described for any earthworm species, earthworms can detect tactile stimuli along their entire body (Laverack 1960), and tactile stimulation has been shown to induce activity in the segmental nerves (Laverack 1960, Mill and Knapp 1967). Earthworms also have distinct sensory cell bumps found along their body surface that contain multiciliate sensory cells (Langdon 1895, Knapp and Mill 1971, Gardner 1976, Mill 1982). A combination of sensory cell bumps and tactile sensitivity in earthworms, makes them a good candidate for vibration reception (Mitra 2009).

Sensory pollution consequences

Human-induced sensory pollutants can directly affect organisms through an impact on their perception, physiology and behavior (Brumm and Slabbekoorn 2005, Barber et al. 2010, Kight and Swaddle 2011, Naguib 2013, Velilla and Halfwerk 2019). It is possible that wind turbine-induced vibrational noise masks the vibrational cues of approaching foraging moles, making earthworms in noisy areas more prone to predation (Dominoni et al. 2020). Vibratory noise could also be misleading to earthworms (Dominoni et al. 2020), who may not be able to distinguish between vibratory cues coming from an approaching predator such as a mole, and the subterranean waves from the turbines. As matter of fact, earthworms are well known to be misled by other organisms, including humans who have developed so-called 'worm grunting' techniques that mimic soil vibrations from approaching moles (Catania 2008). Future studies should experimentally test which sensory mechanism is responsible for the patterns we revealed in this study. Alternatively, soil vibrations induced by wind turbines could alter the direct physical environment, e.g. through soil particle sorting or an impact on eartworm tunnel structures, thereby influencing water drainage and other abiotic conditions. Such physical impact should however also impact the mesofauna, which we did not report on our study. However it is clear that more data on the effects of vibrations on soil structure are needed, and vice versa.
Our findings suggest that noise could decrease earthworm densities, and ultimately modify the distribution of species that depend or interact with earthworms (Gutiérrez-López et al. 2010). In our study we did not find evidence for an effect of variation in earthworm abundance on the abundance of smaller soil animals. However, our measurements and observations were carried out in agricultural fields, possibly influencing the effects that earthworms would have under natural wild conditions, or in a different season. Further studies should examine the effect of vibrational noise on earthworm abundance in non-managed fields and its consequences on other soil organisms.
Earthworms play a crucial role in several soil processes including: soil formation, soil structure, water infiltration, nutrient cycling, carbon sequestration, climate regulation and primary production (Blouin et al. 2013, Bertrand et al. 2015). Furthermore, earthworms are known to play an important role in plant production (Baker et al. 2006, Blouin et al. 2013). Therefore, the negative relationship we find between wind turbine noise levels and earthworm abundance could potentially have cascading effects on other soil organisms and processes and should also draw attention to other sources of seismic noise (Lecocq et al. 2020).

Reference Number 7.23:
Impacts of wind turbines on a large terrestrial mammal – the moose – Does the presence of wind power turbines affect moose activity and habitat selection? Carolin Veronika Berndt. Swedish University of Agricultural Sciences, SLU Department of Wildlife, Fish and Environmental Studies Management of Fish and Wildlife Populations (M.Sc.) Umeå 2021

Across Europe and Sweden, the use of 'green' energies, such as wind power turbines, solar energy or hydropower is increasing. The growth of those alternative energies are expected to continue to be able to mitigate the effects of the climate change. Despite the positive effects, especially wind turbines can have severe direct impacts on wildlife species. Whereas the influence of wind turbines has been studied for many volant species, the impacts on terrestrial mammals are still understudied and remains ambiguous. This knowledge gap does not only result in an underrepresentation of mammal's needs in wind park planning processes, but also leaves unclarities about the impact on species' fitness, which is important for wildlife managers. The effects of constructional work of wind turbines on species comprises especially the increased noise effects, human occurrence, building of related infrastructures (e.g. roads), and direct habitat loss. However, if wind turbines during the operational period affect species in a similar way remains vague. Here, I used an existing dataset of 31 moose In northern Sweden to Investigate If three small wind parks affect a large mammal – the moose – in movement behaviour in sense of step length, and habitat selection in proximity of wind turbines. Furthermore, I used a step selection function to test if moose were selecting steps towards wind turbines or away from them.
Moose decreased their step length in proximity to the wind turbines and selected proportionally more forest habitats in relation to their availability, when their core area was in average closer to wind turbines than those which had their core area in average more than 5 km away from a wind turbine. Furthermore, moose surprisingly selected in average steps towards wind power turbines instead of away. However, the individual variation in selection strength was relatively high. Those partly contradictory results suggest an impact of wind turbines in some behavioural responses of moose. Further research is needed to clarify the magnitude of wind turbines impact on moose and other terrestrial mammals.

Reference Number 7.24:
How far are birds, bats, and terrestrial mammals displaced from onshore wind power development? – A systematic review Anne Tolvanen a, Henri Routavaara, Mika Jokikokko, Parvez Rana. Biological Conservation 288 (2023) 110382

Wind power is a rapidly growing source of energy worldwide. It is crucial for climate change mitigation*, but it also accelerates the degradation of biodiversity through habitat loss and the displacement of wildlife. To understand the extent of displacement and reasons for observations where no displacement is reported, we conducted a* systematic review *of birds, bats, and terrestrial mammals. Eighty-four peer-reviewed studies of onshore wind power yielded 160 distinct displacement distances, termed cases.*

For birds, bats, and mammals, 63 %, 72 %, and 67 % of cases respectively reported displacement.
Cranes (3/3 cases), owls *(2/2), and semi-domestic reindeer (6/6) showed consistent displacement on average up to 5 km.*
Gallinaceus birds showed displacement on average up to 5 km, but in 7/18 cases reported to show "no displacement".
Bats were displaced on average up to 1 km in 21/29 cases.
Waterfowl (6/7 cases),
raptors (24/30),
passerines (16/32)
and waders *(8/19) were displaced on average up to 500 m.*
Observations of no displacement were suggested to result from methodological deficiencies, species-specific characteristics, and habitat conditions favourable for certain species after wind power development.
This review provides information on distance thresholds that can be employed in the design of future wind energy *projects. However, most studies assessed the effects of turbine towers of <100 m high, while considerably larger turbines are being built today.*

Reference Number 7.25 :
Responses of GPS-Tagged Territorial Golden Eagles Aquila chrysaetos to Wind Turbines in Scotland. Alan H. Fielding, David Anderson, Stuart Benn, John Taylor, Ruth Tingay, Ewan D. Weston and D. Philip Whitfield. Diversity 2023, 15, 917. https://doi.org/10.3390/d15080917 https://www.mdpi.com/journal/diversity

Birds' interactions with wind turbines are a concern, and research has often focused on large raptors. This focus is largely on large raptors' demonstrable or purported vulnerability to collision with turbine blades.
Large raptors also possess life history traits sensitive to additive mortality from anthropogenic sources, notably in older individuals. Alarms have been raised
on collision mortality potentially affecting population viability in several species.
Another potentially adverse effect is avoidance, including avoidance of turbine arrays (wind farms) or individual turbines (macro- or meso-/micro-avoidance, respectively: through disturbance and displacement or wariness. This can produce functional habitat loss.
Despite an erstwhile predominance of recorded or assumed collision mortality, several studies have nonetheless concluded avoidance as the main response of large raptors to wind turbines, highlighting the consequential functional (indirect) habitat loss.
Functional habitat loss can incur serious impacts on large raptor populations. It may potentially affect territory occupancy and reproductive output in part because individuals occur at low densities with extensive habitat requirements. The significance of any habitat loss to territorial birds will depend not just on the amount of lost habitat but also on whether there is scope for compensatory territorial boundary reconfiguration which will, in turn, depend on the adjacent landscape suitability and the proximity of neighbouring pairs. The use of key resources by migratory individuals may also be affected detrimentally.
Simplistically, avoidance is antagonistic to collision. A bird that does not enter a wind farm or avoids flying close to turbine blades cannot collide with a turbine blade and be killed. The two processes are not necessarily mutually exclusive in risk, however. The observed balance in risk between avoidance (towards functional habitat loss) and collision (towards fatality) appears complex, involving several factors. Understanding these risk factors to predict the most likely adverse impact is critical in environmental impact assessments of future wind farm proposals.
The golden eagle Aquila chrysaetos is well-studied in wind farm research. In North America, the consensus is that both non-territorial and territorial birds are mostly vulnerable to collision and consequent fatalities. Avoidance may be more

likely in migrating eagles through the use of different sources of wind energy uplift to some resident birds. First-year (juvenile) eagles at Altamont in California, USA were less likely collision victims.
In Europe, the spatial coincidence between wind farm development and golden eagle distribution has been described repeatedly [53–55]. To our knowledge, however, there are no reports of golden eagle collision fatality rates from European wind farms comparable to those from North America. Scottish studies empirically concluded avoidance as the substantive response of golden eagles to wind turbines.
The risk of collision via proximity to turbines for non-territorial birds during natal dispersal in Scotland was increased if turbines were placed in a more preferred habitat, and at higher wind speeds, but not according to the age of turbines and their specifications or birds' age. Given the number of turbines, the duration of their operation, and their coincidence with the distribution of numerous eagles, however, reported collision fatalities were very low. In confirmation, a subsequent update (NatureScot unpublished data) lists only five collisions over a 10-year period.
This observation shows the balance between avoidance and collision is not either/ or. It is independently consistent, nevertheless, with the predominant reactions of GPS-tagged dispersing Scottish golden eagles to the presence of turbines, to avoid flying near them. This evidence from movement behaviour included records of spatial use before and after turbine presence.
Most Scottish studies have involved non-territorial eagles. Territorial eagles may not show the same degree of avoidance as non-territorial dispersing birds because they are
more spatially constrained to a territory. Non-territorial birds have a greater capacity to compensate for functional habitat loss by being able to utilise more areas free of turbines. An inherent cost of wariness in avoiding turbines, which occupy intrinsically preferred habitats, should be greater for territorial birds. Moreover, despite no evidence suggesting habituation in non-territorial eagles, repeated exposure to the same turbines may favour habituation in territorial birds (see also. This, again, could lessen avoidance responses so that collision may be more likely. Territorial birds also engage in flight displays, pair interactions, and territory defence behaviours that may distract from their ability to detect and respond to spinning turbine blades. We could expect, therefore, that territorial birds differ in their reaction to turbines and are less wary.

A key and generic international takeaway from the present and earlier studies of Scottish golden eagles' responses to turbines is that, if proposed turbines are in a highly
preferred habitat, then regardless of the base response to turbines (on the avoidance— collision continuum), such locations should be problematic in wind farm planning. This is because, if consented, they will either disproportionately increase the risk of greater functional habitat loss or increase the risk of collision fatalities. The two outcomes differ in their effects, but each has detrimental impacts.

Reference Number 7.26:
Wind Turbine Noise Behaviourally and Physiologically Changes Male Frogs, Jun-Kyu Park and Yuno Do . Biology 2022, 11, 516. https://doi.org/10.3390/biology11040516 https://www.mdpi.com/journal/biology

Wind turbines can induce behavioural and physiological responses in animals by emitting various types of noises.
In this study, we investigated the behavioural, physiological, and immunological responses of male Japanese tree frogs (Dryophytes japonicus) when exposed to wind turbine noise.
To determine the effects during the breeding season, frogs were collected from areas with and without wind turbines. Additionally, we exposed the frogs to recorded wind turbine noise at a site without a wind generator for 1 h to 24 h to analyze the short-term effects.
Three types of calling patterns (dominant frequency, note duration, and call rate) were analyzed to investigate behavioural responses. Physiological responses were assessed using two steroid hormones assays, namely testosterone and corticosterone detection in the saliva. The immunity of each individual was assessed using a bacterial killing assay. The wind turbine group in the field had a higher call rate and corticosterone levels and lower immunity than the group in the field without turbines present, and all three of these variables were correlated with each other. Conversely, in the noise exposure experiment, a higher call rate was only observed post-exposure compared to pre-exposure. Thus, turbine noise seems to induce decreased immunity in Japanese tree frogs as an increase in energy investment that triggers a behavioural response rather than acting as a sole physiological response that leads to a direct increase in corticosterone. This decreased immunity due to energy tradeoff or physiological response can change the disease epidemiology of the population and create new adaptive patterns in these habitats.

In addition to humans, these noises can potentially affect other animals that hear or interact with sounds.

Graylag geese raised near wind turbines were physiologically affected by the noise itself, so they had higher cortisol levels in blood and lower weight gain than geese raised away from turbines. Turbine noise also affects the vocal communication of the greater prairie chicken (Tympanuchus cupido pinnatus) by changing the soundscape of its surroundings.
Additionally, turbine noise actually induces increases in cortisol through the hypothalamic–pituitary–adrenal (HPA) axis response of the European badger (Meles meles), which the researchers suggest could alter the risk of infection or disease in the population by changing the immune system.
Frogs that live in various types of freshwater habitats assemble at specific locations during the breeding season and use acoustic signals to find mates. Therefore, wind turbine noise during the breeding season may negatively affect the mating of frogs. If the sound pressure level of the noise during this period is large or the frequency of noise overlaps with that of the calling in a frog species, a masking effect that dilutes the acoustic signal can occur at breeding sites. Although select studies have reported on the masking effect of noise on various biological responses in frogs, these studies have focused primarily on noise emitted by traffic and airplanes. These noises can show strong pulses in a short time, with irregular intervals, whereas the noise generated by wind turbines can be persistent and of relatively low intensity. Additionally, it is necessary to understand whether wind turbine noise acts as a single stressor or affects species through other complicated processes.
Male frogs can enhance advertisement calling to avoid these masking effects, a response that could be physiologically associated with corticosterone, a glucocorticoid hormone that aids in glucose mobilization. Additionally, noise can directly affect the endocrine system of frogs. A change in the endocrine response due to stress leads to increased corticosterone by stimulation of the HPA axis. Whether these two effects act alone or in combination, a momentary increase in corticosterone allows the animal to respond appropriately to a threatening situation by assisting in the immediate coping mechanism caused by metabolic changes and the allocation of required energy.
However, the chronic increase in corticosterone due to prolonged energy tradeoffs caused by stress can lead to reduced immunity by a maladaptive response, such as imbalances in energy allocation.

Reference Number 7.27:
Irish Government 1.2 Policy Context
In growing recognition of the importance of reversing biodiversity decline and its interactions with climate change adaptation and mitigation, international and EU biodiversity policies are being strengthened. At the UN High-Level Summit for Biodiversity in September 2020, An Taoiseach signed up to the Leaders' Pledge for Nature which supports the 30/30 targets and calls for an ambitious and meaningful post-2020 global agreement that will address the biodiversity crisis and help bring about the transformative change needed to halt biodiversity loss on a global level. The EU has published its European Green Deal and its constituent element, the EU Biodiversity Strategy to 2030, which is intended to support a green recovery following the Covid-19 pandemic. The Strategy's objective is to put the EU's biodiversity on the path to recovery by 2030 and that by 2050, all of the EU's ecosystems are restored, resilient and adequately protected. It contains specific actions and commitments, including:

- Establishing a larger EU wide network of protected areas on land and at sea by 2030 (30% on both land and sea, 10% of both being strictly protected)

- Establishing a Nature Restoration Plan, with legally-binding restoration targets

- Unlocking funding for transformative change and a strengthened governance framework.

The Biodiversity Strategy also includes a requirement that Member States ensure that at least 30% of species and habitats not currently in favourable conservation status achieve that status or show a strong positive trend by 2030, and that none show further signs of deterioration. The Nature Restoration Regulation aims to complement existing EU environmental policy and legislation. It is intended to work effectively in synergy with other EU environmental laws, primarily the Habitats Directive, but also the Birds Directive, the Water Framework Directive, the Marine Strategy Framework Directive and the Invasive Alien Species Regulation. It also will align with the Common Fisheries Policy, the Common Agricultural Policy, the EU Soils Strategy, the EU Green Infrastructure Strategy and the new EU Forest Strategy for 2030. Restoring ecosystems is also necessary for the EU to meet its commitments under the United Nations Framework Convention on Climate Change, and the Paris Agreement. The links between biodiversity-rich environments and climate resilience are recognised in our National Climate Objective under the Climate Action and Low Carbon Development (Amendment) Act 2021. The regulation requires Member States to establish and implement measures to

restore at least 20% of the EU's land and sea areas by 2030. Member States will also be required to develop national restoration plans and report on progress made.

At the international level, the Convention on Biological Diversity has concluded its negotiations on the post-2020 global biodiversity framework, with four goals and 23 targets for achievement by 2030. These include
- To have effective conservation and management of at least 30% of the world's lands, inland waters, coastal areas and oceans, with emphasis on areas of particular importance for biodiversity and ecosystem functioning and services

- To have restoration completed or underway on at least 30% of degraded terrestrial, inland waters, and coastal and marine ecosystems

and a goal of

- Halting of human-induced extinction of known threatened species, increasing the abundance of native wild species to healthy and resilient levels.

Ireland's 4th National Biodiversity Plan, due for publication in January 2024, will reflect these changing global, European and national contexts.
European energy policy context is also rapidly evolving, particularly in view of the conflict in Ukraine and energy security pressures, with the EU deciding in early 2023 on targeted amendments to the renewable energy directive3.
Dedicated areas are to be identified at the Member State level to facilitate accelerated permitting of renewable energy developments; these areas are to exclude Natura 2000 sites, amongst others.

5.3 Wind energy development
There is considerable overlap between the breeding range of hen harriers and the upland areas in which wind energy development has been concentrated in Ireland. As of 2016, over two hundred and fifty wind turbines occurred within the hen harrier SPA network.
The Windharrier project carried out by University College Cork (UCC) between 2012 and 2014, with funding from the wind energy industry, examined a range of potential impacts of wind energy development on hen harrier (Wilson et al., 2015). The low numbers and density of hen harriers makes it difficult to carry out scientific work at a sufficient scale to provide strong statistical evidence, and such work may only provide indications of effects rather than certainty. That said, in relation to hen harrier breeding parameters, the study found:

(a) that breeding success was statistically non-significantly lower within 1000m of wind turbines, although sample sizes were relatively small; and

(ii) that, based on composite considerations of findings, it is possible that lower breeding success recorded within 1000m of wind turbines reflects a biologically relevant pattern.
In addition, the density of all bird species, including likely prey species for hen harrier, was lower at wind energy development sites than control sites, and lower again closer to turbines.
Windharrier found that the risk of direct collision with wind turbine rotors was low. However, since its conclusion in 2015, NPWS has received evidence of one "possible"6 and three "probable/confirmed"7 incidences of hen harrier mortality caused by turbine strike.

*In summary, there is now some evidence that hen harrier breeding productivity may be impacted by wind turbine development close to nesting areas. This is particularly relevant as the Habitats Directive requires that planning decisions must ensure that there are no adverse effects on the integrity of European, or Natura, sites, for a project or plan to be consented to under Article 6(3) of the Habitats Directive. Furthermore, judgments of the European Court of Justice and the Irish courts have set out that appropriate assessments should "**include complete, precise and definitive findings and conclusions that are capable of removing all scientific doubt as to the effects of the proposed development on … [sites] concerned**" (High Court, 2014).*

Reference Number 7.28:
[2023/2413: DIRECTIVE (EU) 2023/2413 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652]

37) The construction and operation of renewable energy plants can result in the occasional killing or disturbance of birds and other species protected under Directive 92/43/EEC or under Directive 2009/147/EC of the European Parliament and of the Council(20). However, such killing or disturbance of protected species should not be considered to be deliberate within the meaning of those Directives if the project for the construction and operation of those renewable energy plants provides for appropriate mitigation measures to avoid such killing, to prevent disturbance, to assess the effectiveness of such measures through appropriate monitoring and, in the light of the information gathered, to take further measures as required to ensure that there are no significant adverse impact on the population of the species concerned.

Article 15c: ***Renewables acceleration areas***

1. *By 21 February 2026, Member States shall ensure that competent authorities adopt one or more plans designating, as a sub-set of the areas referred to in Article 15b(1), renewables acceleration areas for one or more types of renewable energy sources. Member States may exclude biomass combustion and hydropower plants. In those plans, competent authorities shall:*

ii) excluding Natura 2000 sites and areas designated under national protection schemes for nature and biodiversity conservation, major bird and marine mammal migratory routes as well as other areas identified on the basis of sensitivity maps and the tools referred to in the point

(iii)using all appropriate and proportionate tools and datasets to identify the areas where the renewable energy plants would not have a significant environmental impact, including wildlife sensitivity mapping, while taking into account the data available in the context of the development of a coherent Natura 2000 network, both as regards habitat types and species under Council Directive 92/43/EEC (2), as well as birds and sites protected under Directive 2009/147/EC of the European Parliament and of the Council*

(b) By 21 May 2024, Member States may declare as renewables acceleration areas specific areas which have already been designated to be areas suitable for an accelerated deployment of one or more types of renewable energy technology, provided that all of the following conditions are met:

(c) such areas are outside Natura 2000 sites, areas designated under national protection schemes for nature and biodiversity conservation and identified bird migratory routes;

'Article 27
'(iii) that areas designated by international or national law or by the relevant competent authority for nature protection purposes, including in wetlands, grassland, heathland and peatlands, are protected with the aim of preserving biodiversity and preventing habitat destruction, unless evidence is provided that the harvesting of that raw material does not interfere with those nature protection purposes;

[It should be noted that most of these species use wind thermals to navigate. The potential 40km wake down wind of the turbines to the East/North-East & to a height of 789.65m OD, will create a disturbed air barrier to their navigation & prevent access from the Clare River to Lough Corrib. This barrier will cause massive displacement & habitat loss.]

Reference Number 7.29:
Observations of wind farm wake recovery at an operating wind farm Raghavendra Krishnamurthy1, Rob K. Newsom1, Colleen M. Kaul1, Stefano Letizia2, Mikhail Pekour1, Nicholas Hamilton2, Duli Chand1, Donna Flynn1, Nicola Bodini2, and Patrick Moriarty. Wind Energ. Sci., 10, 361–380, 2025 https://doi.org/10.5194/wes-10-361-2025 ©Author(s) 2025.

Wind turbine wakes, i.e., velocity deficits due to extraction of the kinetic energy from an operating wind turbine, are observed to extend several kilometers during stable atmospheric conditions both onshore and offshore (Hirth et al., 2012; Banta et al., 2015; Krishnamurthy et al., 2017; Fernando et al., 2019; Ahsbahs et al., 2020; Zhan et al., 2020). Wind farm wakes from a large cluster of wind turbines in mesoscale model simulations, and offshore observations can reach over 50km downwind under stable atmospheric conditions (Platis et al., 2018; Lundquist et al., 2019, Schneemann et al., 2020). Large-eddy simulations of large wind farms also show that wind farm wakes can alter the

surface momentum and heat fluxes (Calaf et al., 2011). Wind farm wakes are known to impact the local meteorological conditions by, for instance, increasing or decreasing the temperature and enhancing turbulence downwind of a wind farm (Baidya Roy et al., 2004; Smith et al., 2013; Siedersleben et al., 2018; Miller and Keith, 2018, Bodini et al., 2021), although the intensity of the impact depends on atmospheric stability, local atmospheric processes, orientation of the wind farms, downwind distance, and the number and operative regimes of wind turbines.

In operational wind farms, intra-farm wakes can result in significant power losses, and it is important to understand the dissipation of wakes within a wind farm. The effect of a wind turbine is to decrease the mean velocity and increase the turbulent kinetic energy above the rotor layer (the layer from the bottom of the wind turbine blade tip to the top of the blade tip; VerHulst and Meneveau, 2014). The turbulent transport term in a steady-state filtered-energy equation includes the entrainment of the mean momentum due to turbulence and the entrainment of the turbulent kinetic energy due to fluctuating velocities (Allaerts and Meyers, 2017).
Today's wind turbines operate within the lowest 300m of the atmospheric boundary layer (ABL), and in offshore or stable atmospheric conditions the ABL can be lower than 300m (Shaw et al., 2022). Although wind farms operate within 300m above ground level, their impacts can be observed through the entire depth of the boundary layer. Therefore, to accurately assess such impacts, observations of mean and turbulent characteristics of wind and temperature should extend up to the top of the ABL.

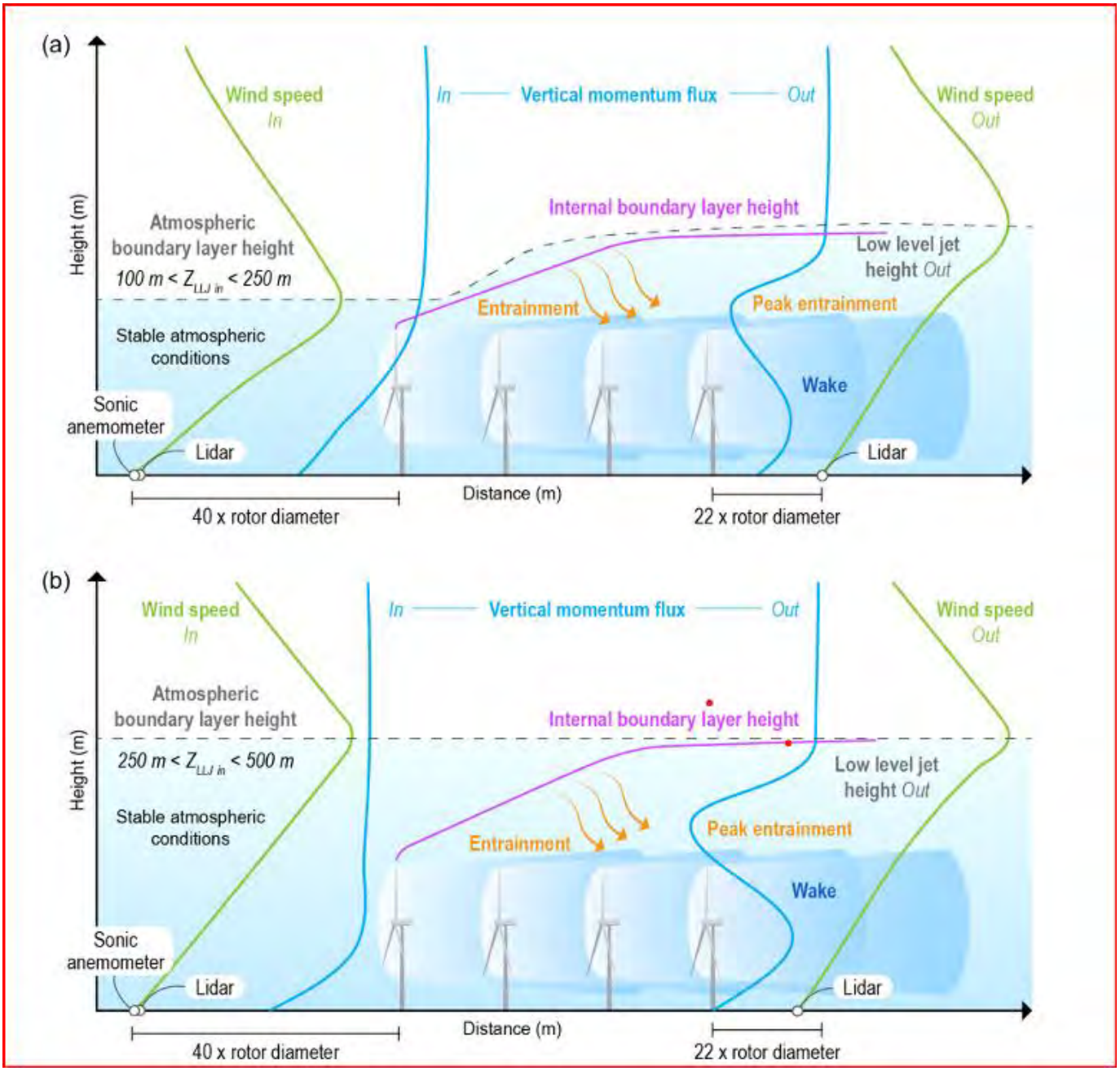


Figure: Schematic of the impact of LLJs on a wind farm boundary layer when (a) 100m<ZLLJ<250m and (b) 250m<ZLLJ<500m.

Note the Wake distance of 22 times rotor diameter which equates to 3.3m for a 150m diameter. Negative wind shear during non-LLJ cases show short wake propagation at 22 Rotor Diameters downwind of a wind turbine.

Reference Number 7.30

How far the wake of a wind farm can persist for? Guodan Dong, Zhaobin Li, Jianhua Qin, Xiaolei Yang. Theoretical and Applied Mechanics Letters 12 (2022) 100314.

With the increased penetration of wind energy in our nation's energy portfolio, wind farms are placed in a way close to each other. Thus, their wakes have to be fully considered in the design and operation of a wind farm. In this study, we investigate the wake of a wind farm using large-eddy simulation with wind turbine rotor modelled by the actuator disk model. The simulated results show that the wake of a wind farm can persist for a long distance in its downstream. For the considered wind farm layout, the velocity in the wake recovers 95% of that of the undisturbed inflow at 55 rotor diameters downstream from its last row, suggesting that the wake of a wind farm should be fully considered in the optimal design and operation for its downstream wind farms.

The simulated results show that the streamwise velocity recovers 95% of the undisturbed incoming wind speed at 55 *D* downstream of the last row of the wind farm. The influences of wind turbine wakes persist for a very long distance, which are still observed even at 165 *Diameters* downstream of the last row of the wind farm.

For a 117m rotor diameter wind turbine, 55D = 6.435km & 165D = 19.305km. Thus houses & farms are subject to property losses, agricultural output losses over these distances, temperature losses & heating costs without their consent.

Reference Number 7.31:

The effect of varying distances from the wind turbine on meat quality of growing-finishing pigs, Małgorzata Karwowska, Jan Mikołajczak, Zbigniew Józef Dolatowski, Sylwester Borowski. *Ann. Anim. Sci., Vol. 15, No. 4 (2015) 1043–1054 DOI: 10.1515/aoas-2015-0051*

This study was conducted to assess the effect of rearing pigs at three different distances from a wind turbine (50, 500 and 1000 m) on the physicochemical properties and fatty acid composition of loin and neck muscles. The experiment was carried out on 30 growing-finishing pigs, derived from Polish Landrace × Polish Large White sows mated to a Duroc × Pietrain boar. The results obtained during the noise measurement showed that the highest level of noise in the audible and infrasound range was recorded 50 m from the wind turbine. Rearing pigs in close proximity to the wind turbine (50 m) resulted in decreased muscle pH, total heme pigments and heme iron as well as reduced content of C18:3*n-3* fatty acid in the loin muscle. Loins of pigs reared 50 m from the wind turbine were characterized by significantly lower iron content (6.7 ppm g–1) compared to the loins of pigs reared 500 and 1000 m from the wind turbine (10.0–10.5 ppm g–1). The concentration of α-linolenic acid (C18:3*n-3*) in loin and neck muscles decreased as the distance from the wind turbine increased. Avoiding noise-induced stress is important not only for maintaining meat quality but also for improving animal welfare.

It should be noted that many applications quote effects from a 2015 paper for Illinois, USA.

Reference Number 7.32:

Observed Thermal Impacts of Wind Farms Over Northern Illinois. Lauren M. Slawsky, Liming Zhou, Somnath Baidya Roy, Geng Xia, Mathias Vuille and Ronald A. Harris. Sensors 2015, 15, 14981-15005; doi:10.3390/s150714981

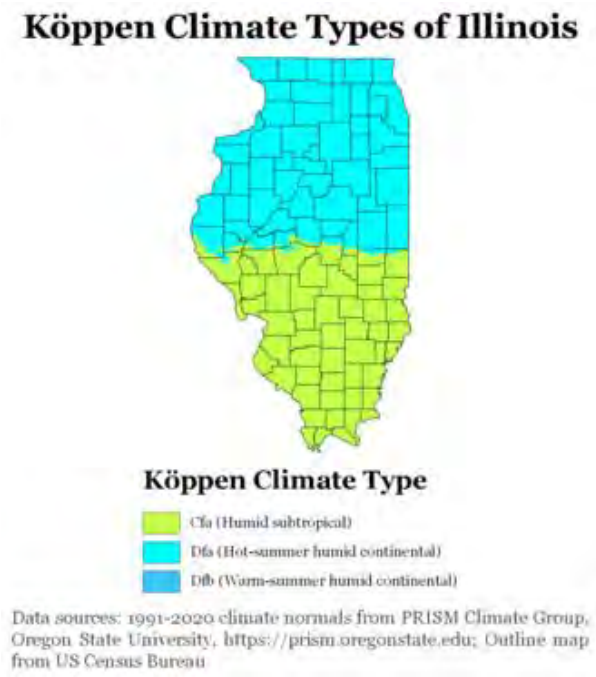
The 2025 Operating Turbines in Illinois have a c80 m hub-height with rotor diameters of about 80 m & an electrical power output capacity of c1.5 Mw to 2Mw before 2015 & far less than 7.2Mw. These turbines do not operate continuously over 12 month periods.

Illinois Plant Name	State	Summer Capacity (MW)	Operating Month	Operating Year	Number of Turbines	Size of Turbines (Mw)	Predominant Turbine Manufacturer	Predominant Turbine Model Number	Design Wind Speed (mph)	Wind Quality Class	Turbine Hub Height (Feet)	Turbine Hub Height (metres)
Alta Farms II Wind Project, LLC	IL	200.5	5	2023	100	2	Siemens Gamesa	SG 5.0-145	23.0	2	107.5	32.8
Sapphire Sky Wind Energy LLC	IL	259.8	2	2023	64	4	Vestas	V150-4.2	18.3	2	383.9	117.0
Moraine Sands Wind Power	IL	165.0	12	2023	38	4	Vestas	V150-4.2	16.8	3	394.0	120.1
Shady Oaks Wind 2	IL	108.3	10	2023	22	5	Vestas	V150-4.2	17.5	3	344.5	105.0
Midland Wind	IL	105.5	12	2023	28	4	Vestas	V150-4.2	22.0	1	344.0	104.9
Ford County Wind Farm LLC	IL	121.3	3	2022	43	3	GE	2.82-127	18.1	1	292.0	89.0
Lincoln Land Wind	IL	302.0	11	2021	107	3	GE	2.82-127	17.4	3	374.0	114.0
Bennington Wind	IL	93.0	10	2021	33	3	GE	2.82-127	17.5	2	290.3	88.5
Glacier Sands Wind Power, LLC	IL	185.0	11	2021	43	4	Vestas	V150-4.2	16.8	3	344.0	104.9
Blooming Grove Wind Energy Center	IL	250.0	12	2020	94	3	GE	2.82-127	17.2	2	292.0	89.0
Cardinal Point Wind	IL	150.0	3	2020	60	3	GE	2.82-127	17.0	2	292.0	89.0

Lone Tree Wind, LLC	IL	79.0	12	2020	32	2	GE	2.5-127	17.4	3	292.0	89.0
Whitney Hill Wind Power LLC	IL	65.0	3	2020	24	3	GE	2.82-127	13.0	2	416.0	126.8
Sugar Creek Wind One LLC	IL	202.0	11	2020	114	2	Vestas	V150-4.2	15.6	3	393.7	120.0
Harvest Ridge Wind Farm	IL	202.0	7	2020	48	4	Vestas	V150-4.2	17.0	2	345.0	105.2
Otter Creek Wind Farm LLC	IL	150.0	3	2020	42	4	Vestas	V136-3.45	16.1	3	269.0	82.0
Green River Wind Farm	IL	194.3	11	2019	74	3	Gamesa	G126-2.5	15.7	3	275.6	84.0
Bright Stalk Wind Farm I	IL	205.2	12	2019	57	4	Vestas	V136-3.45	18.2	3	325.0	99.1
Hilltopper Wind Project	IL	185.0	12	2018	74	3	GE	2.5-100	25.0	2	380.0	115.8
Bishop Hill III	IL	119.0	6	2018	53	2	GE	2.3-116	27.0	2	295.3	90.0
Walnut Ridge Wind Farm	IL	212.0	12	2018	106	2	Vestas	V100-2.0	15.7	3	312.0	95.1
Radfords Run Wind Farm	IL	278.0	12	2017	139	2	Vestas	V110-2.0	14.5	4	311.6	95.0
Kelly Creek Wind Project	IL	184.0	12	2016	92	2	Vestas	V100-2.0	19.0	2	262.5	80.0
Pilot Hill Wind Farm	IL	175.0	8	2015	103	2	GE	1.7-100	19.0	3	262.4	80.0
Hoopeston Wind LLC	IL	98.0	3	2015	49	2	Vestas	V100-2.0	17.0	2	311.0	94.8
Minonk Wind Farm	IL	192.3	11	2012	100	2	Gamesa	G90-2.0	18.3	2	328.1	100.0
California Ridge Wind Energy LLC	IL	200.0	12	2012	134	1	GE	1.6-100	18.1	3	328.1	100.0
Bishop Hill Energy LLC	IL	200.0	6	2012	133	2	GE	1.6-97	16.1	2	328.1	100.0
Bishop Hill II Wind Farm	IL	81.0	10	2012	50	2	GE	1.6-100	16.8	3	328.0	100.0
Shady Oaks Wind Farm	IL	109.5	5	2012	71	2	Goldwind	GW 82/1500	17.0	3	328.1	100.0
Heartland Community College	IL	1.7	6	2012	1	2	Vestas	V82-1.65	14.5	3	262.0	79.9
Settlers Trail Wind Farm LLC	IL	150.4	10	2011	94	2	GE	1.6 XLE	16.6	2	262.4	80.0
Pioneer Trail Wind Farm, LLC	IL	150.4	12	2011	94	2	GE	1.6 XLE	17.4	2	262.4	80.0
White Oak Energy LLC	IL	150.0	6	2011	100	2	GE	1.5 XLE	16.8	3	262.5	80.0
Brown County Wind Turbine	IL	1.5	9	2011	1	2	VENSYS	VENSYS77	16.5	2	281.0	85.6
Big Sky Wind LLC	IL	239.4	2	2011	109	2	Vestas	V120-2.0	19.0	2	277.2	84.5
Streator Cayuga Ridge South	IL	300.0	3	2010	150	2	Gamesa	G87-2.0	16.1	3	256.0	78.0
Blackstone Wind Farm II LLC	IL	200.0	8	2010	132	2	GE	1.5 SLE	19.0	2	262.0	79.9
EcoGrove Wind LLC	IL	100.5	7	2009	67	2	Acciona	AW82/1500	16.8	3	262.4	80.0
FPL Energy Illinois Wind LLC Hybrid	IL	217.5	12	2009	145	2	GE	1.5 XLE	17.9	2	262.4	80.0
Blackstone Wind Farm LLC	IL	106.0	10	2009	68	2	GE	1.5 SLE	19.0	2	262.0	79.9
Rail Splitter Wind Farm	IL	100.5	8	2009	67	2	GE	1.5 SLE	19.0	2	262.0	79.9
Grand Ridge Wind Energy Center	IL	51.0	12	2009	34	2	GE	1.5 SLE	17.2	2	263.0	80.2
Grand Ridge Wind Energy Center	IL	49.5	12	2009	33	2	GE	1.5 SLE	17.2	2	263.0	80.2
Grand Ridge Wind Energy Center	IL	10.5	12	2009	7	2	GE	1.5 SLE	17.2	2	263.0	80.2
Geneseo	IL	1.5	9	2009	1	2	VENSYS	VENSYS77	18.0	2	200.0	61.0
Geneseo	IL	1.5	10	2009	1	2	VENSYS	VENSYS77	18.0	2	200.0	61.0
Providence Heights Wind LLC	IL	72.0	8	2008	36	2	Gamesa	G87-2.0	15.7	3	256.0	78.0
Grand Ridge Wind Energy Center	IL	99.0	10	2008	66	2	GE	1.5 SLE	18.3	2	263.0	80.2
Com Adam 1WF-1	IL	2.5	10	2007	1	3	Clipper	Liberty C96	17.0	3	328.0	100.0
Com Adam 1WF-1	IL	2.5	10	2007	1	3	Clipper	Liberty C93	17.0	3	262.4	80.0
GSG LLC	IL	80.0	6	2007	40	2	Gamesa	G87-2.0	19.0	2	256.0	78.0
Camp Grove Wind Farm	IL	150.0	12	2007	100	2	GE	1.5 SLE	15.5	2	262.0	79.9
Agriwind	IL	8.4	7	2007	4	2	Suzlon	S88-2100	15.9	2	262.4	80.0
Old Trail Wind Farm	IL	213.8	12	2007	120	2	Vestas	V82-1.65	19.0	2	262.0	79.9
High Trail Wind Farm LLC	IL	210.9	3	2007	120	2	Vestas	V82-1.65	19.0	2	262.0	79.9
Crescent Ridge	IL	53.0	12	2005	28	2	NEG-Micon	NM82/1650	21.0	2	256.0	78.0
Pike County Wind Power	IL	1.7	5	2005	1	2	Vestas	V82-1.65	13.7	2	235.0	71.6
Mendota Hills, LLC	IL	76.2	11	2003	29	3	Gamesa	G126-2.5	18.0	2	275.0	83.8

				TOTAL no. Tur-bines	3,777							

The **Climate of Illinois** describes the weather conditions, and extremes, noted within the state of Illinois, United States, over time.



Köppen climate types of Illinois (with counties overlaid), using 1991-2020 climate normals.

Because of its nearly 400-mile (640 km) length and mid-continental location, Illinois has a widely varying climate. Most of Illinois has a humid continental climate (Köppen climate classification *Dfa*) with hot, humid summers and cool to cold winters. However, the southern half of the state, from about Springfield southward, has a humid subtropical climate (Köppen *Cfa*) with winters becoming more moderate as one travels south. Average yearly precipitation for Illinois varies from 48 inches or 1,220 mm at the southern tip to 35 inches or 890 mm in the northern portion of the state. Normal annual snowfall exceeds 38 inches or 0.97 m in Chicago, while the southern portion of the state normally receives less than 14 inches or 0.36 m.[1] The highest temperature recorded in Illinois was 117 °F (47.2 °C), recorded on July 14, 1954, at East St. Louis, while the lowest temperature was −38 °F (−38.9 °C), recorded on January 31, 2019, at Mount Carroll.

Monthly average high and low temperatures in Fahrenheit for various Illinois cities

City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cairo	41/25	47/29	57/39	69/50	77/58	86/67	90/72	88/69	81/61	71/49	57/39	46/30
Chicago	31/16	35/20	47/29	59/39	70/48	80/58	84/64	82/63	75/54	62/43	48/32	35/21
Edwardsville	36/19	42/24	52/34	64/45	75/55	84/64	85/59	86/66	79/58	68/46	53/35	41/25
Moline	30/12				73/50	83/60	86/64	84/62	76/53	64/42	48/30	34/18
Peoria					73/51	82/60	86/65	84/63	77/54	64/42	49/31	36/20
Rockford					71/48	81/58	84/63	82/61	75/52	62/40	47/30	33/17
Springfield					74/53	83/62	86/66	84/64	78/55	67/44	51/34	38/23

Basically, a tip height of 120m & not comparable to Ballinla at 185m & 7.2Mw, nor is the weather. Using 10-year-old scientific papers for non-comparable windfarm size is not objective.

"Most modeling studies indicate that the presence of large groups of wind turbines is expected to have noticeable climatic impacts from local to regional scales, and likely at global scales as well."…. The effect of wind farms on meteorology is essentially an atmospheric boundary layer (ABL) problem. The detailed physical processes of ABL-turbine interactions remain mostly unknown because of the complexity and heterogeneity of turbulence over different regions."

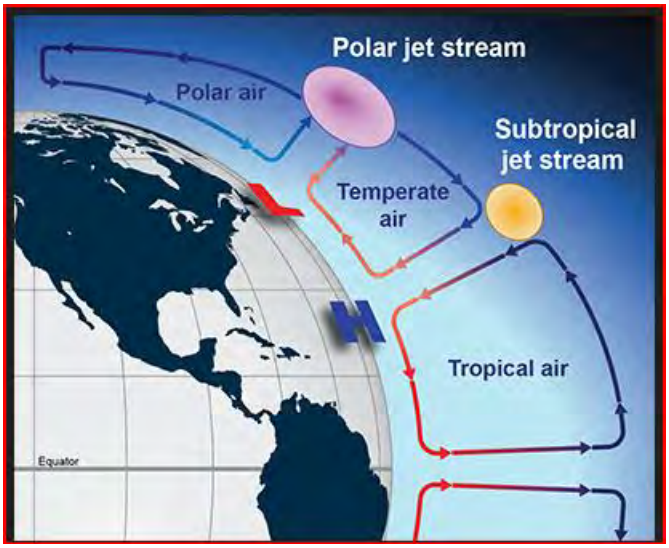
"Turbulence decreases farther downwind from the rotor blades , and a distance of ten rotor diameters downstream is enough for the flow to recover from the turbulence caused by the rotor blades. For example, the 1.5 MW GE wind turbines have a rotor diameter of ~80 m, meaning 10 rotor diameters away would be 800 m."

Reference Number 7.33:

Climatic Impacts of Wind Power. Miller & Keith, Joule 2, 2618–2632 December 19, 2018. 2018 Elsevier Inc. https://doi.org/10.1016/j.joule.2018.09.009

Climatic impacts due to wind power extraction were first studied using general circulation models (GCMs). These studies found statistically significant climatic impacts within the wind farm, as well as long-distance teleconnections, with impacts outside the wind farm sometimes as large in magnitude as impacts inside the wind farm. Note that such impacts are unlike greenhouse gas (GHG)-driven warming, as in some cases wind power's climatic impacts might counteract such GHG warming—at least four studies have found that mid-latitude wind power extraction can cool the Arctic. However, these studies often used idealized or unrealistic distributions of turbines installed at unrealistic scales. Model simulations of geometrically simple, isolated wind farms at smaller scales of 3,000–300,000 km2 (10- to 1,000 times larger than today's wind farms) in windy locations found substantial reductions in wind speed and changes in atmospheric boundary layer (ABL) thickness, as well as differences in temperature, precipitation, and vertical atmospheric exchange.

In central USA, The warming is greatest in an N-S corridor near the center of the wind turbine array, perhaps because of an interaction between wind turbines and the nocturnal low level jet (LLJ). The LLJ is a fast nocturnal low-altitude wind (>12 m/ s at 0.5 km) common in the US Midwest, which occurs when the atmosphere decouples from surface friction, resulting in a steep vertical temperature gradient —meteorological conditions that might be sensitive to perturbations by wind turbines.



The climatic impacts of wind power may be unexpected, as wind turbines only redistribute heat within the atmosphere, and the 1.0 W m2 of heating resulting from kinetic energy dissipation in the lower atmosphere is only about 0.6% of the diurnally averaged radiative flux. ***But wind's climatic impacts are not caused by additional heating from the increased dissipation of kinetic energy. Impacts arise because turbine-atmosphere interactions alter surface-atmosphere fluxes, inducing climatic impacts that may be much larger than the direct impact of the dissipation alone.***

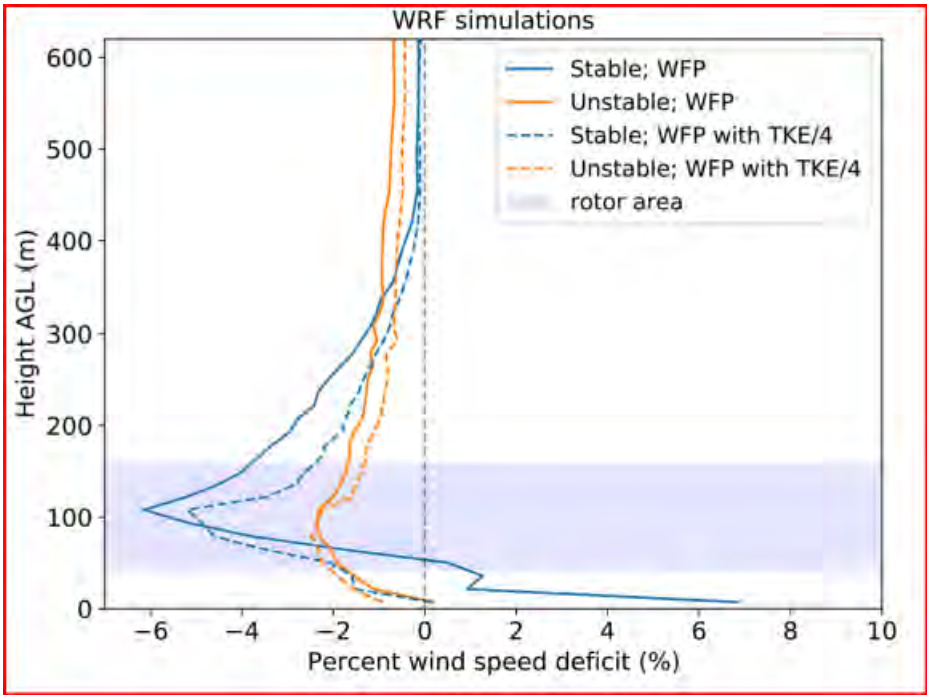
As wind turbines extract kinetic energy from the atmospheric flow and slow wind speeds, the vertical gradient in wind speed steepens, and downward entrainment increases. These interactions increase the mixing between air from above and air near the surface. The strength of these interactions depends on the meteorology and, in particular, the diurnal cycle of the atmospheric boundary layer(ABL).

Reference Number 7.34:

Wind plants can impact long-term local atmospheric conditions Nicola Bodini, Julie K. Lundquist, & Patrick Moriarty. Scientific Reports | (2021) 11:22939 | https://doi.org/10.1038/s41598-021-02089-2.

The presence of the wind plant induces a wake that varies with wind speed, wind direction, and ambient turbulence.

The magnitude of the wake increases as wind speed increases toward the rated wind speed of the turbines; the wake erodes quickly in daytime convective conditions but persists for long distances downwind in stable conditions.



Supplementary Abstract

Long-term weather and climate observatories can be affected by the changing environments in their vicinity, such as the growth of urban areas or changing vegetation. Wind plants can also impact local atmospheric conditions through their wakes, characterized by reduced wind speed and increased turbulence. We explore the extent to which the wind plants near an atmospheric measurement site in the central United States have affected their long-term measurements. Both direct observations and mesoscale numerical weather prediction simulations demonstrate how the wind plants induce a wind deficit aloft, especially in stable conditions, and a wind speed acceleration near the surface, which extend c30km downwind of the wind plant. Turbulence kinetic energy is significantly enhanced within the wind plant wake in stable conditions, with near-surface observations seeing an increase of more than 30% a few kilometers downwind of the plants.

As wind flows past the rotating blades of a wind turbine, some of its momentum is devoted to moving the blades and generating electricity. As a result, the downwind flow is slower and more turbulent. Assessing the characteristics of this wake has been identified as one of the grand challenges that wind energy science needs to face to drive innovation in the sector and meet future energy demand. Wakes are particularly complex: their characteristics depend on the incoming wind speed, wind direction, and turbulence, as well as turbine operation and associated parameters. In convective conditions, wakes tend to be eroded rapidly by ambient turbulence. In stably stratified conditions with weak turbulence, wakes tend to exhibit a large wind speed deficit and persist for long distances downwind. For example, aggregated wakes from multiple turbines, i.e., wind plant wakes, can extend more than 50 km downwind of a wind plant, offshore in stable conditions. In addition to the wind speed deficit and the enhancement of turbulence at the heights above the surface corresponding to the wind turbine rotor, wakes can affect local surface conditions.

Reference Number 7.35:

Impacts of 319 wind farms on surface temperature and vegetation in the United States. Yingzuo Qin et al 2022 Environ. Res. Lett. 17 024026

Despite the climate benefits of wind power, there is a growing concern about the environmental effects of the increased land use and land cover change for wind farms. For example, the large deployment of wind farms can adversely affect local animal habitats, and the rotary blades of wind turbines can kill birds (Bright et al 2008) and bats (Voigt et al 2012). Wind farm construction can also result in deforestation, soil erosion, and impacts on land carbon sequestration (Dai et al 2015, Armstrong et al 2016).

The modification of land surface properties by wind farms also strongly influences the local and regional climate (Kirk-Davidoff and Keith 2008, Baidya Roy and Traiteur 2010, Zhou et al 2012), which in turn will influence ecosystem processes (Armstrong et al 2016). Changes to the climate are attributable to the wind turbines increasing the surface roughness (Kirk-Davidoff and Keith 2008) with implications for turbulence (Xia et al 2016) and mixing in the atmospheric boundary layer (ABL) (Baidya Roy and Traiteur 2010). Moreover, the wind turbines remove energy from the system and decrease downstream wind speeds (Miller and Kleidon 2016).

As for impacts on vegetation, ***our results showed decreased vegetation for most wind farms,*** *especially those large farms. However, positive and insignificant impacts were observed as well. The decreased vegetation is mainly caused by the construction of wind farms and the associated land cover changes, limiting vegetation growth in wind farms (Tang et al 2017, Urziceanu et al 2021). The increased vegetation in wind farms may be caused by the changing microclimate conditions induced by wind farms.*

Our results from a large sample of wind farms revealed significant local warming effects at night, insignificant impacts during the daytime, and the mostly negative impacts on vegetation.

Reference Number 7.36:

Local-scale impact of wind energy farms on rare, endemic, and threatened plant species Mihaela Urziceanu, Paulina Anastasiu, Laurentiu Rozylowicz and Tatiana Eugenia Sesan. PeerJ 9:e11390 http://doi.org/10.7717/peerj.11390

Although the number of wind energy farms within protected areas has significantly increased in the past decade, few studies have quantified their impact on protected plant species recovery. Our study suggests that wind energy farms' operation affects the local diversity of protected plant species.

Legislation: Wildlife Act 1976, Wildlife (Ammendment Act) 2000, Bonn Convention, Bern Convention (Appendix II), Eurobats Agreement, Habitats Directive (Annex IV)

Total 2023 (Table 20)	35402	Total 2024 (Table 30)	60,331
	2023 Table 14	2024 Table 27	
Common pipistrelle	8,111	5182	
Soprano pipistrelle	13,035	5756	
Leisler pipistrelle	739	2304	
Myotis	365	103	
Brown Long eared	116	482	
Nathusius pipistrelle	0	15	

Bat Conservation Ireland Wind Turbine/Wind Farm Development Bat Survey Guidelines Version No. 2.8 December 2012

Wind turbines and bats Wind turbines are a known risk to bats (Arnett et al. 2008, Baerwald et al. 2008, Betts 2006, Cryan and Brown 2007, Johnson et al. 2003, Johnson and Strickland 2004, Zagmajster et al. 2007) and the UNEP/EUROBATS Secretariat published guidelines on bats and wind farm projects (Rodrigues et al. 2008) to ensure bats are considered as part of development proposals.

Although further worldwide research on bat/turbine interactions needs to be undertaken, studies to date in Europe and the U.S.A. (Kunz et al. 2007, Arnett et al. 2008, Horn et al. 2008, Rydell et al. 2010), have shown that bat mortality due to wind turbines is a serious issue. Bats are known to be killed either through a fatal change in pressure within the lungs (Baerwald et al 2008) or through collision with rotor blades (Rollins et al. 2012). There is no evidence to suggest that the Irish context is unique in avoiding such a conflict.

To date, ten bat species have been recorded in Ireland and all, apart from one, Leisler's bat Nyctalus leisleri, are normally low fliers e.g.<10m above ground level and as such are considered to be at a lower risk from turbine impacts. However, pipistrelle species have been observed to investigate new landscape structures such as turbine masts. Data from European wind turbine related mortality includes high numbers of pipistrelle species of which approximately 50% occur outside the migratory season.

Leisler's bat is classified as a high risk species in relation to wind turbines as it is a high flier (Carlin and Mitchell-Jones 2009) which travels considerable distances (up to 13.4km has been recorded in Ireland, Shiel et al. 1999) between roosts and foraging areas. The species has evolved for fast flight in excess of 40km/h (Dietz et al. 2007) and is less manoeuvrable as a consequence. It therefore avoids cluttered environments by keeping above the tree canopy normally flying between 10m and 70m above the ground (Russ 1999) but the species has been known to reach heights of 500m (Bruderer and Popa-Lisseanu 2005). Flying at such heights potentially brings it into direct risk of collision with wind turbines.

BATLAS 2020 – A Bat Distribution Survey

Final Report 2016-2018

Pickett, S., Aughney T., Roche N. & Langton, S.

Table 1: Total number of records for BATLAS 2020 Target Bat Species and Non Target Bat Species (2015-2019 dataset).

Target Bat Species	No. of Records (% of total survey sites)	Non-Target Bat Species	No. of Records
Common pipistrelle	1,977 (55%)	Brown long-eared bat	134
Soprano pipistrelle	2,465 (68%)	Natterer's bat	78
Leisler's bat	1,304 (36%)	Whiskered bat	34
Daubenton's bat	1,105 (31%)	Nathusius' pipistrelle	55
		Lesser horseshoe bat	14

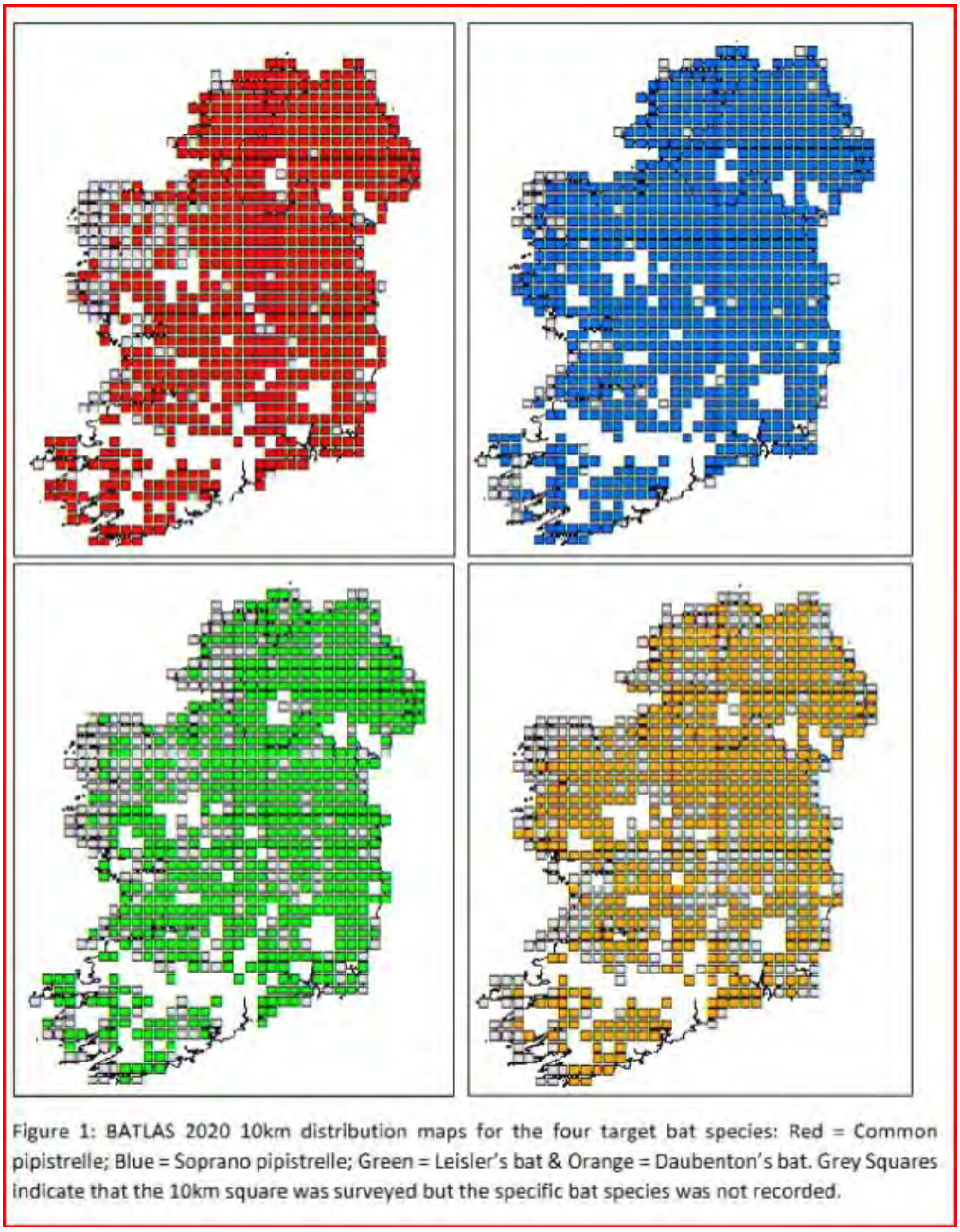


Figure 1: BATLAS 2020 10km distribution maps for the four target bat species: Red = Common pipistrelle; Blue = Soprano pipistrelle; Green = Leisler's bat & Orange = Daubenton's bat. Grey Squares indicate that the 10km square was surveyed but the specific bat species was not recorded.

Reference Number 8.1 :
An Assault on Lakeland Wildlife and Animals, Wind Concerns in Home, Elk Point/St. Paul, Wildlife and Birds. March 9, 2023

Recent studies are definitive: wind turbines wreak havoc on many animals, bats, and fowl that are forced to live among them.
In a landmark court decision in France,[1] evidence was presented showing that exposure to IWTs (industrial wind turbines) is associated with an increased risk of AHEs (adverse health effects).

This analysis concludes that living or working near IWTs can result in AHEs in both people and animals:

"Wind turbines and adverse health effects: Applying Bradford Hill's criteria for causation", (2021) Dumbrille et. al., journals.lww.com

Regarding animals, the study concluded:

- ***Reports of negative effects on animals, which are known not to show any nocebo effect and which live close to wind turbines, resulted not only in stress reactions, but also in negative effects on fertility, development and reproduction.***

Reports from the USA, Canada, Denmark, Japan, Portugal, France, Taiwan and Great Britain indicated teratogenic and mutagenic effects (see Appendix Dumbrille et al.).

In layman's terms, that's malformed embryos and genetic mutation in animals.

Health impacts of wind turbines on animals, birds and bats is a perennial question, especially as wind farms proliferate around the globe. Studies from well over a decade ago were already harbingers that the noise and infrasonic (low inaudible range frequencies) of wind turbines were affecting animals. In a 2009 paper, the author's concluded that "There is growing documentation from medical professionals about the related adverse health effects on humans and animals living within affected areas."[2]

Startling costs to insect and bird populations

There are over three hunded studies compiled by National Wind Watch on the adverse effects in a range of animals, birds, bats, and insects (see here*). For instance, cortisol levels have been found to increase in geese and ground dwelling animals*[3] *when as near as half a kilometer from wind turbines. By the end of the study, geese nearest the turbine had lost weight, weighing in 10% less than those further away.*[4]

'Researchers found that wind turbines in Germany resulted in a loss of about 1.2 trillion insects *of different species each year. In India, they found almost four times fewer buzzards, hawks, and kites in areas with wind farms—a loss of about* 75 percent*. They found that wind turbines are akin to adding a top predator to the ecosystem, killing off birds, but allowing small animals to increase their populations resulting in a trickle effect throughout the ecosystem.'*[5]

Cattle farmers have laid blame for mass deaths and other issues on wind turbines,[6] *including the electrical currents induced by them through the ground.*[7] *Equestrian property owners have reported their horses dwelling at the far reaches of their pastures to escape the effects of the massive turning blades.*[8] *And in Norway, the Supreme Court awarded herdsmen there 90 million NOK (10 million USD) in 2021 for wind farms that interfered with their livelihoods:*

> *The animals steer clear of the turbines because they are disturbed by their view and noise. On top of that, in the coldest months large chunks of icy snow can be thrown into the distance as the blades turn. It is dangerous for humans and animals alike.*
>
> *Leif Arne Jåma, "Indigenous Sámi Win Landmark Case against Wind Power Company", Nov. 4, 2021;* earthisland.org

While buildings and cats claim hundreds of millions of bird deaths each year, the proliferation of wind farms is only making matters worse. Studies show as many as 1.17 million birds are killed by wind turbines in the United States alone each year — a number that will only increase with the rapid spread of massive wind farms.[9] *While that's far less than deaths by cats, vehicles, communication towers, etc. what is notable and concerning is that it is large migratory species that are being affected.*

> *The results of this ground-breaking study are really eye-opening — the buildout of wind energy is already having a negative cumulative impact. There are more than 10,000 wind turbines scattered throughout the Whooping Cranes' migratory pathway. We now know that too many of these turbines are eliminating important migratory stopover habitat for this Endangered species.*
>
> *Joel Merriman, Director of the Bird-Smart Wind Energy Campaign at American Bird Conservancy, April 1, 2021;* ESA

And German zoologists are raising the alarm that millions of bats are slaughtered each year because of these industrial wind projects.[10] *See* Bat Apocalypse*.*

Still, this article has merely grazed the scope of environmental harm these massive industrial warm farms are causing to wildlife (and, of course, people).[11] *Which is why it is almost incomprehensible that the province of Alberta may permit two wind farm projects to be built along the North Saskatchewan River near Elk Point, Alberta — a major recreational and wildlife corridor, fishing paradise, migratory path, and horse and cattle sanctuary, highly populated with rural residences.*

Reference Number 8.2:
Bat Apocalypse by Wind Concerns in Home, Wildlife and Birds, August 17, 2023

The destruction of migratory birds by industrial wind turbines has earned them the well-deserved title "bird blenders." But even more alarming is the far more widescale destruction of bat populations, many of them now endangered species.

Studies in both Germany *and* North America *have determined that hundreds of thousands if not millions of bats are being slaughtered now annually by wind turbines. There appear to be two causes of death, the first being blunt force trauma: the bats are hit by the turbine blades, suffering broken arms, wings, and skull bones. The second, believed to be the majority of fatalities, is through what is known as "barotrauma": as a turbine blade spins, it forms pockets of low-pressure air trailing behind the blade. The sudden expansion of the air in nearby bats' lungs causes them to rupture resulting in fatal haemorrhaging. Either is a brutal death.*

Unlike birds, it appears that bats are actually drawn toward turbines, either mistaking their tall structure for trees or perhaps because insects and moths, the staple diet of most bats, are drawn to wind farms by the heat they generate.

Certain species are attracted to wind turbines. When we point thermal cameras up and watch bat activity in and around wind turbines, we see bats contacting the structures like the tower, the nacelle, chasing the blades, making swoops and patterns. It's not just bats randomly passing through and happening to get hit by the wind turbine blades; they're spending time and increasing their risk.

Dr. Cris Hein, Senior project lead in the National Renewable Energy Laboratory, November 18, 2022; Cosmos Magazine

With wind energy corporations building increasingly taller turbines, the crisis is only worsening.

As turbine height increases, bat deaths increase exponentially. What we found is a lot of internal haemorrhaging.

Erin Baerwald, Ecologist, University of Calgary; August 26, 2008; Scientific American

Wind turbines kill at least 500,000 bats annually in the U.S., according to Texas-based Bat Conservation International.

"When you start wiping out bat populations like this that are already in decline, the concern isn't just the loss of endangered species but the impact this has on the entire ecosystem," says Wind Concerns Editor-in-Chief, Mark Mallett.

Experts predict that four bat species will lose more than half of their populations due to collisions with wind turbines in the next 15 years if effective conservation actions are not taken soon.

"State of the Bats Expert Elicitation Summary", 2023, batcon.org

Bats play an essential role in pest control, pollinating plants and dispersing seeds. Recent studies estimate that bats eat enough pests to save more than $1 billion per year in crop damage and pesticide costs in the United States corn industry alone. Across all agricultural production, consumption of insect pests by bats results in a savings of more than $3 billion per year. "They also keep moths and caterpillars at bay increasing crop yields," says Professor Fiona Mathews of Exeter University who published a study *on wind farm bat casualties. "So it's something that affects us all."*

Earlier this year, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) announced that the Hoary Bat, Eastern Red Bat and Silver-haired Bat have been assessed as Endangered in Canada. This listing now means that 5 of the 9 bat species that occur in Alberta have been formally assessed as Endangered.[5]

Moreover, "it is illegal to harm or kill any species of bats in Alberta," which are protected under the Alberta Wildlife Act. Across North America, millions of cave-hibernating bats have died from the disease White-Nose Syndrome, caused by a fungus that grows in caves. This fungus was detected in Alberta in 2022. According to the Alberta government's fact sheet updated in June 2023, "It is important to protect bats and their habitat to ensure they can recover from the disease"

It isn't clear, then, how any future wind turbine projects can be approved without violating this provincial law — unless the province grants a wind energy corporation a permit to essentially continue the slaughter.

Bat casualty

"So if I swing a bat and kill one of these species, I go to prison," says Mallett. "If the wind energy corporations do it, several times a day, they get a free pass. When wind energy is unreliable to begin with, why are governments continuing to allow these environmentally destructive industrial wind plants to continue?"

In order to mitigate bat deaths, some wind companies are turning off their turbines at night or during migratory periods.

We need to remember bats have been around for at least 30 million years and during that time have been able to fly happily without the risk of colliding with a spinning object. If bats are actively attracted to turbines then it might not prove possible to predict this accurately in advance.

Professor Fiona Mathews, Exeter University, Nov 8, 2016, Express

"So how is this a solution for creating reliable energy?" asks Mallett. "This is the point that Premier Danielle Smith has been repeatedly asserting: the power grid needs constant and reliable energy. That's neither wind nor solar at the best of times. And the solution is to make wind energy even less effective? This is nonsensical."

Trudeau's federal government is now demanding that provinces reach so-called "net-zero" emissions by 2035. However, Saskatchewan's leader called the plan "impossible" while Premier Smith warned this would create energy insecurity and is "unconstitutional, irresponsible and utterly out of step with reality."

"So, from where we stand," says Mallett, "we are strongly urging the Premier to simply put an end to wind energy expansion in this province and look for other clean reliable sources that aren't so incredibly harmful, destructive, and divisive. There is absolutely nothing "green" about wind energy. Period."

Wind turbine plants take up huge tracts of land; they require massive amounts of fossil fuel to manufacture, transport, and install; they have a short lifespan; they produce power unreliably; they are toxic and present serious problems in their decommissioning; they kill massive amounts of large migratory birds, bats, and now whales; they use up prime farmland; they destroy pristine landscapes; and they have been proven definitively to harm both human and animal health.

"And now, if we continue to destroy bats which are essential to our ecosystem," says Mallett, "how exactly are we saving the planet?"

Reference Number 8.3:
Post construction bird and bat monitoring at wind farms in Victoria Ver. 1.0 Public report 13th Wind Wildlife Research Meeting 2020. Symbolix

1.2.1 Cumulative estimated mortality rates
We present a table in Section 4.6 of the estimated annual mortality per turbine for each species. This is limited to the species found at three or more sites, as we cannot reliably report combined results for species found at only one or two sites.
• Turbine size influences the mortality estimate, due to differing 'fall zones' for carcasses (Hull and Muir 2010). We estimated per turbine mortality for two size classes.
– Small (SML) turbines have rotor diameter of less than or equal to 103m. Anything larger was classed as Large (LRG).
– At time of writing there were 544 small class turbines and 220 large class turbines in Victoria (Appendix A).

• Between 7 and 10.8 bat mortalities occur per turbine per year in Western Victoria. The rate is not significantly different for different sizes (Section 4.5.1)

• For birds, significantly more mortalities occur at larger turbines. For small turbines, between 3.4 and 4.1 bird mortalities occur per turbine per year. For large turbines, the range varies between 5 and 6.7 per turbine per year.

• Our study suggests that mortalities are higher for White-striped Freetail Bats than any other bat or bird species. Between four to six White-striped Freetails are struck per turbine, and they were discovered at every site in the study. This implies that turbines in Western Victoria strike around as many White-striped Freetails as all birds combined.

Table 5: Twenty-five most documented species during carcass searches (at included sites)

Common name	*No. found*	*No. sites*
White-striped Freetail Bat	*229*	*10*
Gould's Wattled Bat	*77*	*8*
Australian Magpie	*69*	*10*
Unidentified Bird	*45*	*7*
Nankeen Kestrel	*41*	*8*
Raven sp.	*35*	*7*
Wedge-tailed Eagle	*33*	*7*
Eastern False Pipistrelle	*33*	*5*
European Skylark	*33*	*3*
Brown Falcon	*26*	*7*
Large Forest Bat	*16*	*6*
Lesser Long-eared Bat	*15*	*<3*
Little Forest Bat	*13*	*6*
Unidentified Bat	*11*	*6*
Southern Freetail Bat	*10*	*4*
Southern Bent-wing Bat	*8*	*<3*
European Goldfinch	*7*	*5*
Common Starling	*7*	*5*
Welcome Swallow	*6*	*4*
Chocolate Wattled Bat	*6*	*4*
Red-rumped Parrot	*5*	*<3*
Grey-headed Flying-fox	*4*	*<3*
House Sparrow	*4*	*<3*
Magpie-lark	*4*	*<3*
Southern Forest Bat	*4*	*<3*

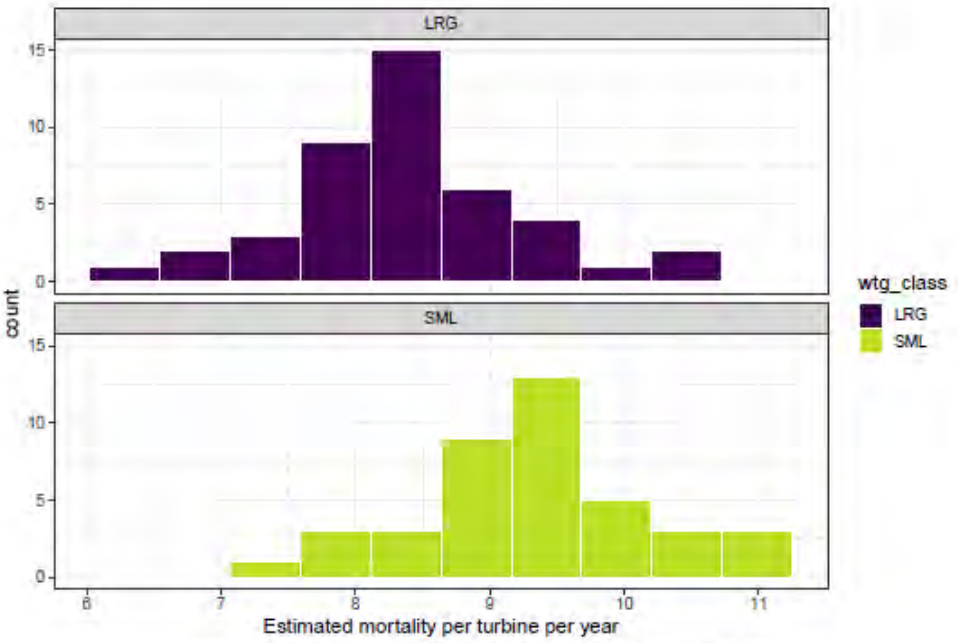


Figure 11: Credible Distribution of Bat Mortalities per turbine year

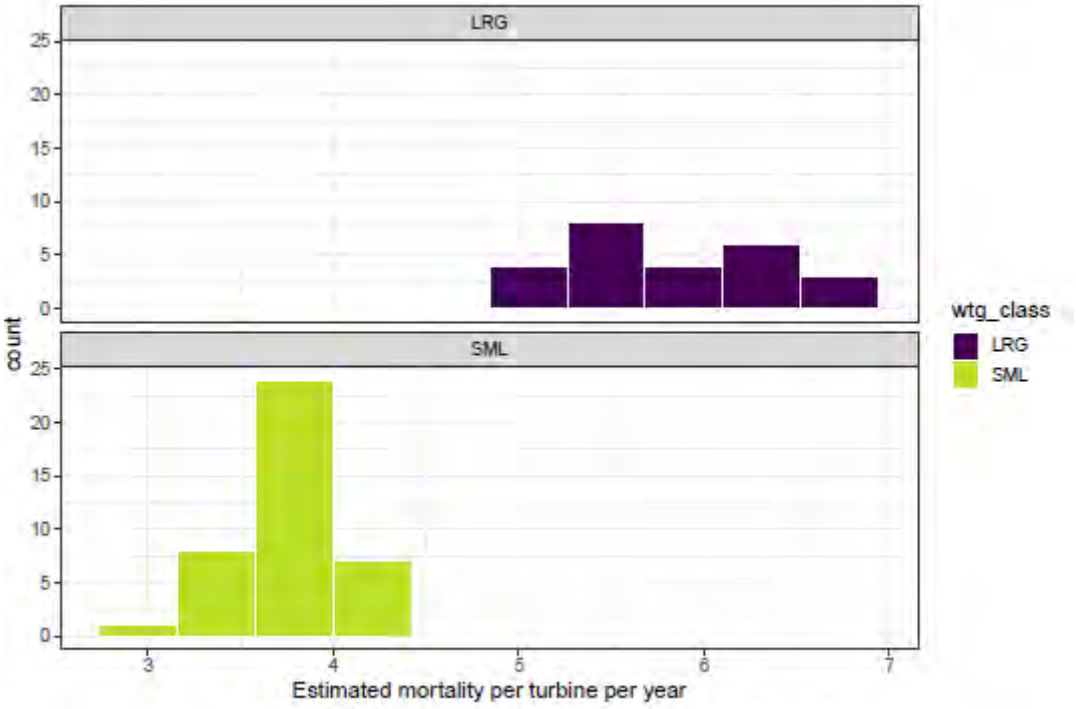


Figure 12: Credible Distribution of Bird Mortalities per turbine year

Reference Number 8.4:
An updated review of Hypothesis regarding bat attraction to wind turbines, Guest, E.E.,Stamps, B.F., Durish, N.D., Hale, A.M., Hein, C.D., Morton, B.P.,Weever, S.P., Frits, S.R. Animals, MDPI, January 2022, 12,343., https://doi.org/10.3390/ani12030343

"Patterns of bat activity and mortalities at wind energy facilities suggest that bats are attracted to wind turbines based on bat behaviour responses to wind turbines. For example, current monitoring efforts suggest that bat activity increases post wind turbine construction, with bats making multiple passes near wind turbines. We separated the attraction hypothesis into five previously proposed explanations of bat interactions at or near wind turbines, including

attraction based on noise, roost sites, foraging and water, mating behaviour, and lights, and one new hypothesis regarding olfaction, and provide a state of the knowledge in 2022."

Noise: " Bat echolation calls are among the loudest natural sounds and provide reliable sensory perception for navigating and foraging at night. Evidence of bats using acoustic cues between 3 and 12kHz from distances of up to several hundred metres prompted the idea that noise emitted from wind turbines could be misinterpreted as prey."

Roosting: "It is hypothesised that the tall, stand-alone structure of wind turbines on the landscape could be misinterpreted by bats as trees and viewed as potential roost structures."

Foraging and Water: "Insect density around wind turbines may be positively correlated with bat activity, because bats may perceive wind turbines as a potential food source. The proposed logic for the accumulation of insects near wind turbines includes hilltopping behaviour, insect attraction to the light or heat emitted from wind turbine structures, and insect attraction to wind turbine colour."

Mating: "It is suggested that male and female bats of some species visually orient toward the tallest trees on the landscape for navigation toward mating aggregations. Direct observation through thermal imaging coupled with mortality trends suggest that wind turbines may be used by bats for orientation to potential mating sites."

Lights: "Lights on wind structures or associated infrastructure may directly or indirectly contribute to increased bat activity."

Olfaction: "Recent work using paired thermal video and acoustic recording at Meteorological tower sites documented swarming activity concentrated at various focal points on the Meteriological tower structure, including mechanical anemometers, wind vanes, the top of the tower, and aircraft marker balls."

Reference Number 8.5:
Bats and onshore wind turbines: Survey, Assessment and Mitigation, version August 2021, NatureScot, Natural England, Natural Resources Wales, RenewableUK, Scottish Power Renewables, Ecotricity Ltd., University of Exeter, Bat Conservation Trust (BCT).

"Assessing potential impacts: Wind farms can affect bats in the following ways:

1) *Collision mortality, barotraumas and other injuries.*
2) *Loss or damage to commuting and foraging habitat.*
3) *Loss of, or damage to, roosts*
4) *Displacement of individuals of populations ."*

Reference Number 8.6:
Conservation: Tracking bats around wind turbines. M. Teague O'Mara, Current Biology 33, R136–R158, February 27, 2023 2022 Elsevier Inc. . https://doi.org/10.1016/j.cub.2022.12.048

Alternative energy is essential for a green future but comes at a high risk for animals. New research shows that forest-based wind turbines may create an ecological trap for bats that typically are repelled by wind turbines.
Like many other tree-roosting migratory bats, common noctules are particularly vulnerable to wind turbine mortality. Common noctules migrate and forage at altitudes commonly occupied by wind turbines. They are the most commonly killed bat species at wind turbine facilities in Germany, and like many bat species worldwide, their populations are declining rapidly. Common noctules will roost in bat boxes, but prefer natural tree cavities such as woodpecker holes for roosting during the day. By placing GPS loggers on common noctule bats that roosted near wind turbine fields in Germany, Reusch and colleagues tracked individual bats over time. This allowed them to test how these bats interacted with wind turbine habitats in and out of forests, both at an individual and population level. Typically, surveys that track bat activity rely on acoustic detectors that record echolocation calls that can then be identified to species or a group of species and give a measure of occupancy and activity for the area. Miniaturized GPS tracking pushes beyond an anonymous, population-level view to understand how individuals arrived at a site, and how the site was selected and used.
Reusch and colleagues found that per night common noctules flew 16 km, covering an area of 11 ± 34 km2, and spent roughly half their time commuting across farmland and meadows to forests where they feed on a wide range of moths, beetles and other insects.

Reference Number 8.7 :
Conservation: Tracking bats around wind turbines. O'Mara, M.T., 2022, Current Biology, https://doi.org/10.1016/j.cub.2022.12.048

"Flying animals face the highest risk from wind turbines, as birds and bats seek out the same conditions that make wind generation profitable. These energetically advantageous conditions allow animals to fly cheaply on uplifting winds and thermals or on prevailing winds. The placement of wind turbines in such profitable wind conditions may dramatically endanger migration, commuting and foraging pathways. Preference for these habitats makes bats particularly vulnerable to turbine related mortality, and efforts in . North America have focussed on why and how bats are attracted to wind turbines at night.....This conflict has resulted in millions of bats killed by wind turbines every year worldwide, including over 300,000 in Germany alone .... Common noctules flew 16km per night covering an area of 11+- 34km2".

Reference Number 8.8:
Wind turbine power and land cover effects on cumulative bat deaths. Aristides Moustakas, Panagiotis Georgiakakis, Elzbieta Kret, Eleftherios Kapsalis. Science of the Total Environment 892 (2023) 164536

Wind turbines (WT) cause bird and bat mortalities which depend on the WT and landscape features. The effects of WT features and environmental variables at different spatial scales associated to bat deaths in a mountainous and forested area in Thrace, NE Greece were investigated. Initially, we sought to quantify the most lethal WT characteristic between tower height, rotor diameter and power. The scale of interaction distance between bat deaths and the land cover characteristics surrounding the WTs was quantified. A statistical model was trained and validated against bat deaths and WT, land cover, and topography features. Variance partitioning between bat deaths and the explanatory covariates was conducted. The trained model was used to predict bat deaths attributed to existing and future wind farm development in the region. Results indicated that the optimal interaction distance between WT and surrounding land cover was 5 km, the larger distance than the ones examined. WT power, natural land cover type and distance from water explained 40 %, 15 % and 11 % respectively of the total variance in bat deaths by WTs. The model predicted that operating but not surveyed WTs comprise of 377.8 % and licensed but not operating yet will contribute to 210.2 % additional deaths than the ones recorded. Results indicate that among all WT features and land cover characteristics, wind turbine power is the most significant factor associated to bat deaths. In addition, WTs located within 5 km buffer comprised of natural land cover types have substantial higher deaths. More WT power will result in more deaths. Wind turbines should not be licensed in areas where natural land cover at a radius of 5 km exceeds 50 %. These results are discussed in the climate-land use-biodiversity-energy nexus.

Bats are long-lived mammals with low reproductive potential and thus high levels of adult individuals survivorship are important for maintaining a viable population (Wilkinson and South, 2002). All European bat species are strictly protected under the Habitats Directive (92/43/EEC, Annex IV) and the national legislation of many countries. Nevertheless, in the absence of specific mandatory regulations, the effect of wind farm installation and operation on bat populations is rarely examined to a sufficient extent in environmental impact assessments. This is in spite of the fact that increased mortality in wind turbines may increase extinction risk for frequently killed species (Frick et al., 2017).
Results indicate deaths are significantly associated to wind turbine power. Power alone explained a third of the variance of bat deaths and it is more lethal than tower height or rotor diameter. Energy, the product of power and time, produced by WT is determined by the size of the turbine (tower height, rotor diameter), and rotor speed (Dixon and Hall, 2014).
To that end decreasing rotor speed would need to be compensated by increasing WT size and vice versa for producing the same amount of energy. Thus, altering WT features will not minimize impacts on bats, as long as the energy produced remains the same or even increases. In addition, having several small or fewer large WT (Dabiri et al., 2015; Krijgsveld et al., 2009) is unlikely to minimize deaths as long as total produced energy remains constant. Avian and bat mortality was reported to be constant per energy
unit produced across wind turbine power capacities (Huso et al., 2021), confirming that not simply the size of turbines but power is the factor better explaining deaths. In the same study, the actual energy produced by each WT, but not the nominal power which is the maximum power capacity was found as a more unbiased estimator of wildlife deaths (Huso et al., 2021).

Reference Number 8.9 :
Insect fatalities at wind turbines as biodiversity sinks. Voight., C.C., Wiley: Conservation Science and Practice. 15th January 2021. DOI: 10.1111/csp2.366. https//orchid.org/0000-0002-0706-3974

Evidence is accumulating that insects are frequently killed by operating wind turbines..... Current observations suggest that mostly hilltopping, swarming, and migrating insects interact with wind turbines. Recently, the annual loss of insect biomass at wind turbines was estimated for Germany to amount to 1,200tonnes for the plant growth period, which equates to about 1.2trillion killed insects per year, assuming 1mg insect body mass. Accordingly, a single turbine located in the temperate zone might kill about 40million insects per year.

Decline of insect populations may also diminish their ecosystem function, including services like pollination.

After collision, most insects leave a layer of organic detritus on the leading edge of blades. This layer disrupts the laminar airflow, causing a significant drop in power production. Indeed, insect remains that stick to the leading edges of blades during low wind periods can halve power generation during high wind periods..... Aerial insectivores such as bats are well known for searching and hunting insects in proximity to wind turbines.

Reference Number 8.10: Increasing evidence that bats actively forage at wind turbines. (2017) Foo. C.C., Bennett. V.J., Hale, A.M., Korstian. J.M., Schildt, A.J., Williams. D.A. PeerJ 5: e3986;DOI 10.7717/peerj.3985

Although the ultimate causes of high bat fatalities at wind farms are not well understood, several lines of evidence suggest that bats are attracted to wind turbines. One hypothesis is that bats would be attracted to turbines as a foraging resource if the insects that bats prey upon are commonly present on and around the turbine towers.

Reference Number 8.11: An updated review of Hypothesis regarding bat attraction to wind turbines, Guest, E.E.,Stamps, B.F., Durish, N.D., Hale, A.M., Hein, C.D., Morton, B.P.,Weever, S.P., Frits, S.R. Animals, MDPI, January 2022, 12,343., https://doi.org/10.3390/ani12030343

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Noise: " Bat echolation calls are among the loudest natural sounds and provide reliable sensory perception for navigating and foraging at night. Evidence of bats using acoustic cues between 3 and 12kHz from distances of up to several hundred metres prompted the idea that noise emitted from wind turbines could be misinterpreted as prey."

Roosting: "It is hypothesised that the tall, stand-alone structure of wind turbines on the landscape could be misinterpreted by bats as trees and viewed as potential roost structures."

Foraging and Water: "Insect density around wind turbines may be positively correlated with bat activity, because bats may perceive wind turbines as a potential food source. The proposed logic for the accumulation of insects near wind turbines includes hilltopping behaviour, insect attraction to the light or heat emitted from wind turbine structures, and insect attraction to wind turbine colour."

Mating: "It is suggested that male and female bats of some species visually orient toward the tallest trees on the landscape for navigation toward mating aggregations. Direct observation through thermal imaging coupled with mortality trends suggest that wind turbines may be used by bats for orientation to potential mating sites."

Lights: "Lights on wind structures or associated infrastructure may directly or indirectly contribute to increased bat activity."

Olfaction: "Recent work using paired thermal video and acoustic recording at Meteorological tower sites documented swarming activity concentrated at various focal points on the Meteriological tower structure, including mechanical anemometers, wind vanes, the top of the tower, and aircraft marker balls."

Reference Number 8.12 : Bats and onshore wind turbines: Survey, Assessment and Mitigation, version August 2021, NatureScot, Natural England, Natural Resources Wales, RenewableUK, Scottish Power Renewables, Ecotricity Ltd., University of Exeter, Bat Conservation Trust (BCT).

"Assessing potential impacts: Wind farms can affect bats in the following ways:

1) *Collision mortality, barotraumas and other injuries.*
2) *Loss or damage to commuting and foraging habitat.*
3) *Loss of, or damage to, roosts*
4) *Displacement of individuals of populations.*

Reference Number 8.13:
Conservation: Tracking bats around wind turbines. O'Mara, M.T., 2022, Current Biology, https://doi.org/10.1016/j.cub.2022.12.048

"Flying animals face the highest risk from wind turbines, as birds and bats seek out the same conditions that make wind generation profitable. These energetically advantageous conditions allow animals to fly cheaply on uplifting winds and thermals or on prevailing winds. The placement of wind turbines in such profitable wind conditions may dramatically endanger migration, commuting and foraging pathways. Preference for these habitats makes bats particularly vulnerable to turbine related mortality, and efforts in North America have focussed on why and how bats are attracted to wind turbines at night. This conflict has resulted in millions of bats killed by wind turbines every year worldwide, including over 300,000 in Germany alone .... Common noctules flew 16km per night covering an area of 11+- 34km2".

Reference Number 8.14:
Wind turbine power and land cover effects on cumulative bat deaths. Moustakas, A., Georgiakis. P., Kret. E., Kapsalis. E., The science of the Total Environment. (May 2023)

"Wind turbines cause bird and bat mortalities which depend on the wind turbine and landscape features..... wind turbine power is the most significant factor associated to bat deaths.....wind turbines located within 5km buffer of natural land cover types have substantially higher deaths. More wind turbine power will result in more deaths. Wind turbines should not be licensed in areas where natural land cover at a radius of 5km exceeds 50%.

Reference Number 8.15:
Wind turbines without curtailment produce large numbers of bat fatalities throughout their lifetime: A call against ignorance and neglect Christian C. Voigt, Klara Kaiser, Samantha Look, Kristin Scharnweber, Carolin Scholz . Global Ecology and Conservation 37 (2022) e02149

Bats are protected by national and international legislation in European countries, yet many species, particularly migratory aerial insectivores, collide with wind turbines which counteracts conservation efforts. Within the European Union it is legally required to curtail the operation of wind turbines at periods of high bat activity, yet this is not practiced at old wind turbines. Based on data from the national carcass repository in Germany and from our own carcass searches at a wind park with three turbines west of Berlin, we evaluated the magnitude of bat casualties at old, potentially poor-sited wind turbines operating without curtailment. We report 88 documented bat carcasses collected by various searchers over the 20-year operation period of this wind park from 2001 to 2021. Common noctule bats (Nyctalus noctula) and common pipistrelles (Pipistrellus pipistrellus) were most often found dead at these turbines. Our search campaign in August and September 2021 yielded a total of 18 carcasses. We estimated that at least 209 bats were likely killed during our field survey, yielding more than 70 casualties/wind turbine or 39 casualties/ MW in two months. Since our campaign covered only part of the migration season, we consider this value as an underestimate. The 20-year period of the wind park emphasises the substantial impact old turbines may have on bat individuals and populations when operating without curtailments. We call for reconsidering the operation procedures of old wind turbines to stop the continuous loss of bats in Germany and other countries where turbine curtailments are even less practiced than in Germany.

Reference Number 8.16:
The presence of wind turbines repels bats in boreal forests Simon P. Gaultier, Thomas M. Lilley, Eero J. Vesterinen, Jon E. Brommer., Landscape and Urban Planning 231 (2023) 104636

Impacts of wind power on bats are usually evidenced by the recorded fatalities, while other impacts are not well understood or considered during project planning. However, wind turbines may affect use of the surrounding habitats by bats. Little is known about such impact, especially in the European boreal biogeographical region. We studied the consequences of operating wind turbines on the presence and activity of bats in forests. We simultaneously monitored bat acoustic activity at 84 sampling sites placed at 200 m intervals from 0 to 1.000 m (2 recorders per distance class), over four months and at seven Finnish wind farms located in forested habitats. Our results show higher presence and activity at 600 m and further from turbines for Eptesicus nilssonii, and higher presence at 800 m and further for Myotis spp. We also saw an increase in bat activity during midsummer, which may be due to increased use of forest canopy cover during the short nights at this time. These results indicate a potential loss in habitat quality around wind turbines, e.g., a greater number of open areas in forests unfavourable to certain bat species. This lower activity and presence could also be an indication for active avoidance of the wind turbines from the bats. Furthermore, these results are the first of their kind for Eptesicus nilssonii, and for the European boreal biogeographical region. They show undeniable impacts of wind power on bats in Finland, and enforce the requirement for better consideration of bats during the development of such projects in Finland. Similarly, these results show impacts of operating turbines on habitat use by bats, impacts that now must be considered in Europe. We also call for investigation on the causative mechanisms of the observed effect, to better facilitate mitigation.

We estimated the area avoided by bats per turbine, and for all current and planned wind power projects in Finland up to June 2022. Information on wind farms in the country is publicly available on the website of the Finnish Wind Power Association. We used the observed range of avoidance (800 m for E. nilssonii, 1,000 m for Myotis spp.) to determine the area avoided around each turbine by each species or group of species. Then, we calculated the proportion of area impacted by the presence of turbines in Finland, for all current and planned turbines.

Reference Number 8.17:
Forest gaps around wind turbines attract bat species with high collision risk Julia S. Ellerbrok , Nina Farwig, Franziska Peter, Finn Rehling, Christian C. Voigt. Biological Conservation 288 (2023) 110347

The global demand for renewable energy has led to an expansion of wind energy production at forested sites. The deployment and operation of turbines requires the clearing of forest areas, resulting in significant habitat changes. To assess the consequences of these changes for forest-associated bats, we measured the acoustic activity of three foraging guilds at turbine clearings, adjacent forest edges, and above nearby closed forests. Open-space and edge-space foraging bats were more active at turbine clearings and forest edges than above closed forests. Similarly, narrow-space foraging bats tended to be more active at turbine clearings than above closed forests. Open-space and edge-space foraging bats are known to be at high risk of colliding with wind turbines and their increased activity at forest gaps around turbines may increase casualties for these guilds. Operation of wind turbines in forests may therefore require longer shutdown periods to prevent legally protected bats from colliding with turbines. Although this may impair the energy yield of wind turbines in forests, such preventive conservation measures will ultimately contribute to a sustainable transition from fossil to renewable energy sources which factors in biodiversity conservation.
Temperate forests are important habitats for a wide range of species, among them bats. For example, 90 % of European bat species use forest structures at least temporarily for foraging and roosting (Dietz and Kiefer, 2014; Russo et al., 2016). Specifically, bats require tree cavities and standing deadwood for roosting as well as resource-rich foraging areas, which they use according to strata, structure, and vegetation density (Jung et al., 2012; Müller et al., 2013; Law et al., 2016). When forests are partially cleared for wind turbines, bats can be affected in several ways depending on their foraging and flight behaviour (Denzinger and Schnitzler, 2013; Aldridge and Rautenbach, 1987). Open-space foraging bats are long-range echolocators with pointed wings foraging mostly in spaces with few or no obstacles (Denzinger and Schnitzler, 2013).

They hunt above treetops and in larger clearings, while they avoid dense vegetation and small clearings (Voigt and Holderied, 2012). Thus, open-space foraging bats may explore and use forest gaps associated with wind turbines in forests. Edge-space foraging bats are mid-range echolocators, which are specialized on hunting prey close to background objects (Denzinger and Schnitzler, 2013). Hence, they are often found at forest edges (Kirkpatrick et al., 2017), which are created when forest patches are clear-cut for wind turbines. Finally, narrow-space foraging bats are short-range echolocators with rounded wings that facilitate foraging in forest understorey (Denzinger and Schnitzler, 2013). Although narrow-space foragers can fly outside of forests (Heim et al., 2018), they mostly occur in the forest

interior and might therefore suffer from the creation of forest gaps for wind turbines. In conclusion, open-space and edge-space but not necessarily narrow-space foraging bats can be expected to increase their activity where forest gaps are created for wind turbines.
Fatalities of bats after collisions with wind turbines are a known global problem (O'Shea et al., 2016; Thaxter et al., 2017). Bat casualties at wind turbines are not equally distributed across species.
In Europe, for example, 95 % of bats found dead under wind turbines belonged to 6 out of 11 assessed genera (Nyctalus, Vespertilio, Pipistrellus, Hypsugo, Miniopterus, Tadarida; Dürr, 2022). Accordingly, bat species from these genera are commonly recognized as high-collision risk species (Rodrigues et al., 2014), which is associated with their ability to fly at the operation range of wind turbines (Reusch et al., 2022, 2023; Roeleke et al., 2016; Roemer et al., 2017).
Noticeably, all bat species recognized as high-collision risk species at wind turbines are members of the open-space or edge-space foraging guild, while bat species of the narrow-space foraging guild are usually considered to be at low risk of colliding with wind turbines (Rodrigues et al., 2014). Consequently, deployment of wind turbines at forested sites might lead to more casualties at wind turbines if bat species of high-collision risk are attracted to the open and edge habitats which were created for the deployment and operation of wind turbines. Besides, bats may also respond to the operation of wind turbines. Indeed, past studied confirmed that wind turbines repel certain bat species in open landscapes (Barr´e et al., 2018; Leroux et al., 2022) and in forests (Ellerbrok et al., 2022; Reusch et al. 2023; Gaultier et al., 2023)

Reference Number 8.18:
Forest bat activity declines with increasing wind speed in proximity of operating wind turbines Julia S. Ellerbrok, Nina Farwig, Franziska Peter, Christian C. Voigt. Global Ecology and Conservation 49 (2024) e02782

The increasing use of onshore wind energy is leading to an increased deployment of wind turbines in structurally rich habitats such as forests. Forest-affiliated bats, in turn, are at risk of colliding with the rotor blades. Due to the legal protection of bats in Europe, it is imperative to restrict the operation of wind turbines to periods of low bat activity to avoid collisions. However, bats have also been observed to avoid wind turbines over several hundred meters distance, indicating a displacement that cannot solely be explained by modifications to the habitat. This avoidance suggests a displacement of bats by indirect factors related to wind turbine operation, e.g., wake turbulences and noise emissions. Therefore, we investigated whether the activity of forest-affiliated bats is influenced by operation mode (on/off) under variable wind conditions along transects from 80 to 450 m distance to wind turbines. We divided recordings by foraging guild, i. e., either narrow-space (Myotis, Plecotus), edge-space (Pipistrellus, Barbastella), or open-space foraging bats (Nyctalus, Eptesicus, Vespertilio), and analyzed the effects of wind turbine operation and wind speed on the recorded bat guild activity with mixed effects models. The acoustic activity of narrow-space foraging bats decreased by 77% with increasing wind speed when wind turbines were operating, while bat activity remained unaffected by wind speed when turbines were not operating. This was neither observed for open-space foraging bats nor for edge-space foraging bats, and neither wind turbine operation nor wind speed (ranging between 0 – 4 m/s at 10 m height above ground) were found to affect bat activity when considered alone. Wind turbine noise emissions are known to increase with rotor speed and consequently, wind speed, thus presenting a likely explanation for the interactive negative effect of turbine operation and wind speed specifically on noise-sensitive narrow-space foraging bats. To understand potential ecological long-term consequences for bat populations in forest areas with wind turbines and to design effective conservation measures, future research should focus on disentangling the effects of different disturbances related to turbine operation.

Reference Number 8.19 :
How far are birds, bats, and terrestrial mammals displaced from onshore wind power development? – A systematic review Anne Tolvanen , Henri Routavaara , Mika Jokikokko, Parvez Rana . Biological Conservation Volume 288, December 2023, 110382

Wind power is a rapidly growing source of energy worldwide. It is crucial for climate change mitigation, but it also accelerates the degradation of biodiversity through habitat loss and the displacement of wildlife. To understand the extent of displacement and reasons for observations where no displacement is reported, we conducted a systematic review of birds, bats, and terrestrial mammals.

Eighty-four peer-reviewed studies of onshore wind power yielded 160 distinct displacement distances, termed cases. ***For birds, bats, and mammals, 63 %, 72 %, and 67 % of cases respectively reported displacement.***

Cranes (3/3 cases), owls (2/2), and semi-domestic reindeer (6/6) showed consistent displacement on average up to 5 km. Gallinaceus birds showed displacement on average up to 5 km, but in 7/18 cases reported to show "no displacement".

Bats were displaced on average up to 1 km in 21/29 cases.

Waterfowl (6/7 cases), raptors (24/30), passerines (16/32) and waders (8/ 19) were displaced on average up to 500 m.

Observations of no displacement were suggested to result from methodological deficiencies, species-specific characteristics, and habitat conditions favourable for certain species after wind power development.

Wind power development can influence wildlife through many mechanisms. Habitat change and fragmentation may decrease habitat suitability and resource availability near turbines (e.g., Campedelli et al., 2014). Disturbance caused by rotor movement, noise, vibration, flickering lights, and increased human presence may lead to behavioural changes such as avoidance and changes in flight paths (Drewitt and Langston, 2006; Marques et al., 2019; Schuster et al., 2015). Avoidance can occur at different scales, at the level of the entire wind farm (macroscale), within the wind farm (meso-scale), or in the immediate vicinity of wind turbines (micro-scale, Marques et al., 2021; May, 2015). Displacement indicates principally macro- (May, 2015) and meso-scale (Marques et al., 2021) avoidance. As a result of displacement, a reduced density of wildlife near wind turbines may be observed. Knowledge of displacement can be used to estimate distance thresholds, beyond which wind power development is not expected to have remarkable biodiversity impacts. This improves the opportunities to mitigate the detrimental effects of wind power on wildlife. There is abundant literature and review articles on the impacts of wind power development on the distribution, abundance, survival, behaviour, and displacement of birds (e.g., Coppes et al., 2020b; Marques et al., 2014, 2021), bats (Cryan and Barclay, 2009; Guest et al., 2022) and on wildlife in general (Schuster et al., 2015; Scholl ¨ and Nopp-Mayr, 2021). Benítez-Lopez ´ et al. (2010) investigated displacement distances from infrastructure using meta-analysis and meta-regression. Using data from 49 studies, of which three studied the wind power, they showed that the main response of mammals and birds to infrastructure was avoidance or a reduced population density. In their analysis, BenítezLopez ´ et al. (2010) omitted the few studies not showing the negative effects of infrastructure. Their models however showed that a large number of studies reporting neutral or positive responses to infrastructure would be needed to reverse their results.

Marques et al. (2021) included 71 studies in their review and found that approximately 40 % of studied bird taxa showed displacement from onshore and offshore wind power development. They suggested improvements for study design, for example, by encouraging observations to be made before the construction of a wind power development. Scholl ¨ and Nopp-Mayr (2021) reviewed 27 studies of birds, bats, and mammals in woodland ecosystems. They concluded that displacement distances (or distance thresholds) varied temporally and spatially, even within species. They also called for the improvement of study design and suggested that BACI (before-after-control-impact) studies should be mandatory for approval and decisions related to wind power development.

Number of cases, i.e., taxa or functional groups, for which displacement distances were presented in the published studies. Classified as displacement/no displacement

Taxa/functional group	*Displacement*	*No displacement*	*Sum*
Birds			
Cranes	*3*	*0*	*3*
Gallinaceous birds	*11*	*7*	*18*
Owls	*2*	*0*	*2*
Passerines	*16*	*16*	*32*
Raptors	*24*	*6*	*30*
Waders	*8*	*11*	*19*
Waterfowl	*6*	*1*	*7*
Several	*3*	*2*	*5*
Sum	***73***	***43***	***116***

Bats	*21*	*8*	*29*
Terrestrial mammals			
Canids	*1*	*1*	*2*
Cervids	*8*	*1*	*9*
Small mammals	*1*	*3*	*4*
Sum	***10***	***5***	***15***
Total	***104***	***56***	***160***

All three cases on cranes were classified as displaced by wind power development. Two studies focused on migrating whooping cranes (Grus americana, Ellis et al., 2022; Pearse et al., 2021). They showed 20 times more activity outside the 5000 m distance from wind turbines compared to the area inside (Pearse et al., 2021). The same displacement distance was observed when the birds looked for a stopover site to forage in the same area in the United States Great Plains (Ellis et al., 2022). GPS marked overwintering sandhill crane (Grus canadensis) showed potential indication of avoidance behaviour <10km distance, although this was suggested to be the result of habitat selection rather than displacement.

We classified eleven out of 18 cases of gallinaceous birds in the displacement category, the median distance being up to 5000 m. Birds were found to reduce lekking near wind power development (LeBeau et al., 2017a; Winder et al., 2015; Zwart et al., 2015), the longest distance being >5000 m for the decreased lek persistence of greater prairie-chicken males (Tympanuchus cupido pinnatus, Winder et al., 2015). Greater prairie-chicken males near turbines spent less time in non-breeding behaviours than those farther away, possibly to compensate for the effects of noise disturbance (Smith et al., 2016). On the other hand, greater prairie-chicken females could nest even within a small wind power development area, but as they selected nest sites >700 m from wind power roads (Harrison et al., 2017), we classified the case as displacement.

Noise was also assumed to disturb capercaillie (Tetrao urogallus) and reduce the success rate and time invested in breeding up to over 800 m (Taubmann et al., 2021). The species showed population declines because of reduced habitat suitability near wind power development (Gonzalez ´ et al., 2016), and there was no indication that habituation occurred eight years after construction (Coppes et al., 2020a). Chick survival in Columbian sharp-tailed grouse (Tympanuchus phasianellus columbianus) decreased by 50 % when there were ≥10 wind turbines within 2100 m of the nest (Proett et al., 2022). A potential reason for this was suggested to be increased predation and noise disturbance, which hindered the passing of alarm sounds to chicks by brood females (Proett et al., 2022). Summer habitat selection of greater osage-grouse (Centrocercus urophasianus) decreased with the increase of surface disturbance ≤1200 m from wind power development, although there was no direct effect on the nest site selection or the survival of females (LeBeau et al., 2017b). Seven gallinaceous bird cases were classified as no displacement, two focusing on the breeding or habitat selection of greater prairie-chicken (McNew et al., 2014; Raynor et al., 2019). The lack of responses in these studies was suggested to be connected with the habitat, i.e. the avoidance of non-grassland areas instead of the displacement from wind power development. The lack of displacement in red grouse (Lagopus lagopus scoticus) was assumed to result from methodology, i.e. a shortterm (three-year) study on a single site after wind power development was operational (Douglas et al., 2011).

Even positive associations with wind turbines were found for common pheasant (Phasianus colchicus, Łopucki et al., 2017) and red grouse (Lagopus lagopus scoticus, Douglas et al., 2011). The suggested reasons for this association were linked to species and habitat through a reduced number of predatory birds and a general affinity for tracks as a source of grit, which is important for digestion (Douglas et al., 2011; Łopucki et al., 2017). Also the short duration of study on a single site was suggested to be a reason for no displacement in Douglas et al. (2011).

Only two cases addressed owls. Both showed that the birds abandoned their territories and nests up to 5000 m from wind power development (Husby and Pearson, 2022; Lopez-Peinado ´ et al., 2020). The owls were suggested to be sensitive to noise and disturbance, and open areas created by wind power development were assumed to be poor hunting habitats.

Passerines showed both displacement and no displacement in 16 cases. The median displacement distance was 500 m and was observed as avoidance behaviour and reduced bird densities (Fern´ andez-Bellon et al., 2019; Pearce-Higgins et al., 2009; Shaffer and Buhl, 2016; Stevens et al., 2013), a reduced number of breeding birds (Leddy et al., 1999; Pearce-Higgins et al., 2009), and reduced nest density (Song et al., 2021). The displacement extended up to 4500 m in a

study of the endangered Dupont's lark (Chersophilus duponti) in Spain, where even local extinctions were suggested to occur in the presence of wind farms (Gomez-Catasús ´ et al., 2018). Nighttime lights and the rotation of turbines were suggested to disturb birds and have adverse effects on communication (Gomez-Catasús ´ et al., 2018, 2022; Leddy et al., 1999). It was also observed that habitat change and reduced forest cover resulted in a large reduction of safe habitats for forest-dwelling passerines (Fernandez-Bellon ´ et al., 2019; Shaffer and Buhl, 2016). In Garcia et al 2015, decreasing population trends were observed among 12 of 15 breeding passerine species during construction, but the species were observed to return to their old nesting sites when construction was completed. We nevertheless classified Garcia et al. (2015) in the "displacement" category, since displacement was observed during the construction period. Also no displacement was shown in 16 cases of passerines. In Hale et al. (2014), breeding grassland passerines were not observed to react to turbines, partially due to the difficulty of isolating the effect of turbine distance from other factors, such as barbed wire fences, covarying with distance. However, their conclusion was criticized by Johnson (2016), who claimed that the conclusion was based on inappropriate statistical analysis of data and that two of the three studied species might in fact show displacement. In Shaffer and Buhl (2016), the vesper sparrow (Pooecetes gramineus) was the only passerine species that did not respond to wind turbines, suggested reason being related to the species and habitat conditions, i.e. its life-history characteristic as the first species to occupy disturbed areas.

For the nest-site selection of the grasshopper sparrow (Ammodramus savannarum), vegetation (i.e. habitat conditions) was assumed to play a more important role than distance from turbines, and snake predation causing failure to nesting was greater close to wooded edges than near wind turbines (Hatchett et al., 2013). In Stevens et al. (2013), three out of four passerine species showed no displacement from wind turbines, and the difference between species was assumed to be in their species-specific predator evasion strategies.

Social species such as Sprague's pipit (Anthus spragueii), savannah sparrows (Passerculus sandwichensis), and meadowlarks (Sturnella sp.) were known to use open areas, and a high number of individuals was suggested to help in the detection of predators. In contrast, Le Conte's sparrow (Ammodramus leconteii) was known to hide in thick vegetation and was observed to show displacement (Stevens et al., 2013).

In Devereux et al. (2008), corvids and Eurasian skylark (Alauda arvensis) did not show displacement and were indeed more likely to occur close to turbines than farther away. Potential reasons were suggested to be the small sampling size (methodological reason), but also higher food availability (habitat conditions) near turbines.

We found displacement in 24 cases of raptors . The median distance was 500 m, ranging from 100 m for Montagu's harrier (Circus pygargus, Schaub et al., 2020) and the golden eagle (Aquila chrysaetos, Fielding et al., 2021, 2022) to 4000 m for the white-tailed eagle (Haliaeetus albicilla, Balotari-Chiebao et al., 2016a). Displacement was represented as changes in abundance (Campedelli et al., 2014; Garwin et al., 2011) and flight behaviour near turbines (Cabrera-Cruz and Villegas-Patraca, 2016; Hull and Muir, 2013; Johnston et al., 2014; Santos et al., 2021, 2022), which were assumed to increase the birds' energy usage (Cabrera-Cruz and Villegas-Patraca, 2016). Functional habitat loss (Campedelli et al., 2014; Marques et al., 2019), and reduced breeding success were also observed (Dahl et al., 2012; Balotari-Chiebao et al., 2016a).

Time could influence the results: Raptor abundances declined immediately after installation (Farfan ´ et al., 2009) but showed some recovery, although not to the preconstruction level, 6.5 years later (Farf´ an et al., 2017). Displacement was not found in six raptor cases, in which distances up to 1000 and 5000 m (median 1000 m) were studied. Due to the lack of displacement, young white-tailed eagles were observed flying into the wind turbine areas, exposing them to the risk of collision (Dahl et al., 2013; Krone and Treu, 2018). The flying behaviour was observed to vary between individual eagles and in relation to food availability (Krone and Treu, 2018).

Individuals of three Buteo hawk species did not show displacement from wind turbines regarding the selection of their nesting territories, but as rotor speed increased, avoidance flights increased, thereby mitigating collisions (Watson et al., 2018). As the avoidance flights occurred in the immediate vicinity of turbine blades, we did not classify them as displacement. Montagu's harrier (Circus pygargus, was expected to choose its nesting site according to the potential of vegetation covering the nests rather than the distance to disturbing features such as wind turbines (Hernandez-Pliego ´ et al., 2015). In Campedelli et al. (2014), the sparrowhawk (Accipiter nisus) was the only species of seven raptors showing no significant difference in observations between pre- and post-construction. The result was not discussed. Hawks, eagles, and falcons did not display avoidance behavior around wind turbines, suggesting that their displacement might be species- and site-specific (Smith et al., 2017).

Waders were the only bird group in which we found no displacement more often than displacement (11 vs. 8 cases, respectively). Displacement effects were manifested as decreased bird density and breeding bird abundance, the median distance being 500 m from wind turbines (Pearce-Higgins et al., 2009; Sansom et al., 2016; Shaffer and Buhl, 2016). Bai et al. (2021) showed that shoreline bird groups (all four cases classified as waders in this study) avoided crossing closely spaced (200 m) turbines. However, their abundance showed no significant change in the study area compared with the control.

Eleven cases of waders showed no displacement, median studied distance across the cases being 1000 m. The longest studied distance reached beyond 5000 m for the little egret (Egretta garzetta) in China, where bird abundance was not influenced (Xu et al., 2021). The abundance of little egrets depended on the habitat conditions, i.e. on the land use type suitable for feeding rather than the distance to the wind farm (Xu et al., 2021). Similarly, no evidence was found for golden plovers (Pluvialis apricaria) avoiding wind turbines in the UK (Douglas et al., 2011) or the USA (Pluvialis dominica, Homoya et al., 2017). These results contradicted those of Pearce-Higgins et al. (2009) and were assumed to be partially due to a single study location and the lack of an assessment before the construction of turbines (Douglas et al., 2011). Also weather conditions between the two survey years were expected to at least partly explain the observed population increase of the golden plover (Douglas et al., 2011). An interesting observation was made for killdeer (Charadrius vociferous), which not only exhibited high tolerance to turbines but also increased in density near them, as turbines were assumed to provide gravel substrates for nesting (Shaffer and Buhl, 2016). Four wetland species were not observed to avoid wind turbines, but the result was thought to arise largely from the small sample size and short duration (three years) of the study, which did not cover potential lag effects on the species (Niemuth et al., 2013).

Six cases of waterfowl showed displacement, the median distance being 500 m from wind turbines. The greatest distance was 1300 m (classified as "up to 5000 m") for the Chinese spot-billed duck (Anas zonorhyncha) and mallard (Anas platyrhynchos, Zhao et al., 2020). Displacement was often shown as changes in the selection of resting and feeding areas (Fijn et al., 2012; Harrison et al., 2018; Larsen and Madsen, 2000; Zhao et al., 2020). To avoid the wind turbines, the birds had to fly farther, which was assumed to require more energy (Madsen and Boertmann, 2008). The associated infrastructure and fragmentation of habitats caused more displacement than the turbines themselves (Larsen and Madsen, 2000). The distance from small wind turbines decreased in 8–10 years for pink-footed geese (Anser brachyrhynchus, Madsen and Boertmann, 2008), and Bewick's swans (Cygnus columbianus bewickii), which were found to feed closer to the wind turbines according to food availability (Fijn et al., 2012). The oldest study of waterfowl, by Meek et al. (1993), indicated that the only species to respond negatively was the red-throated diver (Gavia stellata). The reason for its decline was however uncertain in the study. The only case for waterfowl showing no displacement was also presented in Meek et al. (1993) as an aggregated result for ducks. It was notable that most studies of waterfowl were conducted using wind turbines with tower heights of <50m.

Three studies of several bird groups showed displacement, and two no displacement, with the studied distances up to 100, 500 m, or 1000 m. Displacement was expressed as reduced abundance and flight rates during a 6.5-year post-construction period (Farfan ´ et al., 2017), a reduction in avian activity during construction (Pande et al., 2013), and changes in aerial space and flight course (Therkildsen et al., 2021). Minderman et al. (2012) did not observe displacement in terms of bird activity related to small turbines (<50m m tower height) and assumed that turbine presence did not affect habitat use, or because displacement occurred at a different spatial scale than what was studied. There was only one study focusing on tall (even above 200 m) wind turbines. It showed that small forest birds (45 species) were sensitive to forest structure, season, and rotor diameter, but not to the proximity of wind turbines (Rehling et al., 2023). We therefore classified the study as showing no displacement. Nevertheless, the study showed that the height and number of turbines, along with rotor length, reduced bird abundance and richness (Rehling et al., 2023).

The vulnerability of bird populations to wind power development can be high especially among long-lived species (Fielding et al., 2021). For example, owls and raptors have slow maturation and reproduction rates (Farf´ an et al., 2009; Garwin et al., 2011). If displacement influences their abundance during the breeding season (Lopez-Peinado ´ et al., 2020), increases the abandonment of nests (Husby and Pearson, 2022), or decreases the success of breeding (Balotari-Chiebao et al., 2016a,b), and these effects occur with increased collisions (e.g., Husby and Pearson, 2022), population effects are inevitable. Habituation to wind turbines has rarely been observed in raptors, suggesting that they do not adjust easily to the presence of a wind farm, and population changes may therefore be permanent (Campedelli et al., 2014 and the references therein).

Bats showed displacement in 21 cases out of 29, the median displacement distance being 1000 m, which was also the maximum distance surveyed (Fig. 3). Apart from the studies by Minderman et al. (2012, 2017) on small wind turbines (<50m tower height) other studies were conducted on turbines taller than 50 m, extending even to over 200 m (Ellerbrok et al., 2022). None of the bat studies included observations before wind power development.

Bat responses were strongly confounded by their foraging environment (forest, edge, open) and the echolocation range of the species (short, mid, long). Especially forest species (which are also short-term ecolocators, e.g., Myotis sp., Barbastella barbastellus) showed displacement, which was expressed as reduced abundance and activity around turbines (Apoznanski ´ et al., 2018; Barr´e et al., 2018; Ellerbrok et al., 2022; Leroux et al., 2022; Gaultier et al., 2023). Loss in habitat quality due to greater amount of open areas (Gaultier et al., 2023), noise (Ellerbrok et al., 2022) and red aviation lights were suggested as reasons for displacement (Barr´e et al., 2018). Displacement was observed in their optimal foraging habitats such as hedgerows (Barr´e et al., 2018) and forests (Gaultier et al., 2023), while the response could be the opposite (i.e., attraction) in less optimal open habitats (Leroux et al., 2022). Reduced activity near turbines resulted in a loss of foraging habitat, which in a tropical biodiversity hotspot was considered to threaten bat conservation (Millon et al., 2018). An interesting observation was made in Reusch et al. (2022), where 70 % of common noctule bats (Nyctalus noctula) showed avoidance behavior toward wind turbines, but when attraction was found, it occurred toward large turbines more than small turbines.

Displacement was not observed in eight cases, the studied distances being up to 1000 m. Edge-space foragers (and mid-range echolocators) Pipistrellus pipistrellus (Ellerbrok et al., 2022) and P. kuhlii/nathusii (Barr´e et al., 2018; Leroux et al., 2022) showed no response to wind turbines in forest landscapes. The lack of responses in Pipistrellus pipistrellus in Ellerbrok et al. (2022) contrasted with the observation by Barr´e et al. (2018) and Minderman et al. (2017), who observed displacement in an open landscape. It was suggested that forest clearing for wind turbines would create ideal foraging habitats for edge-space foragers (Ellerbrok et al., 2022). Regarding the lack of response in P. kuhlii/nathusii, a potential explanation was the contrasting behavior (avoidance vs. attractiveness) of the species within this bat group due to their different migratory status (Barr´e et al., 2018; Leroux et al., 2022). Open space foragers were observed to be attracted to wind turbines in open areas (Leroux et al., 2022) or during certain seasons (Ellerbrok et al., 2022). However, the suggested reasons for this attraction were inconsistent (Ellerbrok et al., 2022).

Bats display a mixture of displacement and attraction, of which displacement occurs at longer distances and attraction around turbines (Millon et al., 2015; Reusch et al., 2022). The maximum observed displacement distance was 1000 m, but this might be an underestimate, since longer distances were not studied (Barr´e et al., 2018). Displacement seems to vary, depending on the preferred foraging habitat (forests or hedgerows vs. open habitats), echolocation range, and migratory pattern, but in general, the mechanisms leading to displacement remain largely unknown (Barr´e et al., 2018). Many studies report negative population effects, and even extinctions have been anticipated if wind power development continues to increase (Friedenberg and Frick, 2021). Despite initial population declines and changes in species diversity due to habitat change and displacement, some bat populations can recover, as shown in a study of 22 tropical bat species in Mexico (Briones-Salas et al., 2017).

Terrestrial mammals

There were only two studies of canids, showing displacement for the red fox (Vulpes vulpes) up to 700 m in Poland (Łopucki et al., 2017) but not significantly for the coyote (Canix lastrans), studied to almost 10,000 m in Nebraska, USA (Smith et al., 2017). Displacement for the fox was assumed to be an indirect effect of wind power development and result from lower prey availability, especially of the hare, near wind turbines (Łopucki et al., 2017) (Fig. 3). Bird carcasses killed by wind turbines were proposed to attract the foxes, but there were no observations of bird remains to support this (Łopucki et al., 2017). Coyote was assumed to have habituated to the wind turbines by the time of the study, which was started eight years after the wind turbines became fully operational (Smith et al., 2017).

Of the nine studies of cervids, six were undertaken of the semidomestic reindeer (Rangifer tarandus), all showing displacement. Three studies were carried out in the same area but on different occasions in Sweden (Skarin and Alam, 2017; Skarin et al., 2015, 2018). Displacement from 100 m to the access road (Colman et al., 2013) up to 15,000 m from the wind farm (Skarin and Alam, 2017) was observed. According to Colman et al. (2013), the distribution of the reindeer was more related to habitat quality than wind power development. Displacement nevertheless occurred especially during the construction phase (Colman et al., 2013; Skarin et al., 2015), although it was observed also during operation (Skarin and Alam, 2017). Calving time was most sensitive for the reindeer (Skarin et al., 2018; Tsegaye et al., 2017). The noise generated by wind turbines was assumed to disturb the interaction between calves and mothers and

negatively affect the reindeer's ability to hear predators (Skarin et al., 2018). As a consequence, displacement during operation occurred farther away than during construction (Skarin et al., 2018). Tsegaye et al. (2017) did not observe a change in the spatial use of areas near wind power development outside calving time. A high seasonal and annual variation in displacement was also observed by Eftestøl et al. (2023), and the reasons were assumed to be linked not only to natural movement patterns but also to herding activities, indicating human interference with the displacement.

Concerning wild cervids, the European roe deer (Capreolus capreolus) avoided wind farm interiors and proximity to turbines up to 600–700 m, potentially due to the difficulty of hearing or sensing their predators (Łopucki et al., 2017). The pronghorn (Antilocapra americana) showed behavioral changes during migration by avoiding turbines and moving more quickly near them, which was assumed to influence their foraging success or the availability of specific routes in the long run (Milligan et al., 2023). The Rocky Mountain elk (Cervus elaphus) was not adversely affected by wind power development, as evidenced by its home range, studied up to a distance of over 5000 m (Walter et al., 2006). The suggested reason was despite disturbance and habitat loss, riparian habitats that were critical seasonal habitats for the elk, were not altered by construction (Walter et al., 2006).

Of the four studies of small mammals, only European hare (Lepus europaeus) showed displacement up to 700 m (Łopucki et al., 2017), whereas three studies focusing on small rodents, shrews, hedgehogs, and hamsters did not show displacement (de Lucas et al., 2005; Łopucki and Mroz, ´ 2016; Łopucki and Perzanowski, 2018). Large temporal variation of populations and difference in temporal trajectories between places (de Lucas et al., 2005), and behavioural and physiological characteristics (Łopucki and Mroz, ´ 2016; Łopucki and Perzanowski, 2018) which were not monitored, were suggested to be reasons for the lack of responses. Also, the hamster was known to live near various types of human infrastructure, including settlements (Łopucki and Perzanowski, 2018).

In our review two thirds of 160 cases show displacement, and there is large variation in the displacement distances within and among taxa. Concerning especially cranes, owls, semi-domestic reindeer and gallinaceous birds the effects of wind power development can extend for several kilometers, suggesting a significant loss of functional habitat for these species. For flying species such as raptors and bats, displacement and collisions create a double-edged sword that causes population decline regardless of whether displacement occurs. "

Reference Number 8.20:

Examples of onshore baseline surveys for bats (adapted from the UNEP/EUROBATS guidelines, Rodrigues *et al*. 2015)

• Identification of important maternity, hibernation and swarming sites based on signs of bats and/or presence and abundance of recorded bats.
• Bat detector surveys on the ground — use of automated detectors to the define bat activity index (number of bat contacts per hour) and habitat use, potentially supplemented with manual surveys (walked transects, vantage-point surveys) and other observational techniques (thermal/infra-red cameras).
• Activity surveys at height — use of automated detectors to define the bat activity index (number of bat contacts per hour).
• Potential need for above-canopy activity surveys and advanced techniques such as trapping and radio-telemetry in woodlands.
• Collection of environmental data (temperature, precipitation, wind speeds).

Main types of impacts on bats (drawn from the UNEP/EUROBATS guidelines)

• Collision and barotrauma — the fatal interaction between bats in flight and wind turbine structures.
• Habitat loss and degradation — the removal of, fragmentation or damage to supporting habitats.
• Disturbance and displacement at roost sites — activities in and around roost sites such as habitat removal or the presence of maintenance vehicles and personnel can result in changes in temperature, humidity, light, noise and vibration within the roost, with a consequent reduction in use or reproductive capacity.
• Loss of flight corridors and roost sites — the physical or functional loss of flight corridors and roosting sites.

Table 5-4 Types of impacts on bats during the project's life cycle for onshore wind energy developments

Types of impacts	Project phase				
	Pre-construction	Construction	Operation	Decommissioning	Repowering
Habitat loss and degradation	X	X	X	X	X
Disturbance and displacement at roost sites	X	X	X	X	X
Habitat fragmentation		X	X	X	
Collision			X	X	
Barrier effect			X	X	
Barotrauma			X	X	
Loss or shifting of flight corridors and roost sites		X	X	X	
Increased availability of invertebrate prey, and thus increased collision risk, due to night illumination			X	X	
Indirect effects		X	X	X	X

Once the wind turbines are in operation, mortality due to collision or barotrauma are considered to be the most significant effects, but the risk differs between species.
Disturbance and displacement could occur at any stage of a project's life cycle, with barrier effects occurring during operation and repowering. These likely significant effects could result in changes in behaviour including attraction (Behr *et al*. 2018; Foo *et al*. 2017), spatial shift of flight corridors, and the exclusion of bats from foraging habitats they would otherwise use (Barré *et al*. 2018). Attraction could result in higher collision risk (Rydell *et al*. 2010a; Voigt *et al*. 2018). However, Millon *et al*. (2018) considered displacement itself to be an important impact to consider, and Barré *et al*. (2018) have recently quantified this effect across a number of wind farms. The assessment of disturbance, displacement and barrier effects should be considered on a case-by-case basis, taking into account the size of the plan or project, the bat species known to be present, their habitat use, and the importance of the supporting habitat to the favourable conservation status of the population, particularly in the light of existing threats and the site's conservation objectives.

Factors for the design of baseline data collection methods and the assessment of significance, in relation to bats

Biological

• Collision risk, to a large extent defined by foraging characteristics, echolocation type and the flight behaviour of species (Denzinger and Schnitzler, 2013; Roemer *et al*., 2017).
• Annual life cycle stage, i.e. active, hibernating, breeding, migrating, swarming.
• The presence of hibernation and maternity roosts.
• Population vulnerability, based on collision risk and the status of species affected (an example can be found in Scottish Natural Heritage *et al*., 2019).

Environmental

• The presence of habitats within 200m of a plan or project likely to be used by bats during their life cycle, e.g. forests (especially mature broad-leaved forests), trees, hedgerow networks, wetlands, waterbodies, watercourses and mountain passes
• Confined areas where bats forage or roost, and/or the potential for narrow bat migration or commuting routes.
• Large river corridors that may serve as migration routes.
• Habitat types at a landscape scale, e.g. the presence of broadleaved woodland within 1.5 km of wind energy developments in Great Britain appeared to reduce risk to all species combined (and soprano pipistrelles analysed separately), but the total area of coniferous woodland was only associated with an increased risk to noctules (Mathews *et al*., 2016). The responses are therefore species- and habitat-dependent. Depending on the species in

question and their habitat associations, the presence/absence of a suitable habitat could be used as a way of 'ruling in' areas potentially suitable for wind energy developments rather than for identifying areas likely to be problematic (Mathews *et al*., 2016).
• Wind speed and direction, temperature and relative humidity are known to be significantly correlated with both bat activity and mortality (Amorim *et al*. 2012; Mathews *et al*. 2016; and others cited in Rodrigues, 2015). These environmental variables may be among those used to determine the level of risk a proposed site is likely to have on bats.

Plan or project design

• Turbine number and rotor swept area.
• Turbine size, which can influence the distance over which displacement occurs [Barré *et al*. (2018) and Minderman *et al*., (2012; 2017)].

Collision risk for European (incl. Mediterranean) species from wind turbines in open habitats(derived from Rodrigues, 2015)

High risk	Medium risk	Low risk
***Nyctalus* spp.**	*Eptesicus* spp.	*Myotis* spp.
***Pipistrellus* spp.**	*Barbastella* spp.	*Plecotus* spp.
Vespertilio murinus	*Myotis dasycneme*[2]	*Rhinolophus* spp.
Hypsugo savii		
Miniopterus schreibersii[1]		
Tadarida teniotis		

[1] *Miniopterus schreibersii* is the only Annex II species in the high-risk category

The annual life cycle of bat species must also be taken into account as the magnitude and significance of an effect can vary depending on the time of year (Table 5-6). The timing of annual life cycle stages varies between species and populations of the same species in different Member States. It is therefore prudent to refer to national guidance in relation to bats and wind energy developments, where this is available, or to the UNEP/EUROBATS guidelines (Rodrigues *et al*. 2015) if there is no national guidance. A comprehensive list of national guidance documents is provided in Appendix E.

The degree of risk associated with impacts on bats in relation to their annual life cycle(drawn in part from Rodrigues et al. 2015)

Likely significant effect	Breeding season	Hibernation season	Spring/autumn
Construction			
Habitat loss and degradation	Low to high, depending on proximity to roosts	High, depending on proximity to roosts	Low (particularly for migrating bats travelling long distances)
Loss of roost sites	Potentially high or very high	Potentially high or very high	Potentially high (e.g. loss of mating roosts)
Turbine operation			
Collision/fatalities	Low to high, depending on the species	Low	High to very high
Loss or shifting of flight corridors	Medium	Low	Low. Migration likely to occur on a broad front, but cumulative effects need to be considered

Key challenges in assessing the significance of effects on bats

All effects

• Limited evidence regarding the effects of small wind turbines, e.g. those with a hub height less than 18 m above ground level.
• Limited evidence regarding the behaviour of bats around turbines (Natural England, 201485 and Mathews *et al*. 2016). Some evidence of attraction has been reported (Behr et. al., 2015), particularly in the presence of red light (Voigt *et al*. 2018).
• In a British wind park, bat activity showed extremely high variability, both within and between years (Mathews *et al*., 2016).

Collision

• There is no way to predict bat fatalities prior to construction with current approaches focused on site-specific surveys rather than multi-site studies, which makes it difficult to identify risk factors (Mathews *et al*., 2016). Arnett *et al*. (2016) identified improving the predictability of bat fatalities as a key area for future research.
• It remains unclear whether pre-construction acoustic data are able to adequately predict post-construction fatality (Arnett *et al*., 2013), and whether current environmental impact assessments fail to reduce the risk of bat casualties on wind farms (Lintott *et al*. 2016).
• It is possible that there are additional high-risk periods in the annual life cycle of bats, but that they remain undetected because of a focus on late summer/autumn, a period coinciding with both autumn migration and the beginning of the presumed mating period in many of the studied species (Rydell *et al*., 2010; Rodrigues *et al*., 2015).

• Search protocols might not identify all casualties, though techniques are improving, particularly with the use of dogs86. Injuries that allow bats to travel out of the typical search area before dying ('cryptic deaths') may mean bat mortality estimates are generally underestimated(Barclay *et al*., 2017). Fatalities from turbines with greater nacelle/rotor heights may also fall outside the search area and be missed (Weber *et al*. 2018).
• There is some evidence of sex- and age-specific vulnerability to collision (Lehnert *et al*. 2014) but this has not been found in all studies (Barclay *et al*., 2017, Mathews *et al*. 2016). The predicted effects on local populations depend heavily on the age and sex structure of casualties, so this is an important data gap.
• There are limited mortality estimates for wind energy developments located along migratory flyways (Rydell *et al*., 2001a)
• The effects of mortality on populations is extremely poorly understood (Weber *et al*. 2018, amongst others)

Disturbance and displacement

• There is limited empirical data on the significance of disturbance and displacement, except in relation to the disturbance of roost sites.
• The extent to which wind farms may displace foraging bats is uncertain but may be important for a broad range of species, and may result in effects on species not considered to be at high risk of mortality (Barré *et al*. 2018).

Barrier effect

• The cumulative barrier effect on long-distance migrants of avoiding multiple obstacles along the course of their migration route remains unstudied.

Habitat loss and degradation

• The extent of functionally linked land that lies beyond the borders of a Natura 2000 site and is necessary to maintain or restore the favourable conservation status of a species is unknown and varies between species (e.g. Apoznański *et al*. 2018). As noted, however, the majority of species vulnerable to collision risk are not Annex II species.

Loss of flight corridors and roost sites

• Empirical data on the significance of the loss of flight corridors is limited.
• Wind turbines may influence populations outside their national borders through effects on migrating bats (Voigt *et al*., 2012; Lehnert *et al*., 2014).
• Connectivity between breeding and wintering areas may be weakened as the increasing cumulative density of wind energy developments disrupts national and transboundary migratory routes (Berkhout *et al*.,2013).

Key recommendations for assessing the significance of effects on bats

• Define clear significance criteria that are aligned with the conservation objectives for the bats concerned, are context specific (case-by-case) and are scientifically underpinned.
• Ensure availability of data, notably in relation to bat populations, their activities, their roost sites, etc. to inform plan-level assessments or detailed project-specific surveys and assessment.
• Invest in research in order to cover the knowledge gaps, as listed in Box 5-8.
• Benefit from the increased availability of post-development monitoring reports to improve the evidence base.
Table 5-7 Possible mitigation measures for bats (A: avoidance; R: reduction)

	Collision and barotrauma	Habitat loss and degradation	Disturbance and displacement at roost sites	Loss of flight corridors (barrier effects) and roost sites
Micrositing: Turbine arrangement and location	A/R	A/R	A/R	A/R
Infrastructure design: Turbine number and technical specifications	R		R	R
Scheduling: Avoiding, reducing or phasing construction activities during ecologically sensitive periods			A/R	
Curtailment and cut-in speeds: Turbine operation timing	R			R
Deterrents: Acoustic and visual measures	A/R			R

Reference Number 8.21:
Consolidating the State of Knowledge: A Synoptical Review of Wind Energy's Wildlife Effects. Eva Schuster · Lea Bulling · Johann Köppel.Received: 10 August 2014 / Accepted: 10 April 2015 / Published online: 26 April 2015 © Springer Science+Business Media New York 2015

Table 1 Predominant hypotheses on wind energy-induced effects on bats based on Köppel et al. (2014 amended)

Hypothesis	Plausible/supported	Implausible/not-supported
Increased mortality due to high flight activity		
Increase in temperature enhances bat activity/fatality (up to 21 °C)	Arnett et al. (2006$^{\delta}$, 2007)$^{\delta}$, Baerwald and Barclay (2011)*; Behr et al. (2011)$^{\delta}$, Brinkmann et al. (2011)$^{\delta}$, Grodsky et al. (2012)*, Hein et al. (2011b)$^{\delta}$, Kerns et al. (2005)$^{\delta}$: Meyersdale, and Redell et al. (2006)$^{\delta}$	Arnett et al. (2006)$^{\delta}$ (>44 m); Horn et al. (2008)*: but in combination with wind speed; Kerns et al. (2005)$^{\delta}$: Mountaineer
Decrease in wind speed leads to a higher bat activity/fatality	Arnett et al. (2006$^{\delta}$, 2008$^{\delta}$), Baerwald et al. (2009)*, Baerwald and Barclay (2011)*, Behr et al. (2007*, 2011$^{\delta}$), Brinkmann et al. (2011)$^{\delta}$, Hein et al. (2011b)$^{\delta}$, Horn et al. (2008)*, Kerns et al. (2005)$^{\delta}$, and Redell et al. (2006)$^{\delta}$	Arnett et al. (2007)$^{\delta}$: highest at moderate wind (8 m/s) and high temperature; Grodsky et al. (2012)*, Hein et al. (2011b)$^{\delta}$: low-frequency bats
High bat fatality/activity in times of high air pressure	Kerns et al. (2005)$^{\delta}$ (before and after storm fronts)	Baerwald and Barclay (2011)* (hoary bat), Cryan and Brown (2007)*, and Horn et al. (2008)*
High bat activity/fatality in times with very low humidity	Behr et al. (2011)$^{\delta}$, Brinkmann et al. (2011)$^{\delta}$, and Kerns et al. (2005)$^{\delta}$	
High bat activity/fatality during moonlit nights	Baerwald and Barclay (2011)*, and Cryan et al. (2014)*	Cryan and Brown (2007)* (low moon illumination together with low wind speeds, and relatively high degrees of cloud cover)

Increased bat activity/fatality during sunset and few hours after sunset	Arnett et al. (2006)[δ]: also sunrise; Behr et al. (2007)*, Brinkmann et al. (2011)[δ], Hein et al. (2011b)[δ]: high-frequency bats and hoary bat; and Horn et al. (2008)*	
Increased bat fatality during late summer/ autumn	Amorim et al. (2012)*, Arnett et al. (2006[δ], 2008)[fi], Behr et al. (2007)* (July–Oct), Brinkmann et al. (2006)[δ], Brinkmann et al. (2011)[δ]: July/August; Cryan and Brown (2007)*, Doty and Martin (2012)*: southern hemisphere; Grodsky et al. (2012)*, Hein et al. (2011b)[δ], Jain (2005)[δ], Johnson et al. (2003*, 2004)*, Redell et al. (2006)[δ], and Rydell et al. (2010b)[fi]	
Increased mortality due to flight behavior		
Migratory species particularly at risk	Arnett et al. (2008)[fi], Baerwald et al. (2009)*, Cryan and Brown (2007)*, Cryan and Barclay (2009)[fi], Grodsky et al. (2012)*, Johnson et al. (2003*, 2004*), and Kunz et al. (2007)[fi]	Ahlén (2003)[δ], Brinkmann et al. (2006)[δ], Behr et al. (2007)*, Hull and Cawthen (2013)*, Rydell et al. (2010a)[fi], and Voigt et al. (2012)*
Use of echolocation during flight, reaction time insufficient	Grodsky et al. (2011)*, Kunz et al. (2007)[fi], Long et al. (2009)[δ], and Rydell et al. (2010a)[fi]	
Increased risk for sub-adults (e.g., lower flight ability)	Fiedler et al. (2007)[δ] (sub-adults and juveniles)	Arnett et al. (2008)[fi], Grodsky et al. (2012)*, Hull and Cawthen (2013)*, Johnson et al. (2004)*, Kerns et al. (2005)[δ], and Rydell et al. (2010a)[fi]
Bats approach turbines while mating, feeding, or swarming	Arnett et al. (2008[fi], 2011b[δ]), Behr et al. (2007)*, Cryan and Brown (2007)*, Cryan (2008)[fi], Cryan et al. (2014)*, Doty and Martin (2012)*: insectivorous bats; Grodsky et al. (2011)*, Horn et al. (2008)*, Hull and Cawthen (2013)*, Redell et al. (2006)[δ], and Rydell et al. (2010a)[fi]	Baerwald and Barclay (2011)* (mating)
Open-air foragers with narrow wings more exposed to collision	Ahlén (2003)[δ], Doty and Martin (2012)*, Hull and Cawthen (2013)*, and Rydell et al. (2010a[fi], 2010b[fi])	
Increased mortality due to attraction		
Investigating turbines as possible tree-roosts increases collisions risk	Ahlén (2003)[δ], Cryan and Brown (2007)*, Cryan (2008)[fi], Cryan and Barclay (2009)[fi], Cryan et al. (2014)*, Hull and Cawthen (2013)*, and Kunz et al. (2007)[fi]	
Attraction due to increased prey availability	Ahlén (2003)[δ], Ahlén et al. (2009)*, Arnett et al (2011b)[δ], Grodsky et al. (2012)*, Horn et al. (2008)*, Kunz et al. (2007)[fi], and Rydell et al. (2010b)[fi]	Hull and Cawthen (2013)*: collision victims had empty stomachs
Bats are attracted to the turbine structure itself	Ahlén et al. (2009)*, Cryan et al. (2014)*, and Horn et al. (2008)*	
Bats are attracted to turbine lighting	Johnson et al. (2004)*: higher activity but no difference in mortality rate	Arnett et al. (2008)[fi], Baerwald and Barclay (2011)*, Horn et al. (2008)*, Johnson et al. (2003)*, and Kerns et al. (2005)[δ]
Increased mortality risk caused by indirect interaction with operating turbines		
Rapid change in air pressure by moving blades can lead to internal injuries and accounts for the main cause of fatality (barotrauma)	Baerwald et al. (2008)*	Grodsky et al. (2011)*, Houck (2012)[δ], Piorkowski and O'Connell (2010)*, and Rollins et al. (2012)*
Bats caught in vortices increases probability of collision	Horn et al. (2008)*	
Bats caught in vortices can be contorted, which may result in injury	Grodsky et al. (2011)*	

Table 2 Predominant hypotheses on wind energy-induced effects on breeding and resting birds

Hypothesis	Plausible/supported	Implausible/not-supported
Construction effects		
Displacement of birds during construction	Drewitt and Langston (2006)[§], Pearce-Higgins et al. (2012)*, and Steinborn et al. (2011)[δ]	Pearce-Higgins et al. (2012)*, and Steinborn et al. (2011)[δ]
Facility-caused effects		
Increased turbine height increases effects (displacement, collision risk)	Hötker (2006)[δ] (displacement of resting birds)	Barclay et al. (2007)*, Everaert (2014)*, Hötker (2006)[δ] (breeding birds); Pearce-Higgins et al. (2012)*, and Stewart et al. (2007)[§]
Spatial turbine layout limits effects on birds if arranged in lines or small clusters	Larsen and Madsen (2000)*	
Operation effects		
Resting species show avoidance behavior near turbines	Devereux et al. (2008)* (common pheasant), Fijn et al. (2012)*, Hötker et al. (2005)[δ], Steinborn et al. (2011)[δ], and Stevens et al. (2013)*	Devereux et al. (2008)* and Stevens et al. (2013)*
Breeding densities increase with increasing distance to turbines	Leddy et al. (1999)*, Pearce-Higgins et al. (2009)*, Winder et al. (2014)*, and Zeiler and Gruenschachner-Berger (2009)*	Douglas et al. (2011)*, de Lucas et al. (2005)*, Steinborn et al. (2011)[δ], and Steinborn and Reichenbach (2012)*
Wind farms cause no effects on breeding success	Reichenbach and Steinborn (2006)[δ]	
Decrease in comfort behavior of some species near turbines	Steinborn et al. (2011)[δ]	
Birds adapt to wind farms and show signs of habituation	Madsen and Boertmann (2008)*	Hötker et al. (2005)[δ] and Rydell et al. (2012)[§]
Enhanced effects due to species characteristics		
Resting birds are more sensitive to wind turbines than breeding birds (avoidance)	Hötker et al. (2005)[δ], Reichenbach and Steinborn (2006)[δ], and Steinborn et al. (2011)[δ]	
Collision risk is species-specific	Drewitt and Langston (2006)[§], Everaert (2014)*, Grünkorn et al. (2009)*, Gue et al. (2013)*, and Morinha et al. (2014)*	
Minor risk of collision for species that spend most of the time on the ground (in particular *Galliformes*)/outside the rotor swept zone	Brennan et al. (2009)[Ψ], Gue et al. (2013)*, LeBeau et al. (2014)*, Pruett et al. (2009b)*, Sandercock et al. (2013)[δ], and Winder et al. (2013)*	Falkdalen Lindahl et al. (2013)[Ψ]
Species show no avoidance behavior during flight	Pearce-Higgins et al. (2009)* and Steinborn et al. (2011)[δ]	Fijn et al. (2012)* and Everaert (2014)*
Displacement is species-specific	Devereux et al. (2008)*, Pearce-Higgins et al. (2009)*, and Stevens et al. (2013)*	
Inter-annual dynamics in reaction to wind turbines	Fijn et al. (2012)* and Morinha et al. (2014)*	
Decrease in predation risk due to impacts of wind turbines on predators (e.g., collision)	Winder et al. (2013)*	Sandercock et al. (2013)[δ]
Species that commute between two habitats (e. g., resting and foraging) are at higher collision and displacement risk	Drewitt and Langston (2006)[§], Hötker et al. (2005)[δ], Langgemach and Dürr (2013)[δ], and Pearce-Higgins et al. (2008)*	
Enhanced effects due to spatial/site characteristics		
Land use can have higher impacts on breeding bird abundances than wind turbines	Steinborn et al. (2011)[δ] and Steinborn and Reichenbach (2012)*	
The less disturbed a natural habitat, the higher the effects on birds by wind farms	Larsen and Madsen (2000)*, Pearce-Higgins et al. (2009)*, and Steinborn et al. (2011)[δ]	

Table 3 Predominant hypotheses on wind energy-induced effects on raptors

Hypothesis	Plausible/supported	Implausible/not-supported
Increased collision risk due to raptor abundance		
High raptor abundance increases collision risk	Barrios and Rodríguez (2004)*, Carrete et al. (2012)*, Smallwood et al. (2009)*, and Martínez-Abraín et al. (2012)*	Garvin et al. (2011)*, de Lucas et al. (2008)*, and Whitfield and Madders (2006)[β]
High abundance on flight paths following areas with major wind currents (depending on topography and weather)	Barrios and Rodríguez (2004)*, Katzner et al. (2012)*, de Lucas et al. (2012b)*, and Hoover (2002)[δ]	
High abundance on flight paths following linear landscape features (e.g., ridges, cliffs, canyons)	Katzner et al. (2012)* and Smallwood et al. (2007)*: borrowing owl	
Increased collision risk due to flight behavior and activity		
Increased flight activity with decrease in turbine—aerie distance/ breeding site increases collision risk	Bevanger et al. (2010)[δ], Eichhorn et al. (2012)*, and Smallwood et al. (2007)*: borrowing owl	Carrete et al. (2012)*
Repeated fly-bys increase collision risk	Katzner et al. (2012)* and Ledec et al. (2011)[δ]	
Search/foraging flight within rotor swept zone increases collision risk	Dahl et al. (2013)*, Ledec et al. (2011)[δ], Mammen et al. (2011)[ψ], Martínez-Abraín et al. (2012)*, and Smallwood and Thelander (2004[δ], 2008*)	
Local populations at greater risk than migrants due to flight behavior (e.g., foraging, fly-bys)	Barrios and Rodríguez (2004)* and Katzner et al. (2012)*	Smallwood et al. (2007)*: borrowing owl
Seasonal behavior influences flight activity	Barrios and Rodríguez (2004)*, Camiña (2011)[ψ], May et al. (2011)[δ], and Smallwood et al. (2009)*	
Species-specific high-risk flight behavior (e.g., circular flight, foraging strategy) increases collision risk	Garvin et al. (2011)*, Hull and Muir (2013)*, de Lucas et al. (2008)*, and Smallwood et al. (2009)*	
Increased collision risk due to site and season characteristics		
Low flight altitude near summits and steep slopes increases collision risk	Barrios and Rodríguez (2004)*, de Lucas et al. (2012b)*, Camiña (2011)[ψ], Hoover (2002)[δ], Katzner et al. (2012)*, Muños Gallego et al. (2011)[ψ], and Orloff and Flannery (1992)[δ]	
Low flight altitude with low air temperature increases collision risk	Barrios and Rodríguez (2004)*, Camiña (2011)[ψ], and Katzner et al. (2012)*	
Raptors drawn to wind farm due to low vegetation cover/open landscapes (favorable hunting ground) increases collision risk	Bellebaum et al. (2013)*, Dürr (2009)[δ], Mammen et al. (2011)[ψ], and Smallwood et al. (2007)*: borrowing owls	
Avoidance		
Raptors show no avoidance behavior and exposes them to greater risk of collision	Bevanger et al. (2010)[δ], Dahl et al. (2013)*, Mammen et al. (2011)[ψ], and Smallwood and Thelander (2004)[δ]	Garvin et al. (2011)*; Hull and Muir (2013)*; de Lucas et al. (2004)*
Low maneuverability due to flight type and morphology increases collision risk	Baisner et al. (2010)*, Barrios and Rodríguez (2004)*, Dahl et al. (2013)*, Katzner et al. (2012)*, and Smallwood and Thelander (2004)[δ]	

Low rotation speed and/or sparse distribution of turbines decreases avoidance response	Hull and Muir (2013)*: hub speed and Smallwood et al. (2007)*: borrowing owl	Orloff and Flannery (1992)[δ]
Attraction due to increase in food availability/change in food distribution increases collision risk	Dürr (2009)[δ], Camiña (2011)[Ψ], and Smallwood et al. (2007)*: borrowing owl	Hoover (2002)[δ]
Inattentiveness during foraging increases risk of collision	Orloff and Flannery (1992)[δ] and Smallwood et al. (2009)*	
Inattentiveness due to interaction behavior increases risk of collision	Dahl et al. (2013)*, May et al. (2010[δ], 2011[δ]), Smallwood et al. (2009)*	
Higher risk of collision for adults than sub-adults	Bellebaum et al. (2013)*, Bevanger et al. (2010)[δ], Camiña (2011)[Ψ]: Northern Spain; in Dahl et al. (2013), and May et al. (2010[δ], 2011)[δ]: due to higher involvement in social behavior	Dahl et al. (2013)*: due to higher abundance within wind farm; de Lucas et al. (2012a)*, Powlesland (2009)[δ]
Indirect effects from wind energy development		
Decrease in breeding attempts/ success due to turbine-induced adult collision risk	Bellebaum et al. (2013)*, Bevanger et al (2010)[δ]: territorial shift, Dahl et al. (2012)*, and Martínez-Abraín et al. (2012)*	
Displacement during operation	Garvin et al. (2011)* and de Lucas et al. (2004)* (except *Falco tinnunculus*)	Dahl et al. (2013)*, Hull and Muir (2013)*, and Madders and Whitfield (2006)[¶]

Table 4 Predominant hypotheses on wind energy-induced effects on migratory birds offshore

Hypotheses		Plausible/supported	Implausible/not-supported
Increase of potential collision risk			
Times of high bird abundance	Migration peaks in spring and autumn	Hein et al. (2011a)*, Hill et al. (2014)$^{\delta}$, Hüppop et al. (2004*, 2006*), and van de Laar (2007)$^{\delta}$: gas platform	
	Majority: nocturnal migrants (esp. songbirds, ducks)	Aumüller et al. (2011)*, Christensen et al. (2004)$^{\delta}$, Hill et al. (2014)$^{\delta}$, and Hüppop et al. (2004*, 2012*)	Plonczkier and Simms (2012)*: pink-footed geese
	Few mass migration events per year	Aumüller et al. (2011)*, Hüppop et al. (2004*, 2006*, 2012*), and Nilsson et al. (2006)*: blue tit	
Weather patterns in departure area trigger migration activity	Tailwinds	Aumüller et al. (2011)*, Hüppop et al. (2004*, 2006*), Nilsson et al. (2006)*, Pettersson and Fågelvind (2011)$^{\delta}$, and Plonczkier and Simms (2012)*	Nilsson et al. (2006)*: regular migrants less influenced then partial
	Low cloud cover	Nilsson et al. (2006)*: blue tit, and Plonczkier and Simms (2012)*	
	Low precipitation	Hüppop et al. (2004)*, Nilsson et al. (2006)*: blue tit, and Pettersson (2005)$^{\delta}$	
	Atmospheric pressure/change	Hein et al. (2011a)* and Shamoun-Baranes et al. (2006)*	
	Temperature	Hüppop and Winkel (2006)*: pied flycatcher	
Areas of high abundance	Migration corridors	Aschwanden et al. (2011)$^{\delta}$ (onshore study); Pettersson and Fågelvind (2011)$^{\delta}$, and Reichenbach and Grünkorn (2011)$^{\delta}$	
	Near coastlines	Burger et al. (2012)*, Hüppop et al. (2004*, 2006*), Kahlert et al. (2011)$^{\delta}$, and Stienen et al. (2007)*	
Reverse migration	Repeated fly-bys	Hüppop et al. (2006)*	
Low maneuverability	Species-specific flight ability resulting from morphology	Furness et al. (2013)*, Garthe and Hüppop (2004)*, and Plonczkier and Simms (2012)*	
	Experience of bird	Hüppop et al. (2006)*	
Low flight altitude	Species-specific flight altitude	Furness et al. (2013)*, Hüppop et al. (2004*, 2006*), and Pettersson and Fågelvind (2011)$^{\delta}$	
	Time of the day and year	Hüppop et al. (2004)*: afternoon, 2. half of night and spring, and Pettersson and Fågelvind (2011)$^{\delta}$: during day and spring	
	Migration distance and flight experience	Hüppop et al. (2006)*	
Decrease in flight altitude	Low visibility	Aumüller et al. (2011)*, Hüppop et al. (2006)*, and Plonczkier and Simms (2012)*	Pettersson and Fågelvind (2011)$^{\delta}$: fly above fog
	Rapid change in weather conditions (precipitation, headwind, strong winds)	Aumüller et al. (2011)*, Hüppop et al. (2004*, 2006*), Pettersson and Fågelvind (2011)$^{\delta}$, and Reichenbach and Grünkorn (2011)$^{\delta}$	
Attraction to artificial light sources	Adverse weather condition with low visibility	Aumüller et al. (2011)*, Blew et al. (2013b)$^{\Psi}$, Hill et al. (2014)$^{\delta}$, Hüppop et al. (2006)*, and van de Laar (2007)$^{\delta}$: gas platform	Kahlert et al. (2011)$^{\delta}$ (periods of low visibility very infrequent)
	Permanent/intense light	Blew et al. (2013a)$^{\Psi}$, Hüppop et al. (2006)*, and van de Laar (2007)$^{\delta}$: gas platform	

Decrease of potential collision risk			
Avoidance behavior	Species-specific	Furness et al. (2013)*, Mateos et al. (2011)[Ψ], Petersen et al. (2006)[δ], and Plonczkier and Simms (2012)*	
	Weather dependent	Aumüller et al. (2011)*, Coppack et al. (2011)[Ψ], Hüppop et al. (2006)*, and Reichenbach and Grünkorn (2011)[Ψ]	Pettersson (2005)[δ]
	Horizontal/vertical/between turbines	Desholm and Kahlert (2005)*, Kahlert et al. (2011)[δ], and Plonczkier and Simms (2012)*	
	Macro-/micro-avoidance	Christensen et al. (2004)[δ], Desholm and Kahlert (2005)*, Furness et al. (2013)*, Hill et al. (2014)[δ], Petersen et al. (2006)[δ], and Pettersson and Fågelvind (2011)[δ]	
	Increased micro-avoidance at operating wind turbines	Hill et al. (2014)[δ]	
Habituation	Over the years	Plonczkier and Simms (2012)*	

Table 5 Predominant hypotheses on wind energy-induced effects on marine mammals

Hypothesis	Plausible/supported	Implausible/not-supported
Habitat change		
Increase in prey availability due to exclusion of fishery	Scheidat et al. (2011)*, SMRU (2009)[ϖ], and Simmonds and Dolman (2008)[Ψ]	
Increase in habitat quality due to artificial reef-effect	Gill (2005)[ß], Russell et al. (2014)*, Scheidat et al. (2011)*, SMRU (2009)[ϖ], and Simmonds and Dolman (2008)[Ψ]	
Entanglement/entrapment in cables/structures	Simmonds and Brown (2010)[ß]	
Collision with floating or submerged structures	Gill (2005)[ß] and Simmonds and Brown (2010)[ß]	Russell et al. (2014)*
Disorientation due to change of magnetic fields	Gill (2005)[ß], SMRU (2009)[ϖ], Simmonds and Dolman (2008)[Ψ]	Lucke et al. (2008)[δ]
Increased vessel activity causing stress/disturbance and risk of strikes	Gordon (2012)[Ψ], Nedwell and Howell (2004)[ϖ], SMRU (2009)[ϖ], and Simmonds and Dolman (2008)[Ψ]	Refuge function: Lindeboom (2012)[Ψ], and Scheidat et al. (2011)*
Contamination due to leaks, spills, and biocides	SMRU (2009)[ϖ], Simmonds and Brown (2010)[ß], and Simms and Ross (2000)[ß]	
Pre-construction		
Increased vessel activity causing stress/disturbance and risk of strikes	Gordon (2012)[Ψ], Nedwell and Howell (2004)[ϖ], and Simmonds and Dolman (2008)[Ψ]	
Noise emission from wind farm-related geophysical surveys	Gordon (2012)[Ψ], Nedwell and Howell (2004)[ϖ], SMRU (2009)[ϖ]	
During construction		
Displacement due to noise emission during piling	Brandt et al. (2009[δ], 2011*), Carstensen et al. (2006)*, Dähne et al. (2013)*, Haelters et al. (2012)[δ], Kastelein et al. (2013b)*, Nedwell and Howell (2004)[ϖ], Nedwell et al. (2007)[δ], Nehls and Betke (2011)[δ], Tougaard et al. (2006a[δ], b[δ], 2009a*), and Wahl et al. (2013)[Ψ]	
Behavioral disturbance due to underwater noise (e.g., feeding, nursing, resting, migration)	Dähne et al. (2014b)[Ψ], Gordon (2012)[Ψ], Kastelein (2013a)[Ψ], SMRU (2009)[δ], and Tougaard et al. (2009a*, 2012[Ψ])	
Temporal hearing impairment	Gordon (2012)[Ψ], Kastelein (2013a)[Ψ], Lucke et al. (2009)*, and Nedwell et al. (2007)[δ]	
Hearing loss/injury/death close to piling site	Gordon (2012)[Ψ]; Kastelein (2013a)[Ψ]; Lucke et al. (2009)*; Nedwell and Howell (2004)[ϖ]; Nedwell et al. (2007)[δ]	

Increased risk due to simultaneous, long-lasting piling activity or contemporary piling intervals	Dähne et al. (2013)*, Lucke et al. (2009)*, Madsen et al. (2006)[fi], Nedwell et al. (2007)[δ], Nehls and Betke (2011)[δ], and Thompson et al. (2010)*	
Mother-calf-separation/ disturbance	Dähne et al. (2014b)[Ψ], and Kastelein (2013a)[Ψ]	
Increased vessel activity causing stress/disturbance and risk of strikes	Carstensen et al. (2006)*, Gordon (2012)[Ψ], Nedwell and Howell (2004)[ω], SMRU (2009)[ω], Simmonds and Dolman (2008)[Ψ], and Simmonds and Brown (2010)[fi]	
Tendency to return after piling	Brandt et al. (2009)[δ], Haelters and Vanermen (2013)[Ψ], Nehls and Betke (2011)[δ], Scheidat et al. (2011)*, Tougaard et al. (2006b)[δ]: Horns Rev, and Wahl et al. (2013)[Ψ]	Tougaard et al. (2006a)[δ]: 2 years
Disperse of sediment causing re-suspension of potentially polluted sediment and turbidity	Carstensen et al. (2006)*, Gill (2005)[fi], and Simmonds and Dolman (2008)[Ψ]	
During operation		
Masking causing disruption of usual behavior	Koschinski et al. (2003)*: harbor seals; Lucke (2008)[δ]: at very short distance	Gordon (2012)[Ψ], Haelters and Vanermen (2013)[Ψ], Koshinski et al. (2003)*: harbor porpoises, Lucke (2008)[δ], Nehls and Betke (2011)[δ], and Tougaard et al. (2009b)*
Avoidance of wind farm area/ change of behavior due to noise emission and vibration	Simmonds and Dolman (2008)[Ψ]and Tougaard et al. (2009b)*: porpoises at very short distance/seals likely	Dähne et al. (2014a)[δ], McConnell et al. (2012)[δ], Nedwell et al. (2007)[δ], and Scheidat et al. (2011)*
During decommissioning		
Habitat loss due to removal of structure	Gill (2005)[fi], and Gordon (2012)[Ψ]	
Injury or behavioral response due to noise emission (e.g., explosion, cutting)	Gordon et al. (2007)[δ], Lucke et al. (2009)*, Prior and McMath (2008)[Ψ], SMRU (2009)[δ], and Simmonds and Dolman (2008)[Ψ]	
Increased vessel activity causing stress/disturbance and risk of strikes	Nedwell and Howell (2004)[ω], and Simmonds and Brown (2010)[fi]	
Disperse of sediment causing re-suspension of potentially polluted sediment and turbidity	Carstensen et al. (2006)*, Gill (2005)[fi], and Simmonds and Dolman (2008)[Ψ]	

The possible impacts to Bats from Windfarms are extensive & under the Precautionary Principle have to be refused.

Reference Number 8.22:
Global Review on Environmental Impacts of Onshore Wind Energy and Their Implications for Forest Ecosystems. Leon Sander , Christopher Jung , Dirk Schindler. Posted Date: 27 May 2024
doi: 10.20944/preprints202405.1727.v1

Wind turbines can lead to micrometeorological alterations of immediate areas. They extract kinetic energy and momentum from the atmosphere , reduce wind speed in the downwind region and cause downwind turbulence (wakes) which alter the surface-atmosphere exchange of energy, momentum, mass, and moisture , and stimulate vertical mixing .
Micrometeorological changes due to WF deployment directly affect the soil carbon cycle and indirectly impact the biotic environment that regulates the soil carbon cycle. Implications for biogeochemical ecosystem processes are highly uncertain.
The impacts of WFs on biodiversity and wildlife species comprise habitat loss, habitat degradation, habitat fragmentation, vegetation disturbance, a potential suppression of ecosystem functions, and alterations of species behaviour.

WFs can affect vegetation structure and vitality negatively and induce an inhibiting effect if near surface Air Temperature (Ta) changes reduce soil moisture and enhance water stress resulting causing inhibited photosynthesis, primary production, and vegetation growth.
Aves (birds) and Chiroptera (bats) are the most evidenced taxa regarding onshore WE impact. It is hypothesized that insects are attracted by Wind Turbines because they accumulate in the lee of tall structures and swarm above prominent high points in landscapes, rest on the surface of towers, or are attracted by light-colored turbines, warm surface temperature induced by blade rotation, heat emission, or the herbaceous vegetation cover around wind turbine bases.
Birds and bats suffer from lethal and sublethal injuries in Wind Farms due to collision with Wind Turbine components and associated infrastructure, electrocution at transmission lines (giant birds), or barotrauma (bats) caused by a sudden pressure drop near the turbine edges. Wind Turbines affect many bird and bat species at all land-cover types. At the global scale, birds that most likely collide with Wind Turbines are of the orders Accipitriformes, Ciconiiformes, Falconiformes, many species within Charadriiformes, Podicipediformes, Strigiformes, Cuculiformes, or Bucerotiformes. Small passerines are the most common bird fatalities caused by collision with Wind Turbines in Latin America, the USA, and Canada, followed by upland game birds and diurnal raptors. In North America, less than one permille of the continent-wide population for each species is estimated to be killed annually by collisions with Wind Turbines.
In most studies, bat fatalities outnumber birds. They are estimated to be tens per turbine per year. Molossidae suffer the most fatalities in Latin America. Together with Hipposideridae, Molossidae have the highest death rates globally. Bats in the genus Lasiurus are among the most collision-susceptible bats in the USA. Nearly one-quarter of all bat species in the USA and Canada are affected by Wind Turbine-related bat mortalities.
The species with the highest collision numbers in Europe are the common pipistrelle (*Pipistrellus pipistrellus*), Nathusius's pipistrelle (*P. nathusii*), and the common noctule (*Nyctalus noctule*), which account together with five other species for 98 % of all bat fatalities at Wind Turbines in northwestern Europe. The largest bat family, Vespertilionidae, includes the five bat species most vulnerable to collision. Some areas are susceptible to bird and bat fatalities.
Hotspots of bird vulnerability are often within critical migratory corridors and along coastlines or regions where raptors use thermals to gain altitude to move between locations and forage.
The most significant number of collisions for bats is observed and predicted in North America at Wind Farms along forested ridgetops in the eastern USA and agricultural regions of southwestern Alberta, Canada, and Europe.
Cumulative direct mortality estimates of birds and bats from Wind Farms mainly focus on the USA and exhibit high uncertainty and a wide value range. Collision risk depends on multiple factors such as season, Wind Turbine and Wind Farm properties, species characteristics, and behavior, number of birds and bats found in the area, climatic conditions, topography, food availability, and habitat quality in general.
Many studies indicate that the seasonal effects of collision mortality are likely due to varying bird and bat behaviour, particularly in habitat use and flight activity. For many migratory passerine and raptor species, spring, fall, and early winter migration, pre-migration, and postmigration periods are characterized by peak mortality at Wind Turbines. In the temperate Northern Hemisphere, fatalities of migratory bats are concentrated during late summer and autumn migration, with a smaller peak in early spring.
Bat species particularly vulnerable to collision, though of different genera, have some morphological and ecological similarities. Migratory, tree-roosting, high-flying, edge or open space aerial foraging, insectivorous bats seem to be at particular collision risk. Still, both migratory and resident bat species are prone to collisions with Wind Turbines throughout Europe. Collisions of bats with Wind Turbines do not appear as chance events. Evidence has been found that bats conduct activities near Wind Turbines and use them. There are different hypotheses as to why bats could be attracted to wind turbines, including bats seeking shelter (roosts), social opportunities (conspecifics; mating), or food (insect prey) at wind turbines. Bats could also be attracted by swishing sounds, heat, acoustic, or visual attractors. Furthermore, bats may misperceive the smooth surfaces of Wind Turbine towers to be water, misperceive Wind Turbines as trees, or suffer from echolocation failure and electromagnetic disorientation.
Bats have the highest collision risk during nights with low wind speed, relatively high air temperature, and no precipitation due to higher activity
Noise pollution generally contributes to disturbance, habitat degradation, and wildlife displacement and masks auditory life-history traits essential for survival and reproduction. It affects habitat use, territorial behaviour, and breeding success of animals. Consequences are, for instance, reduced bird densities, avoidance behaviour of bats and birds, alterations of wildlife migration routes, or other behavioural impacts. Operation noise can be a deterrent or an attractive effect. For wildlife, the loudness of noise is relatively less critical than the consistency of noise. In general,

the impacts of Wind Turbine noise on wildlife are highly species specific, and some species even occur in zones with the highest noise exposure.

Reference Number 8.23:

Wind turbines displace bats from drinking sites. Carolin Scholz, Hannah Klein, Christian C. Voigt. Biological Conservation 302 (2025) 110968. https://doi.org/10.1016/j.biocon.2025.110968. 3 January 2025. 0006-3207/© 2025 The Authors. Published by Elsevier Ltd.

Bats depend on water for drinking and foraging, but the increasing number of wind turbines may pose a problem for bats, as operating wind turbines are known to displace bats over long distances. We asked whether turbines displace bats from critical habitats, namely small ponds where bats drink and forage. We recorded the acoustic activity and foraging activity of three functional guilds of bats, i.e. open space, edge space and narrow space foraging bats, using automated detectors at 59 ponds located at varying distances (~50 to 5000 m) from wind turbines. We observed that edge space foraging bats were most abundant at focal ponds compared to narrow and open space foraging bats. The overall acoustic activity of open and narrow space foraging bats decreased with decreasing distance to wind turbines, whereas the activity of edge space foraging bats was unaffected by wind turbines. The feeding activity of bats at focal ponds decreased for open space foraging bats in proximity to wind turbines. For narrow space foraging bats, we observed a trend towards reduced feeding activity at ponds close to wind turbines, whereas we did not observe any effect of wind turbines on the feeding activity of edge space foraging bats. The siting of wind turbines close to drinking sites may degrade the resource landscape for bats, which could lead to population declines. Avoiding the proximity of turbines to important bat habitats is essential to protect biodiversity on farmland.

We investigated whether wind turbines displace bats from drinking sites during the critical lactation and weaning period of females in early summer. Our study was conducted in northeastern Germany, an area characterised by intensive agriculture, increasing drought (Zink et al., 2016, Boeing et al., 2021), a high density of wind turbines (FA Wind, 2023, Voigt et al., 2015), and high rates of bat mortality at wind turbines (Kruszynski et al., 2022; Voigt et al., 2022). At the same time, many small ponds are scattered across the landscape, providing drinking and foraging sites for local bats. We found that both general activity and hunting activity of narrow and open space foraging bats decreased with decreasing distance from wind turbines, even in highly attractive habitats such as drinking sites; however, we acknowledge a trend in hunting activity of narrow space foraging bats. Overall, our observations are consistent with the idea that bats avoid ponds in close proximity to wind turbines.

We conclude from our results that the operation of wind turbines on farmland can contribute to a reduction in local bat diversity, not necessarily due to casualties at wind turbines, but rather due to displacement from wind turbines. This decline in the abundance of narrow and open space foraging bats near wind turbines is associated with a loss of their ecological function on farmland (Scholz and Voigt, 2022). Bats are known to provide ecosystem services by consuming insect pests (Kunz et al., 2011; Boyles et al., 2011; Williams-Guill´en et al., 2016; Maslo et al., 2022; Russo et al., 2018). Therefore, displacement of bats over large areas around wind turbines may contribute to reduced crop production and the need for increased pesticide application to compensate. Displacement effects on wildlife caused by wind turbine operations may contribute to cryptic cascading trophic effects that have not been previously recognised (Thaker et al., 2018; Scholz and Voigt, 2022). Our results highlight the urgent need to consider the loss of critical habitats for vulnerable bats and other wildlife when planning wind turbines (Barr´e et al., 2018).

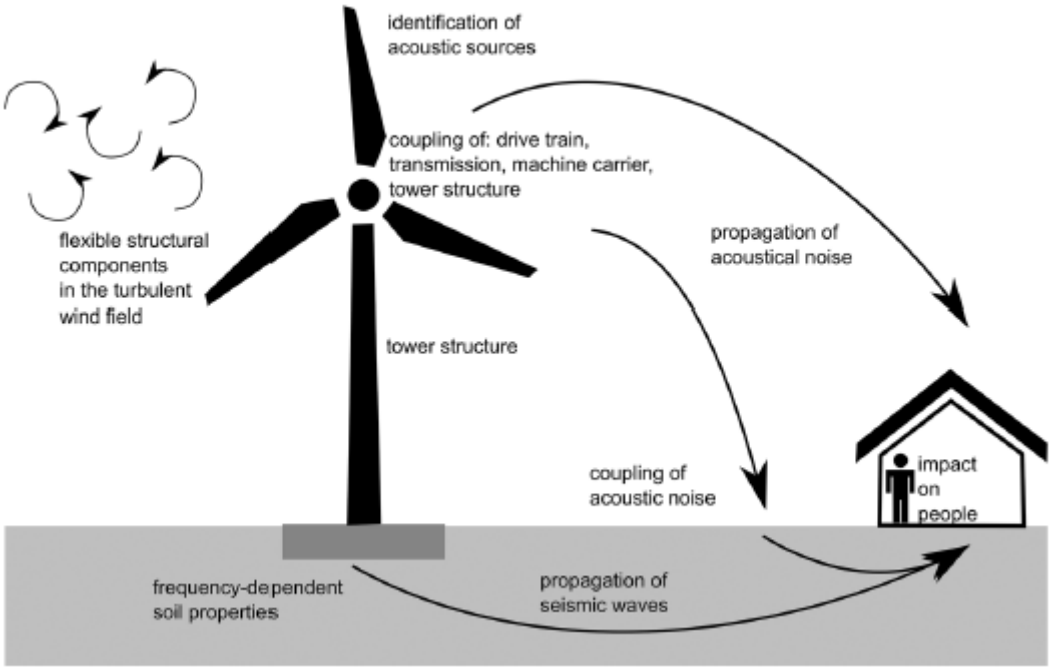
Reference number 9.1 :
SEISMIC ANALYSIS OF WIND TURBINE WITH SOIL STRUCTURE INTERACTION: CRITICAL REVIEW. Saher El-Khoriby, Marwan Shahen, Tamer M. El Koran3, Faten El-Fekky., *International Conference on Advances in Structural and Geotechnical Engineering* ICASGE'21 15-18 March 2021, Hurghada, Egypt

Long-term versus short-term conditions (onshore wind turbines case)
An important aspect of the FE model was the modelling of groundwater and drainage conditions of the soil. In this regard, it must be acknowledged that because one of the mechanisms for cyclic degradation is the accumulation of excess pore water pressure with increasing number of loading cycles, it is primarily associated with fully saturated soil conditions. It must further be recognized that in terms of soil behaviour, cyclic loading can be categorized into short-term or long-term loading.

Long-term conditions	*short-term conditions*
During long-term cyclic loading, the pore pressure generated by cyclic loading dissipates and drained soil behaviour may be assumed.	*short-term cyclic loading leads to undissipated pore pressures which result in: decrease the effective stresses in the soil stiffness degradation*

Reference number 9.2:
Ground motions induced by wind turbines Sven Nagel, Toni Zieger, Birger Luhmann, Peter Knödel, Joachim Ritter, Thomas Ummenhofer. Civil Engineering Design. 2021;3:73–86. wileyonlinelibrary.com/journal/cend

Wind flow transfers forces to the wind turbine's rotor blades. These then set the rotor in motion. The hub and the gearbox, where present, transfer this rotational energy to the generator for conversion into electrical power. All the rotating components have significant mass and are located at the head of a slender, elastic load-bearing tower in which they induce dynamic effects. The resulting vibrations, generated at the upper end of the tower, are modified by the dynamic properties of the tower structure and pass through the foundations into the ground. Broadband seismometers record these ground vibrations not only directly adjacent to the wind turbine but also at greater distances of (up to) several kilometres from the turbine. We are aware that local residents and opponents of wind power consider that these vibration phenomena bear potential negative health effects. In the context of this paper, seismic vibrations were measured at the foundation of a 2 MW reference turbine. These seismic signals were compared to numerical simulations. Based on this, we explain the physical background. In the past, any ground vibrations measured have usually been attributed exclusively to the excitation frequencies from the rotor. However, the investigations presented here show that the structural properties of the tower structure significantly influence the type and intensity of the vibrations induced in the ground and dominate the ground motion amplitudes.



The issue of seismic vibration is not addressed in the application. During the last Ice Age, about 10,000 years ago, Ireland was covered by a 1km deep ice glacier. As this glacier melted, it left eskers & drumlins. The South Gort karstic flooding in 2009 resulted in the bringing to the surface of vast amounts of sand from buried conduits. A similar situation with deposited mud & sand exists for this site application in its present karstic underlying strata. These materials could be moved by vibration to block existing conduits serving groundwater drinking schemes. It could also be flushed out into Lough Corrib & create damage to existing Salmon & Trout. Additionally, the effect of the seismic vibration on fish species is unknown.

Reference Number 9.3 :
Assessment of Brazilian onshore wind turbines foundations Andrei Nardellia , Marcos Massao Futaib , IBRACON Estrut. Mater., vol. 15, no. 5, e15508, 2022

Onshore wind turbine foundations are subjected to large overturning moments. The wind action imposes cyclic and dynamic loading conditions which occur in extreme and service scenarios. Deep foundations, when used, transfer this large overturning moment through a pile group which combines the axial and lateral resistance of all piles. The paper explored the key aspects of onshore wind turbine foundations in Brazil. The main reason to explore this subject is that several authors consider onshore wind turbine foundations a well-understood topic; however, limited data from actual situations have been published, especially in developing countries where wind energy projects have only recently started. Thus, a survey of Brazilian energy companies and foundation designers was conducted, and the first Brazilian database of wind turbine foundations was created. This database contains data from more than three thousand Brazilian wind turbine foundations. The key aspects, types and dimensions of these foundations were summarized. Worldwide, concrete gravity foundations are the most used foundation type for onshore wind turbines. In Brazil, 43.3% of wind turbines have shallow foundations, essentially concrete gravity, and 56.7% have deep foundations, mostly continuous flight auger piles. This first stage of the research identified that Brazilian wind turbine foundations are significantly different from the ones of other countries. Approximately 70% of Brazilian wind turbine deep foundations used continuous concrete flight auger piles, most of them embedded in sandy soils. Concrete and steel are the main materials used in wind turbine structures.

Wind farms consist of an ensemble of wind turbines. The main components of these wind turbines are the foundation, grid connection cables, tower, nacelle, generator, and rotor blades. Foundation is a crucial component which transfers permanent and variable loads from the structure to the ground throughout wind turbine's lifespan. As a result of structure height and slenderness, wind turbine foundations are subjected to large overturning moments due to the presence of considerable horizontal loads, primarily caused by wind . The wind imposes a cyclic and dynamic loading condition which occurs in extreme and service scenarios. The progressive increase in the turbine size, tower height, and

rotor diameter, implied in significant increase in the overturning moment at the foundation, which can raise the tower and foundation costs . Although the foundations are a key component of a wind turbine, wind farm locations are mostly based on energy assessments and, as a result, it is common that the construction sites are geotechnical unfavourable . Horgan identified five influential foundation design variables, which include surface roughness, soil type, construction materials, generating capacity and tower height. According to Hassanzadeh, the type and the size of a wind turbine foundation are chosen according to the geotechnical conditions of the site, rated power of the wind turbine, and the type of the tower.

Reference Number 9.4 :

The impact of seismic noise produced by wind turbines on seismic borehole measurements Fabian Limberger, Georg Rümpker, Michael Lindenfeld, and Hagen Deckert. Solid Earth, 14, 859–869, 2023 https://doi.org/10.5194/se-14-859-2023

Seismic signals produced by wind turbines can have an adverse effect on seismological measurements up to distances of several kilometres.

Seismic signals of WTs are characterised by frequencies between 1 and 10 Hz and have been described in detail in a number of studies (e.g. Saccorotti et al., 2011; Stammler and Ceranna, 2016; Zieger and Ritter, 2018). The systematic decays of the corresponding signal amplitudes with distance from the WT or wind farms (WFs) have been analysed at various WFs (Neuffer and Kremers, 2017; Limberger et al., 2021; Gaßner and Ritter, 2023). Analytical and numerical approaches to modelling the amplitudes have been developed in terms of considering single WTs (Gortsas et al., 2017; Lerbs et al., 2020; Abreu et al., 2022) and complete WFs (Limberger et al., 2021, 2022), including wave field interferences from multiple WTs. On this basis, methods for predicting and reducing seismic noise from WTs or other noise sources are developed taking into account, for example, meta-materials (Colombi et al., 2016; Abreu et al., 2022), interferences and topographic effects (Limberger et al., 2021, 2022), and denoising methods (e.g. Heuel and Friederich, 2022). However, effective and robust solutions to compensate the seismic noise without losing the quality of the natural seismological signals are missing.

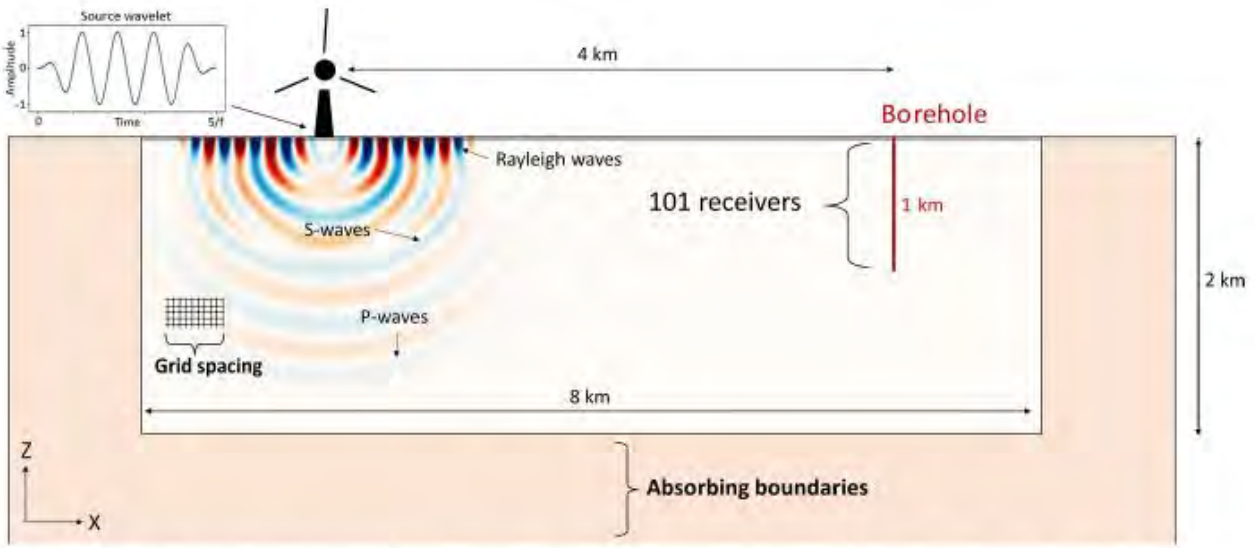


Figure 1. The numerical model includes a sinusoidal source wavelet, receivers located along a line from the surface to a depth of 1 km and a sufficient grid spacing (three elements per minimum wavelength of the simulation) as well as absorbing boundaries (2 times the maximum wavelength of the simulation). P waves, S waves and surface waves are simulated during the forward modelling. Synthetic seismograms are extracted at positions indicated by the red line (borehole).

Reference Number 9.5 :

Structural vibration considerations for the design of onshore piled wind turbine foundations, N.R Featherston ,*Mott Macdonald Limited 2019*

Wind turbine structures are generally tall slender towers with a rotor and blade assembly placed at the top of the tower. These slender structures are prone to vibration due to dynamic environmental actions (such as wind forces) as well as the structure's own dynamics (Bhattacharya & Adhikari, 2011). Analysis of the dynamic behaviour of wind turbines is fundamental to the stability, performance and operational safety of these structures. Wind turbine towers need to sustain continuous vibration-induced forces throughout their operational life (Satari and Hussain, 2008).

Tower height is an important factor in the design of a wind turbine. The height of the tower is typically a compromise between the need to place the rotor as high as possible (thereby taking advantage of stronger winds), and the need to limit the height to accommodate structural foundation and constructability limitations. The early wind towers were only approximately 20 meters tall, which limited their power generation capabilities to approximately 75 kW and were constructed with a simple lattice-type or tubular steel design.
The next generation of wind farms will require turbines with 250m high towers and generation capacity exceeding 20MW. The global projected rate of increase in demand is 1.2 GWH to 2 GWH per year (Sassi, 2106). Figure 2 gives an indication of the expected growth capacity of wind turbine development with the diameter of the blades being indicated. The operating frequency of the three-blade turbine can potentially cause dynamic amplification of the forces acting on it significantly enough to pose a threat to the overall structural integrity. Sufficient separation between the structural system natural frequency and the turbine operational frequencies is crucial to avoiding potentially catastrophic failures. The turbine operating frequency is typically lower than the structural system natural frequency, however it could approach it as higher turbine output is obtained. Idealized assumptions of fixity at the base of the tower are generally un-conservative; a more realistic analysis accounting for the foundation flexibility yields lower estimates of the natural frequency for the system.

There are several loads and unbalanced forces acting on the wind turbine tower which are ultimately transferred to the foundation and can be classified into two types: static (or dead load) due to the self-weight of the components and the dynamic loads (which in some instances can be cyclic).
These include the dead loads of the nacelle, the rotor's self-weight and tower's self-weight. Gravity forces on the blades generally cause sinusoidal loading due to their rotation. This kind of load is important for fatigue analysis since wind turbines are designed to produce electricity for a minimum of 20 years. Thus, a turbine with blades rotating at an average of 11.2 rpm will be subjected to 1.1773×10^8 stress cycles over its lifetime (Sassi, 2016). In the average life of a wind turbine tower it is therefore subjected to an order of magnitude higher number of loads than a bridge receiving daily traffic would.

Any machinery with a rotating component causes forces on its foundation. The amplitude of the centrifugal force F depends on the rotating mass m, the mass unbalance e and the angular frequency ω as follows:
$F = me\omega 2$
Foundations carrying machinery on soil with or without foundation piles can be analyzed as one or two mass-spring systems (van Koten, 2012). The harmonic loading by rotating machines can be accurately determined. Concise formulas are available for the stiffness, equivalent mass and damping calculations. The natural system frequencies and displacement amplitudes can be obtained by hand calculations, without the use of complex software. The amplitude can then be evaluated as acceptable or not.
Soil at the sides of foundations has been found to considerably increase the damping and strongly reduce the displacement amplitudes (van Koten, 2012). The vertical vibrations are well damped by the soil, but the horizontal vibrations can be disturbing even at a large distance from the foundation. The challenging part of the analysis is therefore the understanding of the dynamic loads acting on the wind turbine which are discussed below (Bhattacharya, 2014):

(a) The lateral load acting at the level of the hub (top of the tower) from the rotating blades produced by the turbulence in the wind. The magnitude of this dynamic component will depend on the turbulent wind speed.

(b) The load caused by the vibration at the hub level due to the mass and aerodynamic imbalances of the rotor. This load has a frequency equal to the rotational frequency of the rotor (referred to as 1P loading in the literature). This is the known as the Primary system excitation frequency. Since most industrial wind turbines are variable speed drive machines, 1P is therefore not a single frequency but rather a frequency band between the frequencies associated with the lowest and the highest rpm.

(c) Loads in the tower due to vibrations caused by blade shadowing effects (this is referred to as 2P/3P in the literature). The blades of the wind turbine passing in front of the tower itself cause a 'shadowing effect' and consequently inflict a loss of wind load on the tower. This is also a dynamic load having frequency equal to three times the rotational frequency of the turbine (3P) for three bladed wind turbines, and two times (2P) the turbine rotational frequency for a two bladed turbine. The 2P/3P loading is also a frequency band such as 1P and is simply obtained by multiplying the limits of the 1P band by the number of the turbine blades.

Due to their slender nature, it is no surprise that wind-turbines are dynamically sensitive at low frequencies, the first modal frequency of the system (often less than 1Hz) being very close to the excitation frequencies imposed by environmental and mechanical loads. As an example, the predominant frequencies of wind are about 0.1 Hz whilst the rotor frequencies are in the range from 0.15 – 0.5 Hz. Figure 6 shows the main frequencies for a three-bladed standard wind turbine. It is clear from the frequency content of the applied loads that the designer of the turbine and foundation has to select a system frequency (the global frequency of the overall wind turbine foundation system) which lies outside the range of environmental frequencies in order to avoid system resonance.
From the point of view of the first natural frequency (fo) of the structure, three types of designs are possible (Bhattacharya, 2014):

(1) Soft-Soft design where fo is placed below the 1P frequency range which is a very flexible structure and almost impossible to design for a grounded system.

(2) Soft-Stiff design where fo is between 1P and 3P frequency ranges. This is generally the most commonly used design in the industry.

(3) Stiff-Stiff designs where fo has a higher natural frequency than the upper limit of the 3P band which would therefore require a very stiff support structure.

The usual choice for fixed wind turbines would lie in the interval between turbine and blade passing frequencies (referred to as a 'soft-stiff' structure). Other definitions of "soft-soft" and "stiff-stiff" can be found n Bhattacharya (2014).

Small scale 1-g tests reported by Bhattacharya et al (2011) and Cox et al (2011) showed that the natural frequency of a wind turbine system changes with its cycles of loading. The main reason for this change is due to the alteration of the foundation stiffness from strain-hardening or strain-softening behaviour of the soil supporting the foundation due to the loading cycles.
The main conclusions drawn from this study can be summarized as follows:

a) For strain-hardening sites (typically- loose to medium dense sand) where the stiffness of the soil increases with cycles of loading, the natural frequency of the overall system will increase.
b) For strain-softening sites (clay sites) where the stiffness of the soil may decrease with cycles of loading, the natural frequency of the overall system will also decrease correspondingly. This depends on the strain level in the soil next to the pile and the number of cycles.

It has been shown that a certain amount of change in natural frequency is acceptable without seriously compromising the performance of a wind turbine. In this respect there are three challenges to the designer:

(a) The foundation stiffness needs to be estimated very accurately from the available soil data for estimation of natural frequency of the system.

(b) The potential for change in foundation stiffness with time (as a consequence of cyclic loading) must be understood so that the risk of the system frequency coinciding with a loading frequency can be minimized.

(c) While a given change in natural frequency may be acceptable over the life time of the structure, it is necessary to understand if that change is gradual or sudden.

This will have a large influence in accurately estimating the corresponding response amplitudes and the structure's subsequent life expectancy.

Many pile types are designed with a reliance on skin friction effects, however piles that are subjected to vibrations can potentially lose their frictional bond with the surrounding soil (particularly with coarse grained materials). Furthermore, the presence of lateral loads to the pile shaft can also often cause compaction of the soil which also results in further diminishment of the pile frictional resistance. The recommendation therefore is that an unrestrained shaft be assumed and that the frictional resistance along the shaft should be ignored in piles that are subjected to vibrations (Tomlinson, 1987).
Under dynamic conditions, the influence of the surrounding soil medium is greatest at the beginning stages of vibration loading, but this tends to reduce with time as the soil becomes more compacted, potentially creating a gap around the shaft. Gohnert et al, (2008) considered a simplified approach using a lumped parameter model with stiffness
equations (piles as springs) that are adapted from CP 2012 (subsequently withdrawn in 2015) – the design code was for many years adopted worldwide for the design of foundations with machine vibrations. The simplified model required effective length and boundary conditions to be calculated or assumed and this relied on the calculation of four coefficients representing the pile group stiffness – the coefficient of uniform compression (cu), the coefficient of non-uniform compression (cO), the coefficient of uniform shear (cr) and the coefficient of non-uniform shear (cs). These coefficients were expressed in the same form as coefficients of subgrade reaction.
In general, piles that are used in foundations with vibrations should be of the end-bearing type. To achieve minimal settlement of the toe of the pile, the pile should preferably be founded on rock, or be sufficiently far into dense/stiff stratum so that an effective length for the pile may be estimated. Shear and moment fixities for the pile toe are achieved with sufficient embedment of the toe into a sufficiently stiff stratum (1.5 diameters into the rock stratum).

Reference Number 9.6: Wind turbines and horse husbandry in France. Translated from french by : Karen DUFFY - Agata RZEKĘĆ - Gwenaëlle GRANDCHAMP-RENARD

A wind turbine produces neither infectious nor chemical agents, but does produce physical phenomena. There are four types of physical effects :

- Acoustic vibration phenomena, i.e. audible sound and infrasounds produced by the movements of the blades and the electric generator.
- Ground vibrations.
- Electromagnetic fields resulting from converting the mechanical power of the wind to an electric current, and the transfer of this current.
- Parasitic electrical current, induced by the electromagnetic fields, but also linked to current leakage, to couplings between electrical and mechanical elements, and faulty earthing.

Horses are not as sensitive to infrasounds as humans, or even as cattle (Heffner and Heffner, 1983)

Scale of sound frequencies in several animal species and in humans (according to Heffner (1998))

Animal species	Low frequency limit (Hz)	High frequency limit (Hz)	Ideal sensitivity (dB)	Ideal frequency (Hz)
Cattle	23	37 000	-11	8 000
Human	20	20 000	-10	4 000
Pigs	42	40 500	9	8 000
Horses	**55**	**33 500**	**7**	**2 000**
Cats	55	79 000	-10	8 000
Dogs	67	44 000	-1	8 000
Laboratory rats	530	70 500	0	8 000
Laboratory mice	900	79 000	5	15 000

The persistence of audible sounds does not appear to affect animal behaviour, unlike some people suffering from hyperacusis.
However, infrasound remains controversial in the equine sector. In an expert study conducted in Portugal, there was a suspicion of consequences on joint tissue in Lusitano horses (Branco *et al*, 2005). The results of this expert study have however not been confirmed by the Lisbon University veterinary thesis (Costa, Pereira e Curto 2012) which analysed the afore mentioned cases

Ground vibrations

Ground vibrations are produced by the wind turbine itself, like any building with foundations and wind.
The transmission of vibrations through the ground depends on the nature and structure of the ground they go through. The mechanical waves through the ground, produced by wind turbines, are essentially surface vibrations (Saccorotti G. *et al*, 2011). There is very little data regarding the level of the vibrations for local residents, produced by wind turbines. The few studies conducted show that when further than 300 metres (Lubw, 2016) to 700 metres away from a wind turbine (internal study by Cerema), the vibrations merge into the backgound noise of the site (vibration speeds below 0,07mm/s).

Electromagnetic fields

The study of electromagnetic fields revolves around three themes:

- Behaviour and neurophysiology
- Zootechnical and sanitary impact
- Cellular and physiological impact

Behaviour and neurobiology

There is little information regarding perception of electromagnetic fields, and our knowledge is mainly related to wildlife. Likewise, there is no data as to whether electromagnetic fields produced by various structures (wind turbines, high voltage power lines…) have an influence on perception. There are no effects noted on the behaviour of farm animals, only on laboratory animals (rats and mice).

Zootechnical and sanitary impact

With regard to cattle, the results of experiments conducted in the field differ from those of experiments in a controlled environment. In an experimental environment, a decrease in the quantity of milk produced and in the percentage of fat was noticeable, as was an increase in the quantity of feed ingested. The field studies showed no changes.
With regard to poultry, electromagnetic fields presented a teratogenic effect (affecting the embryo, and causing malformation) with a window effect (non-linear effect, i.e. the negative effect of electromagnetic fields is lesser for the weaker and the stronger fields).

Cellular and physiological impact

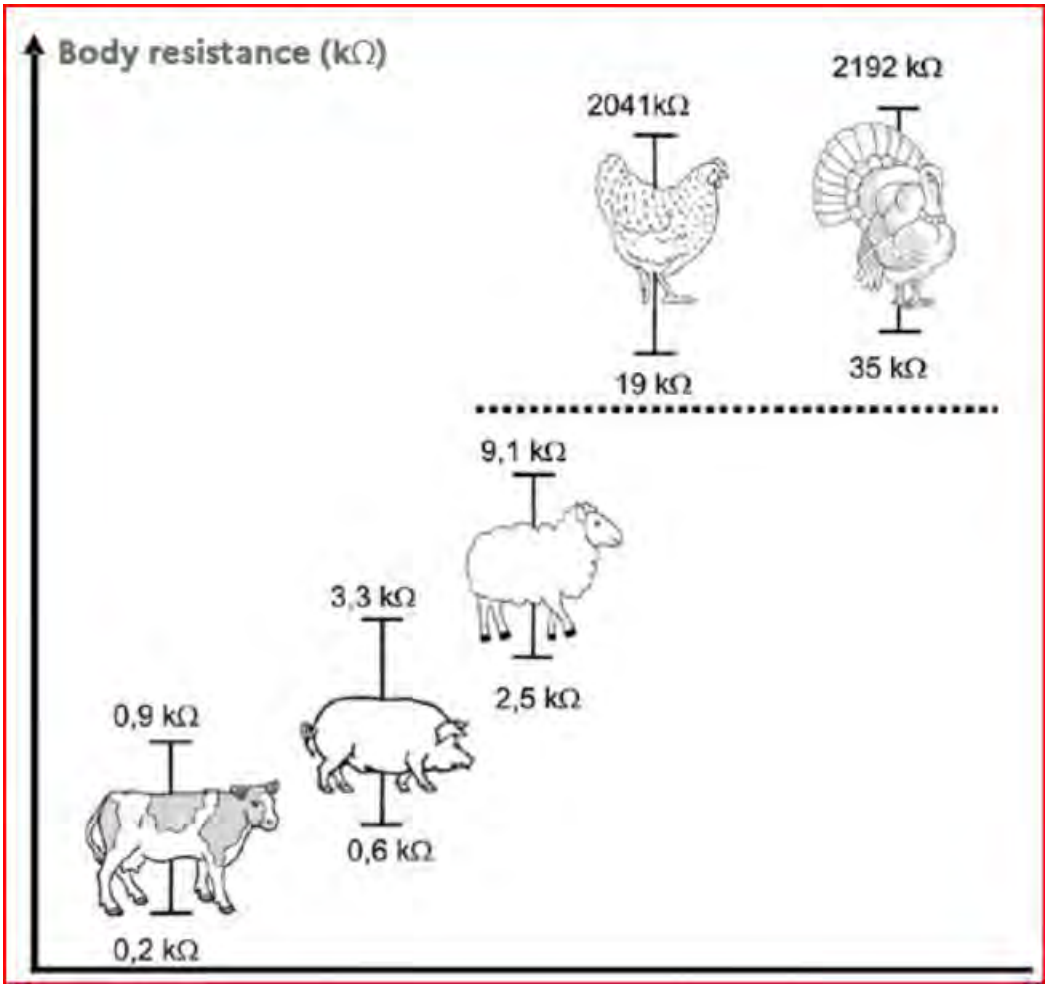
Studies conducted *in vitro* show a genotoxic effect (capacity to compromise the structure or the functioning of the genome) of electromagnetic fields. Moreover, these fields amplify the action of chemical products which have an effect on DNA. Cells submitted to electromagnetic fields are more sensitive to oxidative stress, i.e. there is a higher count of DNA lesions, therefore more frequent cell death. Electromagnetic fields also have an effect on the circadian cycle («the internal clock » of an organism) by modifying the release patterns of melatonin, or through other mechanisms yet to be discovered. However, electromagnetic fields have no effect on immunity and physiological stress (ways in which the organism copes with real or presumed aggression).

Parasitic current

Parasitic current is derived either from electromagnetic fields, or from electrical current (cables…). Parasitic currents can cause different types of voltage :

- Contact voltage (contact with a metallic element such as a drinking trough) ⇒ the current goes through the animal and back to earth though the legs.
- Pace voltage ⇒ Current goes from the front legs to the rear legs.

The sensitivity of animals depends on the electrical resistance of the species, of the individual and on living conditions.



Animals are more sensitive than humans. Parasitic currents cause pain, leading to physiological stress which can modify behaviour (avoidance, refusing to drink, memory and training issues…) and the state of health (weight loss, decrease in immunity, higher risk of gastric ulcers and colic, genetic alterations in the long term…). An animal's sensitivity to parasitic current can be increased due to its living conditions.

A horse stabled in a building with a lot of metallic structures and/or in a box with damp bedding, is more at risk of being a conductor of parasitic current.

To summarize

Wind turbines produce sounds and infrasound, vibrations, electromagnetic fields and parasitic current
To date, only parasitic currents are a real issue for horses, but vigilance is required nevertheless, due to our lack of knowledge.

Reference Number 10.1:
Australian Draft Wind Energy Guideline. Department of Planning and Environment dpie.nsw.gov.au. Technical Supplement for Landscape and Visual Impact Assessment. November 2023

Setback

Wind turbines close to sensitive receivers including dwellings, historic homesteads, tourist accommodation, places of worship, town centres and central business districts, can be visually dominating despite the scenic quality or importance of the view. For example, a single 250 m turbine will generally have a dominant appearance if located within 2 km of a sensitive receiver and is completely visible.

Figure 2 prescribes a setback for turbines that are likely to have a dominant appearance. This setback applies from sensitive receivers and scales depending on the height of the turbines being proposed.

The setback is equivalent to 7 degrees of a person's vertical field of view.

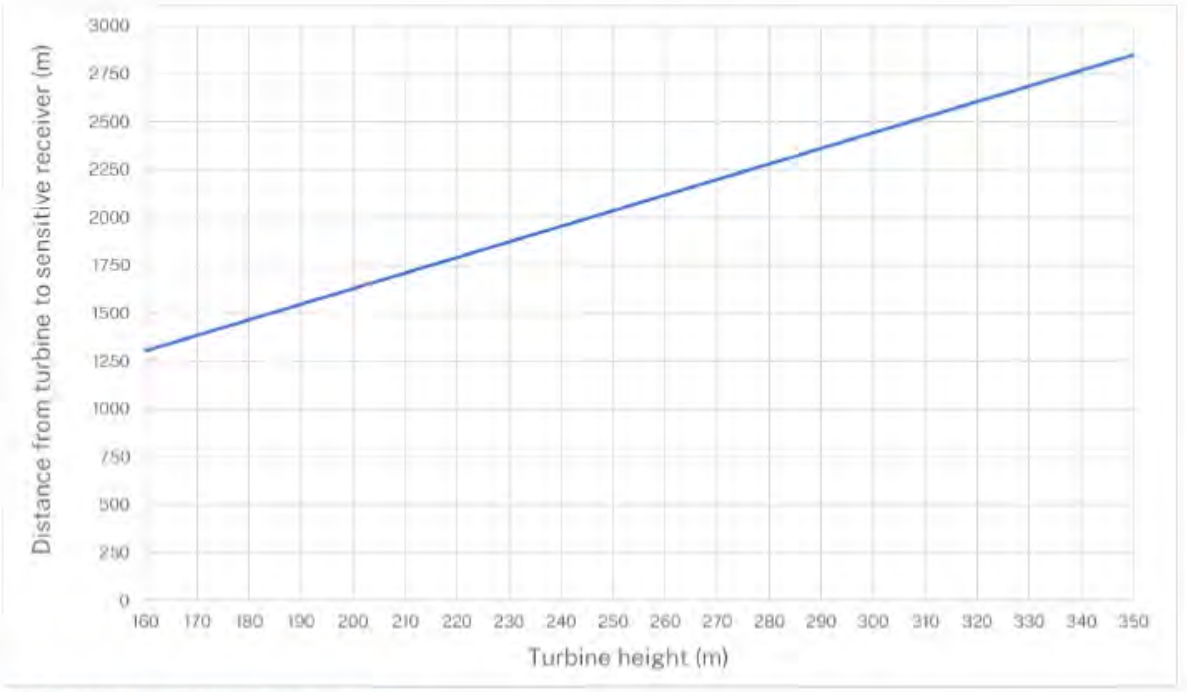


Figure 2. Setback from sensitive receivers

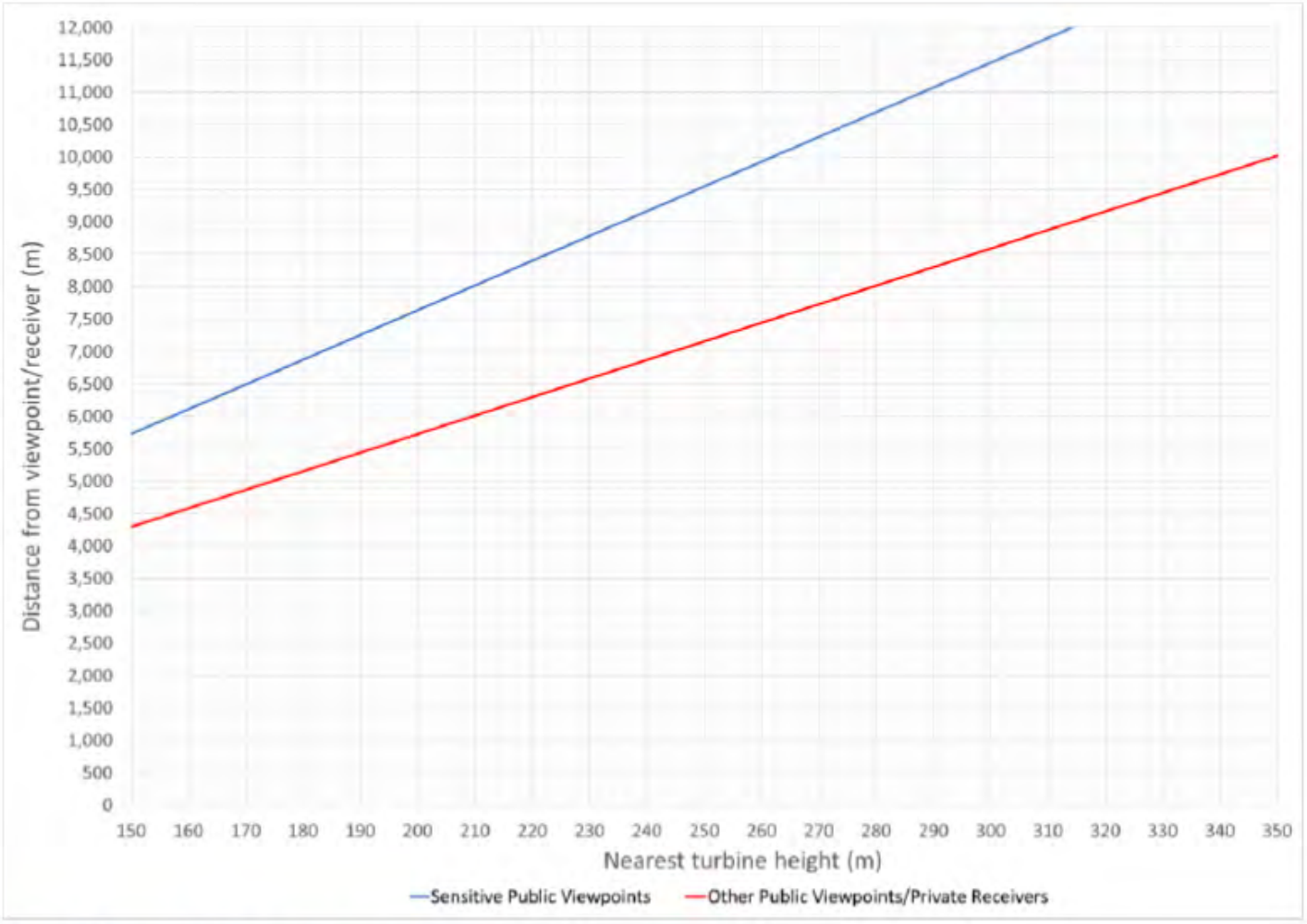


Figure 7. Extent of the scoping study area

The first step of the scoping stage is for the applicant to identify a visual study area. The extent of the study area can be determined using the maximum height of the proposed wind turbines and the distances set out in Figure 7. The study area differs between public viewpoints and private receivers to recognise different values the community places on these locations and the reasons for their use.

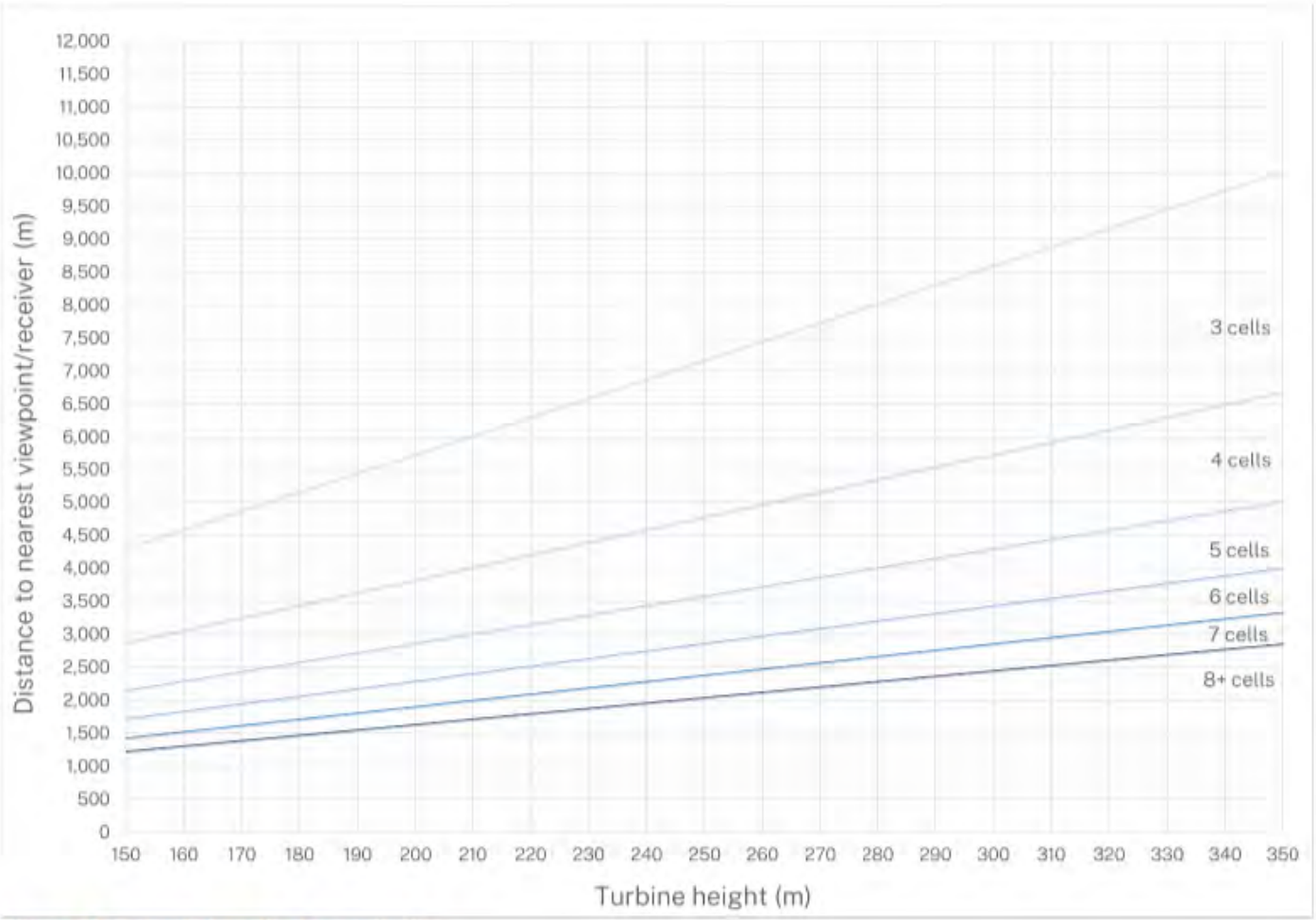


Figure 10. Potential vertical magnitude

Reference Number 10.2:
Collapse mechanism and risk management of wind turbine tower in strong wind. Jui-Sheng Chou, Yu-Chen Ou,Kuan-Yu Lin. Journal of Wind Engineering & Industrial Aerodynamics 193 (2019) 103962

In this study, the 1479 cases from 2007 to 2017, are considered.

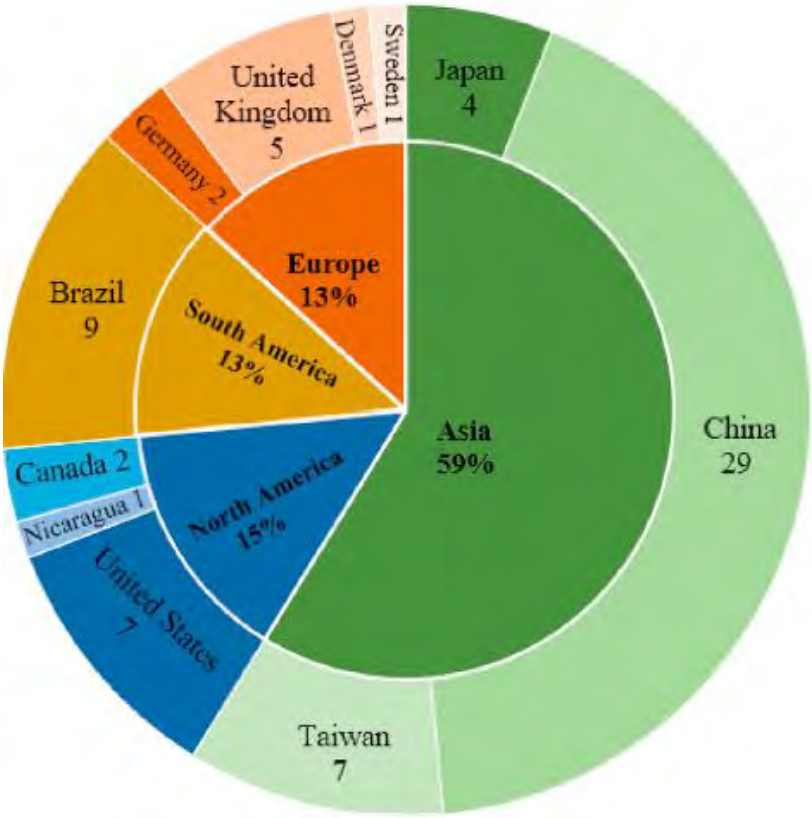


Fig. 3. Wind turbine collapse cases distribution across countries.

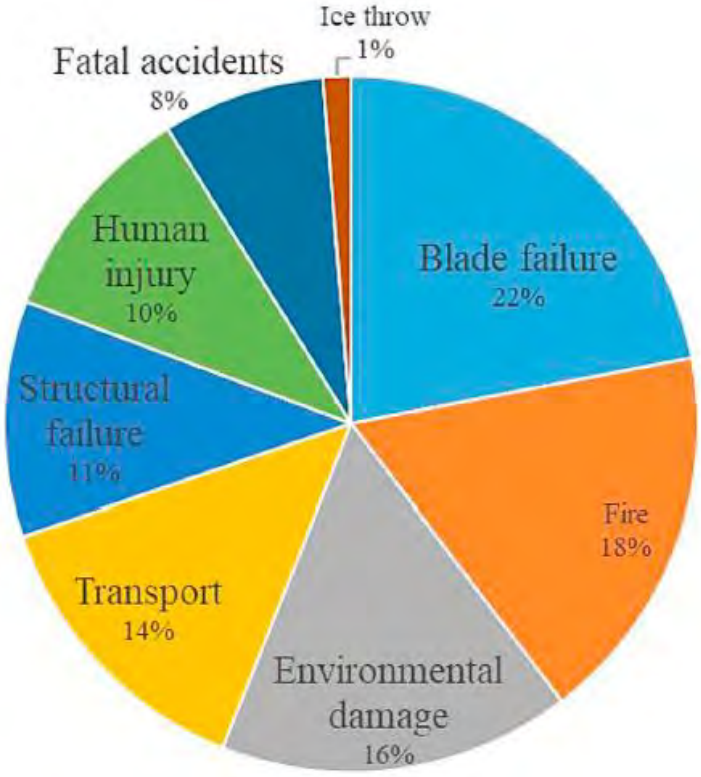


Fig. 1. Wind turbine disasters in recent years (excluding those associated with miscellaneous cases).

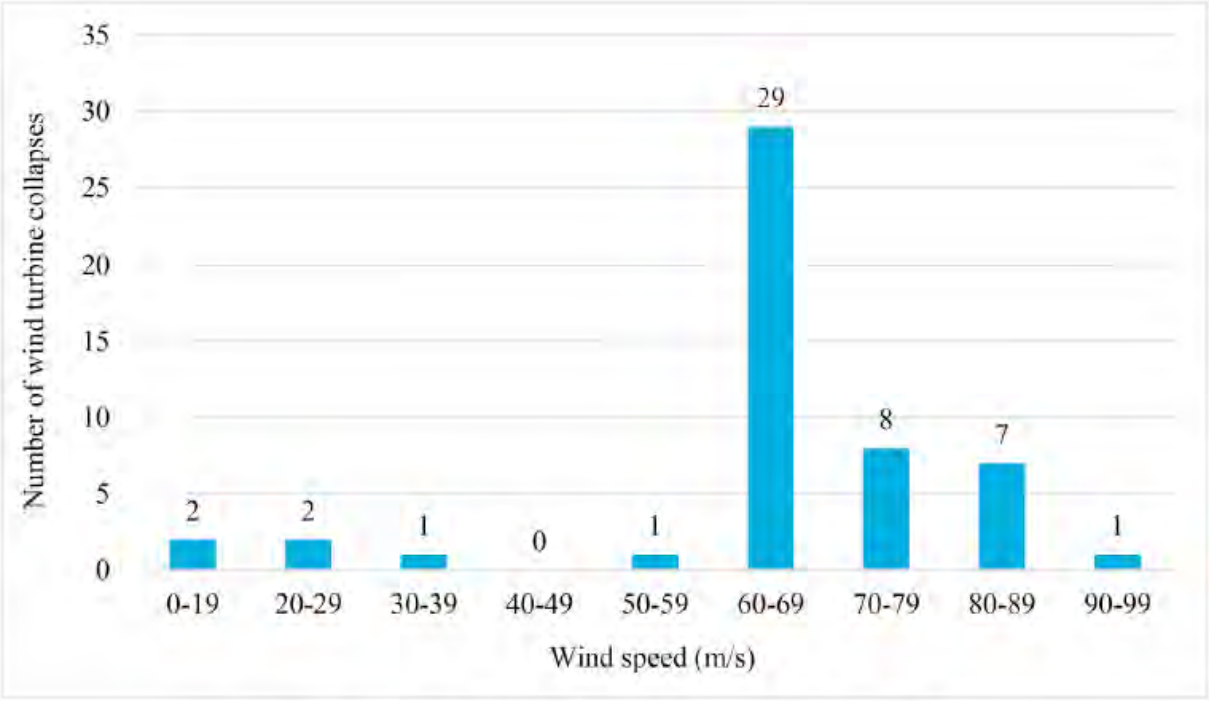


Fig. 4. Statistics on highest wind speed recorded when wind turbine collapses.

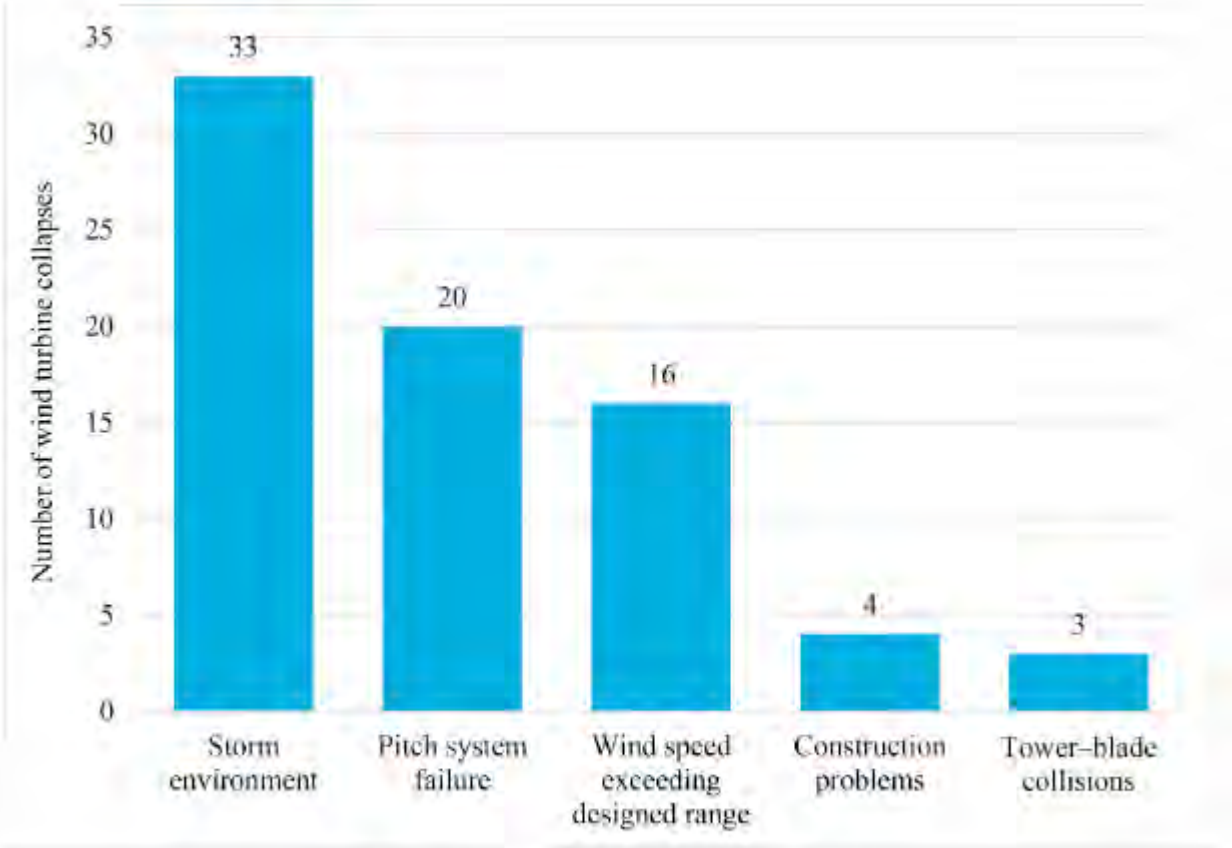


Fig. 7. Statistics on causes of wind turbine collapse.

Reference Number 11.1 :

Wind turbines and adverse health effects: Applying Bradford Hill's criteria for causation. Dumbrille, Anne; McMurtry, Robert Y. Krogh, Carmen Marie. Environmental Disease 6(3):p 65-87, Jul–Sep 2021. | DOI: 10.4103/ed.ed_16_21

The weight of evidence indicates occurrences of adverse health effects (AHEs) from living and working near industrial wind turbines (IWTs). Descriptions of the AHEs being reported by those living or working near the turbines are similar. While these occurrences have been associated with exposure to audible and inaudible noise annoyance, the causation of reported wind turbine-associated health effects remains controversial. Establishing an argument of causation of adverse health outcomes has important clinical, scientific, and societal implications. Bradford Hill (BH) criteria have been widely used to establish causality between an environmental agent and risk of disease or disability, but have not previously been used to evaluate the relationship between IWTs and AHEs. The objective was to apply the BH criteria to evaluate the relationship between IWTs and AHEs. The nine criteria include the strength of the association, consistency, specificity, temporal sequence, biological gradient, plausibility, coherence, experimental evidence, and analogous evidence. These nine criteria have been applied to IWT exposure and reported AHEs using peer-reviewed and other published literature that describes clinical, animal, and laboratory studies, testimony and reported experiences, and internet sources. Applying the BH criteria to the IWT-related clinical, biological, and experimental data demonstrates that the exposure to IWTs is associated with an increased risk of AHEs. This analysis concludes that living or working near IWTs can result in AHEs in both people and animals. Our findings provide compelling evidence that the risk of AHEs should be considered before the approval of wind energy projects and during the assessment of setback distances of proposed and operational projects.

Proof of causation typically requires the rigor of a scientific standard. Consequently, the evidence required to make a scientific determination about causality has a higher standard than the Precautionary Principle that is recommended by the World Health Organization (WHO).The Bradford Hill (BH) criteria, sometimes referred to as Hill's criteria for causation, are a set of nine criteria that have become a frequently cited framework for establishing epidemiologic evidence of a causal relationship between a presumed cause and an observed effect. They were established by Sir Austin Bradford Hill and have been reviewed in numerous articles and presentations.[Researchers have applied Hill's criteria in examining the evidence of causality of environmental and other exposures on health, for example, connections between smoking and asbestos and cancer, ultraviolet B radiation, Vitamin D and cancer, Vitamin D and pregnancy and neonatal outcomes, alcohol and cardiovascular disease outcomes, infections and risk of stroke, nutrition and biomarkers related to disease outcomes, and sugar-sweetened beverage consumption, and the prevalence of obesity and obesity-related diseases.

The nine criteria described by Hill are strength of association, consistency, specificity, temporal relationship, biological gradient, plausibility, coherence, experimental evidence, and analogous evidence. Three recent additional approaches that have been used to evaluate potential outcomes are (i) directed acyclic graphs, (ii) sufficient-component cause models, and (iii) the grading of recommendations, assessment, development, and evaluation methodology. The criteria that have been examined using these approaches are consistent with the BH criteria: strength of association (including analysis of plausible confounding); temporality; and plausibility and experiments (including implications of study design on exchangeability). The overlap between the BH viewpoints and the other approaches substantiates the ongoing influence and the application of BH criteria in causal assessments

Applying the BH criteria to the IWT-related clinical, biological, and experimental data gives evidence that exposure to IWTs is associated with an increased risk of AHEs.

Criteria 1: Strength of the association

The bulk of scientific evidence associated with AHEs due to IWT installations comes from individual exposure information from both those living near IWTs and from industrial workers. Evidence includes thousands of case reports and incident reports that have been submitted to the Government of Ontario, Canada, and international reports that are available through government inquiries, judicial proceedings, and from the Internet.

Criteria 2: Consistency

Compelling information is derived from the consistency of effects as described in published case reports and thousands of adverse event reports of those affected living near IWTs. These effects occur despite the range of international locations and the language spoken in the country in which these events originate. The descriptions of effects reported in different countries are consistent; the common factor is the siting of IWTs near family homes or in occupational settings. Epidemiological studies, reviews, and reports describe proximity to IWTs as being most commonly associated with annoyance/human distress, sleep disorders, headaches, mood disorders, inability to concentrate, tinnitus, and vestibular problems. Some describe effects from nonauditory pathways such as vibratory sensations, heart palpitations, or pressure changes.

Criteria 3: Specificity

Exposure to a risk factor does not necessarily result in a uniform incidence rate of AHE. For example, not all smokers develop lung cancer. The same is true of AHE resulting from IWTs where a nontrivial percentage, but not all, of the exposed population reports adverse events. Incident reports/complaints can serve as a valuable resource and a form of public health surveillance during the introduction of IWTs – a new noise source – into quiet rural communities. The large number of AHE formally reported to governments, the self-published reports on social media and Internet websites, and those collected systematically, such as the WindVOiCe collection from Ontario by Krogh et al., 2011, and the investigations by physicians such as Harry and Pierpont indicate that the AHEs associated with IWT exposure go well beyond a few rare individuals who are extremely susceptible.

Criteria 4: Temporality

A case-crossover study provides one of the most compelling sources of epidemiologic data. In a study of this type, subjects are exposed to a substance or environmental factor of perceived threat and exhibit symptoms, followed by a reduction of their exposure to that substance or factor and then followed once more by re-exposure. To date, only limited case-crossover safety studies have been performed on exposure to IWTs.

- *A case series crossover study by Pierpont in the USA included families from Canada, the United States of America, Ireland/United Kingdom, and Italy. Data documenting health status and medical problems for residents were collected: (1) before exposure to operating wind turbines, (2) during exposure, and (3) when people reduced their exposure to operating wind turbines by leaving their homes or spending a prolonged period away. The study involved 38 people from ten affected families (aged infant to 75 years), living 305 m to 1.5 km from IWTs. Adults and older teens completed a detailed clinical interview about their own and their children's symptoms, sensations, and medical conditions. A clear pattern of symptoms relating to exposure to operating wind turbines was documented. Symptoms developed are described in Criteria 1: Strength of Association. Symptoms developed after the turbines started operating near their homes and went away when the subjects temporarily and/or permanently vacated/abandoned their homes. The symptoms returned when the affected people went back to their homes. Eventually, 8 of the 10 families moved away with some abandoning their homes.*

- *An Australian case series crossover study was conducted and reported by Hansen et al. Hansen et al. documented symptoms correlating with the intermittent shut down of turbines. Full spectrum acoustic monitoring was conducted at six locations at distances from 1.3 km to 7.6 km from the Waterloo Wind Energy facility. The study compared the effects on the residents when the wind turbines were operating, then not operating for a week, and then when again operating. The authors documented symptoms in the residents that correlated with the intermittent shut down of the turbines. The acoustic survey report confirmed that sleep disturbance correlated with exposure to wind turbines at a distance of up to 8 km. The range in the overall A-weighted levels was noticeably larger indoors and ranged from 5 dB(A) to 38 dB(A). There was a direct correlation between LFN events and complaints registered in noise diaries. The Danish LFN guidelines were exceeded on a number of occasions, generally in downwind conditions and when hub height wind speeds were greater than 8 m/s. Based on these observations, the authors concluded that "there is a LFN problem associated with the Waterloo wind farm."*

- *A comprehensive acoustic survey was conducted at the Cape Bridgewater Wind Development in Australia by Cooper, an independent acoustical consultant, with The Acoustic Group (2014), where turbines were temporarily shut off and on. The study was commissioned by the wind energy developer to address several years of noise complaints received since the project was put in service in 2008. Tests, including measuring noise emissions, were performed inside three homes (6 occupants) located between 650 m and 1.6 km of the wind facility over 8 weeks. At the end of the 2nd week of the test program, the wind turbines were shut down daily for 10–12 h per day for 2 weeks. Residents were asked to record in a diary perceived impacts of noise, vibration, and other disturbances, on a 1–2 hourly basis. The study did not include any testing in relation to sleep disturbance. The results obtained showed a trend toward an association between the high-level "Sensations" disturbance and the operating power of the turbines. Sensation measured included headache, pressure in head, ears, or chest, ringing in ears, heart racing, or a sensation of heaviness. Participants recorded a significant sensation disturbance occurring when the turbines were about to start up, with a change in power output of 20%, and when the turbine had reached maximum power. No correlation of sensation disturbance with the dB(A) noise levels or impacts that residents identified as coming from the turbines was detected, indicating that emissions outside the hearing range were likely causing the sensations.*

In addition, before and after impact studies have reported that residents were symptom free before the start-up of an adjacent wind turbine project, and developed symptoms subsequent to the onset of wind turbine operation.

Criteria 5: Biological gradient (dose–response effect)

The process of quantitatively assessing the dose received and response by a biological entity produces a dose–response relationship. This is recognized as an important part of the process in assessing health risk associated with exposure to various contaminants in the environment. A correlation has been documented between distance to IWTs and/or the associated noise energy and reported AHE. Below, five studies are described: Four examined the association between AHE and noise levels, followed by one examining the effect of distance.

A stratified cross-sectional study by Nissenbaum et al. was performed in the USA to compare sleep and general health outcomes of participants living close to IWTs with those living further away from them. As described in Criteria 1: Strength of Association, enrolled participants lived between 375 m and 1.4 km (N = 38) and 3.3 km and 6.6 km (N = 41) from IWTs. Validated questionnaires were used to collect information on sleep quality (PSQI), daytime sleepiness (ESS), and general health (SF36v2), together with psychiatric disorders, attitude, and demographics. Descriptive and multivariate analyses were performed to determine if the distance to the nearest IWT had any effects on various health outcome measures. Analyses showed that participants living within 1.4 km of an IWT had worse sleep, were sleepier during the day, and had worse SF36 mental component scores compared to those living further than 1.4 km away. Significant dose–response relationships between PSQI, ESS, SF36 mental component score, and the log distance to the nearest IWT were identified after controlling for gender, age, and household clustering.

Taken together, the above studies demonstrate that dose–response relationships exist between exposure to IWTs and AHEs, as determined either with "dose" calculated as the distance to the turbines or SPLs. The responses (i.e., the AHEs) observed include annoyance, effects on sleep, and effects on mental health score. It is of importance to note that noise annoyance, including that associated with operational IWTs, has been acknowledged as a health/AHE by Health Canada (2005), quoting the WHO and by others.

Criteria 6: Plausibility

Research, incident reports/complaints, and reports by people living near IWTs indicate that wind turbines impact people's senses, resulting in adverse health symptoms. There may be more than one factor contributing to the effects. Evidence suggests that a plausible mechanism involves responses to audible and inaudible noise, including infrasound and LFN. In addition, evidence is emerging indicating that EMF and RF energy and shadow flicker contribute to turbine-associated AHE.

The precise noise and vibration frequencies which are causing the reported symptoms in people near IWTs are not fully elucidated. Indeed, the safe exposure cumulative dose (short and long term) of noise and vibration frequencies has not yet been defined for any age group.

Criteria 7: Coherence

In describing his criteria for causality, Bradford Hill noted that "... lack of such [laboratory] evidence cannot nullify the epidemiological effect on associations." However, as described above, in experiments during which people were exposed to infrasound, similar symptoms are reported by those living and working near turbines.

Although low-frequency hearing sensitivity depends on many factors including the mechanical properties of the middle ear, it is known to be correlated with cochlear length for many species with nonspecialized cochleae, including humans and guinea pigs. The thresholds of guinea pig hearing have been measured with stimulus frequencies as low as 50 Hz; the average sensitivity recorded in four studies at 125 Hz was SPL of 37.9 dB, which is 17.6 dB less sensitive than the sensitivity of humans at the same frequency and is consistent with the shorter cochlea of guinea pigs. It is therefore reasonable to assume that if responses are present in the guinea pig at a specified level of low-frequency sound, then they will be present in the human at a similar or lower stimulus level. Thus, the guinea pig may represent a valid experimental model which is likely to under-estimate the effect in humans.

Consistent with AHEs being reported several kilometers from IWTs, Schofield measured vibration signals at the Stateline wind farm in Oregon (US) that consisted of 399 wind turbines, each with a rated power of 0.66 MW. The study found that the propagation of a 4.3 Hz vibration signal was measurable at distances up to approximately 18 km from the turbines. Escaler and Mebarki demonstrated that vibrations measured in full-scale wind turbines were highest at less than 1 Hz.

Criteria 8: Experimental Evidence

While large-scale controlled clinical studies have not been performed, there is increasing evidence that the adverse events reported by those living at least 10 km from IWTs could in part be the result of infrasound emitted by the turbines. In experiments where people have been exposed to infrasound, similar symptoms are reported as by those living and those working near turbines.

There is experimental evidence that exposure to LFN/infrasound can lead to adverse events in animals as well as in people. Animal studies have demonstrated serious health effects from proximity to IWTs: geese, pigs; LFN: chick embryo; and high-frequency vibration: rats

There is clear experimental evidence that exposure to IWTs cause adverse events in animals and people. LFN/infrasound such as that emitted by IWTs can lead to adverse events similar to those reported by people living near IWTs. This suggests that the infrasound emitted by turbines contributes toward the adverse events reports by those living within 10 km or more of IWTs.

Criteria 9: Analogous evidence

Stimuli that are not perceived by the senses, such as ionizing radiation and carbon monoxide, can be pathogenic. The claim that noise must be audible to be considered significant is not a defensible conclusion by analogy or by virtue of the literature on LFN, infrasound, vibration, and other potential contributors. AHEs reported in people living and working near IWTs, the effects on animals, and the correlation between LFN and effects when turbines are turned off and on (described above) reveal an association between AHEs and IWTs.

The BH criteria represent an important tool for determining cause between an environmental exposure and a health outcome (i.e., disease or disability) in a scientifically rigorous manner. The criteria are far more stringent than the Precautionary Principle, which the WHO (1999) provides as the environmental management principles on which government policies, including noise management policies, can be based.

*The WHO document states that: "**When there is a reasonable possibility that the public health will be endangered, even though scientific proof may be lacking, action should be taken to protect the public health, without awaiting the full scientific proof**."*

Appendix 1: Reports of adverse effects on animals

Reported AHE of animals located near IWTs include the following:

- *Disturbances in animal reproduction have been reported related to wind energy facilities in Wisconsin (USA). Reported abnormalities include teratogenic effects in cattle (missing eyes and tails); health, teratogenic and reproduction problems in a formerly award-winning herd of cattle (cancer deaths, cows not calving properly, mutations such as absent eyeballs or tails, cows holding pregnancy only 1–2 weeks and then aborting, blood from nostrils); as well as teratogenic effects in chickens (crossed beaks, missing eyeballs, deformities of the skull, joints of feet/legs bent at odd angles)*

- *Farmers near a wind turbine development near Goderich, Ontario, Canada, observed health problems with their livestock which began shortly after the wind turbines were installed. The cattle were reported to exhibit unusually aggressive and erratic behavior, "including the kicking of newborn calves, prolapsed birthing, weight loss, decline in fertility, a high incidence of mastitis, calves being deformed at birth, and a high incidence of still-births"*

- *Similar adverse health effects and excess mortalities in various animal species have been reported that were temporally coincidental with the installation of industrial wind turbines and associated generating stations, that include the following:*
    - *Cows: Reduced fertility (Canada); fertility and structural issues (Japan); and mortality (France)*
    - *Goats: Reduced fertility and health problems (Canada)and mortalities in 450 of 700 (Taiwan)*
    - *Horses: Leg deformities (Portugal)*
    - *Emu: Mortalities in 30 of 38 and reduced laying (Canada)*
    - *Mink: 1600 miscarriages and birth defects (Denmark)*
    - *Badgers: High cortisol levels, an indicator of stress (UK)*
    - *Other effects.*

Reference No. 11.2: Environmental Impact of Wind Farms. Bošnjakovi´c, M.; Hrka´c, F.; Stoi´c, M.; Hradovi, I. Environments 2024, 11, 257. https://doi.org/ 10.3390/environments11110257

See previous reference

Reference Number 12.1: The extent of windfarm infrastructures on recognised European blanket bogs Guaduneth Chico, T. Clewer, N. G. Midgley, P. Gallego-Anex, P. Ramil-Rego, J. Ferreiro, E. Whayman, S. Goeckeritz & T. Stanton . Scientific Reports | (2023) 13:3919 | https://doi.org/10.1038/s41598-023-30752-3

Peatland environments are the Earth's largest terrestrial carbon store and have the potential to act as carbon sinks. However, the development of windfarms on peatlands is affecting their morphology, hydrology, ground-level climate conditions, carbon functions and vegetation, and long-term consequences still need to be assessed. Blanket bogs are a rare type of ombrotrophic peatland that are typical of oceanic areas with high precipitation and low temperatures. Their distribution has been mapped across Europe, where they are mainly located on hill summits where wind energy potential is higher, making them attractive sites for windfarm developments. The promotion of renewable energy is currently a priority given the environmental and economic drive to increase low-carbon energy production. Establishing windfarms on peatland in pursuit of greener energy, therefore, risks compromising and undermining the green-energy transition. Despite this, the extent of windfarm infrastructures on blanket bogs have not yet been reported at the European scale. This research reports the extent of windfarm infrastructures on recognised blanket bogs, with a geographical focus on Europe, where blanket bogs have been mapped systematically. Under the EU Habitats Directive (92/43/EEC), there are 36 European regions NUTS level 2 with recognised blanket bogs. Of these, 12 have windfarm developments, including 644 wind turbines, 253.4 km of vehicular access tracks and an affected area of 207.6 ha, mainly in Ireland and Scotland where the extent of blanket bogs is also higher. However, despite Spain having under 0.2% of Europe's recognised blanket bogs area, this was the most affected country. In Scotland, a comparison of the recognised blanket bogs under the Habitats Directive (92/43/EEC) with blanket bogs recorded in national inventories indicates that the extent of windfarm developments was higher, with 1,063 wind turbines and 634.5 km of vehicular access tracks. Our results highlight the extent of windfarm developments on blanket bog habitat, both in areas where peatlands are broadly distributed across the landscape, and also in areas where this recognised habitat is particularly rare. There is a pressing need to assess the longterm impacts of windfarms on peatlands to ensure that efforts to meet energy targets result only in carbon sequestration, and do not jeopardise ecosystem services. Blanket bogs represent a particularly vulnerable habitat, the study of which should be prioritised updating national and international inventories to protect and restore this habitat.

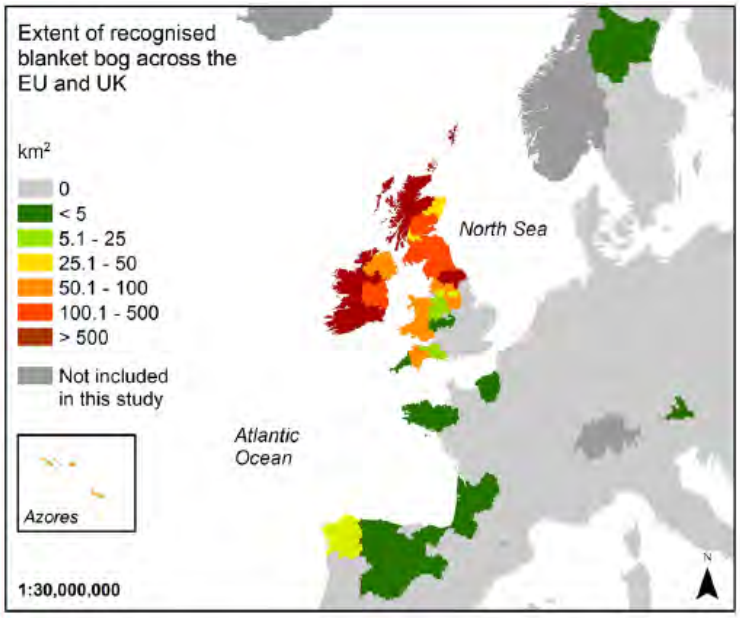
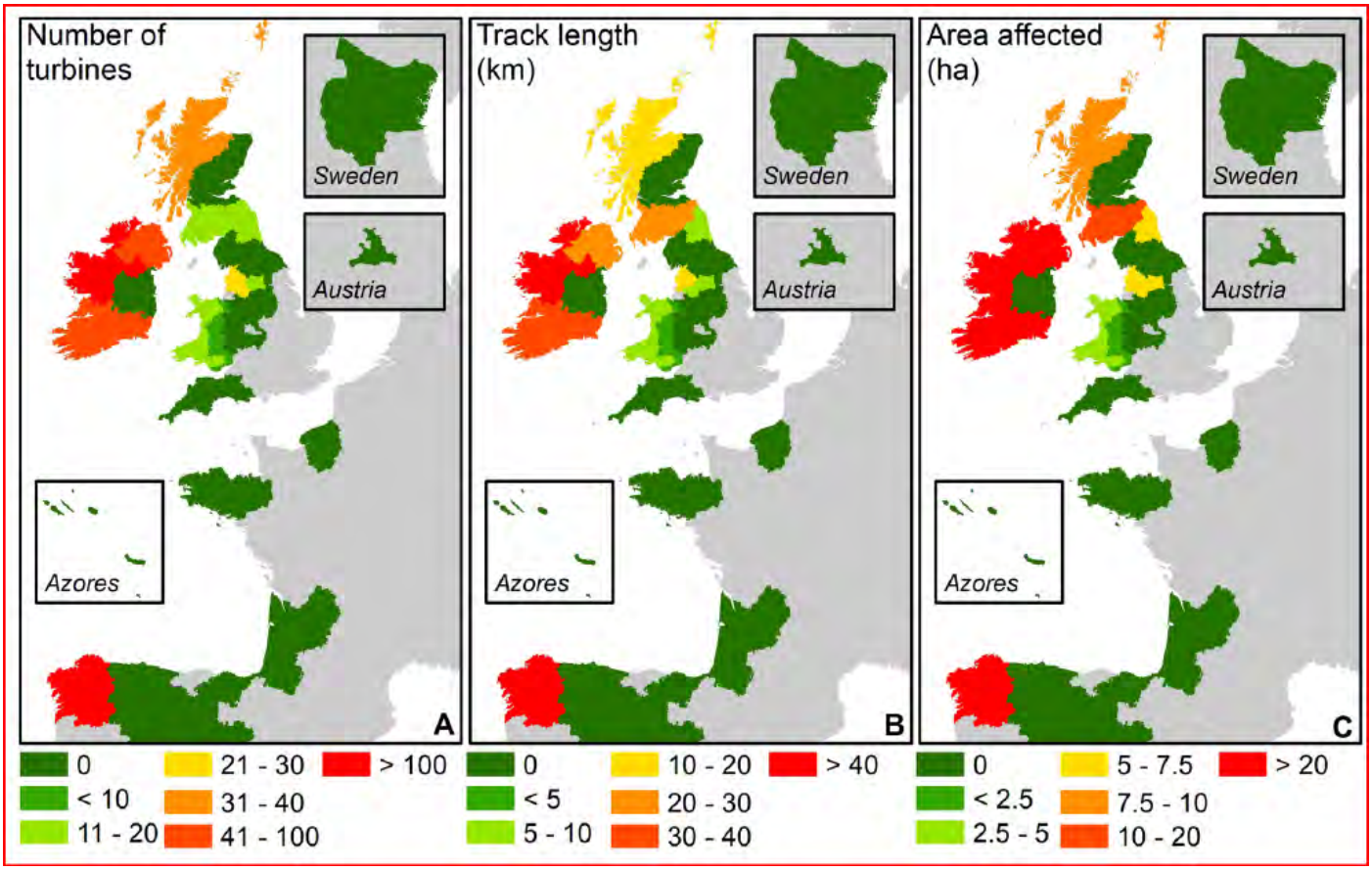


Figure 1. Total extent of the recognised blanket bog by European regions NUTS level 2 based on the Habitats Directive (92/43/EEC) including the last update from the UK before Brexit. Map created in ArcGIS 10.8.1.

Country		Wind and Energy	Intensive grazing	Agriculture	Peat extraction/ cutting	Invasive species	Forestry	Drainage	Abiotic pressures	Tourism / Sport/ Recreation	Infrastructure/ Mining	Air pollution	Climate Change	Burning	Management of game	Other
Spain	Pressure	M	M	M	H	M								M		
	Threat	M	M	M	H			M					M	M		
Republic of Ireland	Pressure	M	H	H	H		H	M	M					H		
	Threat	M	H	H	H		H	M	M				M	H		
United Kingdom	Pressure	M	H		M	M		H				H	M	H	H	M
	Threat	M	H		M	M		H				H	M	H	H	M
Portugal	Pressure		H	H			H	H	M	M						M
	Threat		H	H			H	H	M	M						M
France	Pressure															M
	Threat			M				M	M			H	H			
Austria	Pressure		H					M		M		M	M			
	Threat		H					M		M		M	M			

Table 1. Pressures and threats on recognised blanket bogs across the EU and UK according to the last habitat assessments[19]. Sweden has not reported this information in their last habitat assessment. H = High, M = Medium.



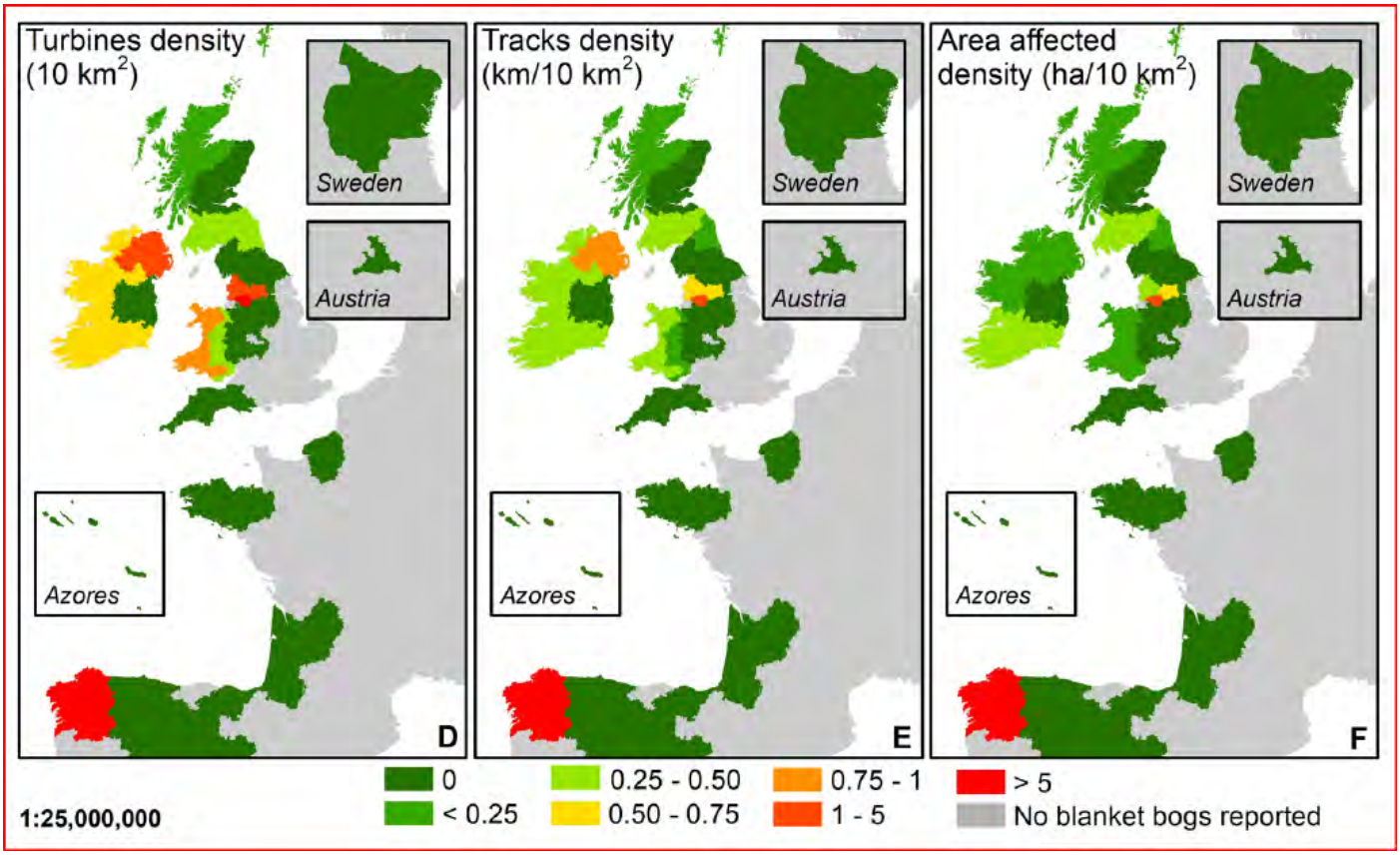


Figure 2. The extent of windfarm developments across the EU and UK on blanket bog habitat 7130 based on the 2013–2018 conservation status report 19 prior to Brexit by European regions NUTS level 2.
Note: Boundaries of the regions have not been added to improve legibility. The political geographical regions do not represent the
extent of blanket bogs. (**A**) Total turbines on blanket bog habitat 7130. (**B**) Tracks length on blanket bog habitat 7130. (**C**) Total area affected by windfarm developments on blanket bog habitat 7130. (**D**) Density of turbines per 10 km2 of blanket bog habitat 7130 by European regions. (**E**) Density of tracks per 10 km2 of blanket bog habitat 7130 by European regions. (**F**) Density of area affected by windfarm developments per 10 km2 of blanket bog habitat 7130 by European regions. *Datasets for blanket bog habitat 7130*: Austria, Portugal, Sweden and France , Scotland ; England ; Wales ; Republic of Ireland and Spain . *Dataset for peatlands (only priority habitat)*: Northern Ireland .
The location of mapped regions in the Azores, Austria, Sweden, and the full extent in Spain is shown in Fig. A (Supplementary materials). Map created in ArcGIS 10.8.1.

	Recognised as blanket bog habitat 7130			Recognised as blanket bog habitat 7130 and protected under Natura 2000 network		
Country	Turbines	Track length (km)	Track area (ha)	Turbines	Track length (km)	Track area (ha)
Spain	252	70.7	46.3	233	65.9	43.7
Republic of Ireland	186	92.2	82.9	24	12.1	9.3
England	72	36.4	28.1	0	0	0
Wales	24	7.8	5.4	0	0.07	0.06
Scotland	55	26.6	25.5	0	1.4	0.9
Northern Ireland	430	203.2	213.9	0	0	0

Table 2. Windfarm developments on recognised blanket bog habitat 7130 compared with recognised blanket bog habitat within a Natura 2000 site. No relationship between the extent of recognised blanket bog and number of turbines ($p = 0.30$), length of tracks ($p = 0.40$) and total affected area ($p = 0.46$) was found.

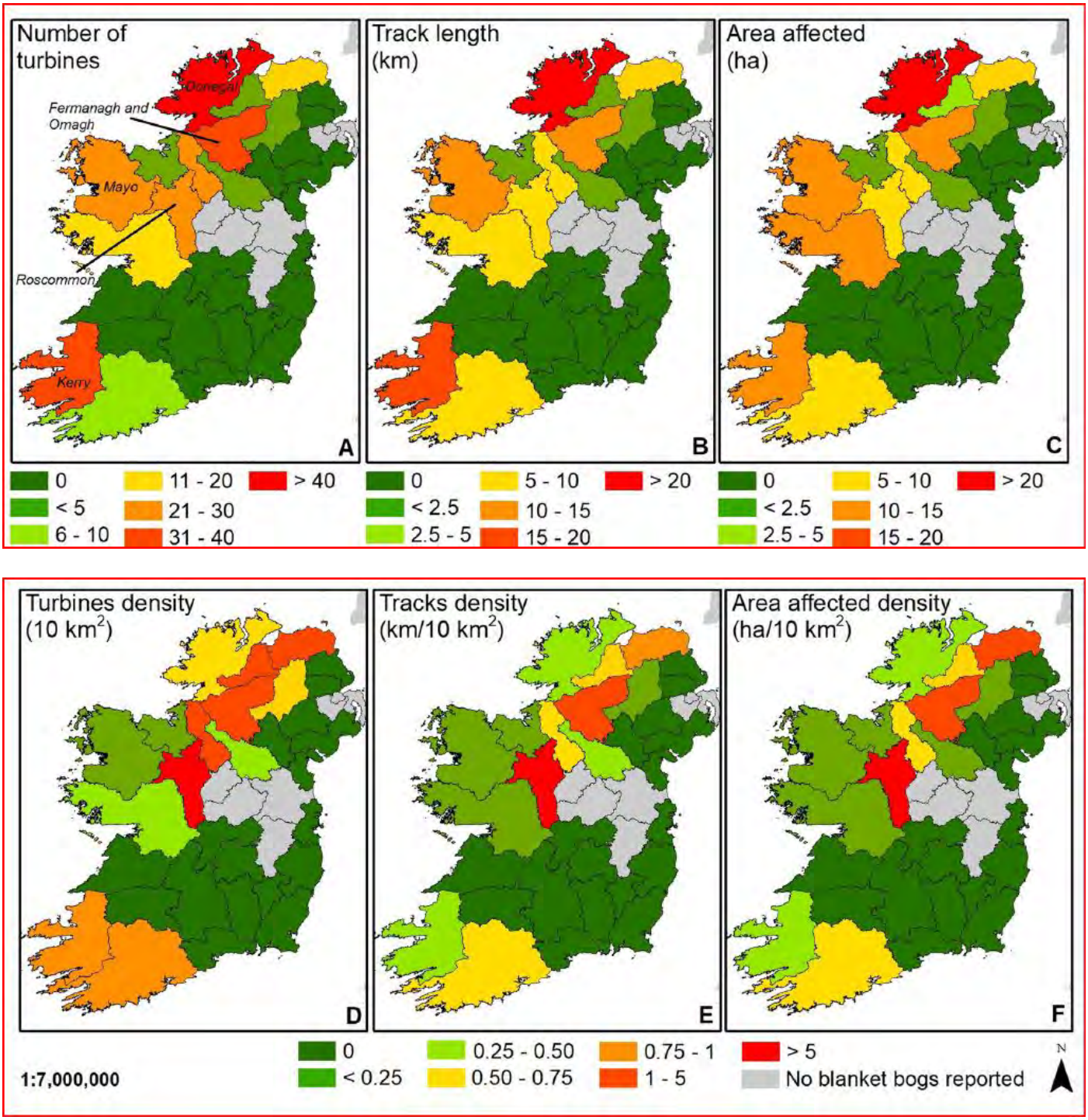


Figure 3. The extent of windfarm developments across the island of Ireland on blanket bog habitat 7130 at county level for the Republic of Ireland and intact or pool complex after blanket bog visual assessment for peatlands on Northern Ireland. (A) Total turbines on blanket bog habitat by county. (B) Tracks length on blanket bog habitat by county. (C) Total area affected by wind farm developments on blanket bog habitat by county. (D) Density of turbines by o10 km2 of blanket bog habitat by county. (E) Density of tracks by 10 km2 of blanket bog by county. (F) Density of area affected by wind farm developments by 10 km2 of blanket bog habitat by county. *Dataset for blanket bog habitat 7130*: Ireland36. *Dataset for peatlands*: Northern Ireland Map created in ArcGIS 10.8.1.

Country	Total number of turbines	Turbines on blanket bog	% of turbines on blanket bog
Spain	21,574[51]	252	1.2
Republic of Ireland	1896**[47]	186	9.8
England	2138*[52]	72	3.4
Wales	1177*[52]	24	2
Scotland	6322*[52]	55 (protected)	0.9
		1,063 (Class 1 & 2)	16.8
Northern Ireland	1950*[52]	54 (only intact blanket bogs)	2.8
		430 (all priority peatlands)	22.1

Table 3. Total % of turbines on blanket bog (recognised/national inventories) in relation with the total turbines installed by country. *Include wind turbines consented, operational and under construction. **Include proposed, constructed and under construction.

Reference Number 12.2 :
Inspector's Report ABP-310788-21ABP-310789-21

My concerns relating to environmental impacts resulting from a landslide at this site and the consequent environmental damage (ultimately to the biodiversity of this area) have been set out previously. While acknowledging concerns raised about impacts on bats, other fauna, etc., I consider that the principal planning concerns on biodiversity, setting aside landslide impacts, relate to the ornithological impacts arising from the proposed development.

I note the submissions to the planning authorities from the Department of Culture, Heritage and the Gaeltacht on nature conservation. The Department referred to the site's location relative to a number of European sites and Carrane Hill Bog NHA and Corry Mountain Bog NHA. The loss of upland blanket bog and wet flush and fen habitats were noted. Peat stability was a particular concern in both of the Department's reports and has been addressed in other sections of this assessment. The Department raised concerns on the assessment of impacts on birds, and in particular on Hen Harrier, Whooper swan, Golden Plover and Curlew. The recording of Whooper swan within the site was acknowledged, being a species of note with respect to Lough Arrow SPA. It was noted that Golden Plover were recorded multiple times, mainly wintering on adjacent habitats but also possibly breeding within a kilometre of the site and concern about potential displacement from upland habitat was referenced. The significance of collision risk and mortality rate were alluded to. The recording of Curlew possibly breeding adjacent to the site was also noted. The Department further noted that the frequency of observations of Hen Harrier within and around the site during the breeding season months supported evidence of the presence of a possible breeding pair. The sensitivity of this bird species to wind farm development was acknowledged. Following the submission of further information by the applicant, the Department again noted the site is in an area where Annex I species were observed, namely Whooper swan, Hen Harrier and Golden Plover. The impacts of the effect of creating a barrier effect for Whooper swan with other wind farm development in the vicinity was referenced. A continuing decline in the breeding population of Golden Plover in Ireland was noted and the importance of sites in West Sligo and Leitrim for Golden Plover was noted. While acknowledging the site itself is not suitable for breeding Golden Plover, it was submitted that breeding pairs outside of the site may be impacted. Acknowledging that the applicant's surveys show that wintering Golden Plover fly through the site frequently, it is submitted that the predicted loss of 22 birds per year (660 mortalities during the lifetime of the proposed wind farm) may have a significant impact on wintering and breeding Golden Plover populations locally. The Department remains concerned about the impact on Hen Harrier also, noting that there is suitable habitat in pockets within the plantation at this location and surrounding the site of importance to Hen Harrier. I acknowledge the monitoring requirements set out at the end of the Department's second report.

In my opinion, there can be no doubt that the continued expansion of wind farm development in this area adversely effects the existence of these species of conservation value at this location. The development of larger and higher turbines on the proposed site, together with the cumulative effect, clearly will increase the displacement of Annex I species in this area, it will affect breeding birds, it will increase the barrier effect with other wind farm development, and it will also have significant impacts by way of collision and mortality. In my opinion, the continued 'squeezing out' of Annex I species from this area due to the ongoing expansion of wind farm development must be

regarded as unsustainable as it erodes the distinct nature conservation value of this location and its role in supporting the key biodiversity traits of the area. Monitoring of further turbine development in this upland location will not respond to or address the loss of suitable habitat or disturbance, displacement and mortality of Annex I species arising from this proposed development. While it may easily be determined that the site of the proposed development is not a designated site of conservation itself, that it is an area already subjected to extensive wind farm development and that more of the same (or even greater in scale and height) will not make much more of a difference, the reality is that this location is important for Annex I bird species. It is an area that is attempting to retain birds of conservation value, notwithstanding it being under significant pressure from wind farm development. I seriously question the sustainability of allowing further wind farm development at this location. I pose the question: when does the time come to put a halt to the cumulative impact of wind farm development because of its impact on Annex I bird species? I submit that all the applicant's bird surveys indicate that more wind farm development at this location is unsustainable.

I submit to the Board that the range of birds of conservation value observed by the applicant on, over and in close proximity to the site in its surveys indicates this is an area of significant ornithological value. This area is under significant pressure from existing wind farm development. The EIAR notes that there are 13 existing wind farms less than 8km from the site, providing a total of 107 turbines, several of which adjoin the site. The potential for further habitat loss, displacement, and collision risk by yet more turbines in this area is apparent from the proposed development. The Board will also note that the proposed turbines are significantly higher and larger than the average turbines existing at present at this location, posing a notably greater risk of collision and avian displacement. The cumulative impact would be significant in my opinion.

Reasoned Conclusion

Having regard to the examination of environmental information contained above, and in particular to the EIAR and supplementary further information provided by the applicant, and the submissions from the planning authories, prescribed bodies and third parties in the course of the application, it is considered that the main significant direct and indirect effects of the proposed development on the environment are as follows:

The proposed development poses a significant risk from landslides, with the development occurring on a peat-dominated environment. A huge volume of waste material totalling 406,830m3 is required to be handled, stored and managed on this site. This upland blanket bogland area is prone to landslides, with a history of landslides occurring on and in the immediate vicinity of this site. The proposals to excavate a borrow pit and repositories and to seek to contain and store extensive volumes of peat and other spoil material on this upland mountainside, the development of access tracks across deep areas of peat, the construction of turbines and hardstanding areas on bog, the removal of extensive conifer plantation, and the provision of a highly complex drainage system would result in a significant pollution threat to waterbodies and the wider environment resulting from a landslide.
An extensive range of birds of conservation value have been observed on, over and in close proximity to the site in the applicant's surveys, indicating that this is an area of significant ornithological value. It is also an area under significant pressure from existing wind farm development, with 13 existing wind farms less than 8km from the site, providing a total of 107 turbines, several of which adjoin the site. The potential for further habitat loss, displacement, and collision risk by yet more turbines arises.
This adverse cumulative ornithological impact is compounded by the proposed turbines being significantly higher and larger in scale than the average turbines existing at present at this location, posing a notably greater risk of collision and avian displacement. The cumulative impact would be significant.

The main aspects of the proposed development that could adversely affect the conservation objectives of Lough Gill SAC, Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC, and Cummeen Strand SPA relate to the potential for construction, operational and decommissioning activities to indirectly impact on surface water quality by way of pollution.
The potential effects would include:

Deterioration of water quality arising from a landslide affecting aquatic habitats and species in the European sites,
A reduction in water quality by way of silt runoff, hydrocarbons, cementitious material and other pollutants during construction, operation and decommissioning which could affect the aquatic habitats and species in the SACs, and

Deterioration in surface water quality by way of silt runoff, hydrocarbons, cementitious material and other pollutants during construction, operation and decommissioning which could affect the supporting wetland habitat of SCI waterbirds in the SPA.

The Board considered that the main significant direct and indirect effects of the proposed development on the environment are as follows:

- A significant risk from a landslide, with due regard to the development occurring on a peat-dominated environment, the requirement for a very significant volume of waste material to be handled, stored and managed on the upland site, the blanket bogland area being prone to landslides, the inadequacy of provisions to contain and store extensive volumes of peat and other spoil material on the site, the development of access tracks across deep areas of peat, the construction of turbines and hardstanding areas on bog, the removal of extensive conifer plantation, and the provision, functionality of and reliance on a highly complex drainage system.

Habitat loss, displacement and collision risk arising from a development of this scale, height and location for birds of conservation value, including Annex I cumulative ornithological impact arising with established wind farm development in the immediate vicinity leading to erosion of the quality of the environment for sensitive bird species of conservation value by distorting migratory routes, eroding habitat, encroaching on foraging areas, and affecting opportunities for roosting and breeding sites.

- Significant adverse landscape and visual impacts arising from the siting, scale and height of the proposed turbines, which would be highly prominent over an extensive geographical area, would have a dominant, obtrusive, skyline impact on visually and environmentally sensitive landscapes, and would impact on the amenity and tourism value of the area, together with the cumulative impact of the proposed development at this location and the expansion of the linear spread of turbines north-westwards in the direction of valued scenic, tourist and amenity locations, which would contribute further to the erosion of the quality of the natural landscape.

Having regard to the conclusions drawn in my planning assessment, the assessment of environmental impacts and my assessment of likely significant effects on European sites, I recommend that permission is refused for the proposed development for the following reasons and considerations:

Reasons and Considerations

1. Having regard to:

The classification of the site by Geological Survey Ireland as being of low to moderately high landslide susceptibility;
The numerous mapped faults in the area, including two within the site;
Blanket bog being the dominant soil type at the site;
The low permeability of the limestone bedrock on the site, leading to a high water table;
The high density of drainage channels throughout the site, both natural and man-made;
The timing of construction works outside of the breeding season for birds coinciding with wetter periods;
The extensive water crossings and crossing upgrades required;
The deep peat at turbine locations and along existing and proposed access roads;
The significant volumes of peat and other spoil material requiring excavation, handling, storage and management on the site;
The instability associated with the works and movement of waste material, including the necessity for placement of vast volumes of waste peat and other spoil materials in three large repositories on bogland hilly terrain;
The construction of high retaining stone buttresses required to contain waste peat and other spoil;
The peat-dominated nature of the soils at the repository locations;
The lack of a clear understanding of the land and ground conditions associated with the development of the proposed peat repositories, including matters relating to the final construction of the primary repository, the drainage of the peat repositories, measures required for the control of groundwater, the type and condition of rock at the repository locations, and the hillside siting of the northernmost repository and the associated clear felling of forestry;

The construction works culminating in interference with the natural terrain by the development of the turbine bases and the hardstanding areas, the construction of access roads cutting across contours on bogland, the provision of preferential flow paths for surface waters, and road widening and improvement works along existing internal roads;
The proposed highly complex system of drainage and the very precise nature of the application of many of the proposed measures required for their functionality; and The destabilising impacts of the proposed engineered drainage works

it is considered that, due to the elevated risk of a major accident arising from a landslide associated with the proposed wind farm, the proposed development would pose a serious danger to the environment, potentially causing extensive pollution of waterbodies within and in the vicinity of the site. Furthermore, the Board is not satisfied that the proposed repositories would be effective in providing for the permanent retention of peat and other unsuitable materials and that the mitigation measures, inclusive of the proposed complex drainage system, would be adequate to ensure the protection of the environment, therefore it is considered that the proposed development would present a significant risk of adverse environmental impact on the sensitive natural habitats of the site and of the wider area, constituting an unacceptable risk of pollution of watercourses in the area and seriously injuring the amenities of property in the vicinity. The proposed development would, therefore, be contrary to the proper planning and sustainable development of the area.

The site of the proposed development is located within an area of significant ecological value, as evidenced by the Bird, Bat surveys.

It is considered that the siting, height, scale and operation of the proposed turbines would result in a loss of habitat, disturbance and displacement for Annex I bird species, inclusive of Hen Harrier, Golden Plover and Whooper swan, as well as significant risk of collision. Furthermore, it is considered that the cumulative impact of wind turbines in the immediate vicinity, together with the proposed development, would substantially erode the quality of the natural environment for these sensitive bird species, including distorting migratory routes, eroding habitat, encroaching on foraging areas, and affecting roosting and breeding sites. The proposed development would, thus, have significant adverse impacts on the ornithological importance of the area by way of collision, mortality, disturbance and displacement of protected bird species, would be incompatible with the policy to treat this area as an ecologically-sensitive entity, and would, therefore, be contrary to the proper planning and sustainable development of the area.

The proposed wind turbines would, thereby, comprise excessively dominant features and a visually obtrusive form of development in this landscape, which would contribute to the erosion of the visual and environmental amenity of the area, would materially conflict with the policies and objectives as set out in the Offaly County Development Plans, and would seriously injure the landscape and visual amenities of the area. The proposed development would, therefore, be contrary to the proper planning and sustainable development of the area.

Reference Number 12.3

The extent of windfarm infrastructures on recognised European blanket bogs. 2023. Guaduneth Chico, Nottingham Trent University, Thomas Clewer,Nottingham Trent University, Nicholas Midgley, Nottingham Trent University, Pablo Gallego-Anex, Nottingham Trent University, Pablo Ramil-Rego, University of Santiago de Compostela, Javier Ferreiro, University of Santiago de Compostela, Eleanor Whayman, Nottingham Trent University, Saskia Goeckeritz, Nottingham Trent University, Thomas Stanton, Loughborough University. DOI: https://doi.org/10.21203/rs.3.rs-2199542/v1

Peatland environments are the Earth's largest terrestrial carbon store and have the potential to act as carbon sinks. However, the development of windfarms on peatlands is affecting their morphology, hydrology ,ground-level climate conditions, carbon functions and vegetation. Blanket bogs are a rare type of ombrotrophic peatland that are typical of oceanic areas with high precipitation and low temperatures. Their distribution has been mapped across Europe, where they are mainly located on hill summits where wind energy potential is higher, making them attractive sites for windfarm developmentS. The promotion of renewable energy is currently a priority given the environmental and economic drive to increase low-carbon energy production. Establishing windfarms on peatland in pursuit of greener energy therefore risks compromising

and undermining the green-energy transition. Despite this, the extentS of windfarm infrastructures on blanket bogs have not yet been reported at the European scale.

Peatland environments are recognised as a potential carbon sink when in either restored or pristine condition. This terrestrial habitat only covers 2.84% of Earth's land surface, but they represent over 25% of the total terrestrial carbon. Blanket bogs are a rare ombrotrophic (rain-fed) type of peatland commonly found in hyperoceanic conditions with high precipitation (>1,000 mm yr-1), low temperature (<15°C) and low seasonal temperature variability.

Since 1992, in the European Union (EU) and the United Kingdom of Great Britain and Northern Ireland (UK) the Habitats Directive (92/43/EEC) has recognised blanket bogs (habitat code: 7130) as a terrestrial habitat, and a priority habitat if active. This designation has required each member state to since report the conservation status of this habitat every 6 years and, when necessary, encouraged and implemented restoration actions to improve the quality and conservation status of the habitat. When reporting the conservation status, a detailed understanding of the extent of this habitat is needed. However, several unrecognised blanket bogs have been described across the EU recently, highlighting the lack of understanding and consequently adequate protection of this important habitat. In addition, some blanket bogs are recognised as special areas of interest and also included under Natura 2000, providing an additional legal protection for key habitats.

Notwithstanding the extensive peatland restoration projects (e.g. LIFE programme) and their positive implications for peatland ecosystem services, a large proportion of these blanket bogs are currently in an unfavourable condition. Blanket bogs with favourable status are only found in France, Sweden and Portugal, where they represent less than 2% of the total extent of recognised blanket bogs across the EU and the UK. Pressures such as peat extraction for fuel and horticulture, forestry, overgrazing, drainage, burning for recreational activities26 and anthropogenic infrastructures, have affected the stability of blanket bog habitats for centuries. Current threats frequently included in Habitat Directive conservation status reports for blanket bogs are variable across Europe, although agriculture and livestock are the most common issues. **However, more recently, windfarm developments have been highlighted as a concerning pressure for this habitat having impacts on peatland hydrology, ground-level climatic conditions and habitat biodiversity,contributing to vegetation changes and habitat transition.**

The Directive EU 2018/2001 on the promotion of the use of energy from renewable resources aims to promote the use of renewable energy across the EU27 based on Article 194 of the Treaty on Functioning of the European Union, requiring member states to promote energy efficiency and saving. By 2030, at least the 32% of the energy consumed across the EU should be renewable. In 2020, 36% of the EU renewable energy was produced by windfarms, demonstrating the importance of this technology in reducing our carbon emissions. Though the need to expand international renewable energy capacities is clear, it is important that the pursuit of legislative energy requirements and targets does not compromise the aims of alternative environmental legislation. There therefore exists a legislative conflict between the Habitats Directive and Renewable Energy Directive that must be acknowledged and addressed. Both directives aim to reduce carbon emissions by restoring carbon sinks and promoting renewable energy transitions and, though windfarm development being permitted on Natura 2000 sites or recognised blanket bogs under the Habitats Directive, **if they negatively affect the integrity of the site and the impacts cannot be mitigated by additional measures, authorisation for the development should not be granted***. Noting the lack of understanding regarding the long-term impacts on the peatland carbon sink function and the fact that windfarms installed on non-degraded peatland would not result in a net long-term carbon benefit, windfarm developments need to be extensively and carefully considered.*

Many countries have also misinterpreted the active status of the blanket bog meaning that it is difficult to define whether the recognised blanket bog habitat is priority or not. Some countries, such as Ireland, had classified as 7130 only active blanket bogs, incorrectly applying the Habitat Directive designation. The priority status is given when the habitat is particularly vulnerable or unique to the EU and necessitates additional measures for their protection and surveillance, however, whilst some blanket bogs may not act currently as carbon sinks, they still contain large amounts of carbon, and when restored they can recover their carbon sink function, further mitigating climate change.

Large extents of blanket bogs have already been damaged, concentrated in the edge-of-range of this habitat and directly affecting hundreds of hectares of blanket bog across the rest of Europe. The full potential long-term damage to the habitat functionality is still unclear, but scientific evidence supports the negative impacts of windfarm

developments on this critical habitat. European blanket bogs need further scientific evidence to demonstrate the real benefit of incentivise degradation of a natural carbon sink and storage to reduce carbon emissions by installing onshore windfarm infrastructures on peatlands.

The issue of windfarm developments across the Republic of Ireland has been previously reported using a peat map3. However, despite researchers highlighting the importance of excluded vulnerable peatland ecosystems on future developments, new areas of windfarms have been built affecting further recognised blanket bogs.
At least 79 wind turbines have been installed in the Republic of Ireland since 2008 on recognised blanket bogs (Table A – Supplementary information), highlighting the importance of this conflict across the country. The contribution of wind energy production for electricity supply was predicted to be up to 30% by 2020. In 2020, wind energy consumed in the Republic of Ireland represented 36%. This represented an average annual increase of wind energy consumption of 16.9% between 2005 and 2020 which may explain part of the increase of 42% on wind turbines since 2008 (Table A – Supplementary information). For the next decade, several governments have developed climate action plans that promote renewable energies to reduce carbon emissions. The government of the Republic of Ireland is aiming to generate up to 80% of electricity from renewable energy by 2030, providing support for onshore windfarm developments with an increase up to the 32% of the renewable energy production by 2030, but with a favourable preference for offshore wind energy production (up to 52% of the renewable energy production).
This may help to reduce the conflict between blanket bogs and windfarm developments. Currently, windfarm annual energy production on blanket bogs accounts for 263.4 MW, 6.1% of the total production of wind energy in the Republic of Ireland. In addition to the promotion of onshore wind energy production38, the lack of protection of the full extent of the blanket bog is also a threat that needs to be considered. In 2008, a peat map was reported showing the distribution of blanket bogs and raised bogs across the Republic of Ireland37. However, the inventory of current recognised blanket bogs under the Habitats Directive does not cover the full extent reported in this research.
While the total extent of recognised blanket bog under the Habitats Directive 92/43/ECC reported a total of, 3,621Km^2 of blanket bogs, the real extent of blanket bogs across the country could be up to 2.5 times more (9,202 km2), highlighting the lack of protection and the potential further increase of the windfarms and peatlands conflict in the Republic of Ireland.

Reference Number 12.4:
Scottish Government, Scottish Natural Heritage, SEPA (2017) Peatland Survey. *Guidance on Developments on Peatland*
Soil survey of Scotland Scottish Peat survey methods

Surface firmness estimation

It is necessary to make some estimate of the bearing capacity of the bog surface as this will influence the type of machines recommended for initial and subsequent exploitation. Modem bog tractors have a ground pressure of less than 2 lb. per square inch but the total pressure applied is also affected by the character and density of the vegetation and whether the tractor carries or pulls its loads. A miller or rotavator for instance imparts a forward push to a tractor. An average man standing on one foot applies a pressure to the ground of between 5 and 6 lbs. p.s.i. and this fact is used to estimate the bearing capacity. The following symbols are used to denote the pressure the ground will stand.
Firmness of surface (P)
PO = Surface too soft to walk on
P1 = Surface just passable
P2 = Surface fairly firm
P3 = Surface firm
As an example, Table 1 shows data from White Moss, Mainland, Orkney.

P0		P1		P2		P3		Total number of observations
No	Percent	No	Percent	No	Percent	No	Percent	
0	-	1	16.7	3	50.0	2	33.3	6

In practice these data mean that some 83 per cent of the bog could be developed with mechanical equipment without much difficulty. On 17 per cent of the area some care would be required but this softer part would be expected to become firmer as drainage began to have a consolidating effect.

Table 2 shows to some extent the relationship between the surface moisture content (for the stratum 0-20 in. (0-0.5 m)) and the estimated bearing capacity.

P-value Moisture content (%)	P1	P2	P3
Average (range)	93.8 (92.4-94.7)	92.2 (86.5-94.5)	89.0 (79.4-92.2)

Although the differences in terms of percentage water in the peat appear small, it is important to note that a 1 per cent increase in water content at or near the figure of 90 per cent which is common for peat, results in a decrease in solids content of 10 per cent and the peat becomes appreciably more fluid and less able to bear applied pressure without collapse.

Observations on the vegetation
The plants growing within a radius of 49 to 66 ft (15-20 m) round each bore hole are recorded, as are the boundaries between well-defined plant communities which are noted during traverses across the bog.

Observations on the peat
i. *Botanical* origin

The range of vegetable remains easily identifiable in the field is strictly limited and laboratory analyses of the many hundreds of samples taken in anyone season would be vastly time-consuming. However, it is usually possible to ascertain the main peat-forming species in the field and this is done for all samples examined.
The universal peat formers found in both Blanket and Raised Basin Bogs are species of *Sphagnum.* Also found in most bogs are the remains of *Eriophorum vaginatum,* the leaf-sheaths of which contain fine fibres which are extraordinarily resistant to the processes of decomposition, and small twigs of *Callana vulgaris* which are generally found in the upper strata. The usual type of peat found in the lower horizons of Basin Bogs is a mixture of the remains of *Carex* species with smaller amounts of *Phragmites, Typha, Equisetum* and *Menyanthes,* all or some of which are usually present. Wood remains are frequent, even in areas which are now treeless such as Shetland. The commonest wood is *Betula* but *Pinus* is not uncommon and it is probable that *Salix, Alnus* and Cory*lus* occur more often than they are recognised. Field identification of wood fragments is somewhat uncertain.

ii. Degree *of humification* - von POST SCALE

The degree of humification of peat samples is estimated in the field according to the method devised by the Swedish botanist L. von Post.
A small amount of peat is squeezed in the hand and the water and! or peat exuded indicates, by its colour and consistency, the degree to which the peat has undergone humification or, more correctly, a type of decomposition which includes breakdown under anaerobic conditions. This is one of the most important observations to be made on the peat and, because it is entirely subjective, one of the most difficult to make with a minimum of error. As far as possible, the same person makes all such observations and experience counts for a great deal. It is necessary to make allowance for moisture content, oxidation of the surface horizons and for the botanical origin of the peat. Obviously for example, pieces of wood do not squeeze between the fingers and yet the matrix in which the wood fragments are embedded may be very highly humified. A very dry peat may appear to be less well humified than it actually is and vice versa. Attempts have been made by various workers to develop an objective method for the estimation of degree of humification but without conspicuous success. The von Post scale ranges from 1 to 10, the higher the number the higher the degree of humification. The full scale is as follows:

DEGREE OF HUMIFICATION- von POST SCALE	Completely undecomposed peat free of amorphous material. On
H1	squeezing, clear colourless water is pressed out.
H2	Nearly undecomposed peat, free of amorphous material, yielding only yellowish brown water on pressing.
H3	Very slightly decomposed peat, containing a little amorphous material. On squeezing, muddy brown water but no peat passes between the fingers. Residue is not pasty.

H4	Slightly decomposed peat containing some amorphous material. Strongly muddy brown water but no peat passes between the fingers. Residue is somewhat pasty.
H5	Moderately decomposed peat containing a fair amount of amorphous material. Plant structure recognisable though somewhat vague. On squeezing, some peat but mainly muddy water issues. Residue is strongly pasty.
H6	Moderately decomposed peat with a fair amount of amorphous material and indistinct plant structure. On pressing, about one third of the peat passes between the fingers. Residue is strongly pasty, but shows the plant structure more distinctly than in unsqueezed peat.
H7	H7 Strongly decomposed peat with much amorphous material and faintly recognisable plant structure. On squeezing, about one half of the peat is extruded. The water is very dark in colour.
H8	Strongly decomposed peat with much amorphous material and very indistinct plant structure. On squeezing, two thirds of the peat and some water passes between the fingers. Residue consists of plant tissues capable of resisting decomposition (roots, fibres, wood, etc.).
H9	Practically fully decomposed peat with almost no recognisable plant structure. Nearly all the peat squeezed between the fingers as a uniform paste.
H10	Completely decomposed peat with no discernible plant structure. On squeezing, all the peat, without water, passes between the fingers.

Mean H-values are calculated for each bog and its sub-areas if required and also for each 20 in. (0.5 m.) layer from the surface to the bottom. The variation with depth is shown graphically in the Bog Reports. The usual pattern is for the H-value to increase more or less steadily with increasing depth unless the origin of the peat changes drastically. When *Carex* peat occurs near the bottom of a deposit, the degree of humification generally falls to a value similar to that found in the upper layers of the bog.
Peats of low degrees of humification are those commonly described as "light" or "brown" and are used as moss litter and in horticulture. The highly humified "black" or "blue" peats comprise good fuel types. In recent years horticulturalists have been less insistent on having the very light peats since rather darker qualities have been found equally useful for many purposes.
Inspection of humification data from the surveys shows that the extremes of the von Post scale are rarely encountered (i.e. H1 and H10). The majority of samples lie about the centre of the scale with small shifts of the average towards the lower or higher values depending upon whether the peat in the bog is of a fuel or a moss litter type.

iii. Fibre

The fibre content of each peat sample is estimated visually and the amounts of the two types (classified 'fine' or 'coarse') are noted on a scale ranging from 0 to 3 as shown below. Accurate quantitative determinations are made later on bulk samples in the laboratory as described in section 4(f).

Fine fibres, mainly derived from *Eriophorum spp*. (F)
F0 = Nil
Fl = Low content
F2 = Moderate content
F3 = High content

Coarse fibres, mainly rootlets (R)
R0 = Nil
Rl = Low content

R2 = Moderate content
R3 = High content

iv. Wood

Wood remains, especially if they are large and resistant, may conceivably cause a certain amount of difficulty during the exploitation of a bog. An attempt is therefore made when sampling to assess the extent of wood. It is estimated on a scale ranging from 0 to 3 as detailed below.
Wood remains (W)
W0= Nil
Wl = Low content
W2 = Moderate content
W3 = High content
Extensive wood remains of a type that might prove a serious obstacle to exploitation are not frequent but bogs with this feature have been surveyed in Sutherland and Aberdeenshire.
In Blanket Bogs, impenetrable wood is found mainly in sheltered valleys; in Raised Basin Bogs it tends to occur at the margins of the deposits.

v. Other *observations*
When peat is freshly sampled and before it darkens by oxidation, note is taken of its colour, stratification, the presence of visible mineral matter and any other features of interest.
Note that this information has not been supplied with this application.

Reference Number 12.5:
Sustainability of Biomethane Production in Ireland: Exploring how Ireland can deliver a sustainable, agriculture-led biomethane industry. October 2021.
The Dowth Farm & Research Facility in Meath, a Global Lighthouse facility ("Dowth"), supported by KPMG Sustainable Futures, has been commissioned by Gas Networks Ireland ("GNI") to produce an independent report assessing the environmental sustainability of a proposed national agricultural led biomethane industry in Ireland.

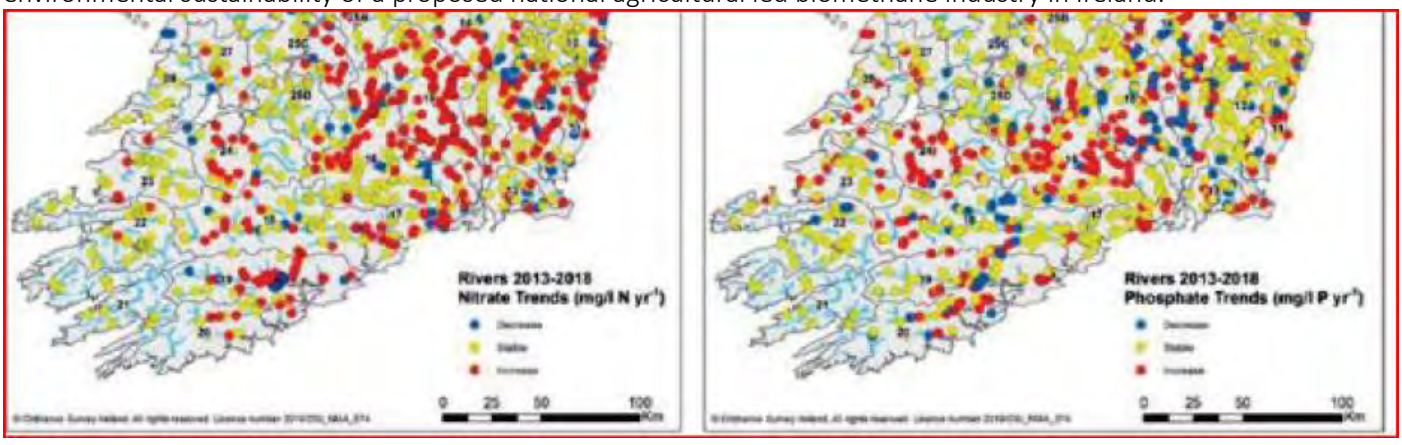


FIGURE 9 WATER QUALITY, SOURCE EPA (2020) STATE OF THE ENVIRONMENT REPORT.
Blue= Increase in water quality; Yellow= Stable water quality; Red = Decline in water quality.

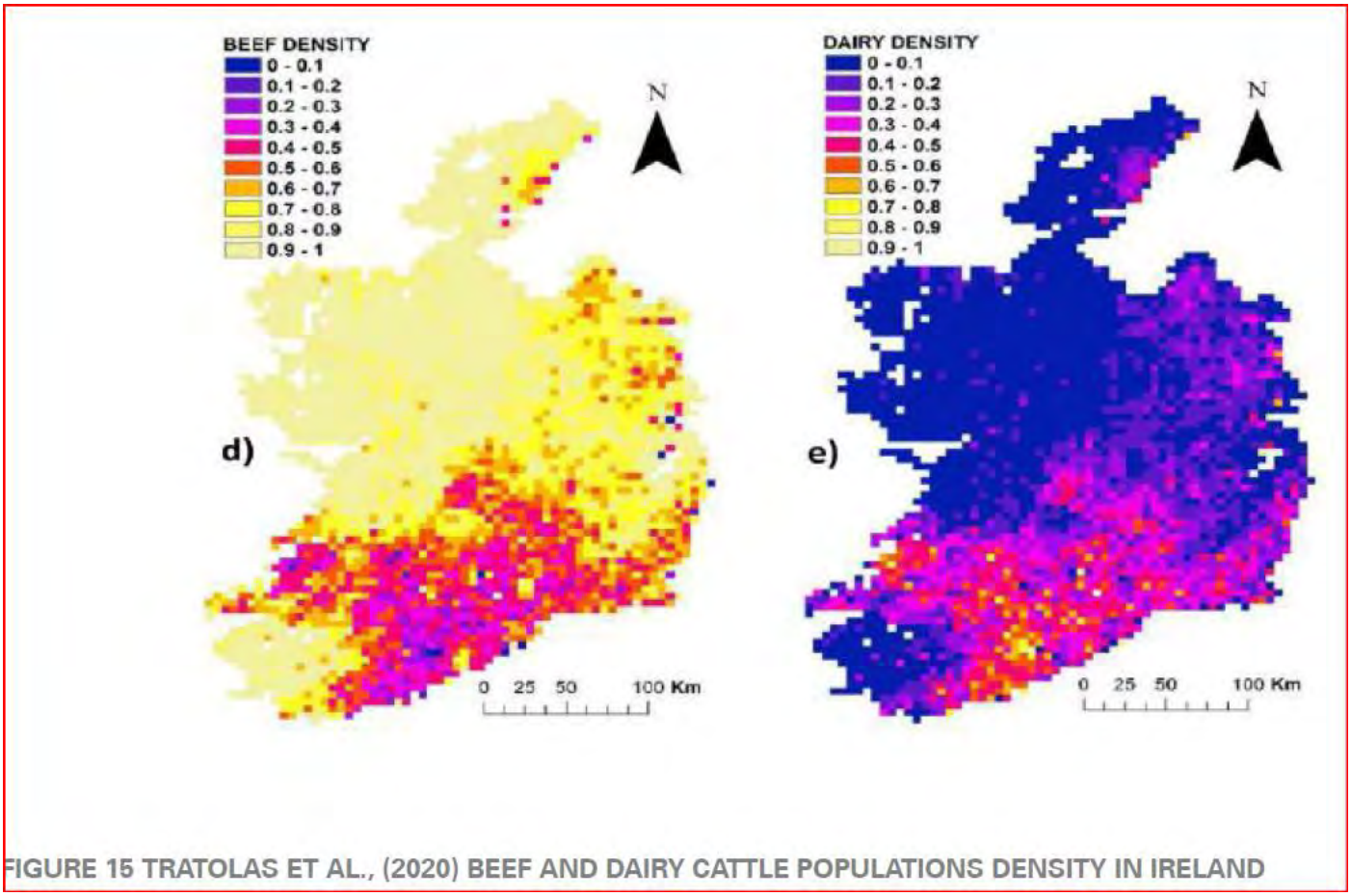


FIGURE 15 TRATOLAS ET AL., (2020) BEEF AND DAIRY CATTLE POPULATIONS DENSITY IN IRELAND

Exclusion of High Nature Value Land

High Nature Value ("HNV") farmland is extensively managed farmland that has high biodiversity, enhanced ecosystem services and societal value. This farmland is important for the conservation of semi-natural habitats and the plants and animals within them. These farms occur most frequently in areas that are mountainous or areas where natural constraints prevent intensification. Farming is important in these areas as it sustains the biodiversity of these landscapes which is integral for maintaining their HNV.

Research conducted by Moran et al. (2021) mapped the spatial distribution of HNV farmland across Ireland (Fig 16). The paper estimates that there is approximately 1.5 m ha of HNV farmland in Ireland. For this report, the HNV map is used as a proxy to screen for areas that are unlikely to meet the RED II protocol. It should be noted that this is a high level screening exercise and it is recommended that where an area of land is identified within a high HNV zone, enhanced screening or an Environmental Impact Assessment ("EIA") is conducted to ensure that the proposed project would comply with the RED II protocol.

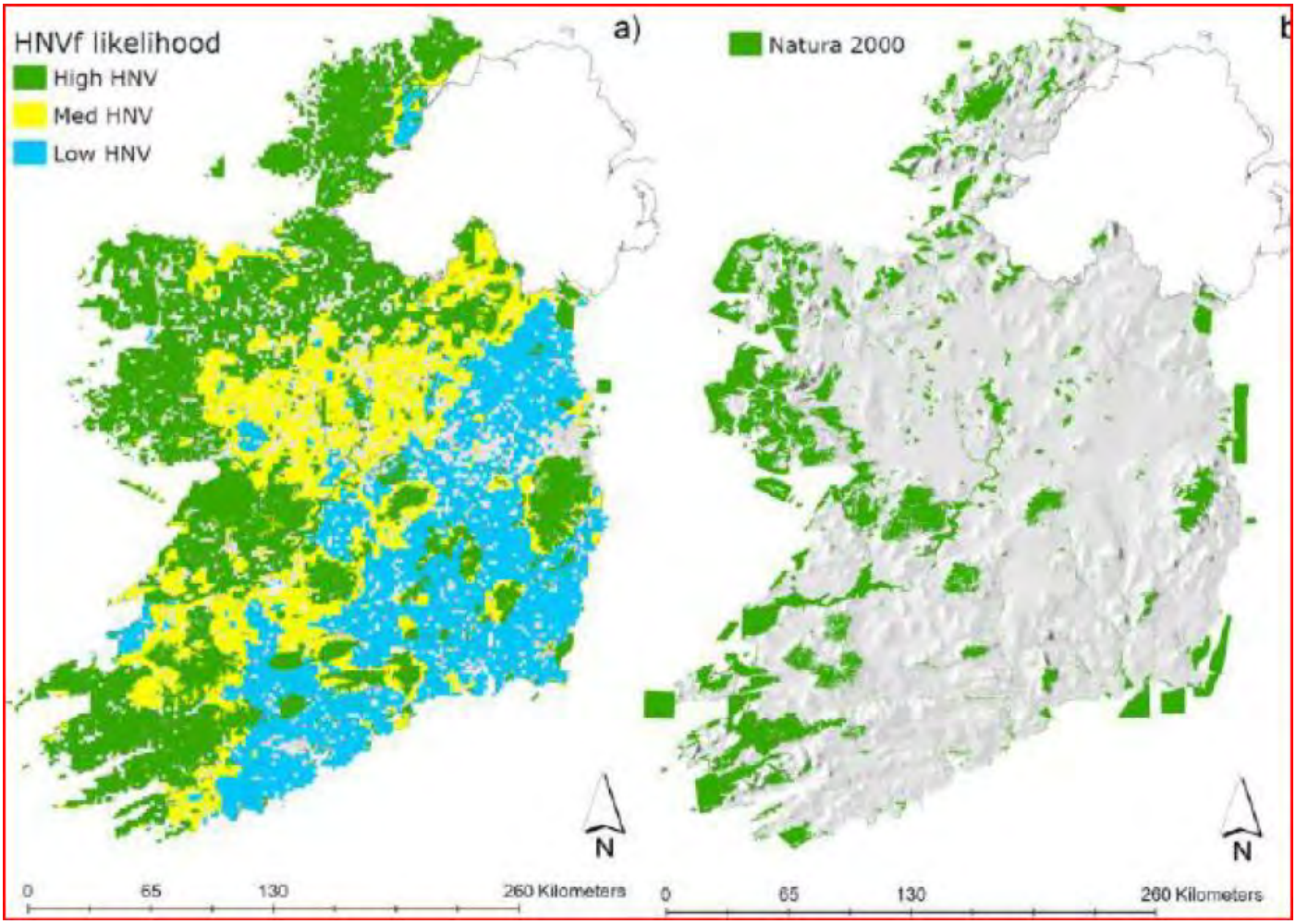


FIGURE 16 MORAN ET AL. (2021) HIGH NATURE VALUE FARMLAND AND NATURA 2000 DESIGNATED SITES SPATIAL DISTRIBUTION IN IRELAND. NOTE THAT HNV SITES AND NATURA 2000 SITES OVERLAP.

This map indicates that the North Kilkenny proposed windfarm is located in High Nature Value Farmland. The reduction in ground temperatures from downwind wake climate change, would adversely effect this farmland.

Reference Number: 13.1
2024/1991 REGULATION (EU) 2024/1991 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 June 2024 on nature restoration and amending Regulation (EU) 2022/869

CHAPTER II
RESTORATION TARGETS AND OBLIGATIONS
Article 4
Restoration of terrestrial, coastal and freshwater ecosystems

1. Member States shall put in place the restoration measures that are necessary to improve to good condition areas of habitat types listed in Annex I which are not in good condition.

Such restoration measures shall be put in place:

(a) by 2030 on at least 30 % of the total area of all habitat types listed in Annex I that is not in good condition, as quantified in the national restoration plan referred to in Article 15;

(b) by 2040 on at least 60 % and by 2050, on at least 90 % of the area of each group of habitat types listed in Annex I that is not in good condition, as quantified in the national restoration plan referred to in Article 15.

7. Member States shall put in place restoration measures for the terrestrial, coastal and freshwater habitats of the species listed in Annexes II, IV and V to Directive 92/43/EEC and of the terrestrial, coastal and freshwater habitats of wild birds falling within the scope of Directive 2009/147/EC that are, in addition to the restoration measures referred to in paragraphs 1 and 4 of this Article, necessary to improve the quality and quantity of those habitats, including by re-establishing them, and to enhance connectivity, until sufficient quality and quantity of those habitats is achieved.

8. The determination of the most suitable areas for restoration measures in accordance with paragraphs 1, 4 and 7 of this Article shall be based on the best available knowledge and the latest scientific evidence of the condition of the habitat types listed in Annex I to this Regulation, measured by the structure and functions which are necessary for their long-term maintenance, including their typical species, as referred to in Article 1, point (e), of Directive 92/43/EEC, and of the quality and quantity of the habitats of the species referred to in paragraph 7 of this Article, making use of information reported under Article 17 of Directive 92/43/EEC and Article 12 of Directive 2009/147/EC, and where appropriate taking into account the diversity of situations in various regions as referred to in Article 14(16), point (c), of this Regulation.

9. Member States shall ensure, by 2030 at the latest, that the condition of habitat types is known for at least 90 % of the area distributed over all habitat types listed in Annex I and that by 2040, the condition of all areas of habitat types listed in Annex I is known.

10. The restoration measures referred to in paragraphs 1 and 4 shall consider the need for improved connectivity between the habitat types listed in Annex I and take into account the ecological requirements of the species referred to in paragraph 7 that occur in those habitat types.

11. Member States shall put in place measures which shall aim to ensure that the areas that are subject to restoration measures in accordance with paragraphs 1, 4 and 7 show a continuous improvement in the condition of the habitat types listed in Annex I until good condition is reached, and a continuous improvement of the quality of the habitats of the species referred to in paragraph 7, until the sufficient quality of those habitats is reached.

12.Without prejudice to Directive 92/43/EEC, Member States shall, by the date of publication of their national restoration plans in accordance with Article 17(6) of this Regulation, endeavour to put in place necessary measures with the aim of preventing significant deterioration of areas where the habitat types listed in Annex I to this Regulation

occur and which are in good condition or are necessary to meet the restoration targets set out in paragraph 17 of this Article.

13.With regard to paragraphs 11 and 12 of this Article, outside Natura 2000 sites, Member States may, in the absence of alternatives, apply the non-deterioration requirements set out in those paragraphs at the level of each biogeographical region of their territory for each habitat type and each habitat of species, provided that the Member State concerned notifies its intention to apply this paragraph to the Commission by 19 February 2025 and fulfils the obligations set out in Article 15(3), point (g), Article 20(1) point (j), Article 21(1) and Article 21(2), point (b).

Article 11

Restoration of agricultural ecosystems

4.Member States shall put in place measures which shall aim to restore organic soils in agricultural use constituting drained peatlands. Those measures shall be in place on at least:

(a) 30 % of such areas by 2030, of which at least a quarter shall be rewetted;

(b) 40 % of such areas by 2040, of which at least a third shall be rewetted;

(c) 50 % of such areas by 2050, of which at least a third shall be rewetted.

Member States may put in place restoration measures, including rewetting, in areas of peat extraction sites and count those areas as contributing to meeting the respective targets referred to in the first subparagraph, points (a), (b) and (c).

In addition, Member States may put in place restoration measures to rewet organic soils that constitute drained peatlands under land uses other than agricultural use and peat extraction and count those rewetted areas as contributing, up to a maximum of 40 %, to meeting the targets referred to in the first subparagraph, points (a), (b) and (c).
Restoration measures that consist in rewetting peatland, including the water levels to be achieved, shall contribute to reducing greenhouse gas net emissions and increasing biodiversity, while taking national and local circumstances into account.

Where duly justified, the extent of the rewetting of peatland under agricultural use may be reduced to less than required under the first subparagraph, points (a), (b) and (c), of this paragraph by a Member State if such rewetting is likely to have significant negative impacts on infrastructure, buildings, climate adaptation or other public interests and if such rewetting cannot take place on land other than agricultural land. Any such reduction shall be determined in accordance with Article 14(8).

The obligation for Member States to meet the rewetting targets set out in the first subparagraph, points (a), (b) and (c), does not imply an obligation for farmers and private landowners to rewet their land, for whom rewetting on agricultural land remains voluntary, without prejudice to obligations stemming from national law.

Member States shall, as appropriate, incentivise rewetting to make it an attractive option for farmers and private landowners and foster access to training and advice to farmers and other stakeholders on the benefits of rewetting peatland and on the options of subsequent land management and related opportunities.

ANNEX I

TERRESTRIAL, COASTAL AND FRESHWATER ECOSYSTEMS – HABITAT TYPES AND GROUPS OF HABITAT TYPES REFERRED TO IN ARTICLE 4(1) AND (4)

The list below includes all terrestrial, coastal and freshwater habitat types listed in Annex I to Directive 92/43/EEC referred to in Article 4(1) and (4), as well as six groups of those habitat types, namely 1) wetlands (coastal and inland),

2) grasslands and other pastoral habitats, 3) river, lake, alluvial and riparian habitats, 4) forests, 5) steppe, heath and scrub habitats and 6) rocky and dune habitats.

1. GROUP 1: Wetlands (coastal & inland)

Mires, bogs and fens	
Habitat type code as referred to in Annex I to Directive 92/43/EEC	Habitat type name as referred to in Annex I to Directive 92/43/EEC
7110	Active raised bogs
7120	Degraded raised bogs still capable of natural regeneration
7130	Blanket bogs
7140	Transition mires and quaking bogs
7150	Depressions on peat substrates of the *Rhynchosporion*
7160	Fennoscandian mineral-rich springs and springfens
7210	Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*
7220	Petrifying springs with tufa formation (*Cratoneurion*)
7230	Alkaline fens
7240	Alpine pioneer formations of the *Caricion bicoloris-atrofuscae*
7310	Aapa mires
7320	Palsa mires
Rivers and lakes	
3110	Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*)
3120	Oligotrophic waters containing very few minerals generally on sandy soils of the West Mediterranean, with *Isoetes* spp.
3130	Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*
3140	Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.
3150	Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* — type vegetation
3160	Natural dystrophic lakes and ponds
3170	Mediterranean temporary ponds
3180	Turloughs

ANNEX V

COMMON FARMLAND BIRD INDEX AT NATIONAL LEVEL

Description

The common farmland bird index summarises population trends of common and widespread birds of farmland and is intended as a proxy to assess the biodiversity status of agricultural ecosystems in Europe. The national common farmland bird index is a composite, multispecies index that measures the rate of change in the relative abundance of farmland bird species across selected survey sites at national level. That index is based on specially selected species that are dependent on farmland habitats for feeding or nesting, or both. National common farmland bird indices are based on species sets that are relevant to each Member State. The national common farmland bird index is calculated with reference to a base year when the index value is typically set at 100. Trend values express the overall population change in the population size of the constituent farmland birds over a period of years.

List of species used for the common farmland bird index in the Member States

Ireland

Carduelis carduelis - Goldfinch
Columba oenas – Stock Dove
Columba palumbus – Common Wood Pigeon
Corvus cornix – Hooded Crow

Corvus frugilegus - Rook
Corvus monedula - Jackdaw
Emberiza citronella - Yellowhammer
Falco tinnunculus - Kestrel
Fringilla coelebs - Chaffinch
Hirundo rustica –Barn swallow
Chloris chloris - Greenfinch
Linaria cannabina - Linnet
Motacilla alba – White Wagtail
Passer domesticus – House sparrow
Phasianus colchicus – Ring-necked Pheasant
Pica pica - Magpie
Saxicola torquatus - Stonechat
Sturnus vulgaris - Starling

ANNEX VII
LIST OF EXAMPLES OF RESTORATION MEASURES REFERRED TO IN ARTICLE 14(16)

(1) Restore wetlands, by rewetting drained peatlands, removing peatland drainage structures or de-poldering and discontinuing peat excavation

(12) Assist migration of provenances and species where it may be needed due to climate change.

(22) Improve connectivity across habitats to enable the development of populations of species, and to allow for sufficient individual or genetic exchange as well as for species' migration and adaptation to climate change.

Reference number: 13.2 :
Client: European Commission, DG Environment.Impact assessment study to support the development of legally binding EU nature restoration targets
Undertaken as part of Contract 07.0202/2019/SER/806106/ENV.D.2. *Supporting the Evaluation of the EU Biodiversity Strategy to 2020 and Followup* .Rotterdam, 06 June 2023.

Figure 2-1 Share of terrestrial surface area by broad ecosystem type in the EU and UK

Note: 1) Marine ecosystem are not included and represent the most extensive ecosystem type in the EU (5.8 million km²); 2) The percentages only add to 98.5% and the remaining 1.5% include some important smaller ecosystems relevant to this Impact Assessment, in particular coastal wetlands
Source: EU Ecosystem Assessment Summary for policy makers[25]. Original source: Corine Land Cover, European Environment Agency, 2018.

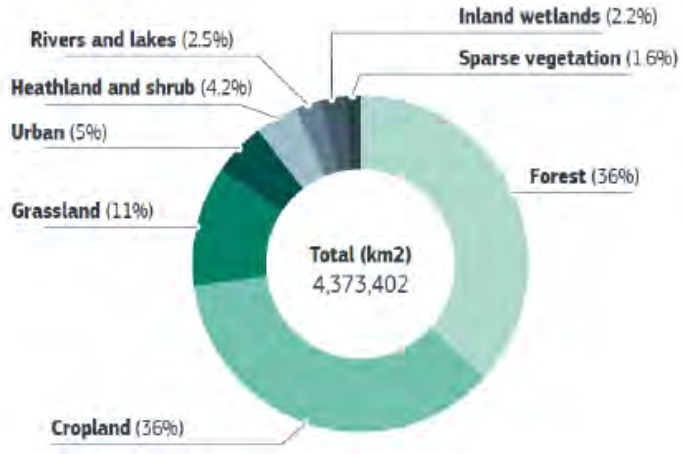
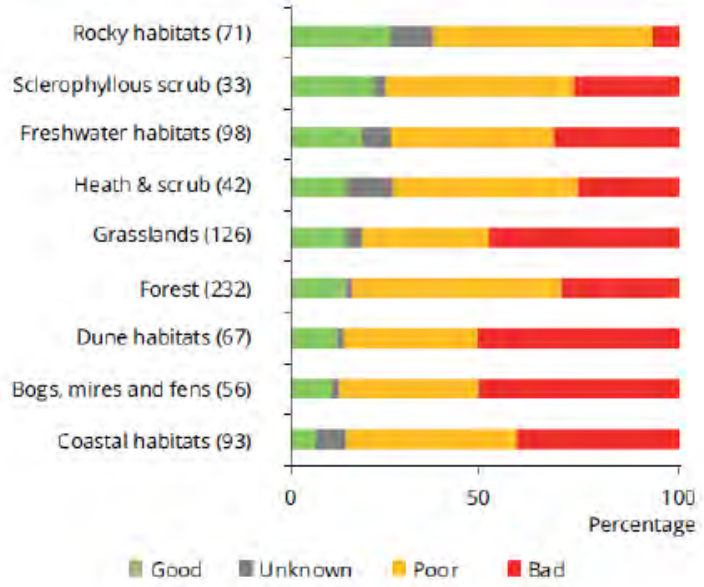


Figure 2-2 Conservation status per habitat group at the EU level

Source: Taken from EEA (2020) State of nature in the EU, Results from reporting under the nature directives 2013-2018. EEA Report No.10//2020.



	• Synergies with related EU initiatives, e.g. LULUCF, Farm to Fork strategy.	
	General *Corresponding to the general objective of the Biodiversity Strategy for 2030.*	Specific Corresponding to the proposal for legally binding restoration targets
Policy and Legal Context	• European Green Deal • EU Biodiversity Strategy • Existing legislation to protect and restore biodiversity and ecosystems such as the Bird and Habitats Directive, Water Framework Directive and the Marine Strategy Framework Directive • Related EU initiatives, e.g. Farm to Fork, revision of the LULUCF Regulation • Strong public interest in nature restoration.	
Problem	General problem: Biodiversity loss and ecosystem degradation	Specific problem: Largely insufficient ecosystem restoration in the EU. Need for more ambitious nature restoration to reverse biodiversity loss, as nature protection alone is insufficient.
Drivers	Main direct drivers of biodiversity loss and ecosystem degradation: • Changes in land and sea use; • Over-exploitation of natural resources; • Climate change; • Pollution; • Invasive alien species.	Specific policy and legislative drivers of insufficient ecosystem restoration in the EU: • Voluntary approaches have been ineffective • Gaps in existing legislation • Lack of comprehensive approach • Funding challenges • Political commitment and ownership by Member States
Objectives	General objective Reverse biodiversity loss so that: • Europe's biodiversity is on the path to recovery by 2030; • All of the EU's ecosystems are restored and resilient by 2050; • Implement the Biodiversity Strategy for 2030).	Specific objectives: To restore degraded ecosystems across the EU, in particular those that have the most potential to remove and store carbon and prevent and reduce the impact of natural disasters. Operational objectives: • Introduce time-bound, measurable, legally binding targets to enable restoration of ecosystems across the board and in a way that addresses the main ecosystem types. • Establish a governance and implementation structure to enable this restoration and ensure that restored ecosystems do not deteriorate. • Set out requirements for effective monitoring, planning, financing and capacity.
Policy Options	Option 1: Baseline scenario Option 2: Overarching legally binding target for ecosystem restoration Option 3: Legally binding targets for specific ecosystems, habitats or (groups of) species Option 4: Hybrid of legally-binding ecosystem-specific targets with an overarching objective	

Figure 4-1 Projected restoration effort (extent) based on Eftec et al and remaining gap to 15-40-100% HD Annex I targets

Note: This figure assumes that Eftec et all only identified 25% of actual restoration action in the then EU28, and the total effort towards the targets reflects the best-estimate total area of degraded Annex I habitats in the EU27 based on the last conservation status reporting under the EU Habitats Directive (Art 17 reporting)[50].

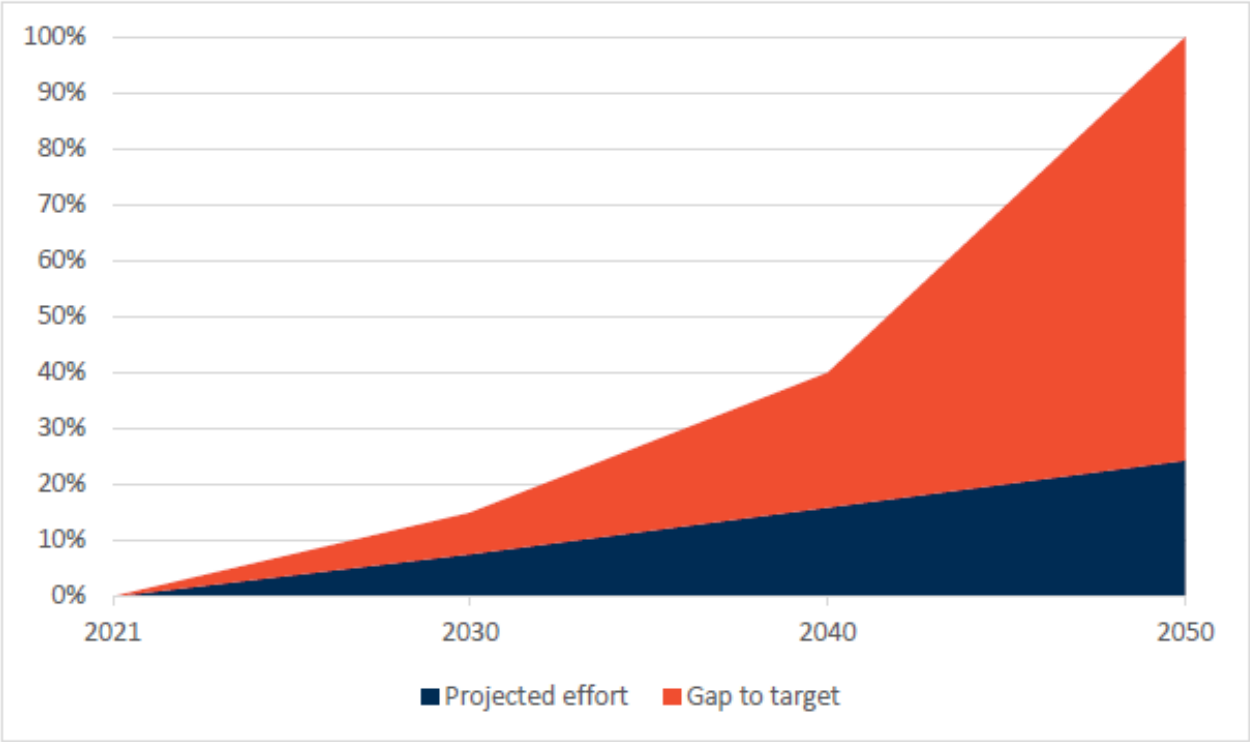


Table 5-1 Potential Ecosystem-specific Targets for Restoration in Step 1 of Stepwise Approach

SELECTED TARGETS FOR STEP 1
WETLANDS (incl. Peatlands, marshlands & coastal wetlands)
- Restore all HD Annex I wetland habitat area to good condition, with all necessary restoration measures completed on 30 % (or 15 %) of degraded areas by 2030, 60 % (or 40 %) by 2040 and 100 % by 2050.
- *For peatlands only*: Re-wetting at least 25 % of HD Annex I peatland habitat area degraded due to drainage by 2030, 50 % by 2040 and 100 % by 2050 so that the water table is at, or with 15cm of the surface. - Recreate 30 % (or 15 %) of additional habitat area required to achieve favourable conservation status of HD Annex I wetland habitats by 2030, 60 % (or 40 %) by 2040 and 100 % by 2050. - Restore and re-create the area as necessary to enhance the conservation status of species listed in Annex II, IV and V of the Habitats Directive as well as wild birds associated with wetlands in view of achieving their favourable conservation status by 2050, with at least 30 % achieved by 2030 and at least 60 % by 2040.

Table 6-1: Overview table of likely dimensions impacting on the prioritisation of certain ecosystem types over others in implementing an overarching target

Key: Blue=Criterion is likely to encourage restoration of this ecosystem within an overall target; Orange=Criterion may have a moderate or mixed effect in encouraging restoration of the ecosystem; Red=Criterion may discourage restoration of this ecosystem within an overall target.

Please note: The scope of this impact assessment also includes pollinators and soils which, due their cross-cutting nature, were not included as a separate ecosystem in this table. Their restoration needs would however need be integrated in the implementation of the overarching target under different ecosystem types.

Ecosystem	Ecosystem extent	Technical feasibility	Need for coordinated international action	Cost per hectare	Benefit:Cost ratio	Opportunity cost/ stakeholder resistance	Contribution to climate mitigation and adaptation	Contribution to disaster prevention and protection	Overall assessment
Peatlands and wetlands	Low	Re-wetting of most drained semi-natural peatland is straightforward, full restoration of highly degraded peatland is difficult	Moderate	Moderate per hectare costs	Good B:C ratios	Low for Annex 1 habitats	Exceptionally high potential for carbon storage and sequestration, improved water retention can also contribute to adaptation	High in flood prone catchments where reversing drainage reduces run-off rates and downstream flooding	Likely to be a priority for restoration for those MS with degraded peatlands, given strong climate mitigation benefits.

Table 6-2 Overview table of all ecosystem-specific target options screened in and assessed for this Impact Assessment study

Ecosystem	Target	Intended impacts			
		Biodiversity	CC mitigation	CC adaptation	Ecosystem services (other)
Inland wetlands and peatlands	The full recovery of Habitats Directive Annex I peatlands to good ecosystem status (i.e. favourable conservation status), including through the following: • Re-wetting at least 25% of HD Annex I peatland habitat area degraded due to drainage by 2030, 50% by 2040 and 100% by 2050 so that the water table is at, or with 15cm of the surface. • Restore all HD Annex I peatland habitat area to good condition, with all necessary restoration measures completed on 15% / 30% of degraded areas by 2030, 40% / 60% by 2040 and 100% by 2050 • Re-create the area necessary to achieve Favourable Conservation Status of HD Annex I peatlands at national biogeographical level by 2050, with 15% / 30% achieved by 2030 and 40% / 60% by 2040, and 100% achieved by 2050.	*****	*****	****	****
	Marshes- to maintain, restore and re-create marshlands as necessary to achieve the favourable conservation status of species associated with marshlands listed in Annex II, IV and V of the Habitats Directive, and the secure status of wild birds associated with marshlands, by 2050, with at least xx% achieved by 2030 and at least xx% by 2040.	****	*****	*****	****
	Peatland converted to cropland- Reduce the area of managed or drained organic soils that are losing carbon by 15% by 2030, 40% by 2040 and 100% by 2050.	***	*****	****	****

Table 6-7 Estimated benefits for each ecosystem under the two scenarios

Overview of benefits for the preferred option - until 2070 (Present Value)				
	Scenario A (15-40-100% targets for 2030-2040-2050)		Scenario B (30-60-100% targets for 2030-2040-2050)	
Restoration of ecosystem type	Carbon benefits in EUR million	Benefits from all ecosystem services (including carbon) in EUR million	Carbon benefits in EUR million	Benefits from all ecosystem services (including carbon) in EUR million
Peatlands	10 629	38 702	13 042	47 488

Reference number 13.3:
WD(2022) 167 final PART 1/12 COMMISSION STAFF WORKING DOCUMENT IMPACT ASSESSMENT Accompanying the proposal for a Regulation of the European Parliament and of the Council on nature restoration Brussels, 22.6.2022

Table I: Restoration needs of habitats listed in Annex I of the Habitats Directive based on reporting by Member States (2013-2018). Romania is excluded because its reported Annex I areas exceed the terrestrial area of the country. Source: EEA.

Ecosystem based on Annex I types *(N° of Annex I habitat types)*	Surface[1] Annex I habitats in km²	Condition in km² & %			Overall restoration needs in km²	
		Good	Not good	Unknown	Area re-establishment (min/max)	Improvement in condition (min/max)
Wetlands[2] (inland & coastal) *(28)*	174 400	62 950 36%	27 100 16%	84 300 48%	3 131 6 910	27 100 111 400
Forests[3] *(69)*	357 952	162 300 45%	79 210 22%	116 444 33%	3 487 8332	79 210 195 000
Agro-habitats and grasslands[4] *(35)*	177 442	84 150 47%	31 180 18%	62 100 35%	2 431 8 798	31 180 93 000
River, lakes, alluvial and riparian habitats[5] *(32)*	96 480	52 970 55%	21 560 22%	21 950 23%	894 2 743	21 560 38 000
Heath & scrub[6] *(21)*	78 582	43 420 55%	6 590 8%	28 600 36%	405 928	6 586 35 000
Rocky and (Coastal) & dunes *(41)*	65 135	30 048 46%	6 619 10%	28 500 44%	355 1 458	6 619 35 100
Total Terrestrial	**949 990**	**435 838** **46%**	**172 259** **18%**	**341 894** **36%**	**10 703** **29 169[8]**	**172 255** **505 500[9]**
				Total restoration terrestrial:	**182 985 – 536 669 km² [10]**	
Marine[7] *(4)*	**240 030**	36 810 15%	34 830 15%	168 390 70%	1 622 3 424	34 828 203 200
				Total restoration marine:	**36 450 – 206 624 km² [11]**	

Table II: Overall restoration needs, by Member State, of habitats listed in Annex I of the Habitats Directive, based on reporting by Member States (period 2013-2018) under Art.17 of the HD – EU27 (excluding Romania for data quality reasons). Source: EEA.

Member State	Member State surface in km²	Overall restoration needs (all ecosystems) in km² TERRESTRIAL				Overall restoration needs in km² MARINE
		Area re-establishment (min/max)	Area improvement (min/max)	Total restoration area (min/max)	% of MS territory (min/max)	(min/max)
Ireland	70 699	313 / 640	5 180 / 5 657	5 493 / 6 297	7.8 / 8.9	3 014 / 24 542

Table III: MINIMUM restoration needs, by Member State and by Annex I habitat, based on reporting by Member States (period 2013-2018) under Art.17 of the HD – EU27. Source: EEA.

		MINIMUM ecosystem areas (km²) for restoration (improvement + re-establishment)						
	MS area (km²)	Wetlands	Rivers & lakes	Grasslands & agri	Forests	Heath & scrub	Rocky & dunes	Terrestrial
IE	70.699	3.753	928	692	19	54	47	5.493

Table IV: MINIMUM restoration needs, by improvement/re-establishment, by Member State and by Annex I habitats, based on reporting by Member States (period 2013-2018) under Art.17 of the HD – EU27. Source: EEA.

Condition: area reported in 'not-good' condition: in need of improvement. Zeros often reflect that most areas have been reported as 'unknown condition'

Additional: for re-establishment: based on minimum Favorable Reference Areas.

	MINIMUM ecosystem areas (km²) for restoration (improvement and re-establishment)												
	Wetlands		Rivers & lakes		Grasslands		Forests		Heath & scrub		Rocky & dunes		
	condition	Additional	condition	Additional	condition	additional	condition	additional	condition	additional	condition	additional	Terre-strial
IE	3.527	226	928	0	611	82	19	0	54	0	42	4	5.493

Our Case Number: ABP-319307-24

Your Reference: Laurclavagh Limited

An Bord Pleanála

MKO
Planning & Environmental Consultants
Tuam Road
Galway
Co. Galway
H91 VW84

Date: 05 March 2025

Re: Proposed no 8 wind turbines and associated works.
Laurclavagh and adjacent townlands, Co. Galway. (www.laurclavaghplanning.com)

Dear Sir / Madam,

I have been asked by An Bord Pleanála to refer further to the above mentioned proposed development which is before the Board for consideration.

Please be advised that the Board; in accordance with section 37F(1)(a) of the Planning and Development Act 2000, as amended, hereby requires you to furnish the following further information in relation to the proposed development:

Item 1. Roads and Traffic (EIAR)

1.1 The N83-L61461 junction layout as outlined in submitted plans, the traffic management plan and in your response to submissions do not appear to be consistent with the existing onsite arrangement. The existing junction layout appears to display restricted sightlines in both northerly and southernly directions onto the N83. Given the application details submitted to date and the existing junction layout, consultation should take place with the planning authority in order to clarify the status of the existing junction layout.

1.2 You are requested to submit a revised site layout plan at an appropriate scale indicating clear sightline triangles at the required standard including at the N83 & L61461 junction. This shall

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clearly dimension the extent of proposed boundary walls to be set back adjoining the L61461 and adjoining the N83. Sightlines at all entrances and junctions should meet required standards.

1.3 If required, submit any letter(s) of consent from any adjoining landowner consenting to set back their property in order to achieve sight distances where current sight distance y-splay traverses through adjoining third-party boundary.

1.4 Site layout plans should be revised to clearly detail the width of L-61461 and its proposed widened areas, at an increased scale, taking into account the width of 2 number passing HGVs.

1.5 The site layout plans should be revised to detail existing junction layouts at the N83-local roads.

1.6 The proposed wind farm development would appear to adjoin/encroach onto third party lands adjoining the L61461, with existing dwellings not delineated on the site layout plans at this location. You are requested to provide clarification on same, and submit relevant consents if/where applicable, with plans revised to detail existing dwellings.

1.7 The details outlined on material assets in your response to submissions including the management of HGV trips on the L-61461, swept path analysis, new temporary access roads access and egress restrictions, and items raised in items 1.1, 1.2, 1.4 & 1.5 above should be included in an updated Road Safety Audit for the construction stage. This should be outlined by way of an addendum to the EIAR.

1.8 A Traffic and Transport Impact Assessment for the N83-L61461 junction encompassing the N83, L61461 and L6146 should be submitted as a standalone document.

1.9 Details of the junction capacity test referenced as included as Appendix 15-3 of the EIAR should be submitted.

1.10 TII outline the proposals to lay the grid cable in the N83 national road reservation has a potential to impact on road authorities and TII in undertaking future maintenance and improvement requirements, and there also may be additional cost implications to improvements and maintenance resulting from the presence of high voltage cabling. Please outline if joint bays can be accommodated within the N83 carriageway, and their locations should be clearly outlined.

Item 2. Ornithology (EIAR & NIS)

2.1 In relation to **the methodology for potential bird mortality and the acceptability of same, the Department of Housing, Local Government and Heritage** consider that both the Ornithology chapter of the EIAR and the NIS do not accurately use the methodology outlined to determine the significance of the potential bird mortality caused by collisions with the proposed turbines. It is

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outlined that the EIAR and NIS make reference to the methodology outlined by Percival (2003) for determining the magnitude and significance of an effect on a given population (e.g. High = < 20% population remains, Negligible = < 1% population lost), and according to Percival (2003), the magnitude of impact on a species population as a result of collisions, would be negligible if the estimated mortality does not increase the natural mortality rate of the population by 1%. It is outlined however, Percival (2003) states that *'one issue in this process concerns the precise area or bird population against which the degree of impact should be judged, and for protected SPAs this is usually quite straightforward, comprising simply the populations for which that site has been designated'*. The Department outline the EIAR and NIS only make reference to national and county populations even when connectivity with Lough Corrib SPA has been identified in the reports. It is outlined for example, the reports establish potential connectivity between the proposed development and the Lough Corrib SPA in relation to potential collision mortality impacts on breeding Black-headed Gulls, which are a qualifying interest of the SPA, however, these impacts are then contextualised in terms of county population and not the SPA population as would be the case if the Percival (2003) methodology was used correctly. So instead of an increase of 0.26% mortality in relation to quoted county population there would be a 0.8% increase in mortality in relation to the SPA population. This change, while still resulting in an increase of mortality below 1%, may be important in relation to the assessment of in-combination effects with other wind farms with potential connectivity to the Lough Corrib SPA.

While the details set out in your response to the submissions are noted, having regard to the observations of the **Department Of Housing, Local Government and Heritage**, to enable a determination of the significance of the potential bird mortality caused by collisions with the proposed turbines on all relevant bird species, from both an individual project and cumulative perspective, collision risk impacts should be clearly contextualised in terms of the county and the SPA population, utilising the Percival (2003) methodology, as per the Departments observation.

2.2 In relation to **methodology and cumulative impacts, the Department of Housing, Local Government and Heritage** outlines the EIAR and NIS both use arbitrary reference areas for assessing the potential in-combination/cumulative effects of collision mortality impacts. It is outlined for example, when considering the potential for the in-combination effects of collision mortality on SCI's of the SPA, such as the Black-headed Gull, arbitrary buffers of 5km and 25km around the proposed development are referenced, and it is recommended that any wind farm with potential connectivity to the Lough Corrib SPA that has similar such impacts should be considered, should they occur, and these may occur at distances much greater than 5km/25km from the proposed development given the size of Lough Corrib SPA. It is outlined if such developments do

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not occur or occur but do not result in the mortality of the same qualifying interest species, this should be made clear. The Department also recommends that when considering in-combination effects of other wind farms with connectivity to the same SPA the EIAR and NIS should make reference to any relevant figures in the relevant reports for any such developments and not just their conclusions. It is stated for example if it is established that another wind farm has connectivity with the SPA and it was predicted that this wind farm would have collision mortality impacts on, for example Black-headed Gulls, the predicted number of this collision mortality should be referenced and not just the conclusion. The combined figure should then be interpreted in relation to the population of the relevant SPA.

While the details set out in your response to the submissions are noted, having regard to the observations of the **Department Of Housing, Local Government and Heritage**, to enable for a comprehensive cumulative and in combination assessment of collision risk impacts, details should be outlined for collision risk impacts for all relevant bird species in the county and SPA population, taking into account appropriate buffer distances and other wind farms, with reference also to be made to relevant figures from other wind farm reports, as per the Departments observation.

EIAR

2.3 Please outline the cumulative impact on red list species including Hen Harrier, Kestrels and other species using the site of the anthropocentric change of use of the lands over the decades, and this should be quantified.

2.4 Please clarify if the existing kestrels and their nesting within an observers lands (E, A, D, and M. Jennings), have been included in the surveys and assessments carried out. These should be revised, if/where applicable.

2.5. Please clarify the location of information in Appendices 6-5 and 7-5.

NIS

2.6 The NIS outlines that for collision risk estimates for Common Gull (Wintering), that due to the increased population sizes of the species during winter, the collision risk analysis will be **inflated** relative to potential impacts on the **breeding population** which is a designated SCI of the SPA. A collision risk analysis has not been identified for the Common Gull breeding population in tables, this statement should be clarified with details to be outlined in tables, where relevant.

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2.7 The revised NIS should clarify the potential for the proposed development to give rise to displacement or barrier effects on Common Gull (Breeding). Mitigation should be set out, if/where applicable.

2.8 The revised NIS should include an assessment of SCI "Wetlands and Waterbirds" A999 including in section 5.1.2.3.14.

2.9 Table 8-1 Wind farm projects within 25km of the Proposed Project should be revised to detail turbine dimensions.

2.10 The NIS should be revised to assess the potential impact of turbine obstacle lighting on the relevant European Sites Special Conservation Interests (SCI's).

Mitigation

2.11 A number of mitigation measures for key ornithological receptors set out in the EIAR relating to construction timing, the requirement for further surveys for breeding birds, and the fencing off of habitat areas utilised by certain bird species, do not correspond to the mitigation for the same species identified as Special Conservation Interests (SCI's) in the NIS. The revised NIS should include these mitigation measures.

2.12 You are requested to clarify if the correct methodology and matrices needed to inform mitigation, have been carried out in the cumulative impact assessment for the EIAR and NIS. Consideration should be given to this issue, with regard given to C-392/96.

Item 3. Bats (EIAR & NIS)

3.1 In relation to the biodiversity sections of the EIAR including the survey work undertaken to inform the collision risk assessment for bats, the Bat Report (Appendix 6-2) outlines the calculated activity thresholds were adapted. Please clarify if the bat collision risk analysis was undertaken based on Table 3-6 or 3-7 of the Bat Report. Collision risk analysis should be based on worst case scenarios and the collision risk calculations should be revised, if/where applicable.

3.2 Consideration should be given to the potential for bat collision risk from insects being attracted to turbines.

3.3 Clarity should be outlined on if the Lesser Horseshoe Bat roosts c.2.3km from Turbine 5 at Caltragh, Belcare. The EIAR outlines the project is outside of the 2.5km foraging range for the species. Clarification should be provided in relation to the presence of any roost site for the species within the foraging range, including within caves, and environmental assessments should be updated, if/where applicable.

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3.4 An assessment of the potential for the proposal to give rise to effects on **the Lesser horseshoe bat, a QI for the Lough Corrib SAC (000297)** has not been identified in the NIS and this should be addressed.

Item 4. Protected Species, Protected Habitats and Plant Species, Local Species (EIAR)

4.1 Clarification should be provided as to whether the site and area includes for any species protected under the flora protection order, and in the event of these species existing, protection measures should be outlined.

4.2 The habitat mapping Figure 6-5 (at a scale of 1:23,000) is not clearly legible. Mapping should be outlined at a scale of 1/1250 to enable an assessment of the proposed developments impact on habitats.

4.3 Please clarify if there will be any turbine over sailing protected habitats areas. In the event of this occurring an assessment of this impact on protected habitats should be carried out. Mitigation measures should be outlined, if/where applicable.

4.4 Please clarify if wake effects will arise from the proposed development on habitats, badgers, species and insects. Consideration should be given to these issues.

4.5 The site and its vicinity may include for a range of species, including pine martin, shrews, dormouse, hedgehogs, cuckoo, bull finches, butterfly and larvae, bees, wasps, snails, worms. While the EIAR details the potential for impacts on fauna, e.g. Irish hare, Fox, Irish Stoat, consideration of the effect of the project on the above listed species should be outlined. This should also consider the proposed and revised Biodiversity Management and Enhancement Plan, in Item 5.

4.6 You are requested to outline the cumulative impact of the proposed development with the anthropogenic effects of noise on biodiversity.

Item 5. Biodiversity Management and Enhancement Plan (BEMP) – (EIAR)

5.1 The referenced Figure 1-1 of the Biodiversity Management and Enhancement Plan (BEMP) which includes habitats clearance areas has not been identified and this should be outlined. The clearance areas should be clearly outlined in the context of existing hedgerow, treelines and woodland, and proposed hedgerow and woodland replanting, on mapping scale of 1:2500.

5.2 You are requested to detail the removal of vegetation proposed, including woodland and hedgerow species, which may include hazel groves, oak, ash, hawthorn. Please clarify the specific species to be removed, and the specific replanting to occur in relation to any species removal. This should be clearly outlined on site layout plans and in BEMP mapping.

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5.3 The EIAR makes reference to the BMEP entailing native woodland planting and these areas should be outlined in the BEMP.

5.4 You are requested to clarify if there are ancient woodlands within the site and these and treatments of same should be outlined in the BEMP. This should be outlined on plans and in the BEMP mapping.

5.5 Clarity should be outlined on the removal of vegetation and its carbon storage provision. Calculations should be outlined in relation to the carbon storage lost from the proposed removal of vegetation, and from carbon storage anticipated to be attained at the post consent stage following proposed replanting. *Mitigation measures should be outlined for the above Biodiversity items, if/where applicable.*

Item 6. Grid Connection (EIAR & NIS)

6.1 The design methodology for the grid connection crossings in the EIAR is not consistent with that set out in the NIS. The EIAR outlines the River Clare crossing at the site of the Lough Corrib SAC will be via Horizontal Directional Drilling (HDD), with the NIS outlining the River Clare crossing is via an existing bridge crossing. Clarification is sought on the river crossings proposed, and this should be addressed in environmental assessments, where appropriate, and in relevant drawings, sections.

6.2 Site layout plans should be revised to detail the location of all HDD locations, and these should be outlined relative to local drainage and water courses.

6.3 Potential noise and vibration effects of the HDD on all relevant species should be outlined for any HDD crossing.

6.4 A schematic of Water Crossing WC1 Type A using standard trefoil formation for the Claretuam Bridge on the N83 should be outlined, if /where applicable.

6.5 Cross profiles of all water crossing locations indicating watercourses, riverbanks should be outlined.

6.6 Clarify if any instream works are proposed.

6.7 Please be advised that TII have made an observation on the design methodology on water crossings for the proposed grid connection. TII recommends for water crossing WC1 (Claretuam Bridge) the existing freeboard should be preserved to allow for increasing the size of drainage culverts to provide additional capacity and accommodate additional water flows as required, and consider a HDD crossing (Option D) of WC1 should be deployed as opposed to Option A. While your response to submissions outlines the proposed watercourse crossing methodologies are deemed appropriate, given the design methodology concerns of TII a detailed response for the proposed water crossing at WC1 should be outlined.

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Item 7. Shadow Flicker (EIAR)

7.1 You are requested to provide clarification on the shadow flicker calculations for dwellings presented in the EIAR given the details outlined for dwelling H075 in Table 5-10 Maximum Potential Daily & Annual Shadow Flicker. Calculations should include all dwellings within the study area including H213.

7.2 Please confirm if the shadow flicker software utilised in the EIAR has been validated.

Item 8. Water (EIAR & NIS)

8.1 You are requested to outline the design capacity of the attenuation and infiltration devices for the management of construction waters and storm water management. Calculations addressing storm water runoff should be clearly outlined.

8.2 The NIS outlines the same mitigation to prevent significant impacts on water quality during construction is likely to be applicable to the decommissioning phase. The NIS should be revised to outline the mitigation measures that shall apply at decommissioning stage.

Item 9. Noise and Vibration (EIAR)

9.1 You are requested to clarify if the wind farm noise calculations are based on collective / standalone turbines.

9.2 Consideration should be given to seismic effects, seismic effects and infrasound from the karstic limestone spindles vibration, impacts of vibration on property.

Item 10. Wake effects (EIAR)

10.1 Please clarify if turbine wake effects would arise at dwellings, lands downwind of site due to prevailing winds, and also give consideration to wake effects on yields, livestock, and local temperature effects arising.

Item 11. Cultural Heritage (EIAR)

11.1 The Department of Housing, Local Government and Heritage outline underwater cultural heritage represented within the proposed development area may encompass riverine heritage structures and features that lie within rivers/streams and on their banks. In light of potential for the

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development to have adverse effects on underwater cultural heritage, a programme of pre-construction underwater archaeological assessment should be undertaken as follows:

Submit an Underwater Archaeological Impact Assessment (UAIA) to include:

11.2 A desktop assessment that addresses the underwater cultural heritage (including wrecks, archaeological objects, built heritage, riverine and industrial heritage) of the proposed development area.

11.3 The UAIA shall include a licensed dive/wade assessment accompanied by handheld metal detection survey centred on any area where works are proposed to the foreshore, to be undertaken by suitably licenced and experienced underwater archaeologist.

Item 12. Landscape (EIAR)

12.1 You are requested to consider the impact on historical landscape value and the proposals compatibility with the European Landscape Convention 2004, with attention paid to the Landscape Directive.

Item 13. Other Matters (EIAR & NIS)

13.1 In relation to blasting, the Noise and Vibration, and Land, Soil and Geology chapters of the EIAR, and the AA Screening Report and NIS should be updated to confirm no blasting is to occur at construction stage, as outlined in your response to the submissions.

EIAR

13.2 Relevant EIAR chapters including Noise and Vibration, Land, Soil and Geology, Water should be updated, by way of addendum to the EIAR, to clearly detail the proposed developments compliance with Gas Networks Irelands guidelines given the siting of the proposed development relative to the gas pipeline.

13.3 Clarity should be outlined on the weight of the transportation loads traversing the gas pipeline at construction stage. While details submitted outline the internal roads which will cross over the pipeline have been designed in accordance with the GNI Code of Practice and design specifications requested, these GNI design specifications requirements should be clearly outlined on plans, and the proposed vehicle weight loadings to be accommodated at these locations relative to GNI required specifications should be outlined.

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13.4 Treatments /recycling of turbine blades at post decommissioning stage should be outlined.

13.5 Technical chapters of the EIAR should be updated by way of an addendum to detail the volumes of wastes arising, where applicable.

13.6 Clarify if SF6 gas is to be used as in insulant for electrical equipment. Relevant safeguards should be outlined, if/where applicable.

13.7 The grade of aggregate, steel and concrete utilised should be outlined for the proposed development.

13.8 All EIAR chapters should clearly outline the indirect/potential indirect effects arising, which should be addressed by way of an addendum.

13.9 The Interactions chapter, EIAR Non-Technical Summery, CEMP and relevant plans should be updated by way of an addendum to take the request for further information into account, where applicable.

13.10 Please clarify details in relation to the project site size (in hectares) and proposed turbine co-ordinates outlined.

13.11 Consideration should be given to potential impacts on equine facilities/businesses/breeding operations, arising from the construction stage impacts and siting of the wind farm. Please provide a map delineating existing equine facilities/businesses/breeding operations in the vicinity of the proposed wind farm site. You are requested to also provide an assessment as to whether significant impacts will arise from the proposed development on such facilities, which is to include horse and Connemara Pony breeding operations, and this should take into account guidance in British Horse Society 'Wind Turbines and Horses – Guidance for Planners and Developers' 2015

13.12 Please clarify if the proposed development would impinge on access to lands under folio GY45478. Mapping and ownership details for this area of the site/lands under the control of the applicant should be outlined. In the event of any access being impinged, relevant consents should be outlined, if/where applicable.

NIS

13.13 The NIS has referred to Appendix 6-1 of the EIAR which relates to a botanical survey. This appendix should be included within the NIS appendices. EIAR documentation referenced within the NIS should be included in the NIS documentation.

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Item 14. Response Format & Timeframe

14.1 The above points of further information should be addressed by way of an addendum to the EIAR, and a revised NIS including the AA Screening Report as relevant and should clearly indicate where changes to the original documents are made. The Traffic and Transport Impact Assessment should comprise a standalone document.

The further information referred to above should be received by the Board within 6 months from the date of this notice **(i.e. no later than 5.30pm on the 6th of September 2025)**

In this regard, please submit 2 hard copies and one electronic copy of the above information.

Please note that following its examination of any information lodged in response to this request for additional information, the Board will then decide whether or not to invoke its powers under section 37(F)(2) of the Planning and Development Act 2000, as amended, requiring you to publish notice of the furnishing of any additional information and to allow for inspection or purchase of same and the making of further written submissions in relation to same to the Board.

If you have any queries in relation to the matter, please contact the undersigned officer of the Board. Please quote the above mentioned An Bord Pleanála reference number in any correspondence or telephone contact with the Board.

Yours faithfully,

Raymond Muwaniri
Executive Officer
Direct Line: 01-8737125
PA11

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Our Case Number: ABP-320089-24

Your Reference: Hessian

An Bord Pleanála

MKO
Planning & Environmental Consultants
Tuam Road
Galway
Co. Galway
H91 VW84

Date: 15 May 2025

Re: Wind Farm Comprising of 11 Wind Turbines and Associated Infrastructure.
Located at townlands of Killavoher, Gortagarraun, Cloonarkan, Lomaunaghroe, Clonberg, Ballagh West, Carrowntryla & Lissybroder, Co Galway
(https://www.clonbernewfplanning.com/)

Dear Sir / Madam,

I have been asked by An Bord Pleanála to refer further to the above mentioned proposed development which is before the Board for consideration.

Please be advised that the Board, in accordance with section 37F(1)(a) of the Planning and Development Act 2000, as amended, hereby requires you to furnish the following further information in relation to the proposed development:

Procedural/Administrative Issues

1. The pre-application consultation undertaken under file ref. ABP 307058-20 provided for consideration of 11 no. 4.8MW turbines with a tip height of 170 metres. The tip height of the 11 no. turbines subject of this application is stated to be 180 metres.

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In this regard you are requested to submit a statement setting out your opinion as to the validity of the application in the context of the development as presented in the pre-application application.

2. Point (iii) of the public notices which sets out the nature and extent of the development for which permission is being sought refers to the provision for the undergrounding of a section of 38kV overhead electrical cabling (as proposed under Galway County Council planning ref. 24/60230) including the provision of 2 no. 38kV Line to Cable Interface End Masts up to a height of 16.2 metres and associated cable ducting to facilitate the undergrounding of the proposed 38kV cabling.

   The said planning application as detailed in the public notices has been withdrawn.

   Revised public notices with the necessary revisions made to provide for the accurate nature and extent of the development for which permission is being sought are required.

   The necessary revisions to the plans and details accompanying the application are also required.

3. Sections 8.3.1 and 9.3.1 of the EIAR notes that 40% of the site is bog where peat cutting in the form of private turbary plots is widespread, with some peat harvesting to the west and southeast of the site. Reference to peat harvesting throughout the Peat Stability Assessment Report is noted.

   Turbines and ancillary development are proposed to be located within the area(s) subject of this peat harvesting.

   (a) You are required to clarify the nature and extent of the peat harvesting area(s) within the site. The extent of the area(s) should be calculated and delineated on an appropriately scaled map(s).

   (b) Confirm whether the proposed development is to utilise the drainage network installed for the purposes of this peat harvesting.

   (c) Confirm whether peat harvesting is to continue during the lifetime of the wind farm and clarify that the proposed drainage plan can be effectively implemented whether or not peat harvesting is taking place.

   (d) Confirm that should peat harvesting continue during the lifetime of the wind farm that it has been appropriately included and assessed in the EIAR and AA.

4. Confirm that all existing and permitted dwellings and other sensitive receptors within 1.62 km of the proposed turbines for the shadow flicker assessment and 2km of proposed turbines for the noise assessment are accounted for and delineated on the relevant plans and drawings that accompany the application.

   Should additional properties be identified for inclusion, details of their location and numbering to be provided.

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5. Table 0-1 of the Non-Technical Summary which provides details of the proposed wind turbine locations, their grid reference coordinates and proposed top of foundation levels is incorrect and does not refer to the development subject of the application. The table should be rectified and the document amended accordingly.

6. Submit a detailed response to the submissions received from observers, prescribed bodies and the local authority to the application.

Biodiversity

1. Section 7.2.4.2.6 (waterbird distribution and abundance surveys) of Chapter 7 (Ornithology) of the EIAR states that "significant wetland sites" were surveyed for waterbird populations. Please provide a scaled map showing the locations of the "significant wetland sites" (labelled). Please provide a table showing the distance of each of the "significant wetland sites" to the EIAR site boundary and to the turbine locations.

2. Please provide a scaled map showing the locations of turloughs/loughs (labelled) in the surrounding area of the proposed development (to at least 8km radius of EIAR boundary). Please provide a table showing the distance of each of the turloughs/loughs to the EIAR site boundary and to the turbine locations.

3. Kilmurray turlough is identified as a "significant wetland site" in Chapter 7 (Ornithology) of the EIAR. An assessment of the likely effects on Kilmurray turlough in terms of hydrology/hydrogeology does not appear to have been included in Chapter 9 (Hydrology and Hydrogeology) of the EIAR. Please provide an assessment of the likely effects from the proposed development on Kilmurray turlough and potential indirect effects on the bird species that it supports. You are requested to also clarify that all other turloughs/loughs/significant wetland sites in the surrounding area have been considered in the assessment (including indirect effects on birds).

4. Please provide details of the ornithology surveys which were undertaken at the proposed borrow pit location, including survey types, dates of surveys and results.

5. Section 7.10.1 of Chapter 7 notes that assessment material for the ornithology cumulative assessment was compiled and verified on 23/11/2023. The cumulative effects assessment (ornithology) should be updated to include any more recent developments, including but not limited to those where the status has since changed from pre-application stage to submitted for consent and/or permitted. Aside from wind energy developments, the

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cumulative effects assessment (ornithology) should also include other plans or projects in the area which could result in significant habitat loss, increased mortality or displacement/disturbance, including but not limited to overhead line developments.

6. You are requested to clarify if wake effects will arise from the proposed development on birds. Consideration to these issues should be given.

7. Please update the following figures/tables related to Chapter 7 (Ornithology) of the EIAR:

- Figure 7.3 (Breeding walkover transects) – transect locations need to be specifically labelled (e.g. 1,2,3, T1, T2 etc) to match information in Appendix 7-2.
- Figure 7.4 (Breeding Raptor Survey Areas) – label 2018/2019 areas to match information in Appendix 7-2.
- Figure 7.5 (Winter walkover transects) - transect locations need to be specifically labelled to match information in Appendix 7-2.
- Figure 7.6 (HH Roost Survey Areas) – add HHVP3 and HHVP4 to match information in Appendix 7-2.
- Figure 7.8 (Connectivity VP Survey Location) – add Kilmurray turlough location.
- Table 8 Appendix 7.2 (Breeding Red Grouse survey effort) – add transect locations to the table for the two 2023 surveys.
- Please provide figures to accompany the waterbird distribution surveys and incidental observations that are presented in Appendix 7.4.

8. Table 6-3 of the EIAR indicates that a pathway for likely significant effects on the Kiltullagh Lough pNHA has been identified and is therefore determined to be within the proposed development's Likely Zone of Impact. However, this site has been omitted from further assessment in the remainder of Chapter 6. If a pathway is confirmed, the Chapter should be updated to identify Kiltullagh Lough pNHA as a Key Ecological Receptor (KER).

9. As per Table 6-20 (Key Ecological Receptors identified during the assessment) of the EIAR, it is indicated that the site surveys did not identify any other protected faunal species (i.e. 'Additional protected fauna') with the potential to be significantly affected by the proposed development at the population level. For this reason, no additional species have been included as KERs. It is noted that Pine Marten (Martes martes), Irish Hare (Lepus timidus) and the Common frog (Rana temporaria) were recorded on the site. Observations on the application received by the Board detail other species such as the Irish Stoat (Mustela erminea subsp. Hibernica), Common lizard (Zootoca vivipara), and smooth newt (Lissotriton vulgaris) as being documented on the site. You are requested to set out its rationale for the exclusion of the forementioned species as KERs. Should the EIAR be revised to include any of the relevant species as KERs, suitable mitigation measures should be outlined.

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10. Clarify the extent of habitat loss required from the provision of the 3 no. passing bays on the L-22321.

11. Stands of mature trees line either side of the eastern extent of the L-22321. The road is to be used by HGVs accessing the site from the proposed borrow pit. You are requested to provide its rationale for the exclusion of this section of the L-22321 from the surveys which have informed both the Bat Survey Report (Appendix 6-2) and Chapter 6 of the EIAR. You are invited to undertake surveys at this location if lacunae is identified and to submit the results. If necessary, the Bat Survey Report and EIAR should be amended accordingly.

12. It is noted that there are 2 no. watercourses (Levally Stream) crossings on the L-22321. Outline suitable mitigation measures to prevent sediment laden surface water run-off from entering the existing watercourses along this access route. Section drawings of the watercourses with the proposed mitigation detailed thereon to be submitted.

13. It is outlined within the Peat and Spoil Management Plan (Appendix 4-3 of the EIAR) that controlled quantities of peat and spoil shall be side-cast adjacent to access roads, i.e. 17,990m3 as per Table 8-2 (Summary of preliminary peat reinstatement volumes). Given the location of the existing and proposed internal roads relative to on-site watercourses, you are requested to identify the locations where it is proposed to side cast peat and soil and provide suitable mitigation measures, where necessary, to avoid the siltation of nearby drainage ditches or watercourses.

14. It is noted that it is proposed to upgrade a section of the internal access road between watercourse crossing no. C4 and C5. Given the location of this access road relative to the Levally Stream, you are requested to submit section drawings to illustrate the relationship between the upgraded access road and the existing watercourse and include the mitigation (silt fences etc.) as proposed to prevent direct surface water runoff. A section drawing should also be submitted of watercourse crossing no. C5.

15. Confirm whether it is necessary to backfill an existing drainage ditch to provide for the proposed spoil storage area. The proximity of the proposed spoil storage area to Levally Stream and the Annex I habitat 'Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels (6430)' is noted. Consideration to be given to additional mitigation measures to prevent silt laden surface water run-off from entering the nearby watercourses at this location. Section drawings showing the relationship between the spoil storage area and the nearby watercourse and drainage ditches to be submitted.

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Roads and Traffic

1. Abnormal Size Load Delivery Route

   - An observation is on file from a landowner at the junction of the N83 and the L6466 (Junction 9a) stating that he has not given his consent to the inclusion of his land or to the lodgement of the application.
   - Junction 9b (bend on L-6466) appears to require the removal of a stand of trees/vegetation on lands along northern side of the L-6466 and the run-over area for the turbine plant deliveries encroaches on lands on the southern side of the L-6466 (i.e. Figure 15-23b of Appendix 15-4). This location is not included within the application but is included in the EIAR for assessment.

   You are requested to demonstrate that it has the consent of the relevant landowner(s) to include the land(s) within the proposed application. Details of alternative access arrangements should be provided should the relevant landowner(s) consent not be secured to allow for the works identified as necessary along the turbine delivery route. Alterations as necessary to the letter of consent to make the application should also be made and submitted.

   Please ensure that all relevant drawings, maps and figures in the documentation accompanying the application accurately reflect the extent of the site to which the application refers and does not include lands where the consent of the relevant landowner(s) has not been secured to make the application. Any revisions/amendments to be detailed and submitted.

2. The proposed development in its current form fails to accord with Development Management Standard 28 of the Galway County Development Plan given the restricted eastern visibility splay from the construction entrance on the R328 (Junction A). Notwithstanding the mitigation measures proposed, you are requested to install an Automatic Traffic Counter (ATC) to determine the 85th percentile (design speed) at this location. Demonstrate the vertical envelope of visibility (i.e. intervisibility in relation to crest/sag road profile) onto the R-328 in accordance with the relevant TII standards.

3. Submit a proposed boundary treatment plan for the access with the R329 (Junction A) following the completion of the abnormal load delivery phase and following completion of the overall construction phase of the development.

4. Submit revised drawings which shows the current extent of hedgerow and/or boundary walling setback for all entrances in order to achieve clear and unobstructed sightlines in both directions. If necessary, letter(s) of consent from any adjoining landowner(s) shall be provided, consenting to set back of their boundary in order to achieve clear and

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unobstructed sight distances. The applicant shall also demonstrate that any adjoining lands to achieve required sight distance triangles are within their control.

5. The design information examined as part of the Road Safety Audit detailed in section 1.4 is noted. This does not include proposed roadside interventions on the turbine delivery route. You are requested to submit an updated Road Safety Audit to include their consideration.

6. Quantify the daily number of HGV traffic movements on local roads L2232 and L-22321 to be generated by the borrow pit.

7. Since the lodgement of the application Galway County Council has granted permission for a quarry with an area of c.6.2ha on the opposite side of local road L2232 to the proposed borrow pit (file reference number 24/60013). The permission provides for reprofiling works on the L2232. It is noted that the development as permitted is subject of a current appeal with the Board under ref. ABP 321022-24. Please address the cumulative impacts on the receiving road network should the borrow pit and quarry be worked in parallel and revise the EIAR and supporting documentation accordingly.

Cultural Heritage

Recorded Monument GA030-073 ---- (Enclosure) is located c. 22m to the east of the hardstand for T2. While this monument is partially upstanding and visible in the landscape, it may have a larger sub-surface extent. You are requested to undertake an archaeological geophysical survey at the location for T2, its associated infrastructure and general environs and provide a report on the findings.

Landscape and Visual Assessment

Provide a photomontage from the following viewpoint: Clonbeme graveyard and protected structures Clonbern Old Graveyard (RPS.41) and Dennis Mausoleum (RPS 40)

Wake Effects

Address the potential for wake effects including consideration of effects on agricultural lands.

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General

Having regard to this further information request, you are requested to provide a summary of all amendments to the EIAR, NIS and other supporting information. All changes are to be clearly identified. You are invited to submit any errata/corrections to the EIAR, NIS and any other supporting information with your response to this further information request. As above, all changes are to be clearly identified.

The further information referred to above should be received by the Board within 6 months from the date of this notice (i.e. no later than **5.30 p.m. on the 17th November 2025**).

In this regard, please submit 2 hard copies and one electronic copy of the above information.

Please note that following its examination of any information lodged in response to this request for additional information, the Board will then decide whether or not to invoke its powers under section 37(F)(2) of the Planning and Development Act 2000, as amended, requiring you to publish notice of the furnishing of any additional information and to allow for inspection or purchase of same and the making of further written submissions in relation to same to the Board.

If you have any queries in relation to the matter please contact the undersigned officer of the Board. Please quote the above mentioned An Bord Pleanála reference number in any correspondence or telephone contact with the Board.

Yours faithfully,

Raymond Muwaniri

Executive Officer

Direct Line: 01-8737125

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THE HIGH COURT

[2023] IEHC 417

[Record No. 2021/3588P]

BETWEEN

DROMADA WINDFARM (ROI) LIMITED

PLAINTIFF

AND

DENIS CREMINS

DEFENDANT

JUDGMENT of Mr Justice Mark Sanfey delivered on the 14th day of July 2023.

Introduction

1. This case concerns an issue in relation to high voltage cables servicing the plaintiff's windfarm which have been laid in the grass verge alongside a public road which abuts the defendant's land. The plaintiff now accepts that the cables are in fact laid on ground which is the property of the defendant. Put at its simplest, the main issue this Court has to decide is whether orders should be made preventing the defendant from interfering with the cables, and allowing them to remain in situ – in which case the plaintiff accepts that the defendant would be entitled to monetary compensation for what is in effect a trespass on his land – or whether the court should order the plaintiff to remove the cables, which the plaintiff submits would result in it incurring a wholly disproportionate loss in circumstances where it alleges that the

cables do not interfere with the defendant's present use of the land in any material way.

2. The cables were laid in or about 2009. The question of trespass by the plaintiff on the defendant's land was first raised by solicitors acting on the defendant's behalf in November 2016. The trespass was denied by the plaintiff, and this led to proceedings entitled "The High Court, Record No. 2017/8323P, between Denis Cremins plaintiff and Dromada Windfarm (ROI) Limited defendant" ('**the 2017 proceedings**') being issued by the defendant. These proceedings were not progressed by the defendant. However, the defendant from June 2019 onwards mounted what could justly be described as a campaign of correspondence, mainly with the plaintiff's parent company, in which he threatened to remove the cables himself, repeatedly pointing out to the plaintiff that if injuries or fatalities occurred as a result, such occurrences would be the responsibility of the plaintiff or its parent.

3. Prolonged correspondence and meetings between representatives of the plaintiff and the defendant did not resolve the matter, and ultimately the present proceedings were issued on 5 May 2021. There was an immediate application for an interim injunction, the court (Allen J) granting an order which effectively restrained the defendant from interacting with the cables. An interlocutory order in the same terms was made on 18 May 2021 by Allen J with the acquiescence of the defendant, who represented himself in court.

4. Mr Cremins delivered a document that he drafted himself on 31 August 2021 by way of response to the plaintiff's statement of claim. It is effectively a defence and counterclaim, in which he seeks orders for the removal of the cables and damage for "interference with my land". The court must now decide what is to be done with the

cables, and what consequences must flow from them either remaining where they are, or being removed.

5. Fortunately, there was no material dispute between the parties as to the facts of the matter, although it will be necessary to set them out in some detail, so that the exercise of the court's discretion can be seen in context. Likewise, the parties are generally agreed as to the legal principles which govern the dispute. There is however major divergence between the parties as to the inferences to be drawn from the facts, and as to the appropriate course of action the court should take.

Background

6. The plaintiff is a company incorporated in the State, and is part of the SSE group of companies. The plaintiff is one hundred percent owned by SSE Renewables Wind Farms (Ireland) Limited which is one hundred percent owned by SSE Renewables Holdings Limited. That company is in turn a subsidiary of SSE plc. The court was told in evidence that SSE entities operate 26 windfarms in Ireland.

7. The defendant is a farmer and, together with his wife Sheila Cremins, is the registered owner of lands comprised in folio 3305F County Limerick ('**the lands**'). The defendant acquired the lands in or around 2006.

8. The plaintiff is the operator of Dromada Windfarm ('**the windfarm**'), which comprises of 19 turbines and ancillary developments located at lands at Clash South, Athea, County Limerick. Planning permission was obtained for the windfarm in 2004, but on the basis that twenty-three wind turbines would be erected, along with the substation, including a control building, the construction and upgrading of site entrances, site tracks and associated works. Permission was subject to 17 conditions.

9. When planning permission was obtained, it was on the basis that three of the 23 permitted turbines would be constructed on lands now owned by the defendant and

the defendant's wife, pursuant to a lease arrangement. In that regard, the plaintiff's predecessor in title had entered into an option agreement ('**the option agreement**') with the previous owners of the lands for the construction of part of the windfarm on their lands, and those lands were included in the planning application on that basis.

10. The defendant acquired the lands in folio 3305F subject to the option agreement for the construction of the turbines and in knowledge of that agreement. When purchasing the lands, the defendant entered into an agreement to be bound by the terms and conditions of the option agreement.

11. It was contended by the plaintiff, and in fact confirmed by the defendant in his evidence before the court, that he has significant experience of dealing with windfarm developments and entering into commercial arrangements regarding the use of lands for windfarm turbines. The defendant has been involved in litigation with another windfarm operator, apparently in relation to the proper construction of an option agreement relating to other lands owned by him. This case was heard in this Court and on appeal in the Court of Appeal. While it appears that Mr Cremins was unsuccessful in those outings, he acknowledged in cross-examination during the hearing that he told Mr Ciaran Maguire, a representative of the plaintiff who spent some time in negotiation with Mr Cremins, that he had obtained compensation of €4m from one windfarm and €6m from another windfarm.

12. The Athea holding of the defendant consists of approximately 150 acres, 50 of which are afforested and the remaining 100 of which have no particular use or function at the moment. It is some significance to note that Mr Cremins resides at some distance from the Athea holdings in Knocknagoshel, Co. Kerry.

13. The option agreement expired in or around May 2007, but negotiations continued between the plaintiff and the defendant with a view to putting a new lease

option in place. However, no agreement was reached, and the windfarm was constructed without the intended three turbines on the defendant's lands being constructed before planning permission expired.

The laying of cables

14. The windfarm has been operational since February 2010 and supplies electricity to the national grid pursuant to contractual arrangements which exist between the plaintiff and EirGrid. This is done *via* 110 KV high voltage cables which connect the windfarm to the national grid.

15. Mr Ciaran Maguire is onshore wind operations manager of SSE Renewables. Mr Maguire swore the grounding affidavit on behalf of the plaintiff for the interim and interlocutory injunction applications, and gave evidence on behalf of the plaintiff before this Court. Mr Maguire indicated in evidence that he has overall responsibility for the 26 windfarms in Ireland owned by SSE entities. In his evidence to the court, Mr Maguire referred to maps and photographs of the area in question. His evidence was that cables connecting nine of the windfarm's turbines to the national grid pass along a section of the public road. He stated that approximately 3km of cable was laid adjacent to the public road, and that 250m of this distance was at or outside Mr Cremins' lands [Transcript, Day 2 pp 12-13].

16. The road is a small rural road with a grass verge on either side. The photographs show that Mr Cremins' land is fenced off with wire and fence posts. From this "fence" the grass verge extends to the edge of the road, and the evidence of Mr Maguire was that the cable was laid between the "fence" and the edge of the road. One might have thought that the "fence" erected on Mr Cremins' lands marked the boundary of those lands, and that therefore cable laid in the grass verge between the fence and the roadway would not have impinged upon those lands. However, as we

shall see, the plaintiff now accepts that the cables are in fact laid in ground which belongs to Mr Cremins. The evidence of Mr Maguire is that the plaintiff had originally intended running the cables through the defendant's lands, but when the defendant refused to agree commercial terms to allow the three turbines to be built on his lands, the plaintiff took the decision to lay the cables in the grass verge alongside the public road.

17. By letter of 9 February 2009, Limerick County Council wrote to Roadbridge Limited, a contractor which had applied for a road opening licence to facilitate the installation of the cables, indicating that the Council had no objection providing there was compliance with an attached list of conditions. The application form indicates the exact location of the proposed opening as "CoolEast/Clash South, Dromada, Athea, County Limerick", and suggests that the length over which the cables were to be installed was in excess of 3,000m, with 2,630m of cabling to be installed in a "grass verge". The average depth of the pipe was expressed to be 1.5m.

18. Mr Maguire stated that the thinking in relation to running the cable alongside a road was that a road was an "ideal avenue to run a cable along…the road was an artery through the countryside where…a cable could be laid properly and without problem". [Transcript, Day 2, p.15, lines 16-23]. He stated that SSE believed that it was entitled to do this at the time. SSE's position as regards planning permission is set out at para. 22 of the statement of claim, which is as follows:

> "22. When the cables were laid in 2009, it was the plaintiff's understanding that planning permission was not required for the laying of electricity cables and that same were exempted development, having regard to class 26 of the First Schedule, Second Part of the Planning and Development Regulations 2001 (as amended). The general understanding in that regard changed

following the decision of the High Court in *O'Grianna v An Bord Pleanála* and in subsequent court decisions, culminating in a decision of *Daly v Kilronan Windfarm Limited*. However, from a planning perspective, the development would have been immune from attack under s.160 of the Planning and Development Act 2000 (as amended) when the Defendant's proceedings issued in 2017, and certainly, by the time the Defendant's letter dated 13 June 2019 was sent".

19. Mr Maguire stated in his evidence to the court that his concern was "to provide sites where people can go to work safely and come home from work to their family safely…". He was unequivocal in his evidence that the cables on the defendant's lands were safe:

> "…[F]irst of all, they are designed safely. Second of all, we maintain them, like we look after them. We carry out maintenance, we carry out surveys, you know, we have a schedule of maintenance to ensure that the balance of plant network, which includes the cable, is being looked after correctly and it will operate as required. And specifically in the case of the cables and the condition they were in, the cables were buried…they were covered". [Day 2, p.17, lines 20-29].

The 2017 proceedings

20. By a letter of 24 November 2016, Messrs O'Connell & Clarke, the firm of solicitors on record for the defendant in the present proceedings, wrote to the plaintiff raising various points in relation to the development of the windfarm. In particular, the letter stated that "our client has carried out searches and has been unable to identify any grant of planning permission in respect of the grid connection works. Accordingly the grid connection and internal [cabling] works are unauthorised

development as these works do not benefit from the exempted development provisions…". Significantly, the letter went on to state that "…we are instructed that the [cabling] works trespass on our client's lands. Our client has not provided any consent to the laying of cables on or over his lands and he has instructed us to request that same are removed forthwith…". The letter pointed out that "T14 and T23 are in immediate proximity to our client's boundary and are interfering with our client's ability to use and development [sic] his own lands".

21. A substantive response was sent by an in-house lawyer for SSE on 1 February 2017 by email. In particular, the email stated that "…my client has confirmed that there are no cables for Dromada Windfarm located on your client's land and there is no trespass on your client's land…". In response to a reply from O'Connell & Clarke, by email of 16 February 2017, the same author stated "…regarding the alleged trespass, we are satisfied from our inspections that there is no such trespass…".

22. A plenary summons on behalf of Mr Cremins against Dromada Windfarm (ROI) Limited issued on 18 September 2017. The general endorsement of claim, which was signed by counsel, sought:

> "1. A declaration that the plaintiff owns land comprising of folio LK3305F at Dromada, County Limerick and that the defendant has no estate or interests in the said lands and, in particular, has no entitlement to lay pipes, cables or conduits in the lands comprising the said folios.
>
> 3. [sic] An order, restraining the defendant its servants or agents from the laying of underground cables/ducting/or other equipment on the plaintiff's lands at Dromada, County Limerick without his consent or otherwise;
>
> 4. Damages for nuisance and trespass…".

23. An appearance was entered on 20 September 2017 by solicitors representing Dromada Windfarm (ROI) Limited. However, it is accepted by the defendant herein that he did not advance these proceedings, and no statement of claim was ever served.

Correspondence from June 2019 to date

24. Mr Cremins appears to have written the following letter on 13 June 2019:

> "To whom it may concern, I, Denis Joseph Cremins, am giving SSE Airtricity Dromada Windfarm until 15 July 2019 to remove the cable that is buried on my lands. Folio no: LK3305F. If the cable is not removed by this date I will have it removed myself. Should any injuries or fatalities occur to either me or my workers as a result of your failure to remove the cable, that you installed by trespassing on my land, you will be held responsible. I will be forwarding a copy of this warning letter to my family and solicitor, should I have to remove the cable myself. You, Airtricity, buried the cable on my lands without planning permission. I am again warning you, Airtricity Dromada Windfarm, should any loss of life occur after 15-07-2019 as a result of your failure to remove the cables my family and solicitor will be able to hold you responsible as you have been put on notice by this official warning letter. I can guarantee the cable, which is buried on my lands, will be removed regardless.
>
> Yours faithfully,
>
> Signed.
>
> Denis Cremins".

25. A further letter from Mr Cremins suggests that this letter was "posted to Airtricity on 13 June 2019", and to "Mr Philips-Davies CEO of SSE (the parent company for Airtricity)" by the said letter of 4 July 2019.

26. A letter was written on behalf of SSE to Mr Cremins on 8 July 2019. The letter stated as follows:

"Dear Mr Cremins,

We refer to the above matter and to your letter of 13th June 2019 in which you state that you intend to remove the underground electrical cable which you state is buried on your lands. The health, safety and welfare of staff and the general public is of paramount importance to SSE. The cable you refer to is a live cable and contact with this cable may cause electrocution and result in fatal injuries. Please find attached a copy of the Code of Practice for Avoiding Danger from Underground Services. This code of practice is a result of a joint initiative between the Health and Safety Authority, the Construction Industry Federation, Irish Congress of Trade Unions, key utilities companies/service providers and local authorities that are involved in the provision and maintenance of vital underground services.

SSE takes any claim or intention to interfere with electrical plant and equipment extremely seriously. We urge you not to take any such action given the extreme danger involved in interfering with live underground cables. In addition to risking your own life and the lives of contractors with any such interference you would also be endangering the safety of members of the public and of SSE staff. In this regard please note that SSE has notified the Gardai of the contents of your letter.

SSE has investigated the claim in your letter that the cable which you refer to is buried on your lands and is satisfied that the cable is not located on your lands but located under the public road. We further note that you have, through your solicitors O'Connell Clarke, issued High Court proceedings against SSE

under record 2017/8323P in respect of this cable and any issues or concerns which you may have in respect of the location of the cable should be raised in the context of those proceedings. In this respect we have copied both your solicitor and the solicitors acting for SSE in these proceedings."

27. Over the course of the next two years, the parties exchanged correspondence in relation to the removal of the cables. The plaintiff's position was that any issues would be determined in the course of the 2017 proceedings, and emphasised the risk inherent in any attempt to remove the cables by Mr Cremins. Mr Cremins however continued to intimate his intention to remove the cables himself, and continually raised the prospect of injury or loss of life occurring as a result. By way of example, in his letter to Mr Alistair Philips-Davies, CEO of SSE, of 23 October 2019 Mr Cremins indicated that, if the cables were "not removed by 10 November 2019 then I will remove them after this date and SSE Dromada Windfarm and the Health and Safety Authority will be held responsible should any danger or even death happen to me as a result of your failure to act. I would rather take that chance than have somebody like SSE trespass on my title without my consent. So please have the cable removed by the above date otherwise any fatality will be in the hands of SSE and the Health and Safety Authority. You have been warned."

28. It then transpired that, in December 2020, the defendant exposed some of the plaintiff's cable ducting on the grass verge of the public road, having used a digger to access the area from his lands. When it learnt of this event, the plaintiff sent operatives out to the road to cover the exposed section of cable ducting with stone chippings and to put up additional marker posts to warn road users of potential danger. By letter of 16 December 2020, SSE wrote to Mr Cremins indicating that, "interfering with live cables…is extremely dangerous and could cause serious injury

to you or any person undertaking such works…", and stated that "…[i]t is imperative that you cease any such works immediately for your own safety and the safety of others. In the event that you cause any further interference with the cable we will be left with no option but to proceed to make an application to the High Court for an injunction to prevent you from interfering with these cables. We urge you to bring this matter to the immediate attention of your solicitors".

29. Mr Maguire then organised a meeting with Mr Cremins on the site on 7 January 2021. By a letter of 22 January 2021, Mr Maguire wrote to Mr Cremins setting out the plaintiff's position, which in essence was that any issues Mr Cremins had with the cable should have been raised in the 2017 proceedings. The response to this was a further letter from Mr Cremins of 1 February 2021 to senior officials of SSE giving until 14 February 2021 to either remove the cables or switch off the power to them, failing which Mr Cremins would be "left with no alternative but to undertake these works myself. SSE Airtricity will be held responsible for any and all injuries, up to and including death, that might ensue as a result of your failure to remove or cut the power to this cable…".

30. Mr Maguire met Mr Cremins on site on a number of occasions in February and March 2021 with a view to attempting to resolve the differences between the parties. However, there were further intimations in April 2021 by Mr Cremins and a firm of solicitors acting on his behalf that he would remove the cable himself if certain requirements of his were not met. By a letter of 19 April 2021, a firm of solicitors – not O'Connell & Clarke – wrote to "SSE Airtricity" enclosing a copy of an engineer's report by Ms Nora Curtin indicating the cables were laid on Mr Cremins' lands. This met with a robust response from the plaintiff's solicitors of 20 April 2021. The letter stated, inter alia, that …[i]n respect of the cables which you

state have been built on your client's lands, these cables were in fact laid in the verge of the public road, some 12 years ago…". The letter did not however go so far as to deny that trespass had taken place, and made "an offer suggesting mediation to your client in respect of all claims arising out of the [2017 proceedings] …".

31. Ultimately, a meeting with the defendant took place at Barack Obama Plaza carpark – due to pandemic restrictions – on 29 April 2021, attended by Mr Maguire and another representative of SSE. The statement of claim in the present proceedings records that:

> "Safety markings to identify the location of the cables, which the Plaintiff's workmen had put over the cables after the defendant attempted to interfere with the cables in December 2020 had been removed. The Defendant confirmed that he had removed the safety markings the previous week. The Defendant demanded that (i) the Plaintiff either remove the cables from the lands, (ii) pay him compensation of €4.5m to leave the cables where they were or (iii) go through a fresh planning process to move the cables to the other side of the road but to de-energise the cables during the currency of that process". [Paragraph 35].

32. It appears that the plaintiff's counterproposals were unacceptable to Mr Cremins, who sent further emails to senior executives of SSE plc confirming his intention to remove the cables himself.

The present proceedings

33. It was in these circumstances that the plaintiff issued the plenary summons in the present proceedings on 5 May 2021. Mr Maguire swore a grounding affidavit, and an application for an interim injunction was made to Allen J who made the following order:

"IT IS ORDERED that the Defendant his servants or agents or any persons aiding abetting or acting in concert with him and any person having notice of the making of the Order be restrained until after 18th day of May 2021 or until further order in the meantime from interfering with and/or digging up and/or accessing in any way (whether with machinery or otherwise) the Plaintiff's electrical plant and equipment including high voltage cables which are connected to the Dromada Windfarm which were laid in the verge of the public road abutting the Defendant's lands at Keale Athea County Limerick in or around 2009".

34. The hearing of the interlocutory application took place on 18 May 2021. Due to the Covid-19 Pandemic, the plaintiff's lawyers attended remotely, but Mr Cremins, who was not represented by lawyers, attended in person. It appears from the order of the court of that date that Mr Cremins did not object to the continuance of the order made on an interim basis against him.

35. Mr Cremins continued to assert that the cables were laid on his property, and to this end swore an affidavit on 14 May 2021 attaching a report by an engineer, Nora Curtin, of 19 April 2021, in which Ms Curtin asserted that "the grid cable is laid within the folio lands of Denis Cremins LK3305F".

36. Mr Maguire swore two affidavits in the matter on behalf of the plaintiff. The first affidavit of 4 May 2021 sets out the background to the matter in detail much as I have set it out above, emphasising the necessity to prevent unauthorised interference with potentially lethal cables, while maintaining that any issues in relation to location of the cables could be dealt with in the 2017 proceedings. It is notable that neither of Mr Maguire's affidavits asserts unequivocally that the cables are not situated on Mr Cremins' land, although there is a passing reference at the start of para. 41 of Mr

Maguire's grounding affidavit to the grass verge being "outside the defendant's lands". At para. 48 of that affidavit, he avers as follows:

> "I say that the balance of convenience clearly favours the granting of an interlocutory injunction. *If the Defendant is correct in asserting that he is suffering a trespass by reason of the installation of the cables some 12 years ago, any wrong which he has suffered is capable of being compensated in monetary terms for the reasons already outlined.* Having regard to the terms of the Defendant's correspondence dated 24 February 2021, which I set out above, it is clear that the Defendant's real motivation is to obtain monetary compensation from the Plaintiff. There are legal proceedings in being in which those issues may be determined. However, if the Defendant interferes with the cables and suffers injury or even death, the consequences to the Defendant will be irreparable". [Emphasis added].

37. Mr Maguire swore a second affidavit on 17 May 2021, the day before the hearing of the interlocutory injunction. At para. 24 of that affidavit, he avers as follows:

> "...The Plaintiff is of the view that even if the Defendant is correct in establishing that he owns the lands on which the cables are laid and that he did not give permission for their installation, his remedy is limited to damages for reasons including the length of time the cables are in situ, the failure of the Defendant to raise any complaint about the cables for eight years after their installation, the fact that the cables are laid on the public road and that any trespass that the defendant might establish is technical in nature and the fact that the Plaintiff's prejudice in having to remove the cables is significantly

greater than any prejudice to the Defendant if the cables remain where they are".

38. This theme is continued in the statement of claim which was delivered on 9 August 2021. The plaintiff alleges at para. 44 that the defendant is estopped by a number of matters from seeking the removal of the cables, and the succeeding paragraph is as follows: -

> "45. In any event, if the Defendant has suffered an alleged trespass as a result of the cables being laid in the grass verge outside the lands, same is capable of being compensated in monetary terms".

39. Mr Cremins delivered what is in effect a defence and counterclaim on 31 August 2021 at a time when he did not have legal representation. In the reliefs he claims, he seeks "damages for interference with my land" at para. 6. In its reply and defence to counterclaim, the plaintiff responds to this claim as follows:

> "8. With regard to the reliefs sought at para. 6, the Plaintiff's position is (as pleaded in the statement of claim) that if this Honourable Court determines that the Plaintiff's cables are laid under the Defendant's lands, albeit that such lands form part of the public road, and this Honourable Court determines that the Defendant should be compensated in that regard, this Honourable Court should assess the compensation to which the Defendant is entitled on the basis that the cables are to remain in situ".

The legality of the laying of cables

40. The hearing of the matter took three days. During a lengthy opening in which the background to the matter was set out at length, the question of the ownership of the land adjacent to Mr Cremins' fenced-off land along which the cables had been laid was addressed. The plaintiff's counsel, Rossa Fanning SC, in addressing the reliefs

sought by the plaintiff, referred to the third paragraph of the reliefs in the statement of claim, which is as follows: -

> "3. A declaration that if the defendant is entitled to any relief as a result of the plaintiff's electrical plant and equipment, including high voltage cables connected to the windfarm, being laid in the verge of the public road abutting the lands at Keale, Athea, County Limerick in or around 2009, same is limited to damages in the High Court proceedings which he has commenced, by reason of his delay in seeking any equitable relief and, if appropriate, measuring such damages (if any) to which the defendant may be entitled in that regard".

41. Mr Fanning commented on this relief in his opening to the court as follows:

> "And that's a central issue, Judge, now, that the court will have to take a view on. That to the extent that we have trespassed, and there is no longer any contest in truth that we have as a result of our reading of Ms Justice Baker's judgment in Daly v Kilronan, which is referred to in my submissions and in the book of authorities, we accept there is a technical trespass here." [day 1, p99, lines 18-25]

42. Counsel for the defendant, Oisin Collins SC, immediately interjected to complain that the defendant had come to court to "defend his ownership of the lands and to establish a trespass". Counsel submitted that the proceedings were based on an entitlement to lay the cables in the grass verge; if counsel for the plaintiff was "…now conceding [that the plaintiff] has no entitlement to be there, it is difficult to see what future his case has at all" [day 1, p.99, line 26 to p.100, line 16].

43. In answer to a direct question from the court, counsel for the plaintiff confirmed that the plaintiff had resiled from the position that it had expressed in

correspondence. Counsel accepted that the laying of the cables on Mr Cremins' land was a "technical trespass", but one that "doesn't actually prejudice Mr Cremins in any respect…[Mr Cremins] can't, as a matter of law…dig [the roadway] up himself…it is a criminal offence to dig up a public road, other than with a licence, which we did have in 2009 when we did these works, but which Mr Cremins has never had…[the plaintiff's] objective in these proceedings…consistent with the reliefs I have sought, is to ensure that Mr Cremins cannot interfere with my cable and to obtain a court order to that effect" [day 1, p.132, lines 17 to p.134, line 25].

44. The legal principles in relation to ownership of the public road are set out at some length in the written submissions of the plaintiff, which were delivered on the first day of the hearing, *i.e.*, not in advance of the trial. The plaintiff notes, *inter alia*, a number of cases establishing the principle that the owner of land beside a public road or river "owns the soil to the middle part of the road or river unless the soil has been acquired by the local authority…" [Kenny J in *Holland v Dublin County Council* [1979] 113 ILTR 1 at 2: see para. 44 of written submissions]. The plaintiff now accepts that the application of this principle confirms that Mr Cremins "owns the soil to the middle part of the road", and that accordingly in the present case, the grass verge between the fence posts and the middle of the road is part of Mr Cremins' lands.

45. The plaintiff's submissions also note that s.13(10) of the Roads Act 1993 provides, *inter alia*, that a person who damages or excavates a public road "without lawful authority or the consent of a road authority…shall be guilty of an offence". The submissions note the requirement, pursuant to s.254 of the Planning and Development Act 2000 for a licence granted by a planning authority for the placement of a "cable, wire or pipeline…under, over or along a public road…"; it is contended however that

the plaintiff is a "statutory undertaker" as defined in s.2 of the Planning and Development Act 2000, to which s.254 does not apply.

46. The plaintiff however suggested that a significant change in the legal position had occurred with the delivery of the judgment of Baker J in *Daly v Kilronan Wind Farm Limited* [2017] IEHC 308. As the plaintiff put it at para. 49 of the written submissions:

> "49. The judgment of Baker J in *Daly v Kilronan Wind Farm Limited*, [2017] IEHC 308, clarified that a road opening licence does not confer a right or interest in the soil, as the purpose of the licence is to provide consent for an action which would otherwise be an offence under the Roads Act 1993. In that case, which involved an application under s.160 of the PDA, Baker J held that even though it formed part of the public road, the grass verge was *prima facie* the property of the applicant and no consent to enter had been given. Thus, *prima facie*, there was a trespass, and the road opening licence did not of itself amount to authorisation or permission to enter upon private land. In the event, Baker J proposed making a limited order prohibiting the continuation of the laying of cables, but she made no order that the works already completed be removed or that the land be restored."

47. Having quoted excerpts from the judgment, the plaintiff went on to state as follows:

> "51. Until this judgment, it had not generally been understood that the road opening licence, coupled with the fact that the laying of cables was exempted development, was not all that was required. Indeed, it might be suggested that the defendant himself laboured under this mistake, given that the judgment of Baker J was delivered on 11 May 2017 and the defendant's 2017 proceedings

subsequently issued on 19 September 2017, when the cables had by that point already [been] in place for eight years. The applicant in Daly and the Defendant were both represented by O'Connell & Clarke Solicitors. It may be that the Defendant had the good fortune to be advised by solicitors who became alive to the point at some stage in 2016, as it was in their letter of 24 November 2016 that they first made the complaint of trespass on behalf of the Defendant."

48. The plaintiff then went on in the written submissions to contend that s.48 of the Electricity Regulation Act 1999 "would have provided a mechanism whereby the plaintiff would have been able to lay the cable without the defendant's consent". Under that section, "[t]he power to lay electric lines…, may, with the consent of the Commission [for the Regulation of Utilities], also be exercised by the holder of an authorisation" within the meaning of the section. The plaintiff contended that it was the holder of such an authorisation in respect of a generating station connected with the windfarm. The plaintiff also submitted that it might have been possible to apply to the Commission for the Regulation of Utilities for an order providing for the compulsory acquisition of the land.

49. Mr Fanning accepted that "the issue fundamentally really is whether the remedy for Mr Cremins ought to sound in damages or whether it ought to sound in removal of the cable" [day 1, p.146, lines 6 to 8]. It was suggested that this issue should be determined first, with the question of compensation of the defendant by the plaintiff – if it were decided that the cables should stay in the ground – to be the subject of a further module. Counsel also said that the plaintiff would in that event agree to an arbitral process to decide the issue of compensation.

50. Mr Collins accepted that the first issue to be resolved was whether the cables should remain in the ground, submitting that they "should be removed forthwith". He made sustained complaint about the way in which the plaintiff had approached the proceedings, stating that it was "absolutely clear that the plaintiff has approached this on the basis that the cable is not in fact on my lands" [day 1, p.151, lines 3 to 5]. Counsel also submitted that "the interlocutory injunction that was obtained in this case was obtained on the basis that this cable was laid outside my client's lands", pointing to para. 41 of Mr Maguire's grounding affidavit, which commences with the averment "…the cables located in the grass verge *outside the defendant's lands* serve nine of the turbines in the windfarm…" [emphasis added]. Mr Collins accepted that "some level of modularisation" was required "…because the [plaintiff's] case has changed so fundamentally from the case that was brought, that it needs now to be reconstituted and brought properly…" [day 1, p.155, lines 7 to 14].

51. In addressing the way in which the plaintiff had approached the present proceedings in general and the injunctive applications in particular, Mr Fanning stated that the plaintiff wasn't "overly keen to acknowledge a trespass…we were perhaps a little bit coy in the way we were putting it". He submitted however that the way the case was being presented at hearing could not be seen as constituting "a significant change of position", pointing out that s.48 of the grounding affidavit referred to the possibility that the defendant "is correct in asserting that he is suffering a trespass by reason of the installation of the cables…", in which case "…any wrong he has suffered is capable of being compensated in monetary terms for the reasons already outlined".

52. Counsel also points to letters written by the plaintiff's solicitors to Mr Cremins suggesting arbitration in relation to compensating him. In its letter of 12 May 2021, in

between the grant of the interim injunction and the hearing of the interlocutory application, Messrs Mason Hayes & Curran on behalf of the plaintiff stated as follows:

> "However, given the long history of the matter and the numerous failed negotiations between the parties, we are of the view that the best way to proceed would be to appoint an independent arbitrator to determine the issue of compensation on the basis that the electrical cables remain where they are. The arbitrator's decision on compensation would be a legally binding decision on both parties. The advantages of arbitration is [sic] that it would be conducted in private and it is capable of facilitating a speedy decision making process in order to bring this matter to a close. As a gesture of good faith, our client has offered to reimburse reasonable legal fees incurred by you during the course of the arbitration process, to ensure that you would have adequate legal advice and that you are fairly represented".

53. This offer was repeated by the plaintiff's solicitors in letters of 18 May 2021 – the date of the grant of the interlocutory injunction – 28 May 2021 and 16 September 2021. The letters do not concede that there had been a trespass; counsel submits however that it is clear that the plaintiff's approach was to accept that Mr Cremins was entitled to compensation as the price of the cables being left in the ground, the position that it ultimately adopted at the hearing.

Mr Maguire's evidence

54. Mr Maguire gave evidence in relation to the matter generally and in particular in relation to a series of meetings he had with Mr Cremins in early 2021, after Mr Cremins had excavated the grass verge in December 2020, thereby removing the markers and exposing the cable. At that time, it appears that Mr Cremins was still

hopeful that the three turbines which were originally to be built on his land could still be erected. At a meeting on 25 March 2021, Mr Maguire confirmed to Mr Cremins that this could not be done. Mr Maguire stated that Mr Cremins told him that, in that case, the plaintiff had two choices: "You compensate me or you take the cable out of the ground". The quantum of the compensation was then discussed, with Mr Cremins estimating damages in the region of €7m, and explaining the basis for the calculation [see day 2, pp. 39 to 41].

55. The negotiations were conducted without rancour or the aggressive tone adopted by Mr Cremins in his correspondence. In fact, Mr Cremins went out of his way in his evidence to compliment Mr Maguire on his approach to the negotiations. However, they did not bear fruit, and the plaintiff ultimately applied for injunctive relief in May 2021 as we have seen.

56. On cross-examination, Mr Maguire accepted that "it was only…during the creation of the affidavit that technically [sic] trespass was discussed …up to that point, I didn't know whether it was a trespass or not a trespass. I knew there was greyness now because of the case in 2017, but my understanding of what trespass was or wasn't in this case, I didn't know" [day 2, p.122, lines 3 to 9]. However, Mr Maguire subsequently acknowledges that "…[o]n advice, it was decided that this is a technical trespass and it needs to go into the affidavit" [day 2, p.122, lines 15 to 19].

57. Mr Maguire stated that he had informed Mr Cremins at their third meeting in March 2021 that the cable could be removed, but that this would involve obtaining planning permission, an environmental impact study would probably have to be commissioned, and that legal advice in relation to the entire operation would have to be procured. He states that Mr Cremins' reaction was to say "…and I'll object, I'll object…" [day 2, p.138, line 25 to p.139, line 3]. Mr Maguire stated that removal of

the cable would "disrupt the operation of the windfarm", and referred to figures relating to the disruption set out at para. 41 of his grounding affidavit. He also referred to the possible "knock-on" effect of other landowners insisting on removal of the cable from their lands, not only in the 3km along which this particular cable was laid, but potentially in respect of cables laid along the roadside in every windfarm operated by the plaintiff.

Mr Cremins' evidence

58. Mr Cremins gave evidence in relation to his involvement with Mr Maguire ("a lovely person to deal with") and to his correspondence in which he constantly sought an acknowledgement that trespass had taken place. He stated that the first time that this was acknowledged to him was on the first day of the hearing. He referred in detail to an email he sent to Mason Hayes & Curran on 6 May 2021 – the day after the grant of the interim injunction – which summarised Mr Cremins' position at the time. As it is of some significance, and essentially represents Mr Cremins' current position, I will quote it in full:

> "1. I want SSE Airtricity to admit the grid cable under dispute, part of the Dromada Wind farm at Keale, Co. Limerick, is in Denis Cremins' land. Mason Hayes & Curran Solicitors who represent Dromada Windfarm have already, inadvertently, admitted this by putting the subject of their correspondence to me as 'lands at LK3305F at Keale, Athea, County Limerick. This land folio title is under my name, Denis Cremins.
>
> 2. I want SSE Airtricity to confirm that they will immediately seal off the grid cable situated on my land, with my permission of course, either with high security fencing or by having a security firm engaged on the site so that no one gets injured or killed. As you can see from my engineer's report yesterday

(5/5/21) which I have already emailed to you, she says this is an extremely dangerous site as a result of the live cables.

3. I would like you to confirm that you will immediately apply for planning for these grid cables on my land. However, should Dromada Windfarm fail to receive such a planning within twelve months (up until the end of April 2022) I want you to promise that you will remove the cables from land folio LK3305F.

If your answer is yes to the above three questions then we will secure the site immediately, you will apply for planning and subsequently remove the grid cable if the planning has not been granted on or before the 30th April 2022.

Provided that we are in agreement with all the above then:

1. I, Denis Cremins, will give permission for Dromada Windfarm to enter my land, folio no.: LK3305F to erect security fencing. A copy of the indemnity insurance will be required before entering.

2. I give my word that I will not object to any planning application for the grid cable that is on my land to any relevant authority, including but not limited to Limerick County Council and An Bord Pleanála.

3. I also give my word that I will not interfere with the grid cables located on my land (folio no.: LK3305F) and I will make this clear to the court as well.

As my engineer reported on 5 May 2021, this is an extremely dangerous site and it needs the full cooperation of both myself, Denis Cremins [sic] and SSE Airtricity to make it safe as soon as possible. Therefore, to protect the lives of people who may be coming on to the site now, partly as a result of the publicity this injunction has caused, please try to have the answers to the above three questions answered by the end of today, the 6th of May 2021. This

is not a time for playing games because I am getting extremely worried that someone might get killed as a result of this unauthorised grid cable. Again, I beg of you, Dromada Wind Farm Ltd to switch off the power, immediately, while we await a satisfactory outcome to the worrying ordeal that you have brought upon me.

Regards"

[Emphasis in original]

59. On cross-examination, it was put to Mr Cremins that the existence of the cable had no impact whatsoever on how he chose to use his lands between 2009, when they were laid, and 2016, when Mr Cremins discovered their existence. Mr Cremins stated that, had he known in 2009 that the cables were there, "…we'd have been probably in the courts in 2009 in relation to this" [day 3, p.54, lines 1 to 6]. He accepted that complaints he had made to Limerick County Council in 2012 in relation to the planning situation were for the purpose of bringing the plaintiff back to the negotiation table. He also agreed that "section 160 proceedings" had never been brought by him in relation to any perceived breach of planning laws, nor had the Council ever commenced any such action against the plaintiff.

60. Mr Cremins was asked about the 2017 proceedings. He accepted that the reliefs included a claim for damages, that the plenary summons did not seek an order that the cables be removed, and that the proceedings have not been progressed in any way. He accepted that he "took [matters] into his own hands" by writing letters rather than getting on with the 2017 litigation. However, he did not agree that his threats to dig up the cable were "unnecessary and inappropriate, or intended to escalate matters to put pressure on the plaintiff…" [day 3, p.83, lines 3 to 23]. He accepted that he was

trying to get the plaintiff's attention in the correspondence ("of course I wanted attention").

61. Towards the end of the cross-examination of Mr Cremins, counsel specifically asked Mr Cremins whether his "repeated threats to personally dig up the cable were 'unnecessary and unsafe and inappropriate'". Mr Cremins said "…they were unsafe but they weren't unnecessary because I was left with no other option to bring you to the table…" [day 3, p.109, lines 1 to 13].

Evidence of Nora Curtin

62. Ms Nora Curtin gave evidence on behalf of Mr Cremins. She stated that she was a civil engineer in Newmarket, County Cork, and had been in private practice for "about eighteen years". Ms Curtin averred that she had a "planning business" which she had operated for eighteen years, submitting planning applications on behalf of individuals to planning authorities.

63. She averred to having attended the property in October 2016 and to having seen the cable. She stated that Mr Cremins wanted her to confirm that the cable was within his folio. Her evidence was that she had ordered Land Registry maps and satisfied herself that these maps gave ownership to Mr Cremins "to the centre of the public road". It is notable that the first allegation of trespass on the part of the plaintiff came in a letter from O'Connell & Clarke Solicitors of the following month on behalf of Mr Cremins.

64. Ms Curtin was again instructed in 2021, at which point she caused a satellite survey to be carried out. In a report of 19 April 2021 which was exhibited to Mr Cremins' affidavit in opposition to the interlocutory injunction application, she expressed herself as "extremely taken aback when [Mr Cremins] informed me he had exposed the electric cable and that SSE Airtricity had come back to his property and

unloaded stone on top of the recently exposed high voltage cable without his consent".

65. In truth, Ms Curtin's evidence was adduced primarily for the purpose of establishing that the cables were laid within Mr Cremins' lands, a matter which had been conceded by counsel for the plaintiff in his opening of the case. Her report is quite cursory, and it does not seem to me that it is of much assistance to the court in relation to the issue of whether or not the cables should be removed.

Legal principles

66. The facts give rise to an important and interesting issue: where a party has tortiously interfered with the land of another, is it ever appropriate to grant the tortfeasor injunctive relief to preserve the effect of the tort, and if so, in what circumstances?

67. In *Patterson v Murphy* [1978] ILRM 85, the plaintiffs, who were musicians, instituted proceedings for damages and an injunction arising from the operation of a nearby quarry. Having heard the evidence, Costello J (as he then was) found that the plaintiffs had established acts of nuisance to a serious degree arising from the emanation of noise and dust from the quarry and from the emanation of noise and dust from a laneway along which lorries travelled to and from the quarry. The plaintiffs "were, in effect, driven out of their home"…and "were not displaying any exaggerated degree of sensitivity in acting as they did" [p. 95].

68. The defendants contended that, even if the plaintiffs' rights had been infringed, the court had a discretion to award damages in lieu of an injunction, and should do so in that case. Costello J accepted that the court had a discretion whether or not to grant relief by way of injunction, but stated that there were "well established principles" in this regard, which he summarised as follows:

"1. When an infringement of the plaintiffs' right and a threatened further infringement to a material extent has been established the plaintiff is *prima facie* entitled to an injunction. There may be circumstances however, depriving the plaintiff of this prima facie right but generally speaking the plaintiff will only be deprived of an injunction in very exceptional circumstances.

2. If the injury to the plaintiff's rights is small, and is one capable of being estimated in money, and is one which can be adequately compensated by a small money payment, and if the case is one in which it would be oppressive to the defendant to grant an injunction, then these are circumstances in which damages in lieu of an injunction may be granted.

3. The conduct of the plaintiff may be such as to disentitle him to an injunction. The conduct of the defendant may be such as to disentitle him from seeking the substitution of damages for an injunction.

4. The mere fact that a wrong-doer is able and willing to pay for the injury he has inflicted is not a ground for substituting damages. (See: *Shelfer v City of London Electric Lighting Company* [1895] 1 Ch 287; and Kerr on Injunctions 6th Edition pp. 656, 657)."

69. In *Shelfer v City of London Electric Lighting Company* [1895] 1 Ch 287, to which Costello J made reference, an electric lighting company erected powerful engines and other works on land near a house which was subject to a lease. Due to excavations for the foundations of the engines, and to vibration and noise emanating from them, structural injury was caused to the house, and annoyance and discomfort to the lessee, who brought an action against the company for an injunction and damages. The trial judge accepted that there was a continuing nuisance as regards the

lessee, and structural injury to the house, but he held that the lessee – and the reversioners, who also sued – were entitled to damages but not an injunction.

70. The plaintiffs appealed, and the Court of Appeal held that the refusal of the injunction by the trial judge was unwarranted, and that the appeal must be allowed. In his judgment Lindley LJ referred at p.315 to Lord Cairns' Act (21 & 22 Vict C27) – an Act of 1858 which conferred on the Court of Chancery in Ireland the jurisdiction to award damages in lieu of specific performance: in this regard see the dicta of Laffoy J. in *McGrath v. Stewart* [2016] 2 IR 704, para. 31 – s.2 of which "conferred upon the Court of Chancery jurisdiction which it had not before to award damages in lieu of an injunction". In relation to the exercise of the jurisdiction, Lindley LJ commented as follows (at pp.315-316):

> "The jurisdiction to give damages instead of an injunction is in words given in all cases…there appears to be no limit to the jurisdiction. But in exercising the jurisdiction thus given attention ought to be paid to well settled principles; and ever since Lord Cairns' Act was passed the Court of Chancery has repudiated the notion that the legislature intended to turn that court into a tribunal for legalising wrongful acts; or in other words, the court has always protested against the notion that it ought to allow a wrong to continue simply because the wrongdoer is able and willing to pay for the injury he may inflict. Neither has the circumstance that the wrongdoer is in some sense a public benefactor (e.g., a gas or water company or a sewer authority) ever been considered a sufficient reason for refusing to protect by injunction an individual whose rights are being persistently infringed…[w]ithout denying the jurisdiction to award damages instead of an injunction, even in cases of continuing actionable

nuisances, such jurisdiction ought not to be exercised in such cases accept under very exceptional circumstances…".

71. In his judgment, AL Smith LJ commented at p.321 of the judgment that "…there is no suggestion of any conduct on the Plaintiff's part depriving him of his prima facie right to an injunction". He went on to state as follows (at p.322):

> "Many judges have stated, and I emphatically agree with them, that a person by committing a wrongful act (whether it be a public company for public purposes or a private individual) is not thereby entitled to ask the Court to sanction his doing so by purchasing his neighbour's rights, by assessing damages in that behalf, leaving his neighbour with the nuisance, or his lights dimmed, as the case may be.
>
> In such cases the well-known rule is not to accede to the application, but to grant the injunction sought, for the plaintiff's legal right has been invaded, and he is prima facie entitled to an injunction.
>
> There are, however, cases in which this rule may be relaxed, and in which damages may be awarded in substitution for an injunction as authorised by this section.
>
> In any instance in which a case for an injunction has been made out, if the plaintiff by his acts or laches has disentitled himself to an injunction the court may award damages in its place. So again, whether the case be for a mandatory injunction or to restrain a continuing nuisance, the appropriate remedy may be damages in lieu of an injunction, assuming a case for an injunction to be made out.
>
> In my opinion, it may be stated as a good working rule that –
>
> (1) if the injury to the plaintiff's legal rights is small,

(2) and is one capable of being estimated in money,

(3) and is one which can be adequately compensated by a small money payment,

(4) and the case is one in which it would be oppressive to the defendant to grant an injunction:

then damages in substitution for an injunction may be given…

It is impossible to lay down any rule as to what, under the differing circumstances of each case, constitutes either a small injury, or one that can be estimated in money, or what is a small money payment, or an adequate compensation, or what would be oppressive to the defendant. This must be left to the good sense of the tribunal which deals with each case as it comes up for adjudication…".

72. Reference was also made to *Shelfer* in the judgment of Feeney J in *McKeever v Hay & Ors.* [2008] IEHC 145. In that case, pipes had been laid across the verge of a public road off the main Carrickart to Downings road in County Donegal which cut across the plaintiff's lands. The purpose of the pipes was to provide a water supply to houses on Island Roy, a small island off the coast of County Donegal. The plaintiff was an owner of one of the folios in "The Commonage", the name under which the land along which the pipes were laid was locally known, and she issued proceedings seeking an injunction and damages in respect of what she alleged was a trespass upon her lands without her consent.

73. At p.15 of the judgment, Feeney J commented that "…the plaintiff…created a situation where the group [of which the defendants were representatives] was able to proceed on a misapprehension that all consents could be obtained. The facts of this case do not demonstrate a wanton interference with the plaintiff's rights nor were the

group's actions oppressive or vindictive. They carried out the works at a time when they truly had a belief that the plaintiff would ultimately consent".

74. However, it was clear that the placing of the waterpipes resulted in a continuing trespass, notwithstanding that the pipes were laid on behalf of Donegal County Council. The Council had instituted compulsory purchase procedures that would result in the land where the pipes were situated being acquired compulsorily. Accordingly, Feeney J awarded damages for €7,500 for trespass up to the date of compulsory acquisition. Feeney J stated at p.31 that the court

> "…is satisfied that no injunction should be granted until the final completion of the compulsory purchase process and then only if that process does not result in final orders. That process has the capacity to ensure that legal permission and authorities in place for such pipes to remain and that appropriate and proper compensation has been identified and paid. This Court is satisfied that the implementation of any injunction must be postponed to allow and permit that process proceed to completion…if the compulsory purchase order process does not result in the way-leaves being obtained then a period of time would still be required to ensure that the residents of the Island Roy could arrange alternative water supply. This Court must recognise that to grant an injunction which would come into effect without providing adequate time to provide alternative water supplies would be oppressive".

75. In his judgment, Feeney J cited the principles set out by Costello J in *Patterson* set out at para. 68 above, and confirmed that, notwithstanding that *Patterson* was a nuisance case, those principles were "also relevant for the purpose of this case". The court confirmed that "…the starting point for consideration by this Court is that the plaintiff is *prima facie* entitled to an injunction. In such

circumstances the plaintiff will only be deprived of her entitlement to such injunction if very exceptional circumstances are identified. This is particularly so where the infringement is in the form of trespass rather than nuisance". [p. 25].

76. In addressing the principle enunciated by Costello J that if the injury to the plaintiff's rights is small and is capable of being estimated in money and can be adequately compensated by a small payment, Feeney J – significantly in the context of the present case – stated as follows: -

> "…However, the mere fact that damage is small is not of itself decisive. If a court comes to the conclusion that the plaintiff's property will remain substantially as useful to the plaintiff as before the act complained of, and does not take the property away from him and the injury can be compensated by money, then an injunction need not necessarily be granted. The court may still grant an injunction if the facts are such as to indicate that the court should exercise its discretion to do so…" [pp. 26-27].

77. Feeney J indicated his intention to follow "the well-established principles" identified by Costello J in *Patterson v Murphy* and reiterated by Millett LJ in *Jaggard v Sawyer & Anor* [1995] 1 WLR 269:

> "When the plaintiff claims an injunction and the defendant asks the court to award damages instead, the proper approach for the court to adopt cannot be in doubt. Clearly the plaintiff must first establish a case for equitable relief, not only by proving his legal right and an actual or threatened infringement by the defendant, but also by overcoming all equitable defences such as laches, acquiescence or estoppel. If he succeeds in doing this, he is prima facie entitled to an injunction. The court may nevertheless in its discretion withhold injunctive relief and award damages instead" [p.287].

78. There is no significant disagreement between the plaintiff and the defendant in the present case that the principles set out above govern their dispute, although they differ as to the application of those principles. There is therefore a roadmap for this Court as to the factors to be considered as to what should be done with the cables. However, the plaintiff draws attention to the following dicta of Millett LJ in *Jaggard v Sawyer*:

> "Reported cases are merely illustrations of circumstances in which particular judges have exercised their discretion, in some cases by granting an injunction, and in others by awarding damages instead. Since they are all cases on the exercise of a discretion, none of them is a binding authority on how the discretion should be exercised. The most that any of them can demonstrate is that in similar circumstances it would not be wrong to exercise the discretion in the same way. But it does not follow that it would be wrong to exercise it differently…" [p. 288]

Analysis

79. In the plaintiff's statement of claim, the plaintiff claims declaratory relief that the defendant be prevented from interfering with or damaging the plaintiff's plant and equipment (reliefs 1 and 2), and reliefs 4 to 6 seek injunctive relief in this regard. The third paragraph of the reliefs is as set out at para. 40 above, *i.e.*, a declaration that, if the defendant is entitled to relief in relation to the cables, that the relief be limited to damages.

80. The defendant drafted his own defence which, as I have previously commented, is effectively a defence and counterclaim. While expressed as "declarations", the first three reliefs clearly seek injunctive relief directed at the removal of the cables from the defendant's land:

"1. A declaration that the plaintiff removes the 20000 KV live cable within my land in folio No.: LK3305F immediately as these live 20000 KV cables were laid on my land without my knowledge or permission.

2. A declaration that the plaintiff will reinstate my land to its original habitat.

3. A declaration that the plaintiff will reapply for planning for the Drommada windfarm [sic] as a number of the turbines built are as a result of having an option over my lands at the time when planning was granted in 2003. These turbines are now only 60 metres from my boundary. This would not have been possible without my land being a part of the original planning permission. These turbines are causing massive noise and shadow flicker as a result of being so close to my property."

81. The plaintiff has now accepted that the cables are laid in the plaintiff's land, and that it has committed what it calls a "technical trespass". Applying the principles approved by Costello J in *Patterson*, the defendant is therefore *prima facie* entitled to the injunction he seeks. It falls to this Court however to determine whether there are circumstances which should cause this Court to exercise its discretion to refuse the defendant an injunction. As the third principle set out by Costello J makes clear, the conduct of both parties must be examined in the exercise of the court's discretion.

The Conduct of the Parties

82. The defendant appears only to have become aware of the existence of the cables in 2016, some seven years after they had been installed. He instructed solicitors who, from their first letter of 24 November 2016, clearly intimated that the cabling works constituted trespass. When the trespass was repeatedly denied by the defendant, the defendant issued proceedings in September 2017: see paras. 20 to 23 above. If those proceedings had been prosecuted by the defendant, the issues in the present

proceedings might well have been resolved, whether by agreement or order of the court, by this stage.

83. However, for whatever reason, having issued the 2017 proceedings, the defendant made no attempt to progress them, and there does not appear to have been any significant contact between the parties until June 2019, when Mr Cremins wrote the letter of 13 June 2019, the text of which is at para. 24 above. This was followed by repeated emails to the plaintiff and to officials of its ultimate parent company in which the defendant repeatedly threatened to remove the cables, and stated that the plaintiff or its affiliates would be responsible for any injuries or fatalities that would occur.

84. What might have seemed an idle threat on the part of the defendant took on a different aspect when, in December 2020, the defendant excavated the verge using a digger and exposed some of the plaintiff's cable, so that the plaintiff had to send out operatives to cover up the cable with stone chippings and erect additional marker posts. This led to a number of meetings between representatives of the plaintiff and Mr Cremins until Mr Cremins renewed his threats to remove the cables, which in turn lead to the plaintiff's application for injunctive relief.

85. At the point of issue of the proceedings in 2017, Mr Cremins' conduct had been appropriate and even commendable. He correctly asserted that the plaintiff was trespassing on his land; when this was denied by the defendant, he issued proceedings, although it is notable that the 2017 proceedings did not seek the removal by the plaintiff of the cables. However, instead of progressing these proceedings, he embarked, from June 2019 onwards, on a campaign of emails which did him no credit. His evidence in court was that he wanted to get the plaintiff's attention; it is very clear that what he was trying to do was to avoid the legal process altogether, and

to force the defendant to negotiate with him on his terms. He did so by means of threats to remove the cables in the knowledge that such a manoeuvre was extremely dangerous, and would be seen as such by the plaintiff; that he acknowledged in his emails the possibility of injury or fatality arising, yet repeatedly asserted his intention to go ahead with the removal, shows his intention to intimidate and coerce the plaintiff into negotiation. The threats became all the more serious when he exposed the cables in December 2020.

86. This course of action ultimately forced the plaintiff into seeking the injunctive relief it was granted by Allen J. As counsel for the plaintiff pointed out, the plaintiff is not a "natural" plaintiff in the current circumstances, having committed trespass; the 2017 proceedings more accurately reflect the respective positions of the parties. However, it is difficult to criticise the decision of the plaintiff to seek injunctive relief, given the actions of the defendant.

87. Although the defendant did not seek removal of the cables by the plaintiff in the 2017 proceedings, seeking "damages for nuisance and trespass" instead, he now seeks an order in this regard by way of counterclaim. Whether the defendant actually wants the cables removed, and perhaps re-routed in another direction, must be open to doubt. The defendant has consistently attempted to agree monetary compensation with the plaintiff, and his contention is that compensation would amount to a substantial seven-figure sum. It is difficult to avoid the conclusion that money is what the defendant wants, particularly given the complete lack of evidence that the installation of the cables has impeded his use or inhibited his enjoyment of the lands in any way. An order that the plaintiff remove the cables – a situation which would cause serious problems for the plaintiff – would improve his bargaining power considerably.

88. However, as Costello J pointed out in *Patterson*, the conduct of both parties must be taken into account. There are reprehensible aspects to the conduct of the plaintiff also. It is not known whether the plaintiff sought legal advice on receipt of the correspondence, from November 2016 onwards, from O'Connell & Clarke, a well-known firm of solicitors specialising in environmental matters, intimating that Mr Cremins owned the land in which the cables were laid. One would have thought that the receipt of the 2017 proceedings at least would have caused it to do so. Likewise, one assumes that the legal position would have been reviewed on the receipt of a barrage of emails from Mr Cremins from mid-2019 onwards, asserting that the plaintiff had trespassed on his lands. In particular, the receipt of Ms Curtin's report by a solicitor's letter of 19 April 2021, to which I have referred at para. 30 above, must have caused the plaintiff to review its position, if it had not done so already.

89. By the time the plaintiff initiated the present proceedings, it is in my view clear that the plaintiff was aware that the cables constituted a trespass on Mr Cremins' lands. Mr Maguire all but acknowledged this in his oral evidence: see para. 56 above. While his affidavit did not explicitly address the question of ownership, the averment at para. 41 of the grounding affidavit of Mr Maguire, to which I have referred above, suggested that Mr Cremins did not own the grass verge. It set out all the steps taken by the plaintiff to prepare for the installation, and gave a clear impression that all appropriate steps had been taken by the plaintiff. The farthest the affidavit went as regards acknowledging a possible right on the part of Mr Cremins was in para. 48 of Mr Maguire's first affidavit, and para. 24 of his second affidavit: see paras. 36 and 37 above.

90. Counsel for the plaintiff conceded that the approach of the plaintiff in relation to the question of ownership was "coy" and "jesuitical"; counsel attributed this attitude to the fact that "Mr Cremins is the sort of litigant, unfortunately…if you give him an inch he tends to take a mile…" [day 1, p.159, lines 14 to 17]. In fairness to the plaintiff, the correspondence in which Mr Cremins vigorously asserted that a trespass had occurred was exhibited to Mr Maguire's first affidavit, and the court was therefore apprised by the plaintiff of Mr Cremins' position that a trespass had taken place. While it was perhaps understandable for tactical reasons to wish not to make concessions to Mr Cremins until it was absolutely necessary to do so, this led to an approach in the affidavits grounding the injunction which, it must be said, did not "front up" about the position regarding ownership, was less than frank, and skirted the boundary of misleading the court. Indeed, it seems extraordinary that the first occasion on which the plaintiff conceded that it had trespassed on Mr Cremins' lands was the first day of the hearing before this Court.

Are the plaintiff's proceedings still viable?

91. As the open concession that trespass had in fact occurred was made by the plaintiff for the first time at the hearing, counsel for the defendant submitted vehemently that the plaintiff's proceedings, which he contended were based on the plaintiff's entitlement to lay the cables in the grass verge, could not now be maintained and would have to be "reconstituted and brought properly": see para. 50 above.

92. The first two reliefs sought in the plaintiff's plenary summons and statement of claim are for declaratory reliefs in relation to the issue of whether or not the defendant should be prevented from interfering with or damaging the cables. The third relief, set out at para. 40 above, sought a declaration that any claim the plaintiff might

have be limited to damages. The fourth, fifth and sixth reliefs sought specific injunctive orders restraining interference with the cables or the windfarm generally.

93. Paragraphs 7 and 8 of the statement of claim – corresponding to para. 8 and 9 of the plenary summons, which has no para. 7 – contain the substantive causes of action on which the plaintiff relies, and are as follows:

> "7. Damages for interference or threatened interference with the plaintiff's property, and with the plaintiff's economic interests.
>
> 8. Damages for nuisance".

94. The plaintiff submits that, even if the cables constitute a trespass on the defendant's land, the defendant is not entitled to interfere with the cables and, in the words of the plaintiff, has "no entitlement to avail of self-help remedies" [written submissions para. 59]. The plaintiff relies in this regard on the decisions of the Court of Appeal of England and Wales in *Arthur v Anker* [1997] QB 564 and *Vine v Waltham Forest LBC* [2000] 1 WLR 2383, both of which concerned clamping of motor vehicles which were trespassing on private lands. In the latter case, the Court of Appeal found that the act of clamping a car, in circumstances where there was no statutory basis for doing so and where it could not be shown that the owner of the car had consented to or willingly assumed the risk of being clamped, was a tortious act of trespass to the car owner's property, notwithstanding the original trespass by the car owner.

95. The plaintiff in the present case maintains that it had operated on a mistaken basis, in laying the cables in the grass verge, that it was not infringing on the defendant's lands, and that in those circumstances, the interference by the defendant with the cables in December 2020 and his campaign of threats to interfere with the

cables unless the plaintiff negotiated with him constituted an actionable interference with the plaintiff's economic interests.

96. It seems to me that, even if the defendant had not threatened to remove the cables or interfered with them in December 2020, but had sought an order in his own proceedings that the plaintiff remove the cables, it would have been open to the court, while acknowledging the defendant's *prima facie* right to an injunction to restrain trespass, to refuse the injunction and confine the plaintiff to a claim in damages. It would seem to follow therefore that the defendant did not have the right to take matters into his own hands and threaten and indeed partially implement a course of action which could have had dangerous and life-threatening consequences, even leaving aside the economic damage to the plaintiff that removal of the cables would inflict.

97. I accept that there will of course be occasions on which a landowner who is the victim of a trespass or nuisance may take reasonable steps to abate or reduce the effect of any such actions with a view to asserting his rights and minimising his loss, or making his land safe. In the present case, there is no evidence whatsoever of any actual loss suffered by the defendant. Between 2009 and 2016, he was unaware of the existence of the cables, which did not interfere in any way with his use or enjoyment of the land. Even when he did discover their existence, and after raising the issue of trespass and finding it denied by the plaintiff, he issued the 2017 proceedings, and did not seek an order of removal of the cables, but sought damages instead. It is clear to me that his interference with the cables and threats to remove them were for the purpose of – as he characterised it himself – getting the attention of the plaintiff so that a settlement could be negotiated by a non-legal route.

98. In the circumstances, it seems to me that, even though a trespass by the plaintiff has occurred, the plaintiff has a stateable cause of action against the defendant which is capable of grounding an application for a permanent injunction. As counsel for the plaintiff has commented – see para. 43 above – the plaintiff's objective is to ensure that Mr Cremins cannot interfere with the plaintiff's cable and to obtain a court order to that effect. I do not accept that the plaintiff's acceptance that a trespass has occurred is fatal to its proceedings, although the circumstances in which this concession was made are a matter which have a bearing on the exercise of the court's discretion. Of course, it must be reiterated that Mr Cremins, as the "trespassee", has a *prima facie* right to restrain the trespass and seek the removal of the cables.

Exercise of the court's discretion

99. Both parties accept that the pressing issue that must be decided is whether or not, as the plaintiff urges, the cables be left where they are, or whether, as the defendant contends, the plaintiff be ordered to remove them. In the former case, the plaintiff accepts that it must compensate the defendant, and envisages quantifying the compensation in a further module in these proceedings, or by mediation or arbitration. However, the plaintiff essentially asks the court to permit the continuance of its trespass.

100. The fourth of the principles set out by Costello J in *Patterson* emphasises the unwillingness of the courts to countenance a wrongdoing simply because the wrongdoer is in a position to pay damages in compensation. As the High Court stated in *Allied Irish Banks plc v Diamond* [2012] 3 IR 549, the courts have always sought to guard property rights, particularly in the context of interlocutory injunctions. Clarke J (as he then was) vividly set out the rationale for this principle:

"Even though there may be a sense in which it may be possible to measure the value of property lost, declining to enforce property rights on the basis that the party who has lost its property can be compensated in damages would amount to a form of implicit compulsory acquisition. If someone could take over my house and avoid an injunction on the basis that my house can readily be valued and he is in a position to pay compensation to that value (even together with any consequential losses), then it would follow that that person would be entitled, in substance, to compulsory acquire my house. The mere fact that it may, therefore, be possible to put a value on property rights lost does not, of itself, mean that damages are necessarily an adequate remedy for the party concerned is entitled to its property rights instead of their value". [P. 590].

101. In my view, the circumstances of the present case are quite distinct from the sort of situation envisaged by Clarke J in this passage. I do not think the actions of the plaintiff in laying the cables in land owned by the plaintiff could be characterised as wilful or reckless. The plaintiff attempted to negotiate a situation where three turbines and the cables could be placed on the defendant's lands. This negotiation proved unsuccessful. Mr Maguire set out the plaintiff's reasons for laying the cables along the roadside, and to steps taken to ensure that this was done in accordance with what the plaintiff considered to be appropriate measures, e.g. obtaining the consent of the road authority pursuant to s.13(10) of the Roads Act 1993. Mr Maguire testified as to the genuine belief of the plaintiff that it had adopted the proper procedures to progress the development. I have no reason to doubt his evidence in this regard, nor is there any basis in evidence to suspect that the plaintiff laid the cables where it did in an opportunistic fashion, knowing that it was committing a trespass in doing so. In the

words of Feeney J in *McKeever v. Hay* "there was no wanton interference with the [defendant's] rights".

102. The defendant complained of the trespass for the first time in 2016, some seven years after the cables had been installed. On receiving an unsatisfactory response from the plaintiff, he initiated the 2017 proceedings, but did not, as part of the reliefs set out in the summons, seek an order directing the plaintiff to remove the cables. These proceedings were not advanced in any way, and the defendant did not seek an order in this regard until service on 31 August 2021 of what is effectively his defence and counterclaim.

103. The plaintiff contends that this inaction on the part of the defendant constitutes laches, which should result in a refusal of the claim by him for an order that the cables be removed. Whether or not that is the case, I am of the view that the failure to prosecute the 2017 proceedings and the campaign waged by the defendant from June 2019 onwards make it clear that the intention of the defendant was to force the plaintiff to the negotiating table so that a monetary settlement could be concluded. I do not accept that the defendant had genuine concerns about safety issues relating to the location of the cables, which had been undisturbed and, it appears, unnoticed between 2009 and 2016.

104. It also seems to me to be the case that the only issues in relation to safety arose because of the threats by the defendant and his action in exposing the cables in December 2020. The unopposed evidence of Mr Maguire suggests that the cables pose no threat as regards safety if left underground. The trespass undoubtedly constituted an interference with Mr Cremins' rights; however, there was no evidence of any practical consequences for the use or enjoyment by him of land which was either afforested or unused.

105. As against that, there is reason to be sharply critical of the manner in which the plaintiff conducted itself in its dealings with Mr Cremins. It incorrectly asserted, in the initial correspondence of Mr Cremins, that there was no trespass. This evolved into a more equivocal stance, culminating in an application for injunctive relief in which the plaintiff never clarified its position as to whether or not it had committed a trespass. If Mr Cremins had forced the issue and contested the interlocutory injunction, rather than acquiescing in it, the plaintiff would have had to acknowledge the trespass openly, and the court might well have had hard things to say about the manner in which the plaintiff approached the application.

106. There have been aspects of the behaviour of both parties which have been unattractive, to say the least. While I deprecate the manner in which the plaintiff approached the issue of trespass in the injunction application, I do consider that Mr Cremins' behaviour in threatening to interfere with the cables required action, and to that extent I accept that the plaintiff's application was justified. The issue now is as to whether the order made on an interlocutory basis should be continued.

107. As regards the second of the principles set out by Costello J in *Patterson* – see para. 68 above – the injury to Mr Cremins' rights could be said to be small, in the sense that there has been little or no interference with his use or enjoyment of the lands. As against that, there has been a significant trespass on his land, with the laying of high voltage cables across it. This Court has no evidence to assist it as to whether a "small money payment" would adequately compensate Mr Cremins; he is vehemently of the view that he is entitled to substantial compensation.

108. The court must also consider whether it would be oppressive to the plaintiff to order that the cables be removed. The evidence before the court of Mr Maguire in this regard is set out at para. 57 above; that the cable could indeed be removed, but that

this would involve obtaining planning permission, an environmental impact survey, and legal advice, with very substantial costs accruing daily. The Order would likely render the plaintiff in breach of its contractual obligations to EirGrid.

109. There is no indication before the court of how long all of this would take. However, it is clear that removal of the cable would cause enormous disruption to the operation of the windfarm while a route around the 250m of Mr Cremins' property was found, in addition to the significant financial losses. Also, the "elephant in the room" – to use that hackneyed phrase – is the possibility of other landowners along the 3km route also insisting on removal of the cables from their respective portions of the grass verge in the hope of exerting pressure on the plaintiff with a view to negotiating substantial compensation, and also the calamitous possibility of similar orders being sought and made in each situation in which a windfarm – whether owned by the plaintiff or not – has laid a cable along a public road.

Conclusions

110. As the case law makes clear, each case must be decided on its own facts. The conduct of neither party in the present case has been beyond reproach. It seems to me however that the appropriate and just result is that no order should be made directing the plaintiff to remove the cables, but that appropriate orders should be made with a view to establishing the compensation to be paid to the defendant by the plaintiff for its admitted trespass.

111. I am particularly influenced in this conclusion by four overarching factors:

(i) it does not appear to me that the plaintiff was aware that it was trespassing on the defendant's land when it laid the cables in 2009;

(ii) the defendant has not been able to point to any particular interference with his use or enjoyment of the lands;

(iii) the motivation of the defendant has always been to extract maximum compensation from the plaintiff, rather than any serious concern over safety;

(iv) there would be profoundly disproportionate consequences for the plaintiff if the removal of the cables were ordered.

112. The defendant is the victim of trespass, and deserves to be compensated. This Court expresses no view as to whether that compensation should be large or small. However, both parties agree that, in the event that the court does not order removal of the cables, a mechanism or further module must be put in place to assess compensation. It also seems to me that any such module would have to address the issue of the terms upon which the cables would remain on Mr Cremins' land, and the respective rights and obligations of the plaintiff as the owner of the cables, and the defendant as the owner of the land in which they are laid.

113. I will therefore allow the parties a period of 10 days from the date of delivery of this judgment to give them an opportunity to make written submissions of not more than 2000 words in relation to the orders to be made, in particular addressing:

(a) the issue of whether the interlocutory order, which remains in place for the moment, should be made permanent;

(b) the issue of whether an order should or can be made granting access to the plaintiff to the cables for the purpose of matters such as repair or maintenance, and if so, on what terms;

(c) the arrangements for a further module in relation to compensation, or

(d) agreed directions as to mediation or arbitration; and

(e) the costs of the proceedings.

114. The parties must observe the word limit set out above; longer submissions will not be accepted, nor will any attempt to reargue any of the issues addressed above. I

reserve the right to convene a hearing in relation to the orders to be made if I deem it necessary, but my intention is that any such hearing would take place before the end of this term.

Reference Number 13.7 : List of 1,651 USA Windfarms (Largest to Smallest) with 74,497 Turbines, operable in 2024 showing far smaller wind turbines than those being proposed for Ireland. The largest unit seems to be 4.0 – 4.5Mw & far lower than the 7.2Mw units in this application. Historic comparators & scientific references from USA are not applicable to Ireland.

2024 Form EIA-860 Data - Schedule 3, 'Wind Technology Data' (Operable Units Only) Plant Name	State	Summer Capacity (MW)	Winter Capacity (MW)	Operating Month	Operating Year	Number of Turbines	Predominant Turbine Manufacturer	Predominant Turbine Model Number	Design Wind Speed (mph)	Turbine Hub Height (Feet)	Turbine Hub Height (Metres)
Priddy Wind Project	TX	302.4	302.4	1	2022	63	Nordex	N149/4.0-4.5	18.6	489.0	149.0
Burke Wind, LLC	ND	199.4	199.4	12	2020	89	GE	2.72-116	19.9	487.0	148.4
Pegasus Wind	MI	130.0	130.0	9	2020	33	GE	2.5-116	15.3	470.0	143.3
Pegasus Wind	MI	48.0	48.0	12	2019	19	GE	2.5-116	15.3	470.0	143.3
Santa Rita Wind Energy	TX	300.0	300.0	4	2018	120	GE	2.5-120	19.2	456.0	139.0
Delta Wind Farm (MS)	MS	184.5	184.5	4	2024	46	Vestas	V150-4.2	15.4	446.2	136.0
Big Level Wind	PA	90.0	90.0	12	2019	25	GE	3.6 SL	16.3	430.0	131.1
UL Advanced Wind Turbine Test Facility	TX	3.4	3.4	7	2018	1	Goldwind	GW 121/2500	23.5	426.0	129.8
White Cloud Wind Project, LLC	MO	236.5	236.5	12	2020	89	Siemens Gamesa	SG 2.7-129	13.0	423.0	128.9
Whitney Hill Wind Power LLC	IL	65.0	65.0	3	2020	24	GE	2.82-127	13.0	416.0	126.8
Diamond Vista Wind Project, LLC	KS	299.3	299.3	12	2018	95	Acciona	AW125/3000	25.0	410.0	125.0
Rattlesnake Creek Wind Project	NE	318.1	318.1	12	2018	101	Acciona	AW125/3000	25.0	410.0	125.0
Red Dirt Wind Project	OK	299.3	299.3	12	2017	95	Acciona	AW125/3150	25.0	410.0	125.0
Baron Winds Farm	NY	130.0	130.0	2	2023	32	Vestas	V150-4.2	16.3	403.5	123.0
Neosho Ridge Wind Energy Center	KS	294.4	294.4	5	2021	139	Vestas	V120-2.0	18.0	400.0	121.9
Kings Point Wind Energy Center	MO	145.6	145.6	4	2021	69	Vestas	V120-2.0	17.0	400.0	121.9
North Fork Ridge Wind Energy Center	MO	145.5	145.5	12	2020	69	Vestas	V120-2.0	17.0	400.0	121.9
High Lonesome Wind Power, LLC Hybrid	TX	449.5	449.5	7	2023	140	Acciona	AW132/3000	18.0	398.0	121.3
Chevelon Butte Phase 2	AZ	216.0	216.0	4	2024	48	Vestas	V150-4.2	14.8	394.0	120.1
Moraine Sands Wind Power	IL	165.0	165.0	12	2023	38	Vestas	V150-4.2	16.8	394.0	120.1
Chevelon Butte Wind Farm	AZ	238.2	238.2	5	2023	57	Vestas	V15	15.5	393.7	120.0
Sugar Creek Wind One LLC	IL	202.0	202.0	11	2020	114	Vestas	V150-4.2	15.6	393.7	120.0
Glass Sands Wind Facility	OK	118.3	118.3	11	2021	28	Vestas	V150-4.2	18.3	393.7	120.0
Sandy Ridge Wind 2, LLC	PA	87.6	87.6	9	2023	15	Vestas	V150-6.0	18.1	393.7	120.0
Reloj del Sol Wind Farm	TX	209.4	209.4	5	2021	51	Acciona	AW132/3000	16.3	393.7	120.0
Panorama Wind, LLC	CO	145.0	145.0	6	2022	66	Vestas	V120-2.2	20.0	393.0	119.8
Rockhaven Wind Project, LLC	OK	140.0	140.0	12	2021	49	Vestas	V120-2.2	27.0	393.0	119.8
White Rock West Wind Project	OK	99.5	99.5	12	2023	17	Vestas	V162-5.6	19.7	390.4	119.0
Ranchland Wind Project II	TX	148.0	148.0	4	2024	32	Vestas	V162-5.6	16.6	390.4	119.0
Deerfield Wind Energy 2	MI	112.1	112.1	3	2023	21	Vestas	V162-5.6	17.4	390.0	118.9
Horizon Hill Wind Project	OK	201.5	201.5	2	2024	34	Vestas	V162-5.6	18.0	390.0	118.9
White Rock East Wind Project	OK	201.5	201.5	1	2024	34	Vestas	V162-5.6	18.5	390.0	118.9
Weaver Wind	ME	72.6	72.6	12	2020	22	Vestas	V126-3.3	16.8	384.0	117.0

Limestone Wind Project	TX	299.2	299.2	12	2022	88	GE	3.8-137	16.8	384.0	117.0
Sapphire Sky Wind Energy LLC	IL	259.8	259.8	2	2023	64	Vestas	V150-4.2	18.3	383.9	117.0
Silver Maple	ME	20.0	20.0	10	2022	5	Vestas	V136-3.45	17.5	383.9	117.0
Eight Point Wind	NY	101.2	101.2	2	2023	25	GE	5.5-158	17.1	383.9	117.0
Babbitt Ranch Energy Center	AZ	163.0	163.0	7	2024	50	GE	3.4-140	16.2	383.0	116.7
Hilltopper Wind Project	IL	185.0	185.0	12	2018	74	GE	2.5-100	25.0	380.0	115.8
Thunder Ranch Wind Project	OK	297.8	297.8	12	2017	120	GE	2.5-116	26.0	380.0	115.8
Lincoln Land Wind	IL	302.0	302.0	11	2021	107	GE	2.82-127	17.4	374.0	114.0
High Banks Wind	KS	604.0	604.0	12	2023	233	GE	2.82-127	19.1	374.0	114.0
Sunflower Energy Center, LLC	KS	200.6	200.6	10	2023	76	GE	2.82-127	18.0	374.0	114.0
Cimarron Bend III	KS	198.8	198.8	12	2020	74	GE	2.82-127	22.0	374.0	114.0
Isabella Wind Park	MI	383.5	383.5	6	2021	136	GE	2.82-127	13.9	374.0	114.0
Walleye Wind	MN	110.0	110.0	12	2022	40	GE	2.82-127	12.0	374.0	114.0
Clearwater Wind I	MT	365.5	365.5	11	2022	131	GE	2.82-127	20.7	374.0	114.0
Clearwater Wind East	MT	207.9	207.9	1	2024	75	GE	2.82-127	22.0	374.0	114.0
Clearwater Wind II	MT	102.8	102.8	12	2023	37	GE	2.82-127	12.0	374.0	114.0
Clearwater Wind III	MT	100.0	100.0	9	2024	36	GE	2.82-127	10.1	374.0	114.0
Young Wind	TX	500.0	500.0	12	2022	177	GE	2.82-127	12.0	374.0	114.0
Canyon Wind Project, LLC	TX	308.8	308.8	1	2024	111	GE	2.82-127	17.2	374.0	114.0
Lacy Creek Wind Energy Center	TX	301.3	301.3	12	2022	108	GE	2.82-127	12.0	374.0	114.0
Roadrunner Wind Farm	TX	256.0	256.0	7	2024	91	GE	2.82-127	12.6	374.0	114.0
Pioneer Hutt Wind Energy	TX	140.0	140.0	1	2024	51	GE	2.82-127	12.0	374.0	114.0
Mesteno	TX	200.0	200.0	12	2019	56	Vestas	V136-3.45	15.0	367.0	111.9
Hidalgo Wind Farm II	TX	50.4	50.4	2	2020	14	Vestas	V136-3.6	19.0	367.0	111.9
Prevailing Wind Park	SD	220.0	220.0	3	2020	57	GE	3.8-137	20.0	365.8	111.5
Little Elk Wind Project LLC	OK	74.0	74.0	12	2015	34	Vestas	V110-2.0	27.0	361.0	110.0
Las Lomas Wind Project	TX	201.6	201.6	12	2020	48	Goldwind	GW155/4200	16.5	361.0	110.0
Rock Creek Wind Project	MO	300.0	300.0	11	2017	150	Vestas	V110-2.0	15.0	360.0	109.7
Frontier Windpower II	TX	351.8	351.8	2	2021	74	Nordex	N149/4.0-4.5	12.0	354.3	108.0
Azure Sky Wind Project, LLC Hybrid	TX	350.2	350.2	8	2024	79	Nordex	N149/4.0-4.5	16.7	354.3	108.0
Maryneal Windpower	TX	182.4	182.4	7	2021	38	Nordex	N149/4.0-4.5	12.3	354.3	108.0
Brazos Wind Farm	TX	182.4	182.4	12	2003	38	Nordex	N155/4800	17.4	354.0	107.9
Blackjack Creek Wind Farm	TX	239.6	239.6	5	2023	50	Vestas	V120-2.2	15.7	354.0	107.9
Oso Grande Wind Farm	NM	216.0	216.0	5	2021	48	Siemens Gamesa	SG 4.5-145	20.0	353.0	107.6
Roaring Brook, LLC	NY	79.7	79.7	10	2021	20	Siemens Gamesa	SG 4.5-145	16.8	352.7	107.5
Coyote Wind LLC	TX	242.5	242.5	1	2021	59	Siemens Gamesa	SG 4.5-145	15.6	352.7	107.5
Iron Star Wind Project	TX	297.6	297.6	12	2021	62	Nordex	N149/4.0-4.5	21.5	351.0	107.0
Dakota Range III Wind Project	TX	153.6	153.6	5	2021	32	Nordex	N149/4.0-4.5	20.6	351.0	107.0
Harvest Ridge Wind Farm	IL	202.0	202.0	7	2020	48	Vestas	V150-4.2	17.0	345.0	105.2
Timbermill Wind, LLC	NC	189.0	189.0	12	2024	45	Vestas	V150-4.2	13.4	345.0	105.2
Milligan 1 Wind Farm	NE	135.0	135.0	3	2021	30	Siemens Gamesa	SG 4.5-145	16.0	345.0	105.2
Number Three Wind Project	NY	106.0	106.0	5	2023	27	Vestas	V150-4.2	14.5	345.0	105.2

Indiana Crossroads Wind Farm II	TX	200.0	200.0	12	2024	42	Nordex	N155/4.5	19.0	345.0	105.2
Na Pua Makani Wind Project	HI	27.6	27.6	12	2020	9	Vestas	V136-3.45	14.0	344.5	105.0
Southern Hills Wind Farm	IA	250.0	250.0	3	2021	67	Vestas	V136-4.2	16.8	344.5	105.0
Diamond Trail Wind Farm	IA	250.0	250.0	12	2020	122	Vestas	V136-4.2	16.8	344.5	105.0
Prescott Wind Farm	IA	38.7	38.7	9	2024	9	Vestas	V150-4.2	17.3	344.5	105.0
Shady Oaks Wind 2	IL	108.3	108.3	10	2023	22	Vestas	V150-4.2	17.5	344.5	105.0
Caprock Wind Farm	NM	80.0	80.0	12	2004	60	Vestas	V150-4.2	18.5	344.5	105.0
Caprock Wind Farm	NM	20.0	20.0	5	2005	20	Vestas	V150-4.2	14.0	344.5	105.0
Wildhorse Mountain Wind Facility	OK	100.0	100.0	12	2019	29	Vestas	V136-3.45	19.4	344.5	105.0
Klondike Wind Power	OR	24.0	24.0	1	2002	16	Vestas	V150-4.2	16.8	344.5	105.0
Twin Ridges Wind Farm	PA	139.4	139.4	12	2012	68	Vestas	V110-2.0	19.0	344.5	105.0
Maverick Creek Wind	TX	491.6	491.6	3	2022	127	Vestas	V150-4.2	16.7	344.5	105.0
Ranchland Wind Project I	TX	114.9	114.9	4	2024	31	Vestas	V150-4.2	16.5	344.5	105.0
Crossing Trails Wind Power Project LLC.	CO	104.0	104.0	4	2021	25	Vestas	V150-4.2	20.8	344.4	105.0
Indiana Crossroads Wind Farm LLC	IN	302.4	302.4	12	2021	72	Vestas	V150-4.2	20.0	344.4	105.0
Bluestone Wind, LLC	NY	111.8	111.8	10	2023	24	Vestas	V150-4.2	14.7	344.4	105.0
Helena Wind	TX	268.2	268.2	6	2022	180	Vestas	V150-4.2	16.0	344.4	105.0
Colorado Green Holdings LLC	CO	162.0	162.0	12	2003	51	Vestas	V150-4.2	15.9	344.0	104.9
Ledyard Windpower, LLC	IA	200.0	200.0	12	2022	46	Vestas	V150-4.2	18.3	344.0	104.9
Glacier Sands Wind Power, LLC	IL	185.0	185.0	11	2021	43	Vestas	V150-4.2	16.8	344.0	104.9
Midland Wind	IL	105.5	105.5	12	2023	28	Vestas	V150-4.2	22.0	344.0	104.9
Rosewater Wind Farm	IN	102.0	102.0	12	2020	25	Vestas	V150-4.2	17.0	344.0	104.9
Caney River Wind Project	KS	200.0	200.0	1	2012	111	Vestas	V90-1.8	23.0	344.0	104.9
Golden Hill Wind	OR	201.3	201.3	4	2022	51	Vestas	V150-4.2	15.9	344.0	104.9
Aurora Wind Project	TX	298.8	298.8	1	2021	71	Nordex	N149/4.0-4.5	27.0	344.0	104.9
El Campo Wind	TX	242.8	242.8	12	2020	67	Vestas	V150-4.2	16.8	344.0	104.9
Haystack Wind Project, LLC	NE	298.0	298.0	3	2022	69	Siemens Gamesa	SG 5.0-145	19.5	336.3	102.5
Reading Wind Project	KS	200.1	200.1	5	2020	64	Siemens Gamesa	G132-3.465	17.9	333.0	101.5
Deerfield Wind Energy, LLC	MI	74.5	74.5	2	2017	36	Vestas	V110-2.0	14.8	331.0	100.9
Deerfield Wind Energy, LLC	MI	41.6	41.6	2	2017	20	Vestas	V110-2.0	14.8	331.0	100.9
Deerfield Wind Energy, LLC	MI	32.9	32.9	2	2017	16	Vestas	V110-2.0	14.8	331.0	100.9
Minonk Wind Farm	IL	192.3	192.3	11	2012	100	Gamesa	G90-2.0	18.3	328.1	100.0
California Ridge Wind Energy LLC	IL	200.0	200.0	12	2012	134	GE	1.6-100	18.1	328.1	100.0
Bishop Hill Energy LLC	IL	200.0	200.0	6	2012	133	GE	1.6-97	16.1	328.1	100.0
Shady Oaks Wind Farm	IL	109.5	109.5	5	2012	71	Goldwind	GW 82/1500	17.0	328.1	100.0
Sandy Ridge Wind Farm	PA	48.2	48.2	2	2012	25	Gamesa	G90-2.0	17.6	328.1	100.0
Chestnut Flats Wind Farm	PA	38.0	38.0	12	2011	19	Gamesa	G90-2.0	19.0	328.1	100.0
Senate Wind LLC	TX	150.0	150.0	12	2012	75	Gamesa	G90-2.0	18.1	328.1	100.0
Highland North Wind Farm	TX	75.0	75.0	3	2012	30	Nordex	N100/2500	19.0	328.1	100.0
Fair Wind	TX	30.0	30.0	11	2015	12	Nordex	N100/2500	17.7	328.1	100.0
Anchor Wind, LLC	IA	5.9	5.9	10	2012	2	Acciona	AW116/3000	16.5	328.0	100.0

Pocahontas Prairie Wind Farm	IA	80.0	80.0	2	2012	40	Gamesa	G97-2.0	20.0	328.0	100.0
Com Adam 1WF-1	IL	2.5	2.5	10	2007	1	Clipper	Liberty C96	17.0	328.0	100.0
Bishop Hill II Wind Farm	IL	81.0	81.0	10	2012	50	GE	1.6-100	16.8	328.0	100.0
Wildcat Wind Farm I, LLC	IN	200.0	200.0	12	2012	125	GE	1.6 XLE	18.1	328.0	100.0
Buffalo Dunes Wind Project	KS	249.8	249.8	12	2013	135	GE	1.85-82.5	24.0	328.0	100.0
Cimarron Bend Wind Project II, LLC	KS	200.0	200.0	3	2017	100	Vestas	V100-2.0	22.0	328.0	100.0
Smoky Hills Wind Project Phase I	KS	100.8	100.8	12	2008	56	Vestas	V80-1.8	24.0	328.0	100.0
Holiday Hill Community Wind	MA	5.0	5.0	12	2019	2	Goldwind	GW 109/2500	14.5	328.0	100.0
Gratiot County Wind LLC	MI	110.4	110.4	5	2012	69	GE	1.6 XLE	14.5	328.0	100.0
Gratiot Wind Park	MI	102.0	102.0	11	2011	64	GE	1.6 XLE	17.0	328.0	100.0
Brookfield	MI	74.8	74.8	2	2014	44	GE	1.6-100	17.0	328.0	100.0
Sigel Wind Park	MI	64.0	64.0	12	2012	40	GE	1.6-100	17.0	328.0	100.0
Echo Wind Park	MI	62.4	62.4	12	2014	39	GE	1.6-100	17.0	328.0	100.0
Echo Wind Park	MI	50.0	50.0	12	2016	30	GE	1.6-100	17.0	328.0	100.0
Echo Wind Park	MI	49.6	49.6	1	2014	31	GE	1.6-100	17.0	328.0	100.0
Minden Wind Park	MI	32.0	32.0	12	2012	20	GE	1.6-100	17.0	328.0	100.0
McKinley Wind Park	MI	14.0	14.0	12	2012	9	GE	1.6-100	17.0	328.0	100.0
Prairie Rose Wind Farm	MN	200.0	200.0	12	2012	119	GE	1.68-82.5	24.0	328.0	100.0
Lindahl Wind Project, LLC	ND	150.0	150.0	3	2017	75	Vestas	V100-2.0	15.0	328.0	100.0
Hardscrabble Wind Power LLC	NY	74.0	74.0	1	2011	37	Gamesa	G90-2.0	16.0	328.0	100.0
Blue Creek Wind Project	OH	302.0	302.0	12	2011	152	Gamesa	G90-2.0	16.5	328.0	100.0
Chisholm View Wind Project	OK	235.2	235.2	12	2012	140	GE	1.68-82.5	24.0	328.0	100.0
Rocky Ridge Wind Project	OK	148.8	148.8	8	2012	93	GE	1.62-100	24.0	328.0	100.0
Chisholm View Wind Project	OK	64.8	64.8	12	2016	27	GE	1.68-82.5	24.0	328.0	100.0
Goodwell Wind Project LLC	OK	200.0	200.0	12	2015	100	Vestas	V100-2.0	27.0	328.0	100.0
Mehoopany Wind Energy LLC	PA	140.8	140.8	12	2012	88	GE	1.6-82.5	19.0	328.0	100.0
Javelina Wind Energy II, LLC	TX	200.0	200.0	11	2016	100	GE	2.0-116	13.0	328.0	100.0
Rippey Wind Farm	TX	50.0	50.0	8	2012	20	Nordex	N100/2500	19.0	328.0	100.0
Elk Wind Farm	TX	40.8	40.8	12	2011	17	Nordex	N100/2500	19.0	328.0	100.0
Fourmile Ridge	TX	40.0	40.0	12	2014	16	Nordex	N100/2500	17.3	328.0	100.0
Hawkeye Wind Farm	TX	34.0	34.0	10	2012	15	Nordex	N100/2500	19.0	328.0	100.0
Community Wind South	TX	30.0	30.0	12	2012	15	REpower	MM92	20.0	328.0	100.0
Keechi Wind	TX	110.0	110.0	1	2015	55	Vestas	V100-2.0	19.0	328.0	100.0
Cashton Greens Wind Farm	WI	4.8	4.8	5	2012	2	Clipper	Liberty C96	15.0	328.0	100.0
Kawailoa Wind	TX	69.0	69.0	11	2012	30	Siemens	SWT-2.3-101	13.0	326.0	99.4
Bright Stalk Wind Farm I	IL	205.2	205.2	12	2019	57	Vestas	V136-3.45	18.2	325.0	99.1
Castle Gap Wind	TX	196.8	196.8	10	2023	41	Nordex	N149/4.0-4.5	17.5	324.0	98.8
Wind Colebrook South	CT	5.0	5.0	11	2015	2	GE	2.85-103	18.7	322.0	98.1
Borderlands Wind, LLC	NM	100.0	100.0	12	2021	34	GE	2.82-127	15.0	322.0	98.1
GE-Lubbock	TX	3.4	3.4	4	2021	1	GE	3.8-137	15.0	322.0	98.1
Red Barn Energy	WI	91.6	91.6	4	2023	28	GE	3.4-140	16.0	322.0	98.1
Anticline Wind	WY	124.3	124.3	12	2024	38	GE	3.4-140	13.2	322.0	98.1
Great Pathfinder Wind	IA	224.4	224.4	2	2023	66	GE	3.2-103	17.4	321.5	98.0
Diversion Wind Energy LLC	TX	102.0	102.0	12	2024	30	GE	3.4-140	7.3	321.5	98.0

Diversion Wind Energy LLC	TX	98.6	98.6	12	2024	29	GE	3.4-140	7.3	321.5	98.0
Boswell Wind	WY	329.8	329.8	12	2024	97	GE	3.4-140	22.1	321.5	98.0
Stoney Corners Wind Farm	TX	59.0	59.0	12	2009	29	Senvion	MM92	15.2	320.0	97.5
Emmons-Logan Wind, LLC	ND	200.0	200.0	12	2019	123	GE	1.7-103	22.0	315.0	96.0
Brady II Wind Energy Center	ND	150.0	150.0	12	2016	72	GE	2.0-116	19.0	315.0	96.0
Brady Wind Energy Center	ND	150.0	150.0	11	2016	87	GE	1.79-100	19.0	315.0	96.0
Cross Winds Energy Park	MI	111.0	111.0	12	2014	62	GE	1.7-100	17.0	314.9	96.0
Orient Wind Farm	IA	400.0	400.0	12	2019	193	Vestas	V110-2.0	16.8	312.0	95.1
Arbor Hill Wind Farm	IA	250.0	250.0	12	2018	125	Vestas	V110-2.0	16.8	312.0	95.1
North English	IA	200.0	200.0	12	2018	100	Vestas	V110-2.0	16.8	312.0	95.1
Beaver Creek Wind	IA	170.0	170.0	12	2017	85	Vestas	V110-2.0	16.8	312.0	95.1
Beaver Creek Wind	IA	170.0	170.0	10	2018	85	Vestas	V110-2.0	16.8	312.0	95.1
Prairie Wind Farm	IA	169.0	169.0	1	2018	84	Vestas	V110-2.0	16.8	312.0	95.1
North English	IA	140.0	140.0	12	2019	140	Vestas	V110-2.0	16.8	312.0	95.1
Orient Wind Farm	IA	100.0	100.0	12	2018	51	Vestas	V110-2.0	16.8	312.0	95.1
Arbor Hill Wind Farm	IA	60.0	60.0	2	2020	17	Vestas	V110-2.0	16.8	312.0	95.1
Walnut Ridge Wind Farm	IL	212.0	212.0	12	2018	106	Vestas	V100-2.0	15.7	312.0	95.1
Marshall Wind Farm	KS	72.0	72.0	5	2016	36	Vestas	V110-2.0	15.6	312.0	95.1
Bull Hill Wind Project	ME	34.5	34.5	10	2012	19	Vestas	V100-1.8	17.0	312.0	95.1
Pisgah Mountain Wind	ME	9.1	9.1	12	2016	5	Vestas	V90-1.8	15.7	312.0	95.1
Pleasant Valley Wind Farm	MN	195.8	195.8	8	2015	100	Vestas	V100-2.0	18.0	312.0	95.1
Border Winds Wind Farm	ND	147.9	147.9	8	2015	75	Vestas	V100-2.0	18.0	312.0	95.1
Grande Prairie Wind Farm	NE	400.0	400.0	12	2016	200	Vestas	V100-2.0	15.6	312.0	95.1
Copenhagen Wind Farm	NY	79.9	79.9	12	2018	40	Vestas	V110-2.0	15.0	312.0	95.1
Arkwright Summit Wind Farm LLC	NY	78.4	78.4	8	2018	36	Vestas	V110-2.0	19.0	312.0	95.1
Hog Creek Wind Project	OH	66.0	66.0	12	2017	30	Vestas	V110-2.0	14.5	312.0	95.1
Flat Top Wind I	TX	200.0	200.0	1	2018	100	Vestas	V110-2.0	15.5	312.0	95.1
Palo Alto Wind Farm	IA	250.0	250.0	1	2020	125	Vestas	V110-2.0	16.8	311.7	95.0
Palo Alto Wind Farm	IA	90.0	90.0	12	2020	45	Vestas	V110-2.0	16.8	311.7	95.0
Michigan Wind 2	MI	90.0	90.0	12	2011	50	Vestas	V100-1.8	15.1	311.7	95.0
Harvest 2	MI	59.4	59.4	11	2012	33	Vestas	V100-1.8	14.9	311.7	95.0
Timber Road IV	OH	125.1	125.1	1	2020	31	Vestas	V150-4.2	16.8	311.7	95.0
Paulding Wind Farm II	OH	99.0	99.0	7	2011	55	Vestas	V100-1.8	16.8	311.7	95.0
Radfords Run Wind Farm	IL	278.0	278.0	12	2017	139	Vestas	V110-2.0	14.5	311.6	95.0
Hoopeston Wind LLC	IL	98.0	98.0	3	2015	49	Vestas	V100-2.0	17.0	311.0	94.8
Headwaters Wind Farm LLC	IN	200.0	200.0	12	2014	100	Vestas	V110-2.0	16.7	311.0	94.8
Meadow Lake Wind Farm V LLC	IN	100.0	100.0	7	2017	56	Vestas	V110-2.0	19.0	311.0	94.8
Lake Winds Energy Park	MI	100.8	100.8	11	2012	56	Vestas	V100-1.8	16.7	311.0	94.8
Quilt Block Wind Farm LLC	WI	98.0	98.0	9	2017	49	Vestas	V110-2.0	12.0	311.0	94.8
Saratoga Wind Farm	IA	66.0	66.0	2	2019	33	Vestas	V116-2.1	17.2	308.0	93.9
Cross Winds Energy Park	MI	75.9	75.9	12	2019	33	GE	2.3-116	17.0	308.0	93.9
Cross Winds Energy Park	MI	44.0	44.0	1	2018	19	GE	2.3-116	17.0	308.0	93.9
Marble River Wind Farm	NY	215.3	215.3	11	2012	70	Vestas	V112-3.0	19.0	308.0	93.9

Wildcat Creek Wind Farm LLC	TX	175.3	175.3	7	2021	51	Gamesa	G126-2.5	17.0	308.0	93.9
Torrecillas Wind Energy, LLC	TX	300.0	300.0	2	2019	121	GE	2.5-120	13.2	308.0	93.9
La Joya NM	NM	141.2	141.2	6	2021	52	Siemens Gamesa	SG 2.6-114	19.9	305.1	93.0
Cassadaga Wind Farm	TX	124.0	124.0	7	2021	37	Nordex	N117/3000	16.6	305.1	93.0
Waverly Wind Farm LLC	KS	199.0	199.0	1	2016	95	Gamesa	G114-2.0	19.0	305.0	93.0
Big Turtle Wind Farm 2	MI	29.4	29.4	10	2016	14	Gamesa	G114-2.0	16.7	305.0	93.0
Big Turtle Wind Farm, LLC	MI	20.0	20.0	12	2014	10	Gamesa	G114-2.0	16.7	305.0	93.0
Desert Wind Farm, LLC	NC	208.0	208.0	12	2016	104	Gamesa	G114-2.0	12.9	305.0	93.0
Jericho Rise Wind Farm LLC	NY	77.7	77.7	12	2016	37	Gamesa	G114-2.0	16.7	305.0	93.0
Paulding Wind Farm III	OH	100.8	100.8	12	2016	48	Gamesa	G114-2.0	16.7	305.0	93.0
Bison 4 Wind Energy Center	TX	201.8	201.8	1	2015	63	Siemens	SWT-3.2-113	20.1	303.5	92.5
BMP Wind (TX)	TX	340.0	340.0	12	2021	68	Siemens Gamesa	SG 4.5-145	14.0	303.0	92.4
Green Pastures Wind I	TX	150.0	150.0	4	2015	50	Acciona	AW116/3000	12.0	302.0	92.1
Green Pastures Wind II	TX	150.0	150.0	10	2015	50	Acciona	AW116/3000	12.0	302.0	92.1
Antrim Wind	TX	28.8	28.8	12	2019	9	Siemens	SWT-3.2-113	16.8	302.0	92.1
Las Majadas Wind Farm	TX	272.6	272.6	3	2021	125	Vestas	V120-2.2	15.0	302.0	92.1
West Raymond Wind Farm LLC	TX	239.8	239.8	10	2021	109	Vestas	V120-2.2	16.6	302.0	92.1
Raymond Wind Farm, LLC	TX	200.2	200.2	6	2021	91	Vestas	V120-2.2	16.8	302.0	92.1
Cranell Wind Farm LLC	TX	220.0	220.0	1	2022	100	Vestas	V120-2.2	14.5	301.8	92.0
El Algodon Alto Wind Farm, LLC	TX	200.2	200.2	5	2022	91	Vestas	V120-2.2	16.3	301.8	92.0
Clear Creek Wind	MO	220.0	220.0	5	2020	100	Vestas	V120-2.0	16.8	301.2	91.8
Bluff Point Wind Facility	IN	119.7	119.7	12	2017	56	GE	2.0-116	18.0	301.0	91.7
Osborn Wind Energy	MO	195.8	195.8	12	2016	97	GE	2.0-116	18.0	301.0	91.7
High Prairie Wind Farm	MO	375.5	385.4	12	2020	175	Vestas	V120-2.2	15.4	301.0	91.7
Oliver Wind III, LLC	ND	99.3	99.3	1	2017	48	GE	2.0-116	19.0	301.0	91.7
Coachella Hills Wind	CA	61.2	61.2	3	2021	17	Vestas	V117-3.45	22.0	300.2	91.5
Painted Hills Wind Park	CA	46.8	46.8	4	2021	13	Vestas	V112-3.45	22.0	300.2	91.5
Bluestem	OK	198.0	198.0	12	2016	60	Vestas	V117-3.3	19.4	300.2	91.5
Sky River Wind Energy Center	CA	60.2	60.2	9	2021	21	Siemens Gamesa	SG 2.9-129	23.0	300.0	91.4
Mesa Wind Repower	CA	30.0	30.0	6	2024	8	Vestas	V117-4.2	21.6	300.0	91.4
Bloom Wind	KS	178.2	178.2	6	2017	54	Vestas	V117-3.3	21.3	300.0	91.4
Ipswich Wind Turbine	MA	1.6	1.6	5	2011	1	GE	1.6-82.5	15.3	300.0	91.4
Milo Wind Project LLC	NM	50.0	50.0	1	2016	25	Vestas	V100-2.0	20.4	300.0	91.4
Beebe 1B	TX	50.4	50.4	12	2014	21	Nordex	N117/2400	13.7	299.0	91.1
Beebe 1A	TX	81.6	81.6	12	2012	34	Nordex	N117/2400	13.5	298.6	91.0
Thunder Spirit Wind, LLC	TX	48.0	48.0	10	2018	16	Nordex	N117/3000	17.9	298.6	91.0
Buckthorn Wind	TX	100.5	100.5	12	2017	29	Vestas	V126-3.45	16.7	298.0	90.8
Cimarron Wind Energy LLC	TX	165.6	165.6	11	2012	72	Siemens	SWT-2.3-108	14.0	297.0	90.5
Summit Winds	CA	46.2	46.2	7	2021	19	GE	2.5-116	17.0	295.3	90.0
Whispering Willow North	IA	201.3	201.3	1	2020	81	GE	2.5-127	17.0	295.3	90.0
Meadow Creek Project Company	ID	115.8	115.8	12	2012	57	Suzlon	S97-2100	17.9	295.3	90.0
High Mesa	ID	39.9	39.9	12	2012	19	Suzlon	S97-2100	14.6	295.3	90.0
Bishop Hill III	IL	119.0	119.0	6	2018	53	GE	2.3-116	27.0	295.3	90.0

Soldier Creek Wind	KS	300.0	300.0	11	2020	120	GE	2.5-103	17.2	295.3	90.0
Palmer's Creek Wind Farm, LLC	MN	44.6	44.6	12	2018	18	GE	2.5-120	16.0	295.3	90.0
Gordon Butte Wind LLC	MT	2.7	2.7	12	2018	1	GE	2.5-116	21.0	295.3	90.0
Gordon Butte Wind LLC	MT	2.7	2.7	12	2018	1	GE	2.5-116	21.0	295.3	90.0
Gordon Butte Wind LLC	MT	2.7	2.7	12	2018	1	GE	2.5-116	21.0	295.3	90.0
Upstream Wind Energy LLC	NE	202.5	202.5	12	2018	81	GE	2.3-116	12.4	295.3	90.0
Kimball Wind	NE	30.0	30.0	6	2018	12	GE	2.5-116	18.5	295.3	90.0
Wildcat Wind	NM	27.3	27.3	7	2012	13	Suzlon	S97-2100	17.8	295.3	90.0
Caddo Wind	OK	303.2	303.2	1	2022	110	GE	2.82-127	17.8	295.3	90.0
Wheatridge Hybrid	OR	200.0	200.0	11	2020	126	GE	2.52-116	22.6	295.3	90.0
Patton Wind Farm	PA	30.0	30.0	12	2012	15	Gamesa	G97-2.0	16.8	295.3	90.0
Ringer Hill Wind Farm, LLC	PA	38.3	38.3	12	2016	14	GE	2.85-103	19.0	295.3	90.0
WED Green Hill, LLC	RI	3.0	3.0	1	2019	1	VENSYS	VENSYS120	12.3	295.3	90.0
WED Plainfield II, LLC	RI	3.0	3.0	1	2019	1	VENSYS	VENSYS120	12.8	295.3	90.0
WED Plainfield III, LLC	RI	3.0	3.0	1	2019	1	VENSYS	VENSYS120	12.0	295.3	90.0
WED Plainfield, LLC	RI	3.0	3.0	1	2019	1	VENSYS	VENSYS120	12.4	295.3	90.0
WED Shun I, LLC	RI	3.0	3.0	1	2019	1	VENSYS	VENSYS120	12.0	295.3	90.0
WED Shun II, LLC	RI	3.0	3.0	1	2019	1	VENSYS	VENSYS120	12.7	295.3	90.0
WED Shun III, LLC	RI	3.0	3.0	1	2019	1	VENSYS	VENSYS120	12.8	295.3	90.0
Willow Springs Wind Farm	TX	250.0	250.0	11	2017	110	GE	2.5-120	16.2	295.3	90.0
Boiling Springs Wind Farm	OK	148.4	148.4	12	2020	60	GE	2.3-116	18.9	295.2	90.0
Mohave County Wind Farm	AZ	350.0	350.0	12	2020	126	GE	2.82-127	17.9	295.0	89.9
Golden Hills North Wind Energy Center	CA	46.0	46.0	11	2017	20	GE	2.3-107	18.0	295.0	89.9
Upland Prairie	IA	299.3	299.3	3	2019	121	GE	2.5-116	17.7	295.0	89.9
Heartland Divide II	IA	200.0	200.0	3	2022	72	GE	2.82-127	12.0	295.0	89.9
Golden Plains	IA	199.8	199.8	3	2020	82	GE	2.5-127	17.0	295.0	89.9
Richland (IA)	IA	130.9	130.9	9	2020	53	GE	2.5-127	17.0	295.0	89.9
Cerro Gordo Wind Farm	IA	42.0	42.0	8	2020	13	GE	2.72-116	17.0	295.0	89.9
East Fork Wind Project, LLC	KS	195.8	195.8	3	2020	72	GE	2.72-116	19.9	295.0	89.9
Future Generation Wind	MA	7.9	7.9	8	2016	4	Gamesa	G97-2.0	15.0	295.0	89.9
Pine River Wind Park	MI	161.3	161.3	3	2019	65	GE	2.5-116	13.4	295.0	89.9
Glen Ullin Energy Center	ND	106.7	106.7	12	2019	43	GE	2.5-116	19.3	295.0	89.9
Thunderhead Wind Energy LLC	NE	300.0	300.0	11	2022	108	GE	2.82-127	14.0	295.0	89.9
Cottonwood Wind Energy Center	NE	89.7	89.7	11	2017	40	GE	2.3-107	19.0	295.0	89.9
Perennial Windfarm	NE	2.3	2.3	7	2018	1	GE	2.3-116	18.6	295.0	89.9
Perennial Windfarm	NE	2.3	2.3	7	2018	1	GE	2.3-116	18.6	295.0	89.9
Perennial Windfarm	NE	2.3	2.3	7	2018	1	GE	2.3-116	18.6	295.0	89.9
Northwest Ohio Wind	OH	100.0	100.0	9	2018	42	GE	2.5-116	16.1	295.0	89.9
Traverse Wind Project, LLC	OK	999.0	999.0	4	2022	356	GE	2.82-127	15.9	295.0	89.9
Origin Wind	OK	150.0	150.0	11	2014	75	Vestas	V100-2.0	27.0	295.0	89.9
Triple H Wind Project	SD	250.2	250.2	11	2020	92	GE	2.7-116	20.1	295.0	89.9
Crocker Wind Farm	SD	200.0	200.0	11	2019	77	GE	2.0-116	19.5	295.0	89.9

Crowned Ridge Wind II Energy Center	SD	192.2	192.2	12	2020	88	GE	2.3-116	19.2	295.0	89.9
Baffin Wind	TX	188.0	188.0	12	2014	101	Gamesa	G97-2.0	15.7	295.0	89.9
High Lonesome Wind Power, LLC Hybrid	TX	50.0	50.0	7	2023	22	GE	2.3-116	18.0	295.0	89.9
Roundhouse Wind Energy Project	WY	124.0	124.0	6	2020	44	GE	2.82-127	12.9	295.0	89.9
Roundhouse Wind Energy Project	WY	79.0	79.0	6	2020	28	GE	2.82-127	12.9	295.0	89.9
Roundhouse Wind Energy Project	WY	23.0	23.0	6	2020	10	GE	2.82-127	12.9	295.0	89.9
Foundation Dole Fresh Vegetables	CA	2.8	2.8	8	2022	1	GE	2.5-127	14.5	292.0	89.0
Foundation Dole Fresh Vegetables	CA	2.8	2.8	8	2022	1	GE	2.5-127	14.5	292.0	89.0
Bronco Plains Wind, LLC	CO	299.0	299.0	9	2020	108	GE	2.85-100	19.5	292.0	89.0
Glaciers Edge Wind Project	IA	200.0	200.0	12	2019	82	GE	2.5-127	18.6	292.0	89.0
Plymouth Wind	IA	200.0	200.0	1	2022	73	GE	2.82-127	18.5	292.0	89.0
Ida Grove II	IA	200.0	200.0	12	2019	81	GE	2.5-127	18.2	292.0	89.0
Contrail Wind Farm	IA	110.0	110.0	12	2020	41	GE	2.82-127	17.6	292.0	89.0
CED Manchester Wind	IA	7.9	7.9	4	2022	3	GE	2.82-127	19.0	292.0	89.0
CED Centerville Wind	IA	7.9	7.9	12	2021	3	GE	2.82-127	19.0	292.0	89.0
CED Mason City Wind	IA	7.9	7.9	5	2020	3	GE	2.82-127	19.0	292.0	89.0
Blooming Grove Wind Energy Center	IL	250.0	250.0	12	2020	94	GE	2.82-127	17.2	292.0	89.0
Cardinal Point Wind	IL	150.0	150.0	3	2020	60	GE	2.82-127	17.0	292.0	89.0
Ford County Wind Farm LLC	IL	121.3	121.3	3	2022	43	GE	2.82-127	18.1	292.0	89.0
Lone Tree Wind, LLC	IL	79.0	79.0	12	2020	32	GE	2.5-127	17.4	292.0	89.0
Jordan Creek Wind Farm, LLC	IN	398.6	398.6	12	2020	156	GE	2.82-127	12.0	292.0	89.0
Irish Creek Wind	KS	300.6	300.6	12	2021	108	GE	2.3-116	15.6	292.0	89.0
Heartland Farms	MI	200.0	200.0	4	2024	72	GE	2.82-127	12.0	292.0	89.0
Polaris Wind Park	MI	168.6	168.6	5	2020	68	GE	2.5-127	13.2	292.0	89.0
Crescent Wind Park	MI	150.0	150.0	2	2021	60	GE	2.82-127	17.5	292.0	89.0
Gratiot Farms Wind Project	MI	150.0	150.0	12	2020	60	GE	2.5-127	17.7	292.0	89.0
Buffalo Ridge Wind	MN	101.9	101.9	12	2022	40	GE	2.82-127	12.0	292.0	89.0
Oliver Wind IV	ND	198.8	198.8	12	2024	73	GE	2.82-127	18.5	292.0	89.0
SPPW1, LLC	NE	2.8	2.8	7	2022	1	GE	2.82-127	18.1	292.0	89.0
SPPW1, LLC	NE	2.8	2.8	7	2022	1	GE	2.82-127	18.1	292.0	89.0
Polk County Renewables, LLC	NE	2.5	2.5	12	2018	1	GE	2.5-120	19.1	292.0	89.0
Cuming County Renewables, LLC	NE	2.5	2.5	12	2019	1	GE	2.5-120	18.7	292.0	89.0
Red Cloud Wind LLC	NM	350.0	350.0	12	2021	124	GE	2.82-127	20.0	292.0	89.0
Clines Corners Wind Farm LLC	NM	325.0	325.0	12	2021	106	GE	2.82-127	20.0	292.0	89.0
La Joya NM	NM	165.0	165.0	2	2021	59	GE	2.82-127	19.5	292.0	89.0
Duran Mesa LLC	NM	105.0	105.0	12	2021	38	GE	2.82-127	19.0	292.0	89.0
Seven Cowboy Wind Project, LLC	OK	301.7	301.7	3	2023	107	GE	2.82-127	20.0	292.0	89.0
Deuel Harvest Wind Energy LLC	SD	300.0	300.0	2	2021	109	GE	2.82-127	19.0	292.0	89.0
Tatanka Ridge	SD	154.0	154.0	1	2021	56	GE	2.82-127	17.8	292.0	89.0
Coyote Ridge	SD	97.4	97.4	12	2019	39	GE	2.5-127	19.0	292.0	89.0
Great Prairie Wind	TX	1,027.0	1,027.0	11	2022	365	GE	2.82-127	19.8	292.0	89.0

Sage Draw Wind	TX	338.4	338.4	8	2021	120	GE	2.82-127	15.7	292.0	89.0
Tahoka Wind	TX	300.0	300.0	12	2018	120	GE	2.5-120	18.5	292.0	89.0
Amadeus Wind Farm	TX	250.0	250.0	12	2020	96	GE	2.82-127	15.0	292.0	89.0
Griffin Trail Wind	TX	225.6	225.6	7	2021	80	GE	2.82-127	17.1	292.0	89.0
Seymour Hills Wind Project, LLC	TX	30.2	30.2	5	2019	12	GE	2.5-120	18.8	292.0	89.0
Rattlesnake Flat	WA	144.0	144.0	12	2020	57	Siemens Gamesa	SG 2.7-129	16.2	292.0	89.0
Cedar Springs II	WY	198.8	198.8	12	2020	72	GE	2.82-127	19.0	292.0	89.0
Corriedale Wind Energy	WY	52.5	52.5	11	2020	21	GE	2.5-127	20.0	292.0	89.0
Bitter Ridge Wind Farm, LLC	IN	130.0	130.0	9	2020	52	GE	2.82-127	14.7	291.9	89.0
Sweetland Wind Farm, LLC	SD	200.0	200.0	10	2023	71	GE	2.82-127	19.9	291.9	89.0
White Mesa Wind	TX	500.6	500.6	10	2021	180	GE	2.82-127	12.4	291.9	89.0
Ranchero Wind Farm LLC	TX	300.0	300.0	9	2019	120	GE	2.5-127	18.3	291.9	89.0
Hubbard Wind	TX	300.0	300.0	11	2021	108	GE	2.82-127	13.4	291.9	89.0
Heart of Texas Wind Project	TX	180.0	180.0	5	2020	64	GE	2.82-127	19.2	291.9	89.0
Sac County Wind, LLC	IA	80.0	80.0	12	2021	29	GE	2.82-127	22.4	291.0	88.7
Plum Creek Wind Project (NE)	NE	230.0	230.0	6	2020	82	GE	2.82-127	18.3	291.0	88.7
Willow Creek Wind Power LLC	SD	103.5	103.5	9	2020	38	GE	2.82-127	19.2	291.0	88.7
Inertia Wind Project	TX	301.0	301.0	1	2023	108	GE	2.82-127	12.0	291.0	88.7
Blue Summit III Wind	TX	200.2	200.2	12	2019	82	GE	2.5-100	18.0	291.0	88.7
Appaloosa Run Wind	TX	171.8	171.8	12	2022	62	GE	2.82-127	12.0	291.0	88.7
GE-Lubbock	TX	3.8	3.8	2	2015	1	GE	2.75-120	15.0	291.0	88.7
Cedar Springs I	WY	200.0	200.0	12	2020	72	GE	2.82-127	12.0	291.0	88.7
Cedar Springs III	WY	133.0	133.0	12	2020	48	GE	2.82-127	12.0	291.0	88.7
Roundhouse Renewable Energy II	WY	105.7	105.7	12	2023	38	GE	2.82-127	12.0	291.0	88.7
Beech Ridge II Wind Energy Center	WV	56.2	56.2	5	2020	20	GE	2.82-127	17.2	290.4	88.5
Bennington Wind	IL	93.0	93.0	10	2021	33	GE	2.82-127	17.5	290.3	88.5
South Peak Wind	MT	80.0	80.0	4	2020	29	GE	2.82-127	16.3	290.0	88.4
Diamond Spring, LLC	OK	303.5	303.5	12	2020	112	GE	2.3-116	15.9	290.0	88.4
Skeleton Creek Energy Center Hybrid	OK	250.0	250.0	12	2020	95	GE	2.82-127	16.5	290.0	88.4
King Plains Wind Project	OK	248.2	248.2	11	2020	88	GE	2.82-127	17.7	290.0	88.4
Jumbo Hill Wind Project	TX	160.7	160.7	3	2020	57	GE	2.82-127	17.7	290.0	88.4
Meridian Wind Park	MI	225.0	225.0	4	2023	77	GE	2.82-127	17.6	289.0	88.1
Heritage Garden Wind Farm I LLC	MI	28.0	28.0	9	2012	14	Gamesa	G97-2.0	16.2	288.0	87.8
Michelangelo Wind 3 LLC	IA	3.0	3.0	2	2017	1	Acciona	AW125/3000	22.8	287.0	87.5
Optimum Wind 5 LLC	IA	3.0	3.0	3	2017	1	Acciona	AW125/3000	22.8	287.0	87.5
Optimum Wind 6 LLC	IA	3.0	3.0	3	2017	1	Acciona	AW125/3000	22.8	287.0	87.5
Optimum Wind 7 LLC	IA	3.0	3.0	3	2017	1	Acciona	AW125/3000	22.8	287.0	87.5
Optimum Wind 4 LLC	IA	3.0	3.0	3	2017	1	Acciona	AW125/3000	16.8	287.0	87.5
Optimum Wind 3 LLC	IA	3.0	3.0	3	2017	1	Acciona	AW125/3000	16.8	287.0	87.5
Leonardo Wind 1 LLC	IA	3.0	3.0	12	2016	1	Acciona	AW125/3000	16.7	287.0	87.5
Venus Wind 3 LLC	IA	3.0	3.0	3	2017	1	Acciona	AW125/3000	22.8	287.0	87.5
Michelangelo Wind 1 LLC	IA	3.0	3.0	3	2017	1	Acciona	AW125/3000	22.8	287.0	87.5

Michelangelo Wind 4 LLC	IA	3.0	3.0	12	2016	1	Acciona	AW125/3000	16.7	287.0	87.5
Chapman Ranch Wind I	TX	249.0	249.0	10	2017	81	Acciona	AW125/3000	15.4	287.0	87.5
Bruennings Breeze Wind Farm	TX	228.0	228.0	12	2017	76	Acciona	AW100/3000	17.1	287.0	87.5
Cameron Wind 1 LLC	TX	165.0	165.0	12	2015	55	Acciona	AW125/3000	15.0	287.0	87.5
Peyton Creek Wind Farm LLC	TX	151.2	151.2	6	2020	48	Acciona	AW125/3000	15.0	287.0	87.5
San Roman Wind I, LLC	TX	95.3	95.3	2	2017	31	Acciona	AW125/3000	16.8	287.0	87.5
North Sky River Energy LLC	CA	162.0	162.0	12	2012	100	GE	1.6 XLE	16.8	286.0	87.2
English Farms	IA	171.5	171.5	3	2019	69	GE	2.5-127	17.2	286.0	87.2
85 B	CA	25.2	25.2	3	2021	7	Vestas	V126-3.45	26.8	285.4	87.0
85 A	CA	21.3	21.3	3	2021	6	Vestas	V126-3.45	26.8	285.4	87.0
New Frontier Wind	ND	100.0	100.0	12	2018	29	Vestas	V126-3.45	20.0	285.4	87.0
Milligan 1 Wind Farm	NE	99.0	99.0	12	2020	36	Siemens Gamesa	SWT-2.415-108	18.1	285.4	87.0
Frontier Windpower	OK	200.0	200.0	12	2016	61	Vestas	V126-3.3	17.7	285.4	87.0
Goodnoe Hills	WA	94.0	94.0	6	2008	47	Vestas	V110-2.0	19.0	285.4	87.0
Mountain Breeze Wind, LLC	CO	171.7	171.7	10	2020	62	GE	2.82-127	16.6	285.0	86.9
Kossuth	IA	152.2	152.2	10	2020	56	GE	2.82-127	17.7	285.0	86.9
Apple Blossom Wind Farm	MI	100.0	100.0	11	2017	29	Vestas	V126-3.45	15.9	285.0	86.9
Little Blue Wind Project, LLC	NE	250.7	250.7	12	2021	87	Siemens Gamesa	SG 2.7-129	12.0	285.0	86.9
Montague Wind Power Facility LLC	OR	200.0	200.0	11	2019	56	Vestas	V136-3.45	13.8	285.0	86.9
Aviator Wind	TX	525.0	525.0	6	2021	191	GE	2.85-100	15.9	285.0	86.9
Patriot Wind Farm	TX	226.1	226.1	6	2019	63	Vestas	V136-3.6	14.9	285.0	86.9
Bearkat	TX	196.7	196.7	2	2018	57	Vestas	V126-3.45	18.5	285.0	86.9
Blue Cloud Wind Energy LLC	TX	148.4	148.4	12	2018	150	Vestas	V126-3.45	18.0	285.0	86.9
Cactus Flats Wind Energy Project	TX	148.4	148.4	7	2018	43	Vestas	V126-3.45	18.0	285.0	86.9
Harpster Wind	OH	1.5	1.5	1	2016	1	Goldwind	GW 87/1500	14.0	283.0	86.3
Jiminy Peak Wind QF	MA	1.8	2.7	8	2007	1	GE	1.5 SLE	16.1	282.5	86.1
Javelina Wind Energy, LLC	TX	249.7	249.7	12	2015	126	GE	2.0-116	20.0	282.0	86.0
Brown County Wind Turbine	IL	1.5	1.5	9	2011	1	VENSYS	VENSYS77	16.5	281.0	85.6
Ninnescah Wind Energy, LLC	KS	208.3	208.3	12	2016	121	GE	1.79-100	13.0	280.0	85.3
Kingman Wind	KS	100.0	100.0	12	2016	60	GE	1.7-103	13.0	280.0	85.3
Kingman Wind	KS	100.0	100.0	12	2016	60	GE	1.7-103	13.0	280.0	85.3
La Chalupa, LLC	TX	198.5	198.5	6	2021	63	Acciona	AW125/3000	16.3	280.0	85.3
Palmas Wind, LLC	TX	142.6	142.6	11	2020	46	Acciona	AW125/3000	16.3	280.0	85.3
Stoneray Power Partners, LLC	TX	100.0	100.0	2	2019	39	Siemens	SWT-2.625-120	20.1	279.2	85.1
NLMU Wind	IA	1.5	1.5	11	2011	1	VENSYS	VENSYS82	15.0	279.0	85.0
Saddleback Ridge Wind Farm	ME	25.7	25.7	9	2015	9	GE	2.85-103	19.0	279.0	85.0
Canton Mountain Wind	ME	22.8	22.8	11	2017	8	GE	2.85-103	19.0	279.0	85.0
Saddleback Ridge Wind Farm	ME	8.5	8.5	12	2014	3	GE	2.85-103	19.0	279.0	85.0
Jericho Power	NH	12.1	12.1	1	2016	5	GE	2.85-103	13.8	279.0	85.0
South Hurlburt Wind LLC	OR	290.0	290.0	7	2012	116	GE	2.5-127	26.8	279.0	85.0
Horseshoe Bend Wind LLC	OR	290.0	290.0	7	2012	116	GE	2.5-127	26.8	279.0	85.0
North Hurlburt Wind LLC	OR	265.0	265.0	2	2012	106	GE	2.5-127	26.8	279.0	85.0
Cirrus Wind 1 LLC	TX	61.2	61.2	12	2012	17	CCWE	CCWE-3600/115.D	14.0	279.0	85.0

Horse Hollow Wind Energy Center	TX	299.0	299.0	6	2006	130	GE	1.5 SLE	22.0	279.0	85.0
Horse Hollow Wind Energy Center	TX	213.0	213.0	12	2005	142	GE	1.5 SLE	22.0	279.0	85.0
Solomon Forks Wind Project, LLC	TX	275.6	275.6	7	2019	105	Siemens	SWT-2.625-120	19.7	279.0	85.0
Waxdale	WI	1.5	1.5	12	2012	1	VENSYS	VENSYS82	14.5	279.0	85.0
Waxdale	WI	1.5	1.5	12	2012	1	VENSYS	VENSYS82	14.5	279.0	85.0
Story City Wind Project	IA	1.5	1.5	10	2010	1	Goldwind	GW 82/1500	23.0	278.9	85.0
Traer Wind Project	IA	1.5	1.5	10	2010	1	Goldwind	GW 82/1500	23.0	278.9	85.0
WED NK Green	RI	1.5	1.5	3	2012	1	Goldwind	GW 82/1500	12.0	278.8	85.0
WED Coventry 1	RI	1.5	1.5	10	2016	1	VENSYS	VENSYS82	12.0	278.8	85.0
WED Coventry 2	RI	1.5	1.5	8	2016	1	VENSYS	VENSYS82	12.5	278.8	85.0
WED Coventry 2	RI	1.5	1.5	8	2016	1	VENSYS	VENSYS82	12.6	278.8	85.0
WED Coventry 2	RI	1.5	1.5	8	2016	1	VENSYS	VENSYS82	12.8	278.8	85.0
WED Coventry 3	RI	1.5	1.5	8	2016	1	VENSYS	VENSYS82	12.6	278.8	85.0
WED Coventry 4	RI	1.5	1.5	8	2016	1	VENSYS	VENSYS82	12.0	278.8	85.0
WED Coventry 5	RI	1.5	1.5	3	2017	1	VENSYS	VENSYS82	13.1	278.8	85.0
WED Coventry 6	RI	1.5	1.5	8	2016	1	VENSYS	VENSYS82	12.4	278.8	85.0
WED Coventry 6	RI	1.5	1.5	8	2016	1	VENSYS	VENSYS82	12.0	278.8	85.0
WED Coventry 6	RI	1.5	1.5	8	2016	1	VENSYS	VENSYS82	12.3	278.8	85.0
WED Portsmouth One, LLC	RI	1.5	1.5	8	2016	1	VENSYS	VENSYS82	15.4	278.8	85.0
Brookfield Tehachapi 1	CA	102.0	102.0	3	2012	34	Vestas	V90-3.0	18.0	278.0	84.7
Kossuth County Wind	IA	70.0	70.0	12	2022	25	GE	2.5-127	12.0	278.0	84.7
Buffalo Center Wind LLC	IA	1.5	1.5	11	2011	1	Goldwind	GW 82/1500	16.0	278.0	84.7
LE Wind Turbine 1	OH	2.5	2.5	7	2011	1	Kenersys	K100 2.5	14.0	278.0	84.7
Rock Falls Wind Farm LLC	TX	154.5	154.5	12	2017	60	Siemens	SWT-2.3-108	19.0	278.0	84.7
Big Sky Wind LLC	IL	239.4	239.4	2	2011	109	Vestas	V120-2.0	19.0	277.2	84.5
Bingham Wind	ME	186.0	186.0	12	2016	56	Vestas	V112-3.3	22.4	277.0	84.4
Oakfield Wind Project	ME	148.0	148.0	10	2015	48	Vestas	V112-3.0	12.9	277.0	84.4
Rising Tree Wind Farm III	CA	99.0	99.0	6	2015	30	Vestas	V112-3.0	19.0	276.0	84.1
Rising Tree Wind Farm	CA	79.2	79.2	1	2015	24	Vestas	V112-3.3	19.0	276.0	84.1
Rising Tree Wind Farm II	CA	19.8	19.8	1	2015	6	Vestas	V112-3.3	19.0	276.0	84.1
Town of Otis Wind Energy Project	MA	1.5	1.5	3	2018	1	VENSYS	VENSYS82	12.0	276.0	84.1
Scioto Ridge Wind Farm	OH	249.8	249.8	5	2021	75	Siemens Gamesa	G132-3.465	15.7	276.0	84.1
Arbuckle Mountain Wind Farm LLC	OK	100.0	100.0	11	2015	50	Vestas	V110-2.0	19.0	276.0	84.1
Green River Wind Farm	IL	194.3	194.3	11	2019	74	Gamesa	G126-2.5	15.7	275.6	84.0
Passadumkeag Windpark LLC	ME	39.9	39.9	7	2016	13	Vestas	V112-3.3	19.4	275.6	84.0
Midway Wind, LLC	TX	162.9	162.9	8	2019	47	Gamesa	G132-5.0	16.4	275.6	84.0
Voyager Wind I	CA	131.1	131.1	12	2019	38	Vestas	V112-3.45	22.0	275.0	83.8
Voyager Wind II	CA	128.7	128.7	12	2018	36	Vestas	V117-3.45	22.0	275.0	83.8
Voyager Wind III	CA	43.2	43.2	12	2018	12	Vestas	V117-3.45	22.0	275.0	83.8
Voyager Wind IV	CA	21.6	21.6	12	2018	6	Vestas	V117-3.45	22.0	275.0	83.8
Mendota Hills, LLC	IL	76.2	76.2	11	2003	29	Gamesa	G126-2.5	18.0	275.0	83.8
Kingdom Community Wind	VT	65.0	65.0	11	2012	21	Vestas	V112-3.0	17.0	275.0	83.8
Canadian Hills Wind	TX	293.7	293.7	12	2012	133	REpower	MM92	18.0	273.0	83.2

Hidalgo Wind Farm LLC	TX	250.0	250.0	12	2016	75	Vestas	V110-2.0	19.0	273.0	83.2
Kit Carson Windpower	CO	51.0	51.0	11	2010	34	GE	1.5 SLE	16.8	272.0	82.9
Seneca Nation Cattaraugus Wind Turbine	NY	1.5	1.5	3	2017	1	VENSYS	VENSYS82	15.6	272.0	82.9
North Allegheny Windpower Project	PA	75.0	75.0	9	2009	35	Gamesa	G87-2.0	14.9	272.0	82.9
Notrees Windpower Hybrid	TX	60.0	60.0	4	2009	40	GE	1.5 SLE	15.0	272.0	82.9
Los Vientos Wind 1B	TX	201.6	201.6	12	2012	84	Mitsubishi	MWT-102/2.4	14.8	272.0	82.9
Shirley Wind	TX	20.0	20.0	11	2010	8	Nordex	N100/2500	16.5	272.0	82.9
Los Vientos Wind 1A	TX	200.0	200.0	12	2012	87	Siemens	SWT-2.3-108	13.9	272.0	82.9
Ironwood Wind	TX	167.9	167.9	8	2012	73	Siemens	SWT-2.3-101	16.7	272.0	82.9
Cimarron Windpower II	TX	131.0	131.0	6	2012	57	Siemens	SWT-2.3-108	17.6	272.0	82.9
Laurel Hill Wind	TX	69.0	69.0	9	2012	30	Siemens	SWT-2.3-108	12.8	272.0	82.9
Ocotillo Windpower	TX	58.8	58.8	9	2008	28	Suzlon	S88-2100	14.9	272.0	82.9
Los Vientos Windpower III	TX	200.0	200.0	4	2015	100	Vestas	V110-2.0	17.8	272.0	82.9
Los Vientos Windpower IV	TX	200.0	200.0	7	2016	100	Vestas	V110-2.0	16.7	272.0	82.9
Los Vientos V Wind Power	TX	110.0	110.0	12	2015	55	Vestas	V110-2.0	15.0	272.0	82.9
Notrees Windpower Hybrid	TX	92.5	92.5	4	2009	56	Vestas	V82-1.65	15.8	272.0	82.9
Top of the World Windpower Project	WY	200.0	200.0	10	2010	110	GE	1.5 SLE	14.6	272.0	82.9
Campbell Hill Windpower	WY	99.0	99.0	12	2009	66	GE	1.5 SLE	15.0	272.0	82.9
Silver Sage Windpower	WY	42.0	42.0	10	2009	20	Suzlon	S88-2100	17.5	272.0	82.9
Happy Jack Windpower Project	WY	29.4	29.4	8	2008	14	Suzlon	S88-2100	16.6	272.0	82.9
St. Olaf Wind Turbine	MN	1.6	1.6	9	2006	1	Vestas	V82-1.65	14.5	270.0	82.3
Henkel U.S. Operations Corporation	NY	1.7	1.7	1	2012	1	Hyundai	HQ1650	20.0	270.0	82.3
Henkel U.S. Operations Corporation	NY	1.7	1.7	1	2012	1	Hyundai	HQ1650	20.0	270.0	82.3
Sunray Wind I	TX	49.5	49.5	9	2009	33	GE	1.5 SLE	16.5	270.0	82.3
Rattlesnake Power, LLC	TX	160.0	160.0	9	2018	64	Goldwind	GW 109/2500	13.4	270.0	82.3
Point Wind	CA	64.5	64.5	3	2021	19	Vestas	V136-3.6	20.0	269.0	82.0
Oasis Wind	CA	60.3	60.3	12	2004	17	Vestas	V136-3.6	22.0	269.0	82.0
Oasis Alta	CA	14.4	14.4	4	2021	4	Vestas	V136-3.6	22.0	269.0	82.0
Turtle Creek Wind Farm LLC	IA	199.2	199.2	12	2018	50	Vestas	V136-3.45	17.0	269.0	82.0
Otter Creek Wind Farm LLC	IL	150.0	150.0	3	2020	42	Vestas	V136-3.45	16.1	269.0	82.0
Nobles 2 Wind Project	MN	250.0	250.0	12	2020	74	Vestas	V136-3.6	19.1	269.0	82.0
Prairie Hill Wind Project	TX	300.0	300.0	12	2020	100	Acciona	AW132/3000	15.7	269.0	82.0
Pinnacle Wind Force LLC	TX	52.9	52.9	12	2011	23	Siemens	SWT-2.3-108	18.1	269.0	82.0
Goodnight	TX	265.5	265.5	4	2024	59	Vestas	V136-4.2	18.9	269.0	82.0
Skookumchuck Wind Facility	WA	136.8	136.8	11	2020	38	Vestas	V136-3.45	16.1	269.0	82.0
Ekola Flats	WY	250.9	250.9	12	2020	63	Vestas	V136-4.2	19.0	269.0	82.0
Strauss Wind Farm	CA	95.3	95.3	12	2023	27	GE	3.8-137	15.1	267.4	81.5
RoxWind	ME	15.3	15.3	11	2021	4	GE	3.8-137	16.8	267.0	81.4
Granite Reliable Power	NH	99.0	99.0	2	2012	33	Vestas	V90-3.0	19.5	266.7	81.3
Cedar Point Wind	CO	252.0	252.0	5	2011	139	Vestas	V90-1.8	19.0	265.0	80.8

Heartland Divide Wind Project, LLC	IA	103.5	103.5	12	2018	43	GE	2.5-100	18.0	265.0	80.8
Wind GEM	IA	1.9	1.9	9	2015	1	GE	1.85-87	16.0	265.0	80.8
Pioneer Prairie Wind Farm	IA	300.0	300.0	10	2008	182	Vestas	V82-1.65	15.8	265.0	80.8
Spearville	KS	100.5	100.5	9	2006	67	GE	1.5 SLE	19.0	265.0	80.8
Spearville	KS	48.0	48.0	12	2010	32	GE	1.5 SLE	19.0	265.0	80.8
Prairie Star Wind Farm	MN	100.7	100.7	12	2007	61	Vestas	V82-1.65	16.4	265.0	80.8
UMM Wind Turbine	MN	0.6	0.9	6	2011	1	Vestas	V82-1.65	18.0	265.0	80.8
Casa Mesa Wind Energy Center Hybrid	NM	50.9	50.9	11	2018	21	GE	2.5-100	19.0	265.0	80.8
Rush Springs Wind	OK	249.9	249.9	12	2016	119	GE	2.0-116	18.0	265.0	80.8
Mammoth Plains	OK	199.0	199.0	12	2014	117	GE	1.7-100	18.0	265.0	80.8
Minco Wind II, LLC	OK	100.8	100.8	11	2011	63	GE	1.6 XLE	18.0	265.0	80.8
Minco Wind III, LLC	OK	100.8	100.8	12	2012	63	GE	1.7-100	18.0	265.0	80.8
Minco Wind I, LLC	OK	99.2	99.2	12	2010	62	GE	1.6 XLE	18.0	265.0	80.8
Coastal Energy Project	WA	6.0	6.0	6	2010	4	GE	1.5 SLE	12.0	265.0	80.8
Smoky Hills Wind Project Phase II	KS	148.5	148.5	1	2009	99	GE	1.5 SE	24.0	264.0	80.5
Creston Ridge Wind Farm	NE	6.8	6.8	12	2015	4	GE	1.7-103	19.0	264.0	80.5
Creston Ridge II, LLC	NE	2.3	2.3	6	2017	1	GE	2.3-107	18.7	264.0	80.5
Creston Ridge II, LLC	NE	2.3	2.3	6	2017	1	GE	2.3-107	18.7	264.0	80.5
Creston Ridge II, LLC	NE	2.3	2.3	6	2017	1	GE	2.3-107	18.7	264.0	80.5
CCC Hastings Wind Turbine	NE	1.7	1.7	12	2016	1	GE	1.7-103	18.0	264.0	80.5
Centennial Wind Farm	OK	120.0	120.0	12	2006	80	GE	1.5 SLE	25.0	264.0	80.5
Great Western Wind Energy, LLC	OK	225.0	225.0	12	2016	93	Vestas	V100-2.0	20.0	264.0	80.5
Crossroads Wind Farm	TX	227.5	227.5	1	2012	98	Siemens	SWT-2.3-101	17.8	264.0	80.5
OU Spirit Wind Farm	TX	101.2	101.2	12	2009	44	Siemens	SWT-2.3-93	17.8	264.0	80.5
Spring Canyon	CO	60.0	60.0	2	2006	40	GE	1.5 SLE	19.5	263.0	80.2
Busch Ranch II Wind Farm	CO	59.4	59.4	11	2019	27	Vestas	V120-2.2	17.0	263.0	80.2
Busch Ranch Wind Energy	CO	29.0	29.0	10	2012	16	Vestas	V100-1.8	22.0	263.0	80.2
Walnut Wind Farm	IA	150.0	150.0	12	2008	102	GE	1.5 SLE	16.8	263.0	80.2
Carroll Wind Farm	IA	150.0	150.0	12	2008	100	GE	1.5 SLE	16.8	263.0	80.2
Pomeroy Wind Farm	IA	123.0	123.0	12	2007	82	GE	1.5 SLE	16.8	263.0	80.2
Victory Wind Farm	IA	99.0	99.0	12	2006	66	GE	1.6-87	16.8	263.0	80.2
Pomeroy Wind Farm	IA	78.0	78.0	12	2007	50	GE	1.5 SLE	16.8	263.0	80.2
Charles City Wind Farm	IA	75.0	75.0	4	2008	50	GE	1.6-87	16.8	263.0	80.2
Pomeroy Wind Farm	IA	62.2	62.2	12	2008	39	GE	1.5 SLE	16.8	263.0	80.2
Century	IA	16.2	16.2	12	2007	10	GE	1.6-87	16.8	263.0	80.2
August Wind Farm	IA	1.8	1.8	2	2017	1	GE	1.79-100	17.4	263.0	80.2
Roseman	IA	1.8	1.8	2	2017	1	GE	1.79-100	17.0	263.0	80.2
Birch	IA	1.8	1.8	2	2017	1	GE	1.79-100	17.4	263.0	80.2
Green Energy Machine	IA	1.7	1.7	6	2016	1	GE	1.7-100	17.0	263.0	80.2
Chickasaw Wind Farm	IA	200.0	200.0	12	2023	66	Siemens Gamesa	SG 2.9-129	16.8	263.0	80.2
Wolverine Creek	ID	64.5	64.5	2	2006	43	GE	1.5 SLE	15.8	263.0	80.2
Grand Ridge Wind Energy Center	IL	99.0	99.0	10	2008	66	GE	1.5 SLE	18.3	263.0	80.2
Grand Ridge Wind Energy Center	IL	51.0	51.0	12	2009	34	GE	1.5 SLE	17.2	263.0	80.2

Grand Ridge Wind Energy Center	IL	49.5	49.5	12	2009	33	GE	1.5 SLE	17.2	263.0	80.2
Grand Ridge Wind Energy Center	IL	10.5	10.5	12	2009	7	GE	1.5 SLE	17.2	263.0	80.2
South Fork Wind Farm	MN	13.0	13.0	12	2016	6	GE	2.3-116	16.3	263.0	80.2
Judith Gap Wind Energy Center	MT	135.0	135.0	12	2005	90	GE	1.5 SLE	19.0	263.0	80.2
High Sheldon Wind Farm	NY	112.0	112.0	2	2009	75	GE	1.5 SLE	15.0	263.0	80.2
Cooper Farms VW Project	OH	4.5	4.5	3	2012	3	Goldwind	GW 87/1500	13.0	263.0	80.2
Haviland Plastic Products	OH	1.5	1.5	5	2013	1	Goldwind	GW 87/1500	13.0	263.0	80.2
Haviland Plastic Products	OH	1.5	1.5	5	2013	1	Goldwind	GW 87/1500	13.0	263.0	80.2
Haviland Plastic Products	OH	1.5	1.5	6	2013	1	Goldwind	GW 87/1500	13.0	263.0	80.2
Breckinridge Wind Project LLC	OK	98.8	98.8	8	2015	57	GE	1.7-103	14.5	263.0	80.2
Willow Creek Energy Center	OR	72.0	72.0	1	2009	48	GE	1.5 SLE	15.2	263.0	80.2
Turkey Track Wind Energy LLC	TX	169.5	169.5	11	2008	113	GE	1.5 SLE	17.4	263.0	80.2
McAdoo Wind Energy LLC	TX	150.0	150.0	9	2008	100	GE	1.5 SLE	19.5	263.0	80.2
Goldthwaite Wind Energy Facility	TX	150.0	150.0	12	2013	85	GE	1.7-100	16.8	263.0	80.2
Briscoe Wind Farm	TX	150.0	150.0	10	2015	81	GE	1.85-87	19.8	263.0	80.2
Scurry County Wind LP	TX	130.5	130.5	5	2007	87	GE	1.5 SLE	18.6	263.0	80.2
Stanton Wind Energy LLC	TX	120.0	120.0	2	2008	80	GE	1.5 SLE	17.4	263.0	80.2
Scurry County Wind II	TX	120.0	120.0	12	2007	80	GE	1.5 SLE	18.6	263.0	80.2
Thunder Spirit Wind, LLC	TX	107.5	107.5	12	2015	43	Nordex	N100/2500	17.9	263.0	80.2
Adams Wind	TX	48.3	48.3	1	2016	20	Siemens	SWT-2.3-108	16.8	263.0	80.2
Tooele Army Depot(CSG)	UT	1.7	1.7	7	2016	1	GE	1.7-103	19.3	263.0	80.2
Vantage Wind Energy LLC	WA	90.0	90.0	10	2010	60	GE	1.5 SLE	17.4	263.0	80.2
Forward Wind Energy Center	WI	99.0	99.0	7	2008	86	GE	1.5 SLE	17.0	263.0	80.2
Forward Wind Energy Center	WI	30.0	30.0	5	2009	20	GE	1.5 SLE	17.0	263.0	80.2
Beech Ridge Energy LLC	WV	100.5	100.5	1	2010	67	GE	1.5 SLE	17.0	263.0	80.2
Summit Winds	CA	10.0	10.0	7	2021	4	GE	2.5-116	17.0	262.6	80.0
Perrin Ranch Wind LLC	AZ	99.2	99.2	1	2012	62	GE	1.6 XLE	16.8	262.5	80.0
Red Horse 2	AZ	30.0	30.0	8	2015	15	Vestas	V110-2.0	14.3	262.5	80.0
EDF Renewable Windfarm V Inc	CA	15.5	15.5	1	1990	71	GE	1.5 SLE	19.0	262.5	80.0
Pinyon Pine I	CA	168.0	168.0	11	2012	56	Vestas	V90-3.0	18.7	262.5	80.0
Pinyon Pine II	CA	132.0	132.0	11	2012	44	Vestas	V90-3.0	18.6	262.5	80.0
Logan Wind Energy	CO	201.0	201.0	10	2007	134	GE	1.5 SLE	19.0	262.5	80.0
Peetz Table Wind Energy	CO	199.5	199.5	9	2007	133	GE	1.5 SLE	19.0	262.5	80.0
Peak View Wind Farm	CO	60.8	60.8	11	2016	34	GE	1.79-100	18.0	262.5	80.0
Springfield Wind	CO	1.5	1.5	2	2004	1	GE	1.5 S	14.6	262.5	80.0
FPL Energy Crystal Lake Wind LLC	IA	150.0	150.0	12	2008	100	GE	1.5 S	19.0	262.5	80.0
FPL Energy Story Wind LLC	IA	150.0	150.0	12	2008	100	GE	1.5 SLE	19.0	262.5	80.0
Garden Wind LLC	IA	150.0	150.0	12	2009	100	GE	1.5 XLE	16.8	262.5	80.0
Crystal Lake 3 LLC	IA	66.0	66.0	12	2009	44	GE	1.5 XLE	16.8	262.5	80.0
Windwalkers LLC	IA	1.6	1.6	9	2011	1	GE	1.6-82.5	17.0	262.5	80.0
Roeder Family Wind Farm LLC	IA	1.6	1.6	9	2011	2	GE	1.6 82.5	17.0	262.5	80.0
Cumberland Rose	IA	1.6	1.6	8	2012	1	GE	1.62-82.5	17.0	262.5	80.0

Fontanelle	IA	1.6	1.6	8	2012	1	GE	1.62-82.5	17.0	262.5	80.0
Greenfield Wind	IA	1.6	1.6	8	2012	1	GE	1.62-82.5	17.0	262.5	80.0
Meadow Ridge	IA	1.6	1.6	7	2012	1	GE	1.62-82.5	17.0	262.5	80.0
Sky Volt	IA	1.6	1.6	8	2012	1	GE	1.62-82.5	17.0	262.5	80.0
Wiota	IA	1.6	1.6	5	2012	1	GE	1.62-82.5	17.0	262.5	80.0
Sawtooth Wind Project	ID	22.4	22.4	10	2011	14	GE	1.6 XLE	12.0	262.5	80.0
Rockland Wind Farm	ID	79.2	79.2	12	2011	44	Vestas	V100-1.8	15.4	262.5	80.0
White Oak Energy LLC	IL	150.0	150.0	6	2011	100	GE	1.5 XLE	16.8	262.5	80.0
Kelly Creek Wind Project	IL	184.0	184.0	12	2016	92	Vestas	V100-2.0	19.0	262.5	80.0
Shooting Star	KS	104.0	104.0	9	2012	65	GE	1.6-82.5	16.8	262.5	80.0
Fort Hays State University Wind Farm	KS	2.0	2.0	11	2013	1	VESTAS	V100-2.0	18.6	262.5	80.0
Fort Hays State University Wind Farm	KS	2.0	2.0	11	2013	1	VESTAS	V100-2.0	18.6	262.5	80.0
Berkshire Wind Power Project	MA	2.3	2.3	9	2019	1	GE	2.3-116	16.0	262.5	80.0
Berkshire Wind Power Project	MA	2.3	2.3	9	2019	1	GE	2.3-116	16.0	262.5	80.0
Tuscola Bay Wind	MI	120.0	120.0	12	2012	75	GE	1.6 XLE	16.8	262.5	80.0
Tuscola Wind II LLC	MI	100.3	100.3	11	2013	59	GE	1.7-100	16.8	262.5	80.0
Michigan Wind 1	MI	69.0	69.0	12	2008	46	GE	1.5 SLE	12.7	262.5	80.0
Woodstock Windfarm	MN	9.2	9.2	5	1999	4	GE	2.3-116	17.9	262.5	80.0
Red Lake Falls Community Hybrid	MN	4.6	4.6	12	2020	2	GE	2.3-116	17.9	262.5	80.0
Odell Wind Farm	MN	200.0	200.0	7	2016	100	Vestas	V110-2.0	16.0	262.5	80.0
Clear Creek Wind	MO	22.0	22.0	5	2020	11	Vestas	V110-2.0	16.8	262.5	80.0
Diamond Willow Wind Facility	MT	30.0	30.0	12	2007	20	GE	1.5-77	12.0	262.5	80.0
Horseshoe Bend Wind Park	MT	9.7	9.7	2	2006	6	GE	1.6 SLE	19.0	262.5	80.0
FPL Energy Ashtabula Wind LLC	ND	148.5	148.5	12	2008	99	GE	1.5 SLE	19.0	262.5	80.0
Ashtabula Wind II LLC	ND	120.0	120.0	10	2009	80	GE	1.5 XLE	16.8	262.5	80.0
Langdon Renewables, LLC	ND	118.5	118.5	12	2007	106	GE	1.5 SLE	19.0	262.5	80.0
Prairie Winds ND1	ND	115.5	115.5	12	2009	77	GE	1.5 SLE	22.4	262.5	80.0
Baldwin Wind LLC	ND	102.4	102.4	12	2010	64	GE	1.6 XLE	16.8	262.5	80.0
Ashtabula Wind III LLC	ND	62.4	62.4	12	2010	39	GE	1.6 XLE	16.8	262.5	80.0
Wilton Wind II LLC	ND	49.5	49.5	11	2009	33	GE	1.5 XLE	16.8	262.5	80.0
FPL Energy Oliver Wind II LLC	ND	48.0	48.0	12	2007	32	GE	1.5 S	19.0	262.5	80.0
Langdon Wind II LLC	ND	40.5	40.5	9	2008	27	GE	1.5 SLE	19.0	262.5	80.0
FPL Energy Burleigh County Wind	ND	31.5	31.5	12	2005	21	GE	1.5 SLE	19.0	262.5	80.0
Cedar Hills Wind Farm	ND	19.5	19.5	6	2010	13	GE	1.5-77	12.0	262.5	80.0
FPL Energy Burleigh County Wind	ND	18.0	18.0	2	2006	12	GE	1.5 SLE	19.0	262.5	80.0
Minot Wind Project	ND	4.5	4.5	12	2009	3	GE	1.5 SLE	17.9	262.5	80.0
Prairie Breeze	NE	200.6	200.6	5	2014	118	GE	1.7-100	19.0	262.5	80.0
Steele Flats Wind Project LLC	NE	74.8	74.8	10	2013	44	GE	1.7-100	16.8	262.5	80.0
Valentine Wind, LLC	NE	1.9	1.9	9	2014	1	GE	1.85-87	19.0	262.5	80.0
Seward Wind Farm	NE	1.7	1.7	12	2017	1	GE	1.7-103	18.8	262.5	80.0
Milligan 1 Wind Farm	NE	66.0	66.0	12	2020	33	Vestas	V110-2.0	18.1	262.5	80.0

Stony Creek Wind Farm NY	NY	94.4	94.4	11	2013	58	GE	1.6-100	15.9	262.5	80.0
RP Wind	OH	3.4	3.4	12	2013	2	GE	1.7-100	16.8	262.5	80.0
Balko Wind LLC	OK	299.7	299.7	8	2015	162	GE	1.85-87	19.0	262.5	80.0
Seiling Wind I	OK	199.0	199.0	12	2014	117	GE	1.7-100	16.8	262.5	80.0
Weatherford Wind Energy Center	OK	106.5	106.5	4	2005	71	GE	1.5 SLE	19.0	262.5	80.0
Seiling Wind II	OK	98.6	98.6	12	2014	58	GE	1.7-100	16.8	262.5	80.0
Weatherford Wind Energy Center	OK	40.5	40.5	12	2005	27	GE	1.5 SLE	19.0	262.5	80.0
Wheat Field Wind Power Project	OR	102.9	102.9	2	2009	46	Suzlon	S88-2100	19.0	262.5	80.0
Arlington Wind Power Project	OR	102.9	102.9	12	2008	49	Suzlon	S88-2100	19.0	262.5	80.0
Prairie Winds SD1	SD	159.3	159.3	2	2011	100	GE	1.5 SLE	22.4	262.5	80.0
Day County Wind LLC	SD	99.0	99.0	4	2010	66	GE	1.5 XLE	16.8	262.5	80.0
Wessington Springs	SD	51.0	51.0	2	2009	34	GE	1.5 SLE	19.0	262.5	80.0
Aurora County Wind	SD	20.0	20.0	10	2018	9	GE	2.3-116	17.0	262.5	80.0
Brule County Wind	SD	20.0	20.0	10	2018	9	GE	2.3-116	17.9	262.5	80.0
Prairie Winds SD1	SD	11.1	11.1	2	2011	7	GE	1.5 SLE	22.4	262.5	80.0
Prairie Winds SD1	SD	1.6	1.6	2	2011	1	GE	1.5 SLE	22.4	262.5	80.0
Dakota Range Wind	SD	297.6	297.6	1	2022	72	Vestas	V136-4.2	17.9	262.5	80.0
DeWind Frisco	TX	20.0	20.0	2	2012	10	DeWind	D8.2	19.2	262.5	80.0
Little Pringle I Wind Farm	TX	10.0	10.0	10	2010	5	DeWind	D8.2	19.7	262.5	80.0
Little Pringle II Wind Farm	TX	10.0	10.0	10	2010	5	DeWind	D8.2	19.7	262.5	80.0
Dermott Wind	TX	253.0	253.0	7	2017	110	GE	2.3-116	15.7	262.5	80.0
Palo Duro Wind	TX	249.9	249.9	12	2014	147	GE	1.79-100	16.5	262.5	80.0
Electra Wind Farm	TX	230.0	230.0	11	2016	100	GE	2.3-116	16.0	262.5	80.0
Horse Creek Wind Farm	TX	230.0	230.0	10	2016	100	GE	2.3-116	14.4	262.5	80.0
Mesquite Creek Wind	TX	211.2	211.2	4	2015	118	GE	1.7-100	18.0	262.5	80.0
Stephens Ranch Wind Energy LLC	TX	211.0	211.0	12	2014	118	GE	1.79-100	16.1	262.5	80.0
Shannon Wind	TX	204.0	204.0	12	2015	119	GE	1.7-103	14.5	262.5	80.0
Stephens Ranch Wind Energy LLC	TX	165.0	165.0	4	2015	92	GE	1.79-100	14.9	262.5	80.0
Blue Summit Wind LLC	TX	135.4	135.4	12	2012	85	GE	1.6 XLE	16.8	262.5	80.0
Callahan Divide Wind Energy Center	TX	114.0	114.0	3	2005	76	GE	1.5 SLE	19.0	262.5	80.0
Wolf Ridge Wind	TX	112.5	112.5	8	2008	75	GE	1.5 XLE	16.8	262.5	80.0
Whitetail	TX	92.3	92.3	12	2012	57	GE	1.6-82.5	13.5	262.5	80.0
Post Wind Farm LP	TX	84.0	84.0	4	2006	56	GE	1.5 SLE	19.0	262.5	80.0
Majestic II Wind	TX	79.6	79.6	8	2012	51	GE	1.6 XLE	16.8	262.5	80.0
Majestic 1 Wind Farm	TX	79.5	79.5	1	2009	53	GE	1.5 SLE	19.0	262.5	80.0
Sendero	TX	78.0	78.0	12	2015	39	GE	2.0-116	14.9	262.5	80.0
Western Plains Wind Farm	TX	280.6	280.6	3	2017	122	Siemens	SWT-2.3-108	19.0	262.5	80.0
Mower County Wind Energy Center	TX	91.1	91.1	12	2006	43	Siemens	SWT-1.0-54	19.0	262.5	80.0
Butler Ridge	WI	54.0	54.0	2	2009	36	GE	1.5 XLE	16.8	262.5	80.0
Glacier Hills	WI	162.0	162.0	12	2011	90	Vestas	V90-1.8	19.0	262.5	80.0
Casper Wind Farm	WY	17.0	17.0	12	2009	11	GE	1.5 SLE	20.0	262.5	80.0
Fire Island Wind	AK	18.0	18.0	9	2012	11	GE	1.6 XLE	16.1	262.4	80.0
Edom Hills Project 1 LLC	CA	20.0	20.0	9	2008	8	Clipper	Liberty C93	19.0	262.4	80.0

Alta Wind XI	CA	90.0	90.0	1	2014	48	GE	1.7-100	22.4	262.4	80.0
Golden Hills Wind	CA	85.9	85.9	12	2015	48	GE	1.79-100	17.9	262.4	80.0
Foundation NWNA	CA	1.9	1.9	9	2018	1	GE	1.85-87	20.4	262.4	80.0
Foundation Cemex River Plant	CA	1.6	1.6	12	2012	1	GE	1.6 XLE	12.0	262.4	80.0
Foundation Cemex River Plant	CA	1.6	1.6	12	2012	1	GE	1.6 XLE	12.0	262.4	80.0
Foundation NWNA	CA	1.6	1.6	12	2012	1	GE	1.6 XLE	20.4	262.4	80.0
Foundation NWNA	CA	1.6	1.6	12	2012	1	GE	1.6 XLE	20.4	262.4	80.0
Ocotillo Express LLC	CA	265.4	265.4	12	2012	112	Siemens	SWT-2.3-108	19.0	262.4	80.0
Hatchet Ridge Wind Project	CA	101.2	101.2	12	2010	44	Siemens	SWT-2.3-93	19.0	262.4	80.0
Vasco Winds	CA	78.2	78.2	12	2011	34	Siemens	SWT-2.3-101	22.3	262.4	80.0
Montezuma Wind II	CA	78.2	78.2	1	2012	34	Siemens	SWT-2.3-93	19.0	262.4	80.0
FPL Energy Montezuma Winds LLC	CA	36.8	36.8	11	2010	16	Siemens	SWT-2.3-108	19.0	262.4	80.0
Mustang Hills LLC	CA	150.0	150.0	5	2012	50	Vestas	V90-3.0	22.4	262.4	80.0
Alta Wind VIII	CA	150.0	150.0	1	2012	50	Vestas	V90-3.0	18.0	262.4	80.0
Solano Wind	CA	128.0	128.0	4	2012	55	Vestas	V90-1.8	16.8	262.4	80.0
Solano Wind	CA	85.5	85.5	5	2024	19	Vestas	V150-6.0	16.8	262.4	80.0
Solano Wind	CA	63.0	63.0	12	2007	21	Vestas	V90-3.0	16.8	262.4	80.0
Solano Wind	CA	24.0	24.0	6	2006	8	Vestas	V90-3.0	16.8	262.4	80.0
Wagner Wind LLC	CA	6.0	6.0	12	2012	2	Vestas	V90-3.0	22.3	262.4	80.0
Golden West Power Partners LLC	CO	250.0	250.0	10	2015	140	GE	1.7-103	14.0	262.4	80.0
Cedar Creek II	CO	248.3	248.3	3	2011	122	GE	1.5 SLE	19.0	262.4	80.0
Limon III Wind LLC	CO	200.6	200.6	8	2014	118	GE	1.7-100	17.0	262.4	80.0
Limon Wind I	CO	200.0	200.0	11	2012	125	GE	1.6 SLE	17.0	262.4	80.0
Limon Wind II	CO	200.0	200.0	11	2012	125	GE	1.6 SLE	14.7	262.4	80.0
Carousel Wind Farm LLC	CO	150.0	150.0	11	2015	88	GE	1.79-100	14.0	262.4	80.0
Colorado Highlands Wind	CO	71.0	71.0	12	2012	42	GE	1.6-100	18.7	262.4	80.0
Spring Canyon Expansion Wind Energy Ctr	CO	34.0	34.0	10	2014	19	GE	1.79-100	20.4	262.4	80.0
Spring Canyon Expansion Wind Energy Ctr	CO	28.6	28.6	12	2014	16	GE	1.79-100	18.6	262.4	80.0
Colorado Highlands Wind	CO	25.1	25.1	9	2013	14	GE	1.7-100	18.7	262.4	80.0
Lamar Plant	CO	4.0	4.0	2	2004	3	GE	1.5 XLE	19.0	262.4	80.0
Lamar Plant	CO	1.5	1.5	2	2004	1	GE	1.5 XLE	19.0	262.4	80.0
Northern Colorado Wind LLC	CO	151.8	151.8	8	2009	66	Siemens	SWT-2.3-93	15.8	262.4	80.0
Vestas Towers America, Inc.	CO	1.8	1.8	4	2010	1	Vestas	V100-1.8	16.8	262.4	80.0
Kahuku Wind Power LLC	HI	30.0	30.0	3	2011	12	Clipper	Liberty C96	19.0	262.4	80.0
FPL Energy Crystal Lake Wind II LLC	IA	199.0	199.0	1	2009	80	Clipper	Liberty C96	19.0	262.4	80.0
Osceola Windpower LLC	IA	98.2	98.2	7	2008	40	Clipper	Liberty C96	19.0	262.4	80.0
Osceola Windpower II	IA	49.6	49.6	9	2008	20	Clipper	Liberty C96	19.0	262.4	80.0
Kirkwood Wind Turbine	IA	0.7	2.3	2	2012	4	Clipper	Liberty C96	13.4	262.4	80.0
Ida Grove Wind	IA	119.6	119.6	12	2016	54	GE	2.3-116	16.8	262.4	80.0
Ida Grove Wind	IA	92.8	92.8	12	2016	41	GE	2.3-116	16.8	262.4	80.0
Ida Grove Wind	IA	60.0	60.0	9	2016	134	GE	2.3-116	16.8	262.4	80.0
Ida Grove Wind	IA	27.6	27.6	11	2016	12	GE	2.3-116	16.8	262.4	80.0

Junction Hilltop Wind Farm	IA	8.0	8.0	3	2012	5	GE	1.62-82.5	17.6	262.4	80.0
Luther College Wind Project	IA	1.6	1.6	10	2011	1	GE	1.6 XLE	16.0	262.4	80.0
Wolverine	IA	1.5	1.5	10	2010	1	GE	1.5-77	17.0	262.4	80.0
Bulldog	IA	1.5	1.5	10	2010	1	GE	1.5-77	17.0	262.4	80.0
Lundgren Wind Project	IA	250.0	250.0	8	2014	107	Siemens	SWT-2.3-108	16.8	262.4	80.0
Eclipse Wind Farm	IA	200.0	200.0	9	2012	87	Siemens	SWT-2.3-108	16.8	262.4	80.0
Adair Wind Farm	IA	174.8	174.8	12	2008	76	Siemens	SWT-2.3-93	16.8	262.4	80.0
Wellsburg Wind Project	IA	138.6	138.6	12	2014	60	Siemens	SWT-2.3-108	16.8	262.4	80.0
Laurel Wind Farm	IA	119.6	119.6	12	2011	52	Siemens	SWT-2.3-101	16.8	262.4	80.0
Macksburg Wind Project	IA	119.6	119.6	12	2014	51	Siemens	SWT-2.3-108	16.8	262.4	80.0
Highland Wind Project (IA)	IA	115.0	115.0	10	2015	49	Siemens	SWT-2.3-108	16.8	262.4	80.0
O'Brien Wind	IA	108.7	108.7	12	2016	45	Siemens	SWT-2.3-108	16.8	262.4	80.0
Vienna Wind Farm	IA	105.6	105.6	11	2012	45	Siemens	SWT-2.3-108	16.8	262.4	80.0
Morning Light Wind Farm	IA	100.9	100.9	10	2012	44	Siemens	SWT-2.3-108	16.8	262.4	80.0
Highland Wind Project (IA)	IA	100.0	100.0	7	2015	40	Siemens	SWT-2.3-108	16.8	262.4	80.0
Ivester Wind Farm	IA	90.0	90.0	12	2018	35	Siemens	SWT-2.625-120	16.8	262.4	80.0
Highland Wind Project (IA)	IA	89.1	89.1	8	2015	38	Siemens	SWT-2.3-108	16.8	262.4	80.0
Highland Wind Project (IA)	IA	89.0	89.0	9	2015	38	Siemens	SWT-2.3-108	16.8	262.4	80.0
Highland Wind Project (IA)	IA	85.8	85.8	11	2015	40	Siemens	SWT-2.3-108	16.8	262.4	80.0
O'Brien Wind	IA	79.7	79.7	12	2016	33	Siemens	SWT-2.3-108	16.8	262.4	80.0
O'Brien Wind	IA	61.9	61.9	9	2016	104	Siemens	SWT-2.3-108	16.8	262.4	80.0
Adams Wind	IA	58.0	58.0	12	2015	20	Siemens	SWT-2.3-108	16.8	262.4	80.0
Vienna Wind Farm	IA	44.6	44.6	12	2013	19	Siemens	SWT-2.3-108	16.8	262.4	80.0
Adams Wind	IA	39.0	39.0	11	2015	18	Siemens	SWT-2.3-108	16.8	262.4	80.0
Pomeroy Wind Farm	IA	33.7	33.7	8	2011	13	Siemens	SWT-2.3-101	16.8	262.4	80.0
Carroll Area Wind Farm	IA	20.7	20.7	1	2015	9	Siemens	SWT-2.3-108	19.2	262.4	80.0
Highland Wind Project (IA)	IA	16.4	16.4	6	2015	214	Siemens	SWT-2.3-108	16.8	262.4	80.0
Highland Wind Project (IA)	IA	4.7	4.7	12	2015	7	Siemens	SWT-2.3-108	16.8	262.4	80.0
Adams Wind	IA	4.7	4.7	10	2015	64	Siemens	SWT-2.3-108	16.8	262.4	80.0
Crosswind Energy Project	IA	21.0	21.0	6	2007	10	Suzlon	S88-2100	19.0	262.4	80.0
Hardin Hilltop Wind LLC	IA	14.7	14.7	5	2007	7	Suzlon	S88-2100	19.0	262.4	80.0
Goshen Phase II	ID	124.5	124.5	9	2010	83	GE	1.5-82.5	19.0	262.4	80.0
Camp Reed	ID	22.5	22.5	12	2010	15	GE	1.5 XLE	14.4	262.4	80.0
Burley Butte Windpark	ID	21.3	21.3	2	2011	13	GE	1.5 XLE	14.9	262.4	80.0
Salmon Falls Wind Park	ID	21.0	21.0	4	2011	14	GE	1.5 XLE	14.4	262.4	80.0
Payne's Ferry	ID	21.0	21.0	12	2010	14	GE	1.5 XLE	14.6	262.4	80.0
Yahoo Creek	ID	21.0	21.0	12	2010	14	GE	1.5 XLE	14.5	262.4	80.0
Milner Dam Wind Park LLC	ID	19.5	19.5	2	2011	13	GE	1.5 XLE	14.4	262.4	80.0
Oregon Trail Wind Park	ID	13.5	13.5	1	2011	9	GE	1.5 XLE	14.0	262.4	80.0
Golden Valley Wind Park LLC	ID	12.0	12.0	1	2011	8	GE	1.5 XLE	14.1	262.4	80.0
Thousand Springs Wind Park	ID	12.0	12.0	1	2011	8	GE	1.5 XLE	13.8	262.4	80.0
Fossil Gulch	ID	10.5	10.5	2	2005	7	GE	1.5 SLE	22.0	262.4	80.0
Pilgrim Stage Wind Park	ID	10.5	10.5	1	2011	7	GE	1.5 XLE	14.9	262.4	80.0
Tuana Gulch Wind Park	ID	10.5	10.5	1	2011	7	GE	1.5 XLE	14.1	262.4	80.0

Ryegrass Windfarm	ID	23.0	23.0	12	2012	10	Siemens	SWT-2.3-101	13.4	262.4	80.0
Hammett Hill Windfarm	ID	23.0	23.0	12	2012	10	Siemens	SWT-2.3-101	13.4	262.4	80.0
Mainline Windfarm	ID	23.0	23.0	12	2012	10	Siemens	SWT-2.3-101	13.4	262.4	80.0
Desert Meadow Windfarm	ID	23.0	23.0	12	2012	10	Siemens	SWT-2.3-101	13.4	262.4	80.0
Cold Springs Windfarm	ID	23.0	23.0	12	2012	10	Siemens	SWT-2.3-101	13.4	262.4	80.0
Two Ponds Windfarm	ID	23.0	23.0	12	2012	10	Siemens	SWT-2.3-101	13.4	262.4	80.0
Mountain Home	ID	21.0	21.0	5	2008	10	Suzlon	S88-2100	15.1	262.4	80.0
Bennett Creek Windfarm LLC - Mountain Home	ID	21.0	21.0	7	2008	10	Suzlon	S88-2100	15.1	262.4	80.0
Cassia Gulch	ID	18.9	18.9	3	2009	9	Suzlon	S88-2100	15.2	262.4	80.0
Tuana Springs	ID	16.8	16.8	5	2010	8	Suzlon	S88-2100	14.8	262.4	80.0
Cassia Wind	ID	8.4	8.4	3	2009	4	Suzlon	S88-2100	15.2	262.4	80.0
Horse Butte Wind I, LLC	ID	57.6	57.6	8	2012	32	Vestas	V100-1.8	15.4	262.4	80.0
EcoGrove Wind LLC	IL	100.5	100.5	7	2009	67	Acciona	AW82/1500	16.8	262.4	80.0
Com Adam 1WF-1	IL	2.5	2.5	10	2007	1	Clipper	Liberty C93	17.0	262.4	80.0
FPL Energy Illinois Wind LLC Hybrid	IL	217.5	217.5	12	2009	145	GE	1.5 XLE	17.9	262.4	80.0
Pilot Hill Wind Farm	IL	175.0	175.0	8	2015	103	GE	1.7-100	19.0	262.4	80.0
Settlers Trail Wind Farm LLC	IL	150.4	150.4	10	2011	94	GE	1.6 XLE	16.6	262.4	80.0
Pioneer Trail Wind Farm, LLC	IL	150.4	150.4	12	2011	94	GE	1.6 XLE	17.4	262.4	80.0
Agriwind	IL	8.4	8.4	7	2007	4	Suzlon	S88-2100	15.9	262.4	80.0
Meadow Lake Wind Farm II LLC	IN	102.3	102.3	8	2010	66	Acciona	AW82/1500	17.0	262.4	80.0
Fowler Ridge Wind Farm LLC	IN	200.0	200.0	12	2009	133	GE	1.5 S	19.0	262.4	80.0
Meadow Lake Wind Farm IV	IN	105.7	105.7	10	2010	48	Suzlon	S88-2100	19.0	262.4	80.0
Fowler Ridge Wind Farm LLC	IN	101.3	101.3	3	2009	61	Vestas	V82-1.65	19.0	262.4	80.0
Fowler Ridge Wind Farm LLC	IN	100.0	100.0	3	2009	61	Vestas	V82-1.65	19.0	262.4	80.0
Fowler Ridge Wind Farm LLC	IN	99.0	99.0	2	2009	60	Vestas	V82-1.65	19.0	262.4	80.0
Fowler Ridge Wind Farm LLC	IN	88.0	88.0	8	2023	40	Vestas	V120-2.2	19.0	262.4	80.0
Flat Ridge Wind Farm	KS	50.0	50.0	2	2009	20	Clipper	Liberty C96	19.0	262.4	80.0
Flat Ridge 2 Wind Energy LLC	KS	470.4	470.4	10	2012	294	GE	1.6-100	16.8	262.4	80.0
Post Rock Wind Power Project, LLC	KS	201.0	201.0	9	2012	134	GE	1.5-82.5	18.0	262.4	80.0
Buckeye Wind Energy Center	KS	200.5	200.5	8	2015	112	GE	1.79-100	20.6	262.4	80.0
Spearville 3 LLC	KS	108.0	108.0	10	2012	63	GE	1.6 XLE	19.0	262.4	80.0
Ensign Wind LLC	KS	98.9	98.9	11	2012	43	Siemens	SWT-2.3-108	19.0	262.4	80.0
Alexander Wind Farm LLC	KS	50.7	50.7	12	2015	21	Siemens	SWT-2.3-108	20.1	262.4	80.0
Slate Creek Wind Project LLC	KS	150.0	150.0	12	2015	75	Vestas	V100-2.0	19.0	262.4	80.0
Central Plains Wind Farm	KS	99.0	99.0	3	2009	33	Vestas	V90-3.0	19.7	262.4	80.0
Flat Ridge Wind Energy LLC	KS	44.0	44.0	3	2009	20	Vestas	V110-2.0	19.0	262.4	80.0
Cape Cod Air Force Station - 6 SWS	MA	1.7	1.7	1	2014	1	GE	1.68-82.5	19.0	262.4	80.0
Cape Cod Air Force Station - 6 SWS	MA	1.7	1.7	1	2014	1	GE	1.68-82.5	19.0	262.4	80.0
Dept of Corrections NCCI Wind	MA	1.7	1.7	11	2013	1	Vestas	V82-1.65	20.5	262.4	80.0
Dept of Corrections NCCI Wind	MA	1.7	1.7	11	2013	1	Vestas	V82-1.65	20.5	262.4	80.0

Criterion	MD	70.0	70.0	12	2010	28	GE	2.5-116	17.1	262.4	80.0
Rollins Wind Project	ME	60.0	60.0	7	2011	40	GE	1.5 SLE	19.0	262.4	80.0
Stetson Wind I	ME	57.0	57.0	1	2009	38	GE	1.5 SLE	19.0	262.4	80.0
Mars Hill Wind Farm Project	ME	42.0	42.0	3	2007	28	GE	1.5 SLE	19.0	262.4	80.0
Stetson Wind II	ME	25.5	25.5	3	2010	17	GE	1.5 SLE	19.0	262.4	80.0
Record Hill Wind	ME	50.6	50.6	1	2012	22	Siemens	SWT-2.3-93	17.0	262.4	80.0
Pheasant Run Wind LLC	MI	74.8	74.8	12	2013	44	GE	1.7-100	16.8	262.4	80.0
Harvest	MI	51.2	51.2	1	2008	31	Vestas	V82-1.65	14.3	262.4	80.0
Adams Wind Generations LLC	MN	20.0	20.0	3	2011	11	Alstom	ECO86	17.7	262.4	80.0
Danielson Wind Farms LLC	MN	20.0	20.0	3	2011	12	Alstom	ECO86	16.6	262.4	80.0
Jeffers Wind 20 LLC	MN	43.1	43.1	10	2008	20	Clipper	Liberty C96	18.3	262.4	80.0
Community Wind North LLC	MN	25.9	25.9	5	2011	12	Clipper	Liberty C96	17.4	262.4	80.0
Taconite Ridge 1 Wind Energy Center	MN	25.0	25.0	5	2008	10	Clipper	Liberty C96	20.0	262.4	80.0
Eolos Wind Energy Research Field Station	MN	2.5	2.5	10	2011	1	Clipper	Liberty C96	19.0	262.4	80.0
GL Wind	MN	2.4	2.4	12	2011	1	Clipper	Liberty C96	15.0	262.4	80.0
GL Wind	MN	2.4	2.4	12	2011	1	Clipper	Liberty C96	15.0	262.4	80.0
Willmar	MN	2.0	2.0	8	2009	1	DeWind	D8.2	14.7	262.4	80.0
Willmar	MN	2.0	2.0	8	2009	1	DeWind	D8.2	14.7	262.4	80.0
Fenton Wind Farm	MN	205.5	205.5	9	2007	137	GE	1.5 SLE	19.0	262.4	80.0
Lakefield Wind Project LLC	MN	205.5	205.5	10	2011	137	GE	1.5 SLE	19.0	262.4	80.0
Wapsipinicon Wind Project	MN	100.5	100.5	2	2009	67	GE	1.5 SLE	19.0	262.4	80.0
Lakeswind Power Partners	MN	50.0	50.0	3	2014	32	GE	1.5-82.5	12.0	262.4	80.0
Ewington Energy Systems, LLC	MN	20.0	20.0	1	2008	9	GE	2.5-116	17.2	262.4	80.0
Elm Creek Wind II LLC	MN	148.8	148.8	12	2010	62	Mitsubishi	MWT-95/2.4	18.4	262.4	80.0
Ridgewind	MN	25.3	25.3	1	2011	11	Siemens	SWT-2.3-93	19.0	262.4	80.0
Grant County Wind LLC	MN	20.0	20.0	8	2010	10	Suzlon	S88-2100	15.6	262.4	80.0
Odin Wind Farm LLC	MN	20.0	20.0	5	2008	10	Suzlon	S88-2100	19.0	262.4	80.0
Cisco	MN	8.4	8.4	2	2008	4	Suzlon	S88-2100	17.0	262.4	80.0
Marshall Wind 2 LLC	MN	4.2	4.2	12	2007	2	Suzlon	S88-2100	18.6	262.4	80.0
Marshall Wind 3 LLC	MN	4.2	4.2	12	2007	2	Suzlon	S88-2100	18.6	262.4	80.0
Marshall Wind 4 LLC	MN	4.2	4.2	12	2007	2	Suzlon	S88-2100	18.6	262.4	80.0
Marshall Wind 5 LLC	MN	2.1	2.1	12	2007	1	Suzlon	S88-2100	18.6	262.4	80.0
Marshall Wind 6 LLC	MN	2.1	2.1	12	2007	1	Suzlon	S88-2100	18.6	262.4	80.0
Marshall Wind 1 LLC	MN	2.1	2.1	12	2007	1	Suzlon	S88-2100	18.6	262.4	80.0
Shane's Wind Machine	MN	1.3	1.3	7	2006	1	Suzlon	S88-2100	16.8	262.4	80.0
Black Oak Wind Farm	MN	78.0	78.0	12	2016	39	Vestas	V110-2.0	15.7	262.4	80.0
Oak Glen Wind Farm	MN	44.0	44.0	11	2011	24	Vestas	V90-2.0	16.0	262.4	80.0
Lost Creek Wind Energy Facility	MO	168.0	168.0	5	2010	100	GE	1.5 XLE	15.6	262.4	80.0
Cow Branch	MO	50.4	50.4	4	2008	24	Suzlon	S88-2100	15.3	262.4	80.0
Bluegrass Ridge	MO	56.7	56.7	6	2007	26	Vestas	V120-2.2	17.0	262.4	80.0
Conception	MO	50.4	50.4	4	2008	23	Vestas	V120-2.2	15.6	262.4	80.0
Big Timber Wind Farm	MT	25.0	25.0	2	2018	14	GE	1.79-100	16.0	262.4	80.0
Fairfield Wind	MT	10.0	10.0	5	2014	6	GE	1.7-100	15.6	262.4	80.0

Tatanka Wind Power LLC	ND	180.0	180.0	1	2008	120	Acciona	AW77/1500	18.8	262.4	80.0
FPL Energy Oliver Wind I LLC	ND	50.6	50.6	12	2006	22	Siemens	SWT-2.3-93	19.0	262.4	80.0
Bison I Wind Energy Center	ND	36.8	36.8	12	2010	16	Siemens	SWT-2.3-101	19.9	262.4	80.0
Laredo Ridge Wind LLC	NE	79.9	79.9	2	2011	54	GE	1.5 XLE	17.0	262.4	80.0
Broken Bow Wind LLC	NE	79.9	79.9	12	2012	50	GE	1.6 XLE	17.0	262.4	80.0
Prairie Breeze II	NE	73.4	73.4	10	2015	41	GE	1.79-100	20.6	262.4	80.0
Broken Bow Wind II, LLC	NE	73.1	73.1	10	2014	43	GE	1.7-100	16.8	262.4	80.0
Flat Water Wind Farm LLC	NE	60.0	60.0	12	2010	40	GE	1.5 XLE	25.7	262.4	80.0
TPW Petersburg	NE	40.5	40.5	11	2011	27	GE	1.5 XLE	19.0	262.4	80.0
Prairie Breeze III	NE	35.8	35.8	4	2016	20	GE	1.79-100	20.6	262.4	80.0
Elkhorn Ridge Wind LLC	NE	81.0	81.0	3	2009	27	Vestas	V90-3.0	22.0	262.4	80.0
Crofton Bluffs Wind LLC	NE	40.0	40.0	11	2012	22	Vestas	V90-3.0	20.0	262.4	80.0
High Lonesome Mesa LLC	NM	100.0	100.0	7	2009	40	Clipper	Liberty C96	19.0	262.4	80.0
Roosevelt County	NM	250.0	250.0	12	2015	125	Vestas	V100-2.0	19.0	262.4	80.0
Macho Springs Power I	NM	50.4	50.4	11	2011	28	Vestas	V100-1.8	13.4	262.4	80.0
Anderson Wind II	NM	10.0	10.0	12	2014	5	Vestas	V100-2.0	19.0	262.4	80.0
Broadview Energy Prime LLC	NM	9.9	9.9	2	2014	6	Vestas	V82	19.0	262.4	80.0
Broadview Energy Prime 2 LLC	NM	9.9	9.9	2	2014	6	Vestas	V82	19.0	262.4	80.0
Anderson Wind I	NM	5.0	5.0	12	2014	3	Vestas	V82-1.65	19.0	262.4	80.0
Spring Valley Wind Project	NV	150.0	150.0	8	2012	66	Siemens	SWT-2.3-101	16.7	262.4	80.0
Cohocton Wind Project	NY	87.5	87.5	1	2009	35	GE	2.5-116	19.0	262.4	80.0
Dutch Hill Wind Project	NY	37.5	37.5	1	2009	15	GE	2.5-116	19.0	262.4	80.0
Munnsville Wind Farm LLC	NY	34.5	34.5	10	2007	23	GE	1.5 SLE	15.9	262.4	80.0
Steel Winds Wind Farm	NY	20.0	20.0	6	2007	8	GE	2.5-116	19.0	262.4	80.0
Steel Winds II	NY	15.0	15.0	1	2012	6	GE	2.5-116	19.0	262.4	80.0
Red Hills Wind Project LLC	OK	123.0	123.0	12	2008	82	Acciona	AW77/1500	19.0	262.4	80.0
Osage Wind, LLC	OK	150.4	150.4	6	2015	94	GE	1.7-103	18.0	262.4	80.0
Elk City LLC	OK	99.2	99.2	12	2010	48	GE	1.5 XLE	16.8	262.4	80.0
Taloga Wind LLC	OK	130.0	130.0	7	2011	54	Mitsubishi	MWT-95/2.4	19.0	262.4	80.0
Kay Wind, LLC	OK	299.0	299.0	12	2015	130	Siemens	SWT-2.3-108	19.0	262.4	80.0
Keenan II Renewable Energy Co LLC	OK	151.8	151.8	12	2010	66	Siemens	SWT-2.3-101	18.0	262.4	80.0
Grant Wind, LLC	OK	150.0	150.0	4	2016	66	Siemens	SWT-2.3-108	19.0	262.4	80.0
Grant Plains Wind, LLC	OK	147.0	147.0	12	2016	64	Siemens	SWT-2.3-108	19.0	262.4	80.0
Elk City LLC	OK	98.9	98.9	12	2009	43	Siemens	SWT-2.3-93	19.0	262.4	80.0
NextEra-Blackwell Wind, LLC	OK	59.8	59.8	12	2012	26	Siemens	SWT-2.3-108	19.0	262.4	80.0
Sleeping Bear LLC	OK	94.5	94.5	10	2007	45	Suzlon	S88-2100	19.0	262.4	80.0
Buffalo Bear LLC	OK	18.9	18.9	12	2008	9	Suzlon	S88-2100	19.0	262.4	80.0
Kingfisher Wind LLC	OK	298.0	298.0	3	2016	149	Vestas	V100-2.0	18.0	262.4	80.0
Blue Canyon Windpower VI LLC	OK	99.8	99.8	12	2011	55	Vestas	V90-1.8	17.9	262.4	80.0
Chopin Wind LLC	OR	10.0	10.0	10	2016	6	GE	1.7-103	15.0	262.4	80.0
Klondike Windpower III	OR	221.0	221.0	11	2007	124	Siemens	SWT-2.3-93	13.4	262.4	80.0
Biglow Canyon Wind Farm	OR	163.3	163.3	9	2009	71	Siemens	SWT-2.3-93	19.0	262.4	80.0
Biglow Canyon Wind Farm	OR	161.0	161.0	8	2010	70	Siemens	SWT-2.3-93	19.0	262.4	80.0

Vansycle II Wind Energy Center	OR	102.3	102.3	12	2009	43	Siemens	SWT-2.3-93	19.0	262.4	80.0
Klondike Windpower III	OR	76.5	76.5	7	2008	51	Siemens	SWT-2.3-93	16.5	262.4	80.0
Threemile Canyon	OR	9.9	9.9	7	2009	6	Vestas	V82-1.65	13.4	262.4	80.0
Oregon Trail Windfarm LLC	OR	9.9	9.9	6	2009	6	Vestas	V82-1.65	13.5	262.4	80.0
Sand Ranch Windfarm LLC	OR	9.9	9.9	6	2009	6	Vestas	V82-1.65	13.5	262.4	80.0
Pacific Canyon Windfarm LLC	OR	8.3	8.3	6	2009	5	Vestas	V82-1.65	13.5	262.4	80.0
Ward Butte Windfarm LLC	OR	6.6	6.6	6	2009	4	Vestas	V82-1.65	13.5	262.4	80.0
Butter Creek Power LLC	OR	5.0	5.0	6	2009	3	Vestas	V82-1.65	14.0	262.4	80.0
Wagon Trail LLC	OR	3.3	3.3	6	2009	2	Vestas	V82-1.65	14.0	262.4	80.0
Big Top LLC	OR	1.7	1.7	6	2009	1	Vestas	V82-1.65	14.0	262.4	80.0
Stony Creek Wind Farm LLC	PA	52.5	52.5	11	2009	35	GE	1.5 SLE	17.4	262.4	80.0
PPL Frey Farm Landfill Wind	PA	3.2	3.2	1	2011	2	GE	1.6 XLE	12.0	262.4	80.0
Lookout Windpower LLC	PA	37.8	37.8	10	2008	18	Suzlon	S88-2100	19.0	262.4	80.0
Forward Windpower LLC	PA	29.4	29.4	4	2008	14	Suzlon	S88-2100	19.0	262.4	80.0
Rolling Thunder Wind Farm Hybrid	SD	25.0	25.0	11	2009	10	Clipper	Liberty C89	22.4	262.4	80.0
Campbell County Wind Farm	SD	94.3	94.3	12	2015	55	GE	1.7-103	18.5	262.4	80.0
Beethoven Wind	SD	80.0	80.0	5	2015	43	GE	1.85-87	20.1	262.4	80.0
Oak Tree Energy	SD	19.5	19.5	12	2014	11	GE	1.85-87	19.0	262.4	80.0
Stella Wind Farm	TX	201.0	201.0	12	2018	67	Acciona	AW125/3000	17.5	262.4	80.0
TX Jumbo Road Wind	TX	299.7	299.7	4	2015	162	GE	1.85-87	20.0	262.4	80.0
Miami Wind Energy Center	TX	288.6	288.6	8	2014	156	GE	1.85-87	19.1	262.4	80.0
Bethel Wind Farm LLC	TX	276.0	276.0	1	2017	120	GE	2.3-116	19.9	262.4	80.0
Wake Wind Energy Center	TX	257.0	257.0	10	2016	150	GE	1.7-103	19.2	262.4	80.0
Pyron Wind Farm LLC Hybrid	TX	249.0	249.0	2	2009	166	GE	1.5 SLE	18.8	262.4	80.0
Panther Creek Wind Farm Three	TX	231.5	231.5	8	2009	133	GE	1.5 SLE	18.1	262.4	80.0
Mariah del Norte	TX	230.4	230.4	11	2016	96	GE	2.4-107	17.5	262.4	80.0
Pattern Panhandle Wind LLC	TX	218.0	218.0	7	2014	118	GE	1.85-87	19.0	262.4	80.0
Grandview Wind Farm, LLC	TX	211.2	211.2	12	2014	118	GE	1.7-100	16.3	262.4	80.0
Rattlesnake Den	TX	207.2	207.2	7	2015	118	GE	1.7-100	19.0	262.4	80.0
TX Hereford Wind	TX	200.0	200.0	12	2014	87	GE	1.85-82.5	19.0	262.4	80.0
Capricorn Ridge Wind LLC	TX	186.0	186.0	4	2008	124	GE	1.5 SLE	19.0	262.4	80.0
Bobcat Bluff Wind Project LLC	TX	161.0	161.0	12	2012	100	GE	1.5 SLE	19.0	262.4	80.0
Spinning Spur Wind II	TX	161.0	161.0	7	2014	85	GE	1.6-82.5	19.0	262.4	80.0
Panther Creek Wind Farm I	TX	153.9	153.9	7	2008	95	GE	1.5 SLE	18.8	262.4	80.0
Cedro Hill Wind LLC	TX	150.0	150.0	12	2010	150	GE	1.5 XLE	17.0	262.4	80.0
Cedro Hill Wind LLC	TX	150.0	150.0	12	2010	150	GE	1.5 XLE	17.0	262.4	80.0
Capricorn Ridge Wind LLC	TX	149.5	149.5	11	2007	65	GE	1.5 SLE	19.0	262.4	80.0
Panther Creek Wind Farm II	TX	124.7	124.7	12	2008	77	GE	1.5 SLE	18.1	262.4	80.0
Gunsight Mountain Wind Energy LLC	TX	120.0	120.0	6	2016	67	GE	1.79-100	17.9	262.4	80.0
Capricorn Ridge Wind LLC	TX	112.5	112.5	5	2008	75	GE	1.5 SLE	19.0	262.4	80.0
Pattern Gulf Wind	TX	283.2	283.2	12	2008	118	Mitsubishi	MWT-95/2.4	19.0	262.4	80.0
Goat Wind LP	TX	69.6	69.6	6	2009	29	Mitsubishi	MWT-95/2.4	19.0	262.4	80.0

Cambria Wind LLC	TX	62.5	62.5	8	2009	25	Nordex	N90/2500	15.0	262.4	80.0
BayWa r.e Mozart LLC	TX	30.0	30.0	12	2012	12	Nordex	N100/2500	19.0	262.4	80.0
Huerfano River Wind	TX	2.0	2.0	10	2013	1	SANY	SE11020	16.8	262.4	80.0
Huerfano River Wind	TX	2.0	2.0	10	2013	1	SANY	SE11020	16.8	262.4	80.0
Huerfano River Wind	TX	2.0	2.0	10	2013	1	SANY	SE11020	16.8	262.4	80.0
Huerfano River Wind	TX	2.0	2.0	10	2013	1	SANY	SE11020	16.8	262.4	80.0
Shiloh Wind Project 2 LLC	TX	150.0	150.0	1	2009	75	Senvion	MM92	19.0	262.4	80.0
Shiloh III Wind Project LLC	TX	102.5	100.0	12	2011	50	Senvion	MM92	19.0	262.4	80.0
Howard Wind Farm	TX	51.3	51.3	12	2011	25	Senvion	MM92	19.0	262.4	80.0
Howard Wind Farm	TX	4.1	4.1	12	2012	2	Senvion	MM92	19.0	262.4	80.0
Rolling Hills Wind Farm	TX	443.2	443.2	12	2011	193	Siemens	SWT-2.3-101	16.8	262.4	80.0
Horse Hollow Wind Energy Center	TX	223.5	223.5	6	2006	150	Siemens	SWT-2.3-93	22.0	262.4	80.0
Capricorn Ridge Wind LLC	TX	214.5	214.5	11	2007	143	Siemens	SWT-2.3-82	19.0	262.4	80.0
Papalote Creek II LLC	TX	200.1	200.1	12	2010	87	Siemens	SWT-2.3-101	16.8	262.4	80.0
Logans Gap Wind LLC	TX	200.1	200.1	8	2015	87	Siemens	SWT-2.3-108	19.0	262.4	80.0
Pattern Panhandle Wind 2 LLC	TX	181.7	181.7	11	2014	79	Siemens	SWT-2.3-108	19.0	262.4	80.0
Hackberry Wind Farm	TX	162.3	162.3	12	2008	72	Siemens	SWT-2.3-93	15.6	262.4	80.0
Wildorado Wind LLC	TX	161.0	161.0	4	2007	70	Siemens	SWT-2.3-93	19.0	262.4	80.0
Spinning Spur Wind LLC	TX	161.0	161.0	11	2012	70	Siemens	SWT-2.3-101	19.0	262.4	80.0
Champion Wind Farm LLC	TX	126.5	126.5	2	2008	51	Siemens	SWT-2.3-93	18.6	262.4	80.0
Tyler Bluff Wind Project, LLC	TX	125.0	125.0	12	2016	52	Siemens	SWT-2.3-108	17.0	262.4	80.0
Forest Creek Wind Farm LLC	TX	124.2	124.2	12	2006	54	Siemens	SWT-2.3-93	18.6	262.4	80.0
Sweetwater Wind 5	TX	80.5	80.5	12	2007	35	Siemens	SWT-2.3-82 VS	16.5	262.4	80.0
Golden Spread Panhandle Wnd Rch	TX	78.2	78.2	9	2011	34	Siemens	SWT-2.3-101	19.3	262.4	80.0
Windthorst-2	TX	67.6	67.6	9	2014	28	Siemens	SWT-2.3-108	17.5	262.4	80.0
Whirlwind Energy Center	TX	57.0	57.0	12	2007	26	Siemens	SWT-2.3-93	17.7	262.4	80.0
Pantex	TX	11.5	11.5	6	2014	5	Siemens	SWT-2.3-101	27.0	262.4	80.0
Porterhouse Wind (4) LLC	TX	79.8	79.8	1	2008	38	Suzlon	S88-2100	19.1	262.4	80.0
Magic Valley Wind Farm I LLC	TX	203.0	203.0	9	2012	112	Vestas	V100-1.8	16.6	262.4	80.0
Longhorn Wind	TX	200.0	200.0	5	2015	100	Vestas	V100-2.0	19.0	262.4	80.0
South Plains Wind Phase I	TX	200.0	200.0	11	2015	100	Vestas	V100-2.0	19.0	262.4	80.0
Trinity Hills	TX	198.0	198.0	12	2011	90	Vestas	V110-2.0	19.0	262.4	80.0
Spinning Spur Wind III	TX	194.0	194.0	9	2015	97	Vestas	V100-2.0	19.0	262.4	80.0
Papalote Creek I LLC	TX	180.0	180.0	9	2009	109	Vestas	V82-1.65	17.4	262.4	80.0
Salt Fork Wind Project, LLC	TX	174.0	174.0	12	2016	87	Vestas	V100-2.0	20.3	262.4	80.0
Route 66 Wind Plant	TX	150.0	150.0	8	2015	75	Vestas	V110-2.0	16.7	262.4	80.0
Sherbino II	TX	132.0	132.0	11	2011	60	Vestas	V110-2.0	19.0	262.4	80.0
Anacacho Wind Farm, LLC	TX	99.8	99.8	12	2012	55	Vestas	V100-1.8	17.0	262.4	80.0
Silver Star I Wind Power Project	TX	52.8	52.8	9	2008	24	Vestas	V110-2.0	19.0	262.4	80.0
Milford Wind Corridor I LLC	UT	203.5	203.5	9	2009	97	GE	1.5 XLE	13.2	262.4	80.0
Spanish Fork Wind Park 2 LLC	UT	18.9	18.9	7	2008	9	Suzlon	S88-2100	19.0	262.4	80.0

Sheffield Wind	VT	40.0	40.0	10	2011	16	Clipper	Liberty C93	18.0	262.4	80.0
Georgia Mountain Community Wind Farm	VT	10.0	10.0	12	2012	4	Goldwind	GW 100/2500	17.5	262.4	80.0
Juniper Canyon I Wind Project	WA	148.8	148.8	3	2011	126	Mitsubishi	MWT-95/2.4	14.2	262.4	80.0
Lower Snake River Wind Energy Project	WA	342.7	342.7	2	2012	149	Siemens	SWT-2.3-101	15.6	262.4	80.0
Tucannon River Wind Farm	WA	266.8	266.8	12	2014	116	Siemens	SWT-2.3-108	22.3	262.4	80.0
Windy Flats Wind Project	WA	262.2	262.2	10	2009	114	Siemens	SWT-2.3-93	15.0	262.4	80.0
Tuolumne Wind Project	WA	136.3	136.3	5	2009	62	Siemens	SWT-2.3-93	16.5	262.4	80.0
Mountain Wind Power II LLC	WY	80.0	80.0	9	2008	38	Suzlon	S88-2100	19.0	262.4	80.0
Mountain Wind Power LLC	WY	61.0	61.0	7	2008	29	Suzlon	S88-2100	19.0	262.4	80.0
Shiloh I Wind Project	CA	150.0	150.0	5	2006	100	GE	1.62-100	13.5	262.0	79.9
Alta Wind Energy Center I	CA	150.0	150.0	1	2011	100	GE	1.5 SLE	22.4	262.0	79.9
Tule Wind LLC	CA	143.0	143.0	12	2017	57	GE	1.5 S	16.2	262.0	79.9
Alta Wind X	CA	138.0	138.0	1	2014	48	GE	2.85-103	22.4	262.0	79.9
Foundation CDCR LAC	CA	1.9	1.9	12	2017	1	GE	1.85-82.5	15.8	262.0	79.9
Foundation Scheid Vineyards	CA	1.9	1.9	9	2017	1	GE	1.85-82.5	13.2	262.0	79.9
Foundation California Training Facility	CA	1.8	1.8	8	2018	1	GE	1.7-100	14.5	262.0	79.9
Foundation Mann Packing	CA	1.8	1.8	4	2019	1	GE	1.7-100	14.0	262.0	79.9
Foundation Salinas Valley State Prison	CA	1.8	1.8	8	2018	1	GE	1.7-100	14.5	262.0	79.9
Anheuser-Busch #2	CA	1.6	1.6	11	2014	1	GE	1.85-82.5	13.4	262.0	79.9
Teichert Materials-Teichert Vernalis	CA	1.0	1.0	10	2010	1	GE	1.5 SLE	12.0	262.0	79.9
Golden Acorn Casino	CA	1.0	1.0	7	2014	1	GE	1.85-82.5	16.1	262.0	79.9
City of Soledad Water Reclamation	CA	1.0	1.0	11	2014	1	GE	1.85-82.5	14.3	262.0	79.9
Taylor Farms	CA	1.0	1.0	11	2014	1	GE	1.85-82.5	13.2	262.0	79.9
Alta Wind Energy Center V	CA	168.0	168.0	4	2011	56	Vestas	V90-3.0	22.4	262.0	79.9
Alta Wind Energy Center II	CA	150.0	150.0	1	2011	50	Vestas	V90-3.0	22.4	262.0	79.9
Alta Wind Energy Center III	CA	150.0	150.0	2	2011	50	Vestas	V90-3.0	22.4	262.0	79.9
Alta Wind Energy Center IV	CA	102.0	102.0	4	2011	34	Vestas	V90-3.0	22.4	262.0	79.9
Twin Buttes II Wind	CO	75.0	75.0	12	2017	36	Gamesa	G114-2.0	19.7	262.0	79.9
Cedar Creek Wind	CO	79.5	79.5	11	2007	53	GE	1.5 SLE	16.6	262.0	79.9
Twin Buttes Wind Project	CO	75.0	75.0	7	2007	50	GE	1.5 SLE	18.3	262.0	79.9
Rush Creek Wind	CO	582.3	582.3	12	2018	300	Vestas	V100-2.0	19.0	262.0	79.9
Cheyenne Ridge Wind Farm	CO	477.1	477.1	8	2020	229	Vestas	V120-2.2	19.7	262.0	79.9
Winnebago Wind Power Project	IA	20.0	20.0	9	2008	10	Gamesa	G87-2.0	18.3	262.0	79.9
Crane Creek Wind Energy Center	IA	99.0	99.0	12	2009	66	GE	1.5 SLE	17.8	262.0	79.9
Flying Cloud Power Partners LLC	IA	43.5	43.5	12	2003	29	GE	1.5 SLE	18.4	262.0	79.9
Lakota Wind Wind Farm	IA	10.5	10.5	3	2009	7	GE	1.5 SLE	22.0	262.0	79.9
Iowa Lakes Superior Wind Farm	IA	10.5	10.5	4	2009	7	GE	1.5 SLE	22.0	262.0	79.9
Whispering Willow Wind Farm - East	IA	199.7	199.7	12	2009	121	Vestas	V82-1.65	17.0	262.0	79.9

Lost Lakes Wind Farm LLC	IA	100.0	100.0	12	2009	61	Vestas	V82-1.65	19.0	262.0	79.9
Franklin County Wind Farm	IA	99.0	99.0	12	2012	60	Vestas	V82-1.65	17.7	262.0	79.9
Top of Iowa Windfarm III	IA	29.7	29.7	2	2008	18	Vestas	V82-1.65	19.0	262.0	79.9
Blackstone Wind Farm II LLC	IL	200.0	200.0	8	2010	132	GE	1.5 SLE	19.0	262.0	79.9
Camp Grove Wind Farm	IL	150.0	150.0	12	2007	100	GE	1.5 SLE	15.5	262.0	79.9
Blackstone Wind Farm LLC	IL	106.0	106.0	10	2009	68	GE	1.5 SLE	19.0	262.0	79.9
Rail Splitter Wind Farm	IL	100.5	100.5	8	2009	67	GE	1.5 SLE	19.0	262.0	79.9
Old Trail Wind Farm	IL	213.8	213.8	12	2007	120	Vestas	V82-1.65	19.0	262.0	79.9
High Trail Wind Farm LLC	IL	210.9	210.9	3	2007	120	Vestas	V82-1.65	19.0	262.0	79.9
Heartland Community College	IL	1.7	1.7	6	2012	1	Vestas	V82-1.65	14.5	262.0	79.9
Benton County Wind Farm	IN	130.5	130.5	5	2008	87	GE	1.5 SLE	15.4	262.0	79.9
Meadow Lake Wind Farm III LLC	IN	103.5	103.5	9	2010	69	GE	1.5 SLE	19.0	262.0	79.9
Fowler Ridge IV Wind Farm LLC	IN	150.0	150.0	1	2016	65	Siemens	SWT-2.3-108	13.0	262.0	79.9
Meadow Lake Wind Farm LLC	IN	199.7	199.7	10	2009	121	Vestas	V82-1.65	19.0	262.0	79.9
Cedar Bluff Wind, LLC	KS	198.6	198.6	12	2015	111	GE	1.79-100	19.0	262.0	79.9
Elk River Wind	KS	150.0	150.0	12	2005	100	GE	1.5 SLE	19.2	262.0	79.9
Western Plains Wind	KS	2.7	2.7	10	2021	1	GE	2.0-116	19.0	262.0	79.9
Pratt Wind, LLC	KS	243.5	243.5	12	2018	88	Siemens	SWT-2.3-101	19.0	262.0	79.9
Cimarron Bend Wind Project I, LLC	KS	200.0	200.0	12	2016	100	Vestas	V110-2.0	15.0	262.0	79.9
Flat Ridge 3	KS	128.0	128.0	12	2021	62	Vestas	V110-2.0	14.0	262.0	79.9
Cloud County Wind Farm	KS	105.0	105.0	12	2008	35	Vestas	V90-3.0	18.3	262.0	79.9
Cloud County Wind Farm	KS	96.0	96.0	12	2008	32	Vestas	V90-3.0	17.6	262.0	79.9
MA Military Reservation Wind Project	MA	1.5	1.5	12	2009	1	Fuhrlander	FL 1500-77	14.5	262.0	79.9
Berkshire Wind Power Project	MA	15.0	15.0	5	2011	10	GE	1.5 SLE	16.0	262.0	79.9
MA Military Reservation Wind Project	MA	1.5	1.5	11	2011	1	GE	1.5 SLE	13.7	262.0	79.9
MA Military Reservation Wind Project	MA	1.5	1.5	11	2011	1	GE	1.5 SLE	13.7	262.0	79.9
Fairhaven Wind	MA	3.0	3.0	4	2012	2	Sinovel	SL1500/82	14.9	262.0	79.9
Scituate Wind	MA	1.5	1.5	3	2012	1	Sinovel	SL1500/82	15.7	262.0	79.9
Notus Wind 1	MA	1.7	1.7	7	2010	1	Vestas	V82-1.65	19.0	262.0	79.9
Mt Wachusett Community College	MA	1.7	1.7	3	2011	1	Vestas	V82-1.65	19.0	262.0	79.9
Mt Wachusett Community College	MA	1.7	1.7	3	2011	1	Vestas	V82-1.65	19.0	262.0	79.9
Beaver Ridge Wind	ME	4.5	4.5	11	2008	3	GE	1.5 SLE	19.0	262.0	79.9
Fox Island Wind LLC	ME	4.5	4.5	11	2009	3	GE	1.5 SLE	14.5	262.0	79.9
Kibby Wind Facility	ME	66.0	66.0	10	2009	22	Vestas	V90-3.0	22.4	262.0	79.9
Kibby Wind Facility	ME	66.0	66.0	10	2010	22	Vestas	V90-3.0	22.4	262.0	79.9
Hancock Wind Plant	ME	51.0	51.0	12	2016	17	Vestas	V117-3.3	22.4	262.0	79.9
Hilltop Power	MN	2.0	2.0	12	2008	1	DeWind	D8.2	12.0	262.0	79.9
Nobles Wind Project	MN	200.0	200.0	12	2010	134	GE	1.5 SLE	18.0	262.0	79.9
MinnDakota Wind LLC	MN	150.0	150.0	1	2008	100	GE	1.5 SLE	17.9	262.0	79.9

Trimont Area Wind Farm	MN	100.5	100.5	11	2005	67	GE	1.5 SLE	17.8	262.0	79.9
Grand Meadow	MN	100.0	100.0	12	2008	67	GE	1.5 SLE	18.0	262.0	79.9
Elm Creek Wind LLC	MN	99.0	99.0	12	2008	66	GE	1.5 SLE	17.6	262.0	79.9
Northern Wind	MN	91.5	91.5	1	2023	38	GE	2.72-116	17.0	262.0	79.9
Moraine II Wind LLC	MN	49.5	49.5	2	2009	33	GE	1.5 SLE	18.0	262.0	79.9
Rock County Wind Fuel, LLC	MN	5.0	5.0	5	2020	2	GE	2.5-116	16.2	262.0	79.9
REG Juhl Glenville Wind, LLC	MN	2.5	2.5	12	2020	1	GE	2.5-116	17.0	262.0	79.9
Lake Region Community Hybrid, LLC	MN	2.0	2.0	12	2018	1	GE	2.0-116	16.2	262.0	79.9
Carleton College	MN	1.6	1.6	10	2011	1	GE	1.6 XLE	14.5	262.0	79.9
Windshare LLC	MN	5.4	5.4	3	2006	3	Suzlon		18.0	262.0	79.9
Bent Tree Wind Farm Phase 1	MN	201.3	201.3	2	2011	122	Vestas	V82-1.65	16.3	262.0	79.9
Freeborn Wind Farm	MN	200.0	200.0	5	2021	100	Vestas	V120-2.2	19.0	262.0	79.9
Blazing Star Wind Farm 1	MN	200.0	200.0	4	2020	100	Vestas	V120-2.0	19.0	262.0	79.9
Red Pine Wind Project	MN	200.0	200.0	12	2017	100	Vestas	V110-2.0	17.9	262.0	79.9
Blazing Star 2 Wind Farm	MN	200.0	200.0	1	2021	100	Vestas	V120-2.0	18.7	262.0	79.9
NaturEner Rim Rock Energy	MT	184.6	184.6	12	2012	126	Acciona	AW77/1500	18.0	262.0	79.9
NaturEner Glacier Wind Energy 1	MT	104.2	104.2	10	2008	71	Acciona	AW77/1500	17.0	262.0	79.9
NaturEner Glacier Wind Energy 2	MT	101.4	101.4	11	2009	69	Acciona	AW77/1500	17.0	262.0	79.9
Spion Kop Wind Farm	MT	40.0	40.0	12	2012	25	GE	1.6-82.5	19.0	262.0	79.9
Gordon Butte Wind LLC	MT	9.6	9.6	1	2012	6	GE	1.5 SLE	21.0	262.0	79.9
Two Dot Wind Broadview East LLC	MT	1.6	1.6	10	2018	1	GE	1.7-100	14.5	262.0	79.9
Pryor Mountain Wind	MT	239.8	239.8	4	2021	114	Vestas	V110-2.0	19.0	262.0	79.9
Courtenay Wind Farm	ND	190.2	190.2	12	2016	100	Vestas	V100-2.0	18.0	262.0	79.9
Foxtail Wind, LLC	ND	150.0	150.0	1	2020	75	Vestas	V120-2.0	19.0	262.0	79.9
Sunflower Wind Project	ND	104.0	104.0	12	2016	52	Vestas	V100-2.0	19.0	262.0	79.9
Jersey-Atlantic Wind Farm	NJ	7.5	7.5	3	2006	5	GE	1.5 SLE	19.0	262.0	79.9
Bayonne MUA-Leitner-Poma Wind Turbine	NJ	0.1	0.3	7	2012	1	Leitwind	LTW77 1.500	15.0	262.0	79.9
El Cabo Wind	NM	298.0	298.0	12	2017	142	Gamesa	G114-2.0	18.4	262.0	79.9
Tecolote Wind LLC	NM	272.0	272.0	12	2021	98	GE	2.3-116	19.0	262.0	79.9
Red Mesa Wind LLC	NM	102.4	102.4	12	2010	64	GE	1.6 SLE	14.0	262.0	79.9
Mesalands Comm College Wind Turbine	NM	1.5	1.5	12	2008	1	GE	1.5-77	15.0	262.0	79.9
Oso Grande Wind Farm	NM	33.8	33.8	5	2021	14	Siemens Gamesa	SWT-2.415-108	19.0	262.0	79.9
Sagamore Wind	NM	90.0	179.0	12	2020	240	Vestas	V120-2.2	19.5	262.0	79.9
Wethersfield	NY	126.0	126.0	4	2009	84	GE	1.5 SLE	19.0	262.0	79.9
Chateaugay	NY	106.5	106.5	4	2009	71	GE	1.5 SLE	14.0	262.0	79.9
Clinton	NY	100.5	100.5	5	2008	67	GE	1.5 SLE	19.0	262.0	79.9
Bliss (NY)	NY	100.5	100.5	5	2008	67	GE	1.5 SLE	19.0	262.0	79.9
Altona	NY	97.5	97.5	4	2009	65	GE	1.5 SLE	19.0	262.0	79.9
Ellenburg	NY	81.0	81.0	5	2008	54	GE	1.5 SLE	19.0	262.0	79.9
Fenner Wind	NY	30.0	30.0	10	2001	20	GE	1.5 SE	24.0	262.0	79.9
Marsh Hill Wind Farm	NY	16.2	16.2	11	2014	10	GE	1.6-103	16.7	262.0	79.9
Maple Ridge Wind Farm	NY	137.0	137.0	12	2005	83	Vestas	V82-1.65	19.0	262.0	79.9

Maple Ridge Wind Farm	NY	91.0	91.0	12	2006	55	Vestas	V82-1.65	19.0	262.0	79.9
Maple Ridge Wind Farm	NY	61.1	61.1	1	2006	37	Vestas	V82-1.65	19.0	262.0	79.9
Maple Ridge Wind Farm	NY	33.0	33.0	6	2006	20	Vestas	V82-1.65	19.0	262.0	79.9
Findlay Wind Farm	OH	3.0	3.0	12	2015	2	Goldwind	GW 87/1500	13.1	262.0	79.9
Zephyr Wind	OH	1.5	1.5	12	2015	1	Goldwind	GW 87/1500	13.0	262.0	79.9
Zephyr Wind	OH	1.5	1.5	12	2015	1	Goldwind	GW 87/1500	13.0	262.0	79.9
Zephyr Wind	OH	1.5	1.5	12	2015	1	Goldwind	GW 87/1500	13.0	262.0	79.9
Whirlpool Corporation - Ottawa Wind Farm	OH	1.5	1.5	1	2018	1	Goldwind	GW 87/1500	13.0	262.0	79.9
Whirlpool Corporation - Marion Wind Farm	OH	1.5	1.5	10	2017	1	Goldwind	GW 87/1500	13.0	262.0	79.9
Whirlpool Corporation - Marion Wind Farm	OH	1.5	1.5	10	2017	1	Goldwind	GW 87/1500	13.0	262.0	79.9
Whirlpool Corporation - Marion Wind Farm	OH	1.5	1.5	10	2017	1	Goldwind	GW 87/1500	13.0	262.0	79.9
Valfilm Wind Project	OH	1.5	1.5	9	2018	1	Goldwind	GW 87/1500	14.0	262.0	79.9
Valfilm Wind Project	OH	1.5	1.5	9	2018	1	Goldwind	GW 87/1500	14.0	262.0	79.9
Whirlpool Corp-Greenville Wind Farm	OH	1.5	1.5	9	2018	1	Goldwind	GW 87/1500	13.0	262.0	79.9
Whirlpool Corp-Greenville Wind Farm	OH	1.5	1.5	9	2018	1	Goldwind	GW 87/1500	13.0	262.0	79.9
Whirlpool Corp-Greenville Wind Farm	OH	1.5	1.5	9	2018	1	Goldwind	GW 87/1500	13.0	262.0	79.9
Zephyr Wind Project - 2.0	OH	1.5	1.5	8	2020	1	Goldwind	GW 87/1500	13.0	262.0	79.9
Zephyr Wind Project - 2.0	OH	1.5	1.5	8	2020	1	Goldwind	GW 87/1500	13.0	262.0	79.9
Zephyr Wind Project - 2.0	OH	1.5	1.5	8	2020	1	Goldwind	GW 87/1500	13.0	262.0	79.9
LafargeHolcim - Paulding Wind Project	OH	1.5	1.5	8	2020	1	Goldwind	GW 87/1500	14.0	262.0	79.9
LafargeHolcim - Paulding Wind Project	OH	1.5	1.5	8	2020	1	Goldwind	GW 87/1500	14.0	262.0	79.9
LafargeHolcim - Paulding Wind Project	OH	1.5	1.5	8	2020	1	Goldwind	GW 87/1500	14.0	262.0	79.9
Martin Marietta Wind Project	OH	1.5	1.5	12	2023	1	Goldwind	GW 87/1500	14.8	262.0	79.9
Martin Marietta Wind Project	OH	1.5	1.5	12	2023	1	Goldwind	GW 87/1500	14.8	262.0	79.9
Martin Marietta Wind Project	OH	1.5	1.5	12	2023	1	Goldwind	GW 87/1500	14.8	262.0	79.9
Blue Canyon Windpower V LLC	OK	99.0	99.0	10	2009	66	GE	1.5 SLE	17.7	262.0	79.9
Blue Canyon Windpower II	OK	151.4	151.4	12	2005	84	Vestas	V80-1.8	16.1	262.0	79.9
Drift Sand Wind Project LLC	OK	108.0	108.0	12	2016	54	Vestas	V110-2.0	12.0	262.0	79.9
Blue Canyon Windpower	OK	74.3	74.3	12	2003	45	Vestas	V82-1.65	19.0	262.0	79.9
Leaning Juniper	OR	100.5	100.5	10	2006	67	GE	1.6 SLE	19.0	262.0	79.9
Wheatridge 1	OR	100.0	100.0	12	2020	40	GE	2.5-127	14.9	262.0	79.9
Klondike Windpower II	OR	81.0	81.0	7	2005	50	GE	1.5 SLE	14.5	262.0	79.9
Jett Creek Windfarm (Burnt River)	OR	10.0	10.0	3	2017	5	GE	2.0-116	14.0	262.0	79.9
Benson Creek Windfarm (Burnt River)	OR	10.0	10.0	3	2017	5	GE	2.0-116	14.7	262.0	79.9

Durbin Creek Windfarm (Burnt River)	OR	10.0	10.0	3	2017	5	GE	2.0-116	12.0	262.0	79.9
Prospector Windfarm (Burnt River)	OR	10.0	10.0	3	2017	5	GE	2.0-116	14.0	262.0	79.9
Willow Spring Windfarm (Burnt River)	OR	10.0	10.0	3	2017	5	GE	2.0-116	15.0	262.0	79.9
PaTu Wind Farm LLC	OR	9.0	9.0	12	2010	6	GE	1.5 SLE	12.0	262.0	79.9
Schumann Wind Farm	OR	8.0	8.0	11	2022	5	GE	1.7-103	15.4	262.0	79.9
Armenia Mountain Wind Farm	PA	100.5	100.5	12	2009	67	GE	1.5 SLE	14.8	262.0	79.9
Casselman Wind Power Project	PA	34.5	34.5	12	2007	23	GE	1.5 SLE	15.5	262.0	79.9
Meyersdale Windpower, LLC	PA	30.0	30.0	12	2003	20	NEG-Micon	NM72C/1500	16.0	262.0	79.9
Fluvanna	TX	155.4	155.4	11	2017	74	Gamesa	G114-2.0	18.0	262.0	79.9
Colbeck's Corner, LLC	TX	200.0	200.0	5	2016	112	GE	1.79-100	19.0	262.0	79.9
Astra Wind Farm	TX	163.0	163.0	5	2017	68	GE	2.4-107	19.0	262.0	79.9
Old Settler Wind	TX	151.2	151.2	4	2017	63	GE	2.4-107	18.2	262.0	79.9
Langford Wind Power	TX	150.0	150.0	12	2009	100	GE	1.5 SLE	18.2	262.0	79.9
Sweetwater Wind 3 LLC	TX	144.0	144.0	12	2005	90	GE	1.5 SLE	19.0	262.0	79.9
Great Plains Windpark LLC	TX	114.0	114.0	1	2009	76	GE	1.5 SLE	19.0	262.0	79.9
Sweetwater Wind 2 LLC	TX	98.8	98.8	2	2005	61	GE	1.5 SLE	19.0	262.0	79.9
Loraine Windpark Project LLC	TX	75.0	75.0	10	2009	50	GE	1.5 SLE	15.8	262.0	79.9
Loraine Windpark Project LLC	TX	73.5	73.5	10	2009	49	GE	1.5 SLE	15.8	262.0	79.9
Cotton Plains Wind Farm	TX	50.4	50.4	3	2017	21	GE	2.4-107	18.1	262.0	79.9
Sweetwater Wind 1 LLC	TX	37.5	37.5	12	2003	25	GE	1.5 S	19.0	262.0	79.9
GE-Lubbock	TX	2.5	2.5	4	2014	1	GE	2.5-100	15.0	262.0	79.9
Penascal Wind Power LLC	TX	201.6	201.6	4	2009	84	Mitsubishi	MWT-92/2.4	16.9	262.0	79.9
Penascal II Wind Project LLC	TX	201.6	201.6	3	2010	84	Mitsubishi	MWT-92/2.4	16.5	262.0	79.9
Roth Rock Wind Farm LLC	TX	40.0	40.0	8	2011	16	Nordex	N90/2500	19.0	262.0	79.9
Power County Wind Park South	TX	22.5	22.5	12	2011	9	Nordex	N100/2500	17.2	262.0	79.9
Power County Wind Park North	TX	22.5	22.5	12	2011	9	Nordex	N100/2500	17.2	262.0	79.9
Roth Rock North Wind Farm, LLC	TX	10.0	10.0	8	2011	4	Nordex	N90/2500	19.0	262.0	79.9
Eva Creek Wind	TX	24.6	24.6	1	2013	12	REpower	MM92	16.5	262.0	79.9
631-56 Airport Owner, LLC	TX	2.0	2.0	2	2012	1	SANY	SE9320III-3	14.0	262.0	79.9
Linden Wind Energy Project	TX	50.0	50.0	6	2010	25	Senvion	MM92	14.0	262.0	79.9
Canadian Breaks, LLC	TX	210.1	210.1	12	2019	87	Siemens	SWT-2.3-108	18.7	262.0	79.9
Live Oak Wind Project	TX	199.5	199.5	3	2019	76	Siemens	SWT-2.625-120	18.6	262.0	79.9
Buffalo Gap 3 Wind Farm	TX	170.2	170.2	8	2008	74	Siemens	SWT-1.3-62	17.0	262.0	79.9
South Plains II	TX	300.0	300.0	6	2016	91	Vestas	V117-3.3	22.4	262.0	79.9
Gopher Creek Wind Farm	TX	158.0	158.0	9	2019	76	Vestas	V110-2.0	19.0	262.0	79.9
Hale Community Wind Farm	TX	128.0	107.0	6	2019	239	Vestas	V110-2.0	19.0	262.0	79.9
Tooele Army Depot(CSG)	UT	1.5	1.5	7	2010	1	CPC	FD77-1500-IIIA	14.0	262.0	79.9
Milford Wind Corridor Stage II LLC	UT	102.0	102.0	5	2011	68	GE	1.5 SLE	19.0	262.0	79.9
Latigo Wind Park	UT	62.1	62.1	3	2016	27	GE	2.0-116	13.0	262.0	79.9
Big Horn Wind Project	WA	199.0	199.0	10	2006	133	GE	1.5 SLE	12.5	262.0	79.9
Palouse	WA	105.3	105.3	12	2012	58	Vestas	V100-1.8	17.0	262.0	79.9

Cedar Ridge	WI	67.7	67.7	12	2008	41	Vestas	V82-1.65	15.0	262.0	79.9
Galactic Wind	WI	9.9	9.9	12	2012	6	Vestas	V82-1.65	14.3	262.0	79.9
Laurel Mountain Hybrid	WV	97.6	97.6	8	2011	61	GE	1.6 SLE	16.1	262.0	79.9
Dunlap	WY	111.0	111.0	10	2010	74	GE	1.85-87	19.0	262.0	79.9
Seven Mile Hill	WY	99.0	99.0	12	2008	66	GE	1.85-87	19.0	262.0	79.9
High Plains	WY	99.0	99.0	9	2009	66	GE	1.85-87	19.0	262.0	79.9
Glenrock	WY	99.0	99.0	12	2008	66	GE	1.85-87	19.0	262.0	79.9
Rolling Hills	WY	99.0	99.0	1	2009	66	GE	1.85-87	19.0	262.0	79.9
Pioneer Wind Park, LLC	WY	80.0	80.0	10	2016	46	GE	1.85-87	19.0	262.0	79.9
Glenrock	WY	39.0	39.0	1	2009	26	GE	1.85-87	19.0	262.0	79.9
McFadden Ridge	WY	28.8	28.5	10	2009	19	GE	1.85-87	19.0	262.0	79.9
Seven Mile Hill	WY	19.5	19.5	12	2008	13	GE	1.85-87	19.0	262.0	79.9
TB Flats	WY	503.2	503.2	10	2021	132	Vestas	V136-4.2	19.0	262.0	79.9
Auwahi Wind Energy Hybrid	HI	24.0	24.0	12	2012	8	Siemens	SWT-3.0-101	24.6	261.0	79.6
Bison 2 Wind Energy Center	ND	105.0	105.0	12	2012	35	Siemens	SWT-3.0-101	19.9	261.0	79.6
Bison I Wind Energy Center	ND	45.0	45.0	1	2012	15	Siemens	SWT-3.0-101	19.9	261.0	79.6
Osage (IA)	IA	0.5	0.5	12	2009	1	GE	1.5 SLE	17.8	260.0	79.2
Two Dot Wind Farm	MT	9.7	9.7	6	2014	6	GE	1.62-82.5	19.2	260.0	79.2
Luverne Wind Energy Center	ND	49.5	49.5	9	2009	33	GE	1.5 XLE	16.0	260.0	79.2
Ashtabula Wind Energy Center	ND	48.0	48.0	10	2008	32	GE	1.5 SLE	16.0	260.0	79.2
Langdon Wind Energy Center	ND	40.5	40.5	12	2007	27	GE	1.6-97	16.0	260.0	79.2
Bison 3 Wind Energy Center	ND	105.0	105.0	12	2012	35	Siemens	SWT-3.0-101	19.9	260.0	79.2
Merricourt Wind Energy Center	ND	150.0	150.0	12	2020	75	Vestas	V110-2.0	19.7	260.0	79.2
Ponderosa Wind Energy Center	OK	200.0	200.0	11	2020	100	GE	2.5-116	14.0	260.0	79.2
Biglow Canyon Wind Farm	OR	125.4	125.4	12	2007	76	Vestas	V82-1.65	19.0	260.0	79.2
White Creek Wind Farm	WA	204.0	204.0	11	2007	89	Siemens	SWT-2.3-93	17.6	260.0	79.2
Harvest Wind Project	WA	98.9	98.9	12	2009	43	Siemens	SWT-2.3-93	17.6	260.0	79.2
Dry Lake Wind LLC	AZ	63.0	63.0	9	2009	30	Suzlon	S88-2100	15.2	259.0	78.9
Welcome Wind Turbine	MN	2.1	2.1	5	2008	1	Suzlon	S88-2100	19.0	259.0	78.9
Rugby Wind Power Project	ND	149.0	149.0	12	2009	71	Suzlon	S88-2100	16.5	259.0	78.9
Leaning Juniper Wind Power II	OR	199.2	199.2	3	2011	116	GE	1.5 SLE	14.0	259.0	78.9
Hay Canyon Wind Power LLC	OR	100.8	100.8	2	2009	48	Suzlon	S88-2100	13.7	259.0	78.9
Pebble Springs Wind LLC	OR	98.7	98.7	1	2009	47	Suzlon	S52	13.2	259.0	78.9
Star Point Wind Project LLC	OR	98.7	98.7	2	2010	47	Suzlon	S88-2100	15.6	259.0	78.9
Buffalo Ridge I LLC	SD	50.4	50.4	4	2009	24	Suzlon	S88-2100	18.4	259.0	78.9
Four Mile Canyon Windfarm LLC	TX	10.0	10.0	6	2009	5	REpower	MM92	14.0	257.5	78.5
Four Corners Windfarm LLC	TX	8.0	8.0	6	2009	4	REpower	MM92	14.0	257.5	78.5
Pacific Wind LLC	TX	140.0	140.0	8	2012	75	Senvion	MM92	19.0	257.5	78.5
Hoosier Wind Project LLC	TX	106.0	106.0	11	2009	50	Senvion	MM92	19.0	257.5	78.5
Shiloh IV Wind Project LLC	TX	102.5	102.5	12	2012	58	Senvion	MM92	19.0	257.5	78.5
Kingman 1	AZ	10.0	10.0	9	2011	5	Gamesa	G90-2.0	27.0	256.0	78.0
Poseidon Wind, LLC	AZ	65.1	65.1	12	2010	31	Suzlon	S88-2100	14.8	256.0	78.0
University of Delaware Wind Turbine	DE	2.0	2.0	7	2010	1	Gamesa	G90-2.0	15.5	256.0	78.0

New Harvest Wind Project LLC	IA	100.0	100.0	12	2011	50	Gamesa	G87-2.0	18.0	256.0	78.0
Barton Windpower LLC	IA	80.0	80.0	6	2009	40	Gamesa	G87-2.0	16.5	256.0	78.0
Barton Windpower LLC	IA	78.0	78.0	6	2009	39	Gamesa	G87-2.0	17.8	256.0	78.0
Streator Cayuga Ridge South	IL	300.0	300.0	3	2010	150	Gamesa	G87-2.0	16.1	256.0	78.0
GSG LLC	IL	80.0	80.0	6	2007	40	Gamesa	G87-2.0	19.0	256.0	78.0
Providence Heights Wind LLC	IL	72.0	72.0	8	2008	36	Gamesa	G87-2.0	15.7	256.0	78.0
Crescent Ridge	IL	53.0	53.0	12	2005	28	NEG-Micon	NM82/1650	21.0	256.0	78.0
Equity Industrial Turbines	MA	4.0	4.0	12	2012	2	Gamesa	G90-2.0	15.9	256.0	78.0
Spruce Mountain WInd	ME	20.0	20.0	12	2011	10	Gamesa	G90-2.0	19.0	256.0	78.0
Valley View Transmission LLC	MN	10.0	10.0	7	2011	5	Gamesa	G87-2.0	13.0	256.0	78.0
Farmers City Wind LLC	MO	146.0	146.0	4	2009	73	Gamesa	G87-2.0	15.1	256.0	78.0
Groton Wind LLC	NH	48.0	48.0	12	2012	24	Gamesa	G78-2.0	14.8	256.0	78.0
Lempster Wind LLC	NH	24.0	24.0	12	2008	12	Gamesa	G87-2.0	15.0	256.0	78.0
Locust Ridge II LLC	PA	102.0	102.0	5	2009	51	Gamesa	G87-2.0	15.5	256.0	78.0
Allegheny Ridge Wind Farm	PA	80.0	80.0	6	2007	40	Gamesa	G87-2.0	19.0	256.0	78.0
South Chestnut LLC	PA	50.4	50.4	4	2012	23	Gamesa	G90-2.0	16.3	256.0	78.0
Locust Ridge	PA	26.0	26.0	3	2007	13	Gamesa	G87-2.0	16.0	256.0	78.0
Wind Park Bear Creek	PA	24.0	24.0	3	2006	12	Gamesa	G87-2.0	19.0	256.0	78.0
Buffalo Ridge II LLC	SD	210.0	210.0	12	2010	105	Gamesa	G87-2.0	17.5	256.0	78.0
Barton Chapel Wind Farm	TX	120.0	120.0	1	2009	60	Gamesa	G87-2.0	15.0	256.0	78.0
Deerfield Wind LLC	VT	30.0	30.0	12	2017	15	Gamesa	G97-2.0	16.7	256.0	78.0
Big Horn Wind II	WA	50.0	50.0	1	2011	25	Gamesa	G90-2.0	14.7	256.0	78.0
Allendorf	IA	2.0	2.0	5	2003	1	Gamesa	G80-2.0	18.0	255.9	78.0
Allendorf	IA	1.8	2.0	8	2020	1	Gamesa	AE59	18.0	255.9	78.0
Big Blue	MN	36.0	36.0	12	2012	18	Gamesa	G97-2.0	16.0	255.9	78.0
Bowling Green Wind	OH	1.8	1.8	12	2004	1	Vestas	V80-1.8	14.9	255.9	78.0
Bowling Green Wind	OH	1.8	1.8	11	2003	1	Vestas	V80-1.8	15.0	255.9	78.0
Bowling Green Wind	OH	1.8	1.8	11	2003	1	Vestas	V80-1.8	14.9	255.9	78.0
Bowling Green Wind	OH	1.8	1.8	11	2004	1	Vestas	V80-1.8	15.4	255.9	78.0
Dempsey Ridge Wind Farm	OK	132.0	132.0	5	2012	66	Gamesa	G90-2.0	18.8	255.9	78.0
Sand Bluff Wind Farm	TX	89.5	89.5	1	2007	37	Gamesa	G87-2.0	18.6	255.9	78.0
Pleasant Hill Wind Energy Project	TX	20.0	20.0	10	2015	11	SANY	SE11020	18.5	255.9	78.0
Ralls Wind Farm	TX	10.0	10.0	7	2011	5	SANY	SE8720IIIE	18.5	255.9	78.0
NedPower Mount Storm	WV	164.0	164.0	3	2008	82	Gamesa	G80-2.0	18.3	255.9	78.0
New Creek Wind	WV	103.0	103.0	12	2016	49	Gamesa	G97-2.0	18.0	255.9	78.0
NedPower Mount Storm	WV	100.0	100.0	12	2008	50	Gamesa	G80-2.0	18.3	255.9	78.0
Northern Iowa Windpower II	IA	80.0	80.0	1	2008	48	Gamesa	G87-2.0	15.7	255.0	77.7
Mesquite Wind Power LLC	TX	200.0	200.0	11	2007	97	Gamesa	G87-2.0	19.0	255.0	77.7
Post Oak Wind LLC	TX	200.0	200.0	3	2008	98	Gamesa	G87-2.0	19.0	255.0	77.7
Northern Colorado Wind LLC	CO	22.5	22.5	8	2009	15	GE	1.5 XLE	16.9	254.0	77.4
Pillar Mountain Wind Project Microgrid	AK	4.5	4.5	6	2009	3	GE	1.5 SLE	22.0	253.0	77.1
Pillar Mountain Wind Project Microgrid	AK	4.5	4.5	9	2012	3	GE	1.5 S	22.0	253.0	77.1

Kotzebue Hybrid	AK	0.9	0.9	5	2012	1	EWT	DW54-900	13.0	250.0	76.2
Kotzebue Hybrid	AK	0.9	0.9	5	2012	1	EWT	DW54-900	13.0	250.0	76.2
Mountain Lake	MN	1.2	1.2	7	2007	1	Suzlon	S64-1250	15.0	246.0	75.0
Musselshell Wind Project	MT	10.0	10.0	12	2012	7	Goldwind	GW 87/1500	22.0	246.0	75.0
Musselshell Wind Project Two LLC	MT	10.0	10.0	12	2012	7	Goldwind	GW 87/1500	22.0	246.0	75.0
Sagebrush Power Partners	WA	100.7	100.7	11	2010	61	Suzlon	S88-2100	17.0	246.0	75.0
Headwaters Wind Farm II LLC	IN	200.0	200.0	6	2021	52	Vestas	V150-4.2	12.0	244.4	74.5
Greensburg	KS	12.5	12.5	2	2010	10	Suzlon	S64-1250	17.8	244.4	74.5
Lincoln Heights I	MN	5.2	5.2	5	2006	4	Suzlon	S64-1250	19.0	244.4	74.5
Lincoln Heights II	MN	3.9	3.9	5	2006	3	Suzlon	S64-1250	19.0	244.4	74.5
Blue Breezes LLC	MN	1.3	1.3	5	2006	1	Suzlon	S64-1250	14.8	244.4	74.5
Blue Breezes II LLC	MN	1.3	1.3	5	2006	1	Suzlon	S64-1250	14.8	244.4	74.5
Sunset Breeze LLC	MN	1.3	1.3	5	2006	1	Suzlon	S64-1250	17.9	244.4	74.5
Minnesota Breeze LLC	MN	1.3	1.3	5	2006	1	Suzlon	S64-1250	17.9	244.4	74.5
G Flow Wind LLC	MN	1.3	1.3	5	2006	1	Suzlon	S64-1250	17.9	244.4	74.5
Wolf Wind Enterprises LLC	MN	1.3	1.3	5	2006	1	Suzlon	S64-1250	17.9	244.4	74.5
Green Acres Breeze LLC	MN	1.3	1.3	5	2006	1	Suzlon	S64-1250	17.9	244.4	74.5
Loess Hills	MO	5.0	5.0	2	2008	4	Suzlon	S64-1250	13.0	244.4	74.5
Filet Wind (5) LLC	TX	10.0	10.0	11	2006	8	Suzlon	S64-1250	20.0	244.4	74.5
Tenderloin Wind (6) LLC	TX	10.0	10.0	1	2007	8	Suzlon	S64-1250	20.0	244.4	74.5
Ribeye Wind (11) LLC	TX	10.0	10.0	5	2008	8	Suzlon	S64-1250	18.1	244.4	74.5
Flat Iron Wind (7) LLC	TX	10.0	10.0	4	2008	8	Suzlon	S64-1250	18.1	244.4	74.5
T-Bone Wind (10) LLC	TX	8.8	8.8	5	2008	7	Suzlon	S64-1250	18.1	244.4	74.5
Tri-Tip Wind (9) LLC	TX	10.0	10.0	4	2008	8	Suzlon	S64-1250	18.1	241.1	73.5
Brisket Wind (8) LLC	TX	10.0	10.0	4	2008	8	Suzlon	S64-1250	18.1	241.1	73.5
Delta Wind Farm	AK	0.9	0.9	10	2009	1	EWT	DW54-900	15.1	240.0	73.2
Allendorf	IA	1.2	1.2	10	1998	4	Micon	M1500-600/150	18.0	240.0	73.2
Worthington	MN	1.0	1.0	12	2003	1	NEG-Micon	NM54/950	19.0	240.0	73.2
Worthington	MN	1.0	1.0	12	2003	1	NEG-Micon	NM54/950	19.0	240.0	73.2
Worthington	MN	0.9	0.9	7	2002	1	NEG-Micon	NM52/900	19.0	240.0	73.2
Worthington	MN	0.9	0.9	7	2002	1	NEG-Micon	NM52/900	19.0	240.0	73.2
Worthington	MN	0.9	0.9	7	2002	1	NEG-Micon	NM52/900	19.0	240.0	73.2
Worthington	MN	0.9	0.9	7	2002	1	NEG-Micon	NM52/900	19.0	240.0	73.2
Stahl Wind Energy	MN	1.7	1.7	12	2004	1	Vestas	V82-1.65	15.7	240.0	73.2
Carstensen Wind	MN	1.7	1.7	12	2004	1	Vestas	V82-1.65	15.7	240.0	73.2
Northern Lights Wind LLC	MN	1.7	1.7	12	2004	1	Vestas	V82-1.65	15.7	240.0	73.2
Lucky Wind	MN	1.7	1.7	12	2004	1	Vestas	V82-1.65	15.7	240.0	73.2
Greenback Energy	MN	1.7	1.7	12	2004	1	Vestas	V82-1.65	15.7	240.0	73.2
Elkhorn Valley Wind Farm	OR	100.7	100.7	12	2007	61	Vestas	V82-1.65	17.0	240.0	73.2
Delta Wind Farm	TX	0.9	0.9	9	2013	1	Northern Power	Northwind 100	15.1	240.0	73.2
Elbow Creek Wind Project LLC	TX	121.9	121.9	12	2008	53	Siemens	SWT-2.3-93	27.0	240.0	73.2
South Trent Wind Farm	TX	101.2	101.2	1	2009	44	Siemens	SWT-2.3-93	20.0	240.0	73.2
TransAlta Wyoming Wind	WY	142.2	142.2	12	2003	78	Vestas	V80-1.8	20.0	240.0	73.2
Fairmont Wind	MN	0.9	0.9	3	2003	1	NEG-Micon	NM54/950	16.8	237.0	72.2
Fairmont Wind	MN	0.9	0.9	3	2003	1	NEG-Micon	NM54/950	16.8	237.0	72.2

Redwood Falls Wind	MN	1.7	1.7	12	2004	1	Vestas	V82-1.65	19.1	237.0	72.2
Redwood Falls Wind	MN	1.7	1.7	1	2005	1	Vestas	V82-1.65	19.1	237.0	72.2
Fairmont Wind	MN	1.7	1.7	12	2004	1	Vestas	V82-1.65	19.1	237.0	72.2
Fairmont Wind	MN	1.7	1.7	1	2005	1	Vestas	V82-1.65	19.1	237.0	72.2
Ridge Crest Wind Partners	CO	29.7	29.7	12	2001	33	NEG-Micon	NM52/900	17.9	236.2	72.0
Old Gold Energy Center, LLC	IA	80.0	80.0	10	2001	88	NEG-Micon	NM52/900	19.0	236.0	71.9
G McNeilus Wind Farm Dodge Center	MN	32.0	32.0	9	2002	34	NEG-Micon	NM54/950	14.0	236.0	71.9
Pike County Wind Power	IL	1.7	1.7	5	2005	1	Vestas	V82-1.65	13.7	235.0	71.6
WCROC Wind Farm	MN	0.4	0.7	3	2005	1	Vestas	V82-1.65	18.0	235.0	71.6
Waverly Community Wind Project	IA	0.9	0.9	3	2009	1	EWT	DW54-900	12.5	234.0	71.3
Waverly Community Wind Project	IA	0.9	0.9	9	2012	1	EWT	DW54-900	12.5	234.0	71.3
Waverly Community Wind Project	IA	0.9	0.9	12	2001	1	NEG-Micon	NM52/900	12.5	234.0	71.3
Cedar Creek Wind	CO	221.0	221.0	11	2007	221	Mitsubishi	MWT-1000	16.6	230.0	70.1
Princeton Wind Farm	MA	3.0	3.0	1	2010	2	Fuhrlander	FL 1500-77	16.0	230.0	70.1
Charlestown Wind Turbine	MA	1.5	1.5	10	2011	1	Sinovel	SL1500/82	8.2	230.0	70.1
G McNeilus Wind Farm Dodge Center	MN	8.0	8.0	5	2003	5	NEG-Micon	NM72C/1500	14.0	230.0	70.1
G McNeilus Wind Farm Dodge Center	MN	3.0	3.0	5	2004	2	NEG-Micon	NM82/1650	14.0	230.0	70.1
Noble Ridge LLC	MN	1.5	1.5	12	2001	1	NEG-Micon	NM72C/1500	19.0	230.0	70.1
Carleton College	MN	1.6	1.6	9	2004	1	Vestas	V82-1.65	14.5	230.0	70.1
NBC Field's Point Wind Farm	RI	4.5	4.5	10	2012	3	Goldwind	GW 82/1500	23.4	230.0	70.1
Sweetwater Wind 4 LLC	TX	241.0	241.0	5	2007	181	Mitsubishi	MWT-1000	16.5	230.0	70.1
Adams Wind Farm	MN	13.5	13.5	9	2003	9	NEG-Micon	NM72C/1500	19.0	229.7	70.0
Adams Wind Farm	MN	9.8	9.8	7	2004	6	NEG-Micon	NM82/1650	19.0	229.7	70.0
Ainsworth Wind	NE	59.4	59.4	10	2005	36	Vestas	V82-1.65	14.5	229.7	70.0
Mountaineer Wind Energy Center	WV	66.0	66.0	12	2002	44	NEG-Micon	NM72C/1500	14.0	229.7	70.0
Iowa Lakes Community College Wind Farm	IA	1.0	1.0	2	2005	1	Vestas	V82-1.65	18.0	229.6	70.0
Camelot Wind LLC	MA	1.5	1.5	10	2012	1	Goldwind	GW 82/1500	16.0	229.6	70.0
Euclid Farm, Stamco N-54	TX	1.0	1.0	10	2012	1	Nordex	N54/1000	19.0	229.0	69.8
Roscoe Wind Farm LLC	TX	209.0	209.0	2	2008	209	Mitsubishi	MWT-1000A	18.3	226.4	69.0
Inadale Wind Farm LLC Hybrid	TX	197.0	197.0	9	2009	197	Mitsubishi	MWT-1000A	18.1	226.4	69.0
Dillon Wind LLC	CA	45.0	45.0	4	2008	45	Mitsubishi	MWT-62/1.0	16.1	226.0	68.9
Aragonne Wind LLC	NM	145.0	145.0	2	2022	53	GE	2.85-100	17.3	226.0	68.9
Aragonne Wind LLC	NM	90.0	90.0	12	2006	33	GE	2.5-100	17.3	226.0	68.9
San Juan Mesa Wind Project LLC	NM	120.0	120.0	12	2005	120	Mitsubishi	MWT-1000A	19.0	226.0	68.9
Eurus Combine Hills Turbine Ranch 2	OR	62.0	62.0	1	2010	63	Mitsubishi	MWT-62/1.0	13.0	226.0	68.9
Bull Creek Wind	TX	180.0	180.0	12	2008	180	Mitsubishi	MWT-62/1.0	14.0	226.0	68.9
Goat Wind LP	TX	80.0	80.0	4	2008	80	Mitsubishi	MWT-1000A	19.0	226.0	68.9
Kumeyaay Wind	CA	50.0	50.0	12	2005	25	Gamesa	G87-2.0	19.0	223.0	68.0

Winona County Wind LLC	MN	0.5	0.4	10	2011	2	Unison	U57	14.0	223.0	68.0
Windstar 1	CA	120.0	120.0	2	2012	60	Gamesa	G80-2.0	27.0	220.0	67.1
CalPortland Company Mojave Wind	CA	23.5	23.5	11	2024	8	Vestas	V90-1.8	14.0	220.0	67.1
Hull Wind II	MA	1.8	1.8	5	2006	1	Vestas	V80-1.8	12.0	220.0	67.1
Greenfield Wind - MT	MT	25.0	25.0	10	2016	13	GE	2.5-100	18.0	220.0	67.1
Madison Windpower LLC	NY	11.5	11.5	10	2000	7	Vestas	V66-1.65	22.0	220.0	67.1
Wild Horse	WA	228.6	228.6	12	2006	127	Vestas	V80-1.8	18.0	219.8	67.0
Hopkins Ridge Wind	WA	149.4	149.4	11	2005	83	Vestas	V80-1.8	16.5	219.8	67.0
Wild Horse	WA	44.0	44.0	11	2009	22	Vestas	V80-2.0	15.4	219.8	67.0
Hopkins Ridge Wind	WA	7.2	7.2	8	2008	4	Vestas	V80-1.8	16.5	219.8	67.0
Pine Tree Wind Power Project	CA	135.0	135.0	6	2009	90	GE	1.5 SLE	19.0	218.0	66.4
Storm Lake 1	IA	104.3	104.3	5	1999	138	Zond	Z-50	12.5	217.0	66.1
Storm Lake II	IA	76.5	76.5	4	1999	102	Zond	Z-50	14.6	217.0	66.1
Storm Lake 1	IA	0.7	0.7	6	1999	1	Zond	Z-50	12.5	217.0	66.1
Storm Lake 1	IA	0.7	0.7	6	1999	1	Zond	Z-50	12.5	217.0	66.1
Velva Windfarm LLC	ND	11.9	11.9	12	2005	18	Vestas	V47-660	19.0	215.0	65.5
San Gorgonio Windplant WPP1993	CA	49.5	49.5	12	2011	33	GE	1.5 SLE	19.0	213.3	65.0
High Winds LLC	CA	145.8	145.8	7	2003	81	Vestas	V80-1.8	22.4	213.3	65.0
High Winds LLC	CA	16.2	16.2	12	2003	9	Vestas	V80-1.8	22.4	213.3	65.0
Hancock County Wind Energy Center	IA	98.0	98.0	12	2002	148	Vestas	V47-660	22.4	213.3	65.0
Gray County Wind Energy	KS	112.2	112.2	11	2001	170	Gamesa	G47	22.4	213.3	65.0
DL Windy Acres LLC	MN	2.0	2.0	12	2003	2	Suzlon	S64-1250	17.8	213.3	65.0
S&P Windfarm LLC	MN	2.0	2.0	12	2003	2	Suzlon	S64-1250	17.8	213.3	65.0
B&K Energy Systems LLC	MN	2.0	2.0	12	2003	2	Suzlon	S64-1250	17.8	213.3	65.0
FPL Energy North Dakota Wind I/II	ND	61.5	61.5	10	2003	41	GE	1.5 S	19.0	213.3	65.0
New Mexico Wind Energy Center	NM	204.0	204.0	9	2003	136	GE	1.5 S	19.0	213.3	65.0
Oklahoma Wind Energy Center	OK	51.0	51.0	10	2003	34	GE	1.5 S	19.0	213.3	65.0
Oklahoma Wind Energy Center	OK	51.0	51.0	10	2003	34	GE	1.5 S	19.0	213.3	65.0
Waymart Wind	PA	64.5	64.5	10	2003	43	GE	1.5 S	15.0	213.3	65.0
Mill Run Windpower LLC	PA	15.0	15.0	12	2001	10	GE	1.5 S	16.0	213.3	65.0
Somerset Windpower LLC	PA	9.0	9.0	12	2001	6	GE	1.5 S	14.0	213.3	65.0
South Dakota Wind Energy Cente	SD	40.5	40.5	10	2003	27	GE	1.5 S	19.0	213.3	65.0
Trent Wind Farm	TX	152.0	152.0	7	2001	100	GE	1.5 S	18.0	213.3	65.0
Whitewater Hill Wind Partners	CA	61.5	61.5	10	2002	41	GE	1.5 S	20.2	213.2	65.0
Coram Energy LLC (ECT)	CA	7.5	7.5	5	2005	5	GE	1.5-77	19.2	213.2	65.0
Coram Energy LLC (4.5MW)	CA	4.5	4.5	1	2004	3	GE	1.5-77	19.2	213.2	65.0
Coram Energy LLC	CA	3.0	3.0	1	2005	2	GE	1.5-77	19.2	213.2	65.0
Cabazon Wind Partners	CA	41.0	41.0	10	2002	62	Vestas	V47-660	23.4	213.2	65.0
Llano Estacado Wind Ranch	TX	80.0	80.0	12	2001	80	Mitsubishi	MWT-1000	18.3	213.2	65.0
Montfort Wind Energy Center	WI	30.0	30.0	6	2002	20	GE	1.5 S	19.0	213.2	65.0
Blue Sky Green Field Wind Project	WI	145.2	145.2	5	2008	88	Vestas	V82-1.65	19.0	213.2	65.0

Manzana Wind LLC	CA	189.0	189.0	12	2012	126	GE	1.5 SE	14.6	213.0	64.9
Foundation AB	CA	1.5	1.5	11	2011	1	GE	1.5 SLE	13.4	213.0	64.9
Foundation Cemex BMQ	CA	1.5	1.5	12	2012	1	GE	1.5 SLE	13.4	213.0	64.9
Foundation Cemex BMQ	CA	1.5	1.5	12	2012	1	GE	1.5 SLE	13.4	213.0	64.9
Foundation Wal-Mart Red Bluff	CA	1.0	1.0	9	2012	1	GE	1.5 SLE	21.0	213.0	64.9
Foundation Cemex Madison	CA	1.0	1.0	8	2012	1	GE	1.5 SLE	21.0	213.0	64.9
Foundation RRM	CA	1.0	1.0	12	2012	1	GE	1.5 SLE	21.0	213.0	64.9
Foundation RRM	CA	1.0	1.0	12	2012	1	GE	1.5 SLE	21.0	213.0	64.9
Coram Energy LLC (4.5MW)	CA	0.1	0.1	12	1985	3	GE	1.5-77	19.2	213.0	64.9
Salka Cabazon Wind	CA	38.9	38.9	1	1999	52	Zond	Z-48	20.0	213.0	64.9
Intrepid	IA	160.5	160.5	12	2004	107	GE	1.5-82.5	16.8	213.0	64.9
Century	IA	150.0	150.0	9	2005	100	GE	1.5-82.5	16.8	213.0	64.9
New England Wind LLC	MA	28.5	28.5	12	2012	19	GE	1.5 SLE	16.7	213.0	64.9
Moraine Wind LLC	MN	51.0	51.0	12	2003	34	GE	1.5 SLE	19.4	213.0	64.9
Uilk Wind LLC	MN	1.5	1.5	1	2010	1	Goldwind	GW 77/1500	16.0	213.0	64.9
Uilk Wind LLC	MN	1.5	1.5	1	2010	1	Goldwind	GW 77/1500	16.0	213.0	64.9
Uilk Wind LLC	MN	1.5	1.5	1	2010	1	Goldwind	GW 77/1500	16.0	213.0	64.9
Windom Wind Project	MN	15.6	15.6	3	2006	12	Suzlon	S64-1250	17.0	213.0	64.9
Eastridge Wind Project	MN	10.4	10.4	4	2006	8	Suzlon	S64-950	17.0	213.0	64.9
TG Windfarm LLC	MN	2.0	2.0	11	2003	2	Suzlon	S64-950	17.0	213.0	64.9
CG Windfarm LLC	MN	2.0	2.0	12	2003	2	Suzlon	S64-950	17.0	213.0	64.9
Bisson Windfarm LLC	MN	2.0	2.0	10	2003	2	Suzlon	S64-950	17.0	213.0	64.9
Tofteland Windfarm LLC	MN	2.0	2.0	10	2003	2	Suzlon	S64-950	19.0	213.0	64.9
Westridge Windfarm LLC	MN	2.0	2.0	11	2003	2	Suzlon	S64-950	17.0	213.0	64.9
Fey Windfarm LLC	MN	2.0	2.0	9	2003	2	Suzlon	S64-950	19.0	213.0	64.9
Windcurrent Farms LLC	MN	2.0	2.0	9	2003	2	Suzlon	S64-950	19.0	213.0	64.9
K-Brink Windfarm LLC	MN	2.0	2.0	2	2003	2	Suzlon	S64-950	17.0	213.0	64.9
Boeve Windfarm LLC	MN	2.0	2.0	8	2003	2	Suzlon	S64-950	17.0	213.0	64.9
Shaokatan Hills LLC	MN	11.8	11.8	8	1999	18	Vestas	V47-660	15.9	213.0	64.9
Tsar Nicholas LLC	MN	1.9	1.9	2	2001	3	Vestas	V47-660	24.0	213.0	64.9
Sun River LLC	MN	1.9	1.9	2	2001	3	Vestas	V47-660	24.0	213.0	64.9
Julia Hills LLC	MN	1.9	1.9	2	2001	3	Vestas	V47-660	24.0	213.0	64.9
Jessica Mills LLC	MN	1.9	1.9	2	2001	3	Vestas	V47-660	24.0	213.0	64.9
Jack River LLC	MN	1.9	1.9	2	2001	3	Vestas	V47-660	24.0	213.0	64.9
Autumn Hills LLC	MN	1.9	1.9	2	2001	3	Vestas	V47-660	24.0	213.0	64.9
Winters Spawn LLC	MN	1.9	1.9	1	2001	3	Vestas	V47-660	24.0	213.0	64.9
Twin Lake Hills LLC	MN	1.9	1.9	12	2000	3	Vestas	V47-660	24.0	213.0	64.9
Spartan Hills LLC	MN	1.9	1.9	1	2001	3	Vestas	V47-660	24.0	213.0	64.9
Soliloquoy Ridge LLC	MN	1.9	1.9	1	2001	3	Vestas	V47-660	24.0	213.0	64.9
Ruthton Ridge LLC	MN	1.9	1.9	1	2001	3	Vestas	V47-660	24.0	213.0	64.9
Hope Creek LLC	MN	1.9	1.9	1	2001	3	Vestas	V47-660	24.0	213.0	64.9
Hadley Ridge LLC	MN	1.9	1.9	12	2000	3	Vestas	V47-660	24.0	213.0	64.9
Florence Hills LLC	MN	1.9	1.9	1	2001	3	Vestas	V47-660	24.0	213.0	64.9
Agassiz Beach LLC	MN	1.9	1.9	2	2001	3	Vestas	V47-660	24.0	213.0	64.9
Buffalo Mountain	TN	0.7	0.7	10	2000	1	Vestas	V47-660	15.2	213.0	64.9

Buffalo Mountain	TN	0.7	0.7	10	2000	1	Vestas	V47-660	15.2	213.0	64.9
Buffalo Mountain	TN	0.7	0.7	10	2000	1	Vestas	V47-660	15.2	213.0	64.9
Marengo Wind Plant	WA	156.0	156.0	8	2007	78	Vestas	V100-2.0	25.3	213.0	64.9
Marengo Wind Plant	WA	78.0	78.0	1	2008	39	Vestas	V100-2.0	25.3	213.0	64.9
Wind Turbine	WI	11.0	11.0	6	1999	17	Vestas	V47-660	18.0	213.0	64.9
Desert Sky	TX	167.7	167.7	1	2002	107	GE	1.5 S	16.5	212.2	64.7
Kaheawa Wind Power II LLC	HI	21.0	21.0	6	2012	14	GE	1.5 SE	22.0	212.0	64.6
Victory Garden (Tehachapi)	CA	1.5	1.5	5	2000	1	GE	1.5 S	19.5	210.0	64.0
Pakini Nui Wind Farm	HI	21.0	21.0	4	2007	14	GE	1.5 SE	21.0	210.0	64.0
Minwind	MN	3.8	3.8	10	2002	4	NEG-Micon	NM54/950	15.6	210.0	64.0
King Mountain Wind Ranch 1	TX	278.0	278.0	6	2001	214	Siemens	SWT-1.3-62	19.0	203.4	62.0
Springview	NE	1.5	1.5	6	2011	1	VENSYS	VENSYS77	16.0	201.7	61.5
Springview	NE	1.5	1.5	6	2011	1	VENSYS	VENSYS77	16.0	201.7	61.5
Buffalo Gap 2 Wind Farm	TX	232.5	232.5	7	2007	155	GE	1.5 S	17.0	201.0	61.3
Mountain View III	CA	22.4	22.4	12	2003	34	Vestas	V47-660	18.7	200.0	61.0
Geneseo	IL	1.5	1.5	9	2009	1	VENSYS	VENSYS77	18.0	200.0	61.0
Geneseo	IL	1.5	1.5	10	2009	1	VENSYS	VENSYS77	18.0	200.0	61.0
Wildcat Ranch Wind Project	TX	150.0	150.0	12	2018	65	GE	2.3-116	19.0	200.0	61.0
Lorenzo Wind	TX	80.0	80.0	12	2018	29	GE	2.3-116	19.0	200.0	61.0
Nine Canyon	WA	95.0	95.0	9	2002	63	Siemens	SWT-1.3-62	14.0	200.0	61.0
Buena Vista Energy LLC	CA	38.0	38.0	12	2006	38	Mitsubishi	MWT-1000	13.6	197.0	60.0
Century	IA	35.0	35.0	12	2007	35	Mitsubishi	MWT-1000A	16.8	197.0	60.0
Intrepid	IA	15.0	15.0	12	2005	15	Mitsubishi	MWT-1000A	16.8	197.0	60.0
Mountain View IV	CA	49.0	49.0	2	2012	49	Mitsubishi	MWT-1000	26.8	196.8	60.0
Mountain View I & II	CA	70.9	70.9	2	2022	23	Vestas	V117-4.2	26.8	196.8	60.0
Condon Windpower LLC	OR	25.2	25.2	5	2002	43	Mitsubishi	MWT-600 (47m)	15.6	196.8	60.0
Condon Windpower LLC	OR	24.6	24.6	12	2001	40	Mitsubishi	MWT-600 (47m)	15.6	196.8	60.0
Buffalo Gap Wind Farm	TX	120.6	120.6	4	2006	67	Vestas	V80-1.8	17.0	196.8	60.0
Deer Island Treatment Plant	MA	0.6	0.6	11	2009	1	Vestas	PS-600	20.4	195.0	59.4
Deer Island Treatment Plant	MA	0.6	0.6	11	2009	1	Vestas	PS-600	20.4	195.0	59.4
Green Providence Wind II, LLC	RI	3.0	3.0	12	2021	2	VENSYS	VENSYS82	12.0	190.0	57.9
Green Providence Wind I, LLC	RI	1.5	1.5	12	2021	1	VENSYS	VENSYS82	12.0	190.0	57.9
Karen Avenue Wind Farm	CA	11.7	11.7	1	1985	12	GE	1.5 S	21.0	185.0	56.4
Hawkeye Power Partners LLC	IA	42.0	42.0	4	1999	55	NEG-Micon	NM48/750	19.0	183.0	55.8
Kaheawa Pastures Wind Farm Hybrid	HI	30.0	30.0	1	2006	20	GE	1.5 SE	22.0	180.4	55.0
Cameron Ridge LLC	CA	59.6	59.6	12	1984	114	Micon	M700-225/40	22.4	180.0	54.9
San Gorgonio Westwinds II LLC	CA	43.4	43.4	6	1999	62	Micon	M700-225/40	22.4	180.0	54.9
Oak Creek Energy Systems I	CA	23.1	23.1	6	1999	33	Micon	M750-400/100	22.4	180.0	54.9
Oak Creek Energy Systems I	CA	4.2	4.2	12	1993	7	Micon	M750-400/100	22.4	180.0	54.9
Oak Creek Energy Systems I	CA	3.7	3.7	6	1999	4	Micon	M750-400/100	22.4	180.0	54.9
Foundation ST	CA	2.0	2.0	6	2011	2	Mitsubishi	MWT-1000A	12.0	180.0	54.9
Foundation IE	CA	1.0	1.0	12	2011	1	Mitsubishi	MWT-1000A	12.0	180.0	54.9
Foundation Superior Farms	CA	1.0	1.0	12	2012	1	Mitsubishi	MWT-1000A	13.9	180.0	54.9
Ridgetop	CA	46.9	46.9	4	1994	71	Vestas	V47-660	22.4	180.0	54.9

Terra-Gen VG Wind LLC	CA	7.4	7.4	1	1984	10	Zond	Z-50	22.4	180.0	54.9
Kas Brothers Windfarm	MN	1.5	1.5	12	2001	2	Micon	M750-400/100	16.0	180.0	54.9
Moorhead Wind Turbine	MN	0.7	0.7	5	1999	1	NEG-Micon	NM48/750	19.0	180.0	54.9
Moorhead Wind Turbine	MN	0.7	0.7	9	2001	1	NEG-Micon	NM48/750	19.0	180.0	54.9
Harbec Energy	NY	0.9	0.9	12	2011	1	Gamesa	G58-850	12.5	180.0	54.9
Combine Hills I	OR	41.0	41.0	12	2003	41	Mitsubishi	MWT-1000A	14.5	180.0	54.9
Big Spring Wind Power Facility	TX	34.3	34.3	12	1998	46	Vestas	V47-660	22.4	180.0	54.9
Swauk Wind LLC	WA	4.3	4.3	12	2012	5	Gamesa	G58-850	19.0	180.0	54.9
Lake Benton I	MN	103.5	103.5	2	1998	139	Zond	Z-48	15.9	175.0	53.3
Lake Benton II	MN	98.8	98.8	6	1999	137	Zond	Z-50	18.4	168.0	51.2
Iowa Distributed Wind Generation Project	IA	2.3	2.3	6	2000	3	Zond	Z-50	15.7	165.0	50.3
Snake River	AK	0.9	0.9	7	2013	1	EWT	DW54-900	20.0	164.0	50.0
Snake River	AK	0.9	0.9	7	2013	1	EWT	DW54-900	20.0	164.0	50.0
Diablo Winds LLC	CA	18.0	18.0	12	2004	31	Vestas	V47-660	17.0	164.0	50.0
Tehachapi Wind Resource II	CA	8.3	8.3	12	2002	13	Vestas	V47-660	19.0	164.0	50.0
Lakota Ridge LLC	MN	11.2	11.2	4	1999	15	Micon	M750-400/100	15.2	164.0	50.0
FPL Energy Vansycle LLC (OR)	OR	122.8	122.8	12	2001	186	Vestas	V47-660	22.4	164.0	50.0
Vansycle	OR	25.0	25.0	8	1998	38	Vestas	V47-660	22.4	164.0	50.0
NWP Indian Mesa Wind Farm	TX	82.5	82.5	5	2001	125	Vestas	V47-660	22.4	164.0	50.0
Woodward Mountain I	TX	82.0	82.0	7	2001	125	Vestas	Vestas V-47	22.4	164.0	50.0
Woodward Mountain II	TX	78.0	78.0	7	2001	117	Vestas	Vestas V-47	22.4	164.0	50.0
FPL Energy Vansycle LLC (WA)	WA	176.9	176.9	12	2001	268	Vestas	V47-660	22.4	164.0	50.0
Phoenix Wind Power LLC	CA	2.1	2.1	6	1999	3	Gamesa	G114-2.0	22.4	160.0	48.8
Sand Point	AK	0.3	0.3	10	2011	1	Vestas	V39-500	19.0	155.0	47.2
Sand Point	AK	0.1	0.1	10	2011	1	Vestas	V39-500	19.0	155.0	47.2
East Winds Project	CA	3.0	3.0	1	1985	5	Micon	M1500-600/150	15.0	151.0	46.0
Coram Tehachapi	CA	6.5	6.5	9	1992	29	Vestas	V27-225	17.6	140.0	42.7
Foote Creek Rim	WY	134.8	134.8	12	2024	43	Vestas	V136-4.2	17.0	136.0	41.5
Searsburg Wind Turbine	VT	5.2	5.0	6	1997	11	Zond	Z-40	18.0	132.0	40.2
Difwind Farms Ltd VI	CA	25.3	25.3	1	1987	251	Micon	108	22.0	131.2	40.0
Hawi Wind Farm	HI	10.6	10.6	5	2006	16	Vestas	V47-660	22.4	131.2	40.0
Garnet Wind Energy Center	CA	6.5	6.5	6	2009	13	NedWind	NEDWIND 40	15.0	131.0	39.9
San Gorgonio Farms Wind Farm	CA	31.0	31.0	3	1983	111	Vestas	V42-600	22.0	131.0	39.9
Harbec Energy	NY	0.3	0.3	12	2001	1	Fuhrlander	FL 250	12.5	131.0	39.9
Lime Wind	TX	3.0	3.0	12	2011	6	Nordtank	NTK 500/41	16.3	131.0	39.9
Delta Wind Farm	AK	0.1	0.1	9	2008	1	Southwest Windpower	Skystream 3.7	15.1	120.0	36.6
UL Advanced Wind Turbine Test Facility	TX	0.1	0.1	1	2016	1	Renewtech	WT100	19.0	120.0	36.6
TG East	TX	336.0	336.0	4	2022	65	Vestas	V162-5.6	18.0	119.0	36.3
Prairie Queen Wind Farm	KS	199.3	199.3	5	2019	59	Gamesa	G132-5.0	13.0	115.0	35.1
Jayhawk Wind Energy Center	KS	197.4	197.4	1	2022	70	GE	2.82-127	18.8	114.0	34.7
Shamrock Wind	TX	223.9	223.9	12	2023	81	GE	2.82-127	19.0	114.0	34.7
Alta Farms II Wind Project, LLC	IL	200.5	200.5	5	2023	100	Siemens Gamesa	SG 5.0-145	23.0	107.5	32.8
Black Rock Wind	WV	115.0	115.0	2	2022	23	Siemens Gamesa	SG 4.5-145	16.8	107.5	32.8

Meadow Lake Wind Farm VI LLC	IN	200.4	200.4	11	2018	61	Vestas	V136-3.45	17.0	105.0	32.0
Atchison County Wind	MO	275.5	288.9	3	2021	91	Vestas	V150-4.2	17.0	105.0	32.0
Ball Hill Wind Energy, LLC	NY	107.5	107.5	12	2023	26	Vestas	V150-4.2	14.7	105.0	32.0
25 Mile Creek	OK	250.0	250.0	1	2023	60	Vestas	V150-4.2	22.0	105.0	32.0
TAC-Distributed Energy Resource Hybrid	TX	0.1	0.1	3	2017	1	Northern Power	NPS 100C-24	12.0	105.0	32.0
Rio Bravo Windpower, LLC	TX	237.6	237.6	6	2019	66	Vestas	V136-3.45	15.2	105.0	32.0
King Creek Wind Farm 2, LLC	TX	209.0	209.0	4	2022	49	Siemens Gamesa	SG 5.0-145	18.8	102.5	31.2
King Creek Wind Farm 1, LLC	TX	184.0	184.0	4	2022	47	Siemens Gamesa	SG 5.0-145	18.3	102.5	31.2
Mesquite Star	TX	418.9	418.9	3	2020	120	Siemens Gamesa	G132-3.465	16.2	101.0	30.8
Mojave 16/17/18	CA	88.5	88.5	12	1989	238	Mitsubishi	MWT-250	22.4	100.0	30.5
Mojave 3/4/5	CA	67.0	67.0	12	1990	300	Mitsubishi	MWT-250	14.0	100.0	30.5
Allendorf	IA	0.6	0.6	10	1998	1	Micon	M1500-600/150	18.0	98.4	30.0
Cedar Creek Wind, LLC	ID	160.0	160.0	3	2024	47	GE	3.4-140	18.0	98.0	29.9
Ponderosa Wind II	OK	100.0	100.0	12	2024	36	GE	2.82-127	13.0	95.0	29.0
Redbed Plains Wind Farm	OK	99.1	99.1	7	2017	48	Gamesa	G114-2.0	19.5	93.0	28.3
Kotzebue Hybrid	AK	0.6	0.6	5	1999	10	AOC	AOC15/50	13.0	90.0	27.4
Kotzebue Hybrid	AK	0.2	0.2	1	1997	3	AOC	AOC15/50	13.0	90.0	27.4
Kotzebue Hybrid	AK	0.1	0.1	5	2005	1	AOC	AOC15/50	13.0	90.0	27.4
Kotzebue Hybrid	AK	0.1	0.1	5	2006	1	AOC	AOC15/50	13.0	90.0	27.4
Kotzebue Hybrid	AK	0.1	0.1	5	2006	1	AOC	AOC15/50	13.0	90.0	27.4
Kotzebue Hybrid	AK	0.1	0.1	5	2006	1	AOC	AOC15/50	13.0	90.0	27.4
Kotzebue Hybrid	AK	0.1	0.1	5	1999	1	AOC	AOC15/50	13.0	90.0	27.4
Kotzebue Hybrid	AK	0.1	0.1	5	2006	1	Vestas	V15	13.0	90.0	27.4
Rock Aetna Power Partners	MN	20.0	20.0	12	2022	38	GE	2.72-116	27.0	90.0	27.4
Sholes Wind Energy Center	NE	160.0	160.0	11	2019	71	GE	2.75-103	16.0	90.0	27.4
Armadillo Flats Wind Project, LLC	OK	247.3	247.3	12	2018	126	GE	2.3-116	18.6	90.0	27.4
Sundance Wind Project, LLC	OK	199.0	199.0	4	2021	72	GE	2.82-127	17.0	90.0	27.4
Persimmon Creek Wind Farm 1, LLC	OK	198.6	198.6	9	2018	80	GE	2.5-120	18.0	90.0	27.4
Minco Wind IV, LLC	OK	130.0	130.0	12	2018	52	GE	2.3-116	18.6	90.0	27.4
Crowned Ridge Wind Energy Center	SD	200.1	200.1	12	2019	87	GE	2.3-116	14.0	90.0	27.4
North Bend Wind Project, LLC	SD	200.0	200.0	12	2023	80	GE	2.82-127	19.0	90.0	27.4
Western Trail Wind, LLC	TX	366.6	366.6	4	2022	130	GE	2.82-127	15.5	90.0	27.4
Karankawa Wind LLC	TX	307.1	307.1	11	2019	124	GE	2.5-127	15.1	90.0	27.4
Century Oak Wind Project, LLC	TX	151.5	151.5	7	2024	45	GE	3.4-140	19.0	90.0	27.4
Blue Summit II Wind	TX	99.4	99.4	1	2019	85	GE	2.5-120	14.0	90.0	27.4
Kotzebue Hybrid	TX	0.1	0.1	5	2002	1	Northern Power	Northwind 100	13.0	90.0	27.4
Bronco Plains Wind II, LLC	CO	199.0	199.0	12	2023	72	GE	2.82-127	12.0	89.0	27.1
Independence Wind Farm	IA	54.0	54.0	12	2021	19	GE	2.82-127	17.0	89.0	27.1
Maverick Wind Project, LLC	OK	288.0	288.0	9	2021	103	GE	2.82-127	18.3	89.0	27.1
Orchard Windfarm 1, LLC	OR	10.0	10.0	12	2020	16	GE	2.5-127	14.8	89.0	27.1
Orchard Windfarm 2, LLC	OR	10.0	10.0	12	2020	4	GE	2.5-127	14.8	89.0	27.1
Orchard Windfarm 3, LLC	OR	10.0	10.0	12	2020	4	GE	2.5-127	14.8	89.0	27.1

Orchard Windfarm 4, LLC	OR	10.0	10.0	12	2020	4	GE	2.5-127	14.8	89.0	27.1
Santa Rita East	TX	302.4	302.4	6	2019	120	GE	2.5-127	12.0	89.0	27.1
Lockett Windfarm	TX	183.8	183.8	9	2019	75	GE	2.5-127	15.2	89.0	27.1
Foard City Wind	TX	350.3	350.3	9	2019	139	GE	2.5-127	16.8	88.0	26.8
Ridgetop Energy LLC	TX	29.0	29.0	1	1984	239	Nordtank	NTK 75/15	22.4	85.0	25.9
Oak Creek Energy Systems I	TX	3.5	3.5	6	1982	37	Nordtank	NTK 75/15	22.4	85.0	25.9
Fairbanks Wind Park	MI	72.8	72.8	1	2022	21	Siemens Gamesa	G132-3.465	14.7	84.0	25.6
Tehachapi Wind Resource II	CA	13.6	13.6	1	1997	175	Bonus	Bonus 65/13kW	19.0	80.0	24.4
TPC Windfarms LLC	CA	28.7	28.7	12	1986	100	Danwin	Danwin 23/160	21.0	80.0	24.4
Mesa Wind Power LLC	CA	33.6	33.6	11	1984	8	Vestas	V15	15.7	80.0	24.4
Victory Garden (Tehachapi)	CA	17.3	17.3	12	1981	241	Vestas	V15	16.5	80.0	24.4
Dinosaur Point	CA	17.0	16.0	5	1988	161	Vestas	V17-90	15.4	80.0	24.4
Helzel & Schwarzhoff 86	CA	2.4	2.4	12	1986	27	Vestas	V17-90	12.0	80.0	24.4
ZCO	CA	1.6	1.6	12	1985	10	Vestas	V15	16.5	80.0	24.4
Niyol Wind, LLC	CO	205.0	205.0	11	2021	74	GE	2.82-127	18.6	80.0	24.4
Stillwater Wind, LLC	MT	79.7	79.7	10	2018	31	Siemens	SWT-2.3-108	24.6	80.0	24.4
Sterling I Wind Farm	NM	29.9	29.9	7	2017	13	GE	2.3-116	18.8	80.0	24.4
Grady Wind Energy Center, LLC	NM	220.5	220.5	8	2019	96	Siemens	SWT-2.3-108	19.0	80.0	24.4
Broadview Energy JN, LLC	NM	181.7	181.7	3	2017	79	Siemens	SWT-2.3-108	19.0	80.0	24.4
Broadview Energy KW, LLC	NM	142.6	142.6	3	2017	62	Siemens	SWT-2.3-108	19.0	80.0	24.4
Rocksprings	TX	149.3	149.3	9	2017	69	GE	2.3-107	18.8	80.0	24.4
Tehachapi Wind Resource I	TX	8.7	8.7	12	1984	134	Nordtank	NTK 65/13	17.0	80.0	24.4

Submission to proposed Ballinla Wind Farm, within the townlands of Leitrim, Lumville, Ballinla, Clarkeville, Ballyfore Big, Ballyfore Little, Ballyeakin and Ballykilleen, in (Coolestown By) Co. Offaly. Ref 323579

OBJECTION 1: DEVELOPER'S PROVEN PATTERN OF NON-COMPLIANCE ACROSS MULTIPLE SITES

The applicant operates Cloghan Wind Farm (Offaly) and Meenwaun Wind Farm (Offaly), both of which have been confirmed as non-compliant with planning conditions.
An independent acoustic survey by *L. Huson & Associates (October 2025)*[1] demonstrates a material breach of Cloghan Wind Farm Planning Register PL2/19/404 Condition 4(a):

- The **43 dB(A) LA90 (10-minute)** noise limit was exceeded on 15 September 2025;
- **Impulsive noise characteristics** were detected (breach of "no impulsive noise" condition); and
- **Tonal characteristics** were detected at 403 Hz with 5.7 dB audibility (breach of "no tonal noise" condition).

The survey concludes:
"The survey has shown that the Cloghan Wind Farm is not compliant with its permitted noise emissions."

At Meenwaun Wind Farm, Offaly County Council issued an enforcement warning (February 2022) for noise-condition breach. No follow-up enforcement occurred despite the confirmed breach, and turbines continue to operate in non-compliance for over three years.

The Minister's *Code of Practice for Wind Energy Development in Ireland – Guidelines for Community Engagement* (Dec 2016) requires local authorities to consider a promoter's past performance when assessing new applications.

Under Section 34(2)(e) of the *Planning and Development Act 2000 (as amended)*, the planning authority must consider any previous planning applications relating to the land or applicant.

Given the applicant's demonstrated inability or unwillingness to comply with noise conditions at two existing sites, refusal is warranted. This pattern shows:

- Planning conditions have proven insufficient to prevent noise impacts;
- The applicant treats such conditions as non-binding; and
- Enforcement has been ineffective.

[1] Appendix One (Job No LHA468)

Granting permission would reward persistent non-compliance. The developer's record renders any proposed mitigation commitments for Ballinla **unreliable**.

An Bord Pleanála has previously refused permissions citing applicant compliance history. The planning authority cannot responsibly grant new consent to a serial non-complier based on assurances already proven worthless.

OBJECTION 2: COMPLAINT-BASED ENFORCEMENT MODEL — SYSTEMATIC FAILURE TO PROTECT PUBLIC HEALTH

An HSE letter dated 12 May 2025[2], responding to a Cloghan Wind Farm noise complaint exposes fundamental gaps in the health-protection framework. The HSE states:
"The National Environmental Health Service (NEHS) does not have a role in the investigation of noise or shadow-flicker related complaints. This would be a matter for the local authority."

Offaly County Council has received noise complaints from multiple neighbours for years. Only after intervention by the national alliance CEPA was a noise investigation initiated. CEPA funded an independent acoustic survey confirming breaches of planning conditions at Cloghan. This mirrors the experience at Meenwaun, where breaches remain unresolved.

The complaint-based model creates systemic failure:

- The HSE refuses a health-investigation role;
- The local authority delays or avoids enforcement; and
- Residents' only remaining remedy is costly civil litigation, as seen in *Webster v Meenacloghspar*, where residents spent years proving nuisance.

Vulnerable residents — including older people, children, and those with health conditions — cannot afford such litigation and are therefore unprotected.

No proactive noise monitoring exists at Irish wind farms. Breaches are detected only when residents commission costly independent surveys. Developer-controlled monitoring presents an **inherent conflict of interest**, and there is no real-time public data.

SCADA operational data should be accessible under AIE (Access to Information on the Environment) regulations. Yet neighbours are denied access, as illustrated by *Right To*

[2] Appendix Two

Know v Raheenleagh, which took seven years and concluded in the Supreme Court (March 2024).

Given this evidence, the planning authority cannot rely on enforcement mechanisms to protect residents. To do so would knowingly ignore demonstrated systemic failure at Cloghan and Meenwaun. Under the principles of proper planning and sustainable development, the authority has a duty of care not to permit development where foreseeable harm cannot be prevented or remedied.

OBJECTION 3: HSE MISCHARACTERISATION OF NOISE LIMITS — NOT AN EVIDENCE-BASED HEALTH STANDARD

The HSE letter of 12 May 2025 responding to a wind farm neighbour's complaint states: "Noise limits are set in accordance with evidence-based health protection standards," referring to the 43 dB LA90 limit.

This assertion conflicts with the HSE's own scoping guidance to developers, which cites the World Health Organisation (WHO) 2018 Environmental Noise Guidelines recommending wind-turbine noise below 45 dB Lden (≈ 37 dB LA90) to prevent sleep disturbance, annoyance, and cardiovascular effects.

When advising developers, the HSE refers to WHO 2018. When responding to residents, it defends a weaker 1996-based 43 dB LA90 standard. This inconsistency undermines public confidence and exposes a policy contradiction.

The HSE also confirms that the NEHS does not carry out Health Impact Assessments (HIA) and has no role in investigating noise complaints. Consequently, health effects are neither properly assessed nor investigated in practice.

This absence of an HIA or any established health baseline is further compounded by reports that wind farm operators have responded inappropriately to health complaints from neighbours — claiming that no health baseline was recorded prior to turbine operation and therefore impacts cannot be verified. Such reasoning highlights a serious procedural gap: without a baseline or ongoing health assessment, affected residents are left without any effective means of demonstrating or addressing health impacts.

EPA 2022 EIAR Guidelines (Section 8.4) require assessment of human-health impacts. Therefore, the planning authority must apply current WHO 2018 health-based standards, not outdated 2006 guideline levels.

Failure to adopt evidence-based limits would perpetuate a regulatory approach that prioritises development consent over health protection.

Conclusion

The pattern of non-compliance, ineffective enforcement, and inconsistent health standards demonstrates that granting permission for the Ballinla Wind Farm would pose unacceptable and foreseeable risks to public health and residential amenity.

For these reasons, I respectfully request that the planning authority refuse permission for the proposed Ballinla Wind Farm.

Brenda Dowling

Appendix One

L HUSON & ASSOCIATES

REPORT

NOISE SURVEY

R42 D274

CLIENT:

Communities & Environmental Protection Alliance (CEPA)

Job No LHA468
October 2025

L HUSON & ASSOCIATES PTY LTD
Consulting Scientists in Acoustics

PO Box 290
WOODEND
VIC 3442
AUSTRALIA

Tel. +61(0)416 143 716

Email: office@huson.com.au

ABN 57 094 096 992

NOISE SURVEY

R42 D274

EXECUTIVE SUMMARY

A noise survey was completed between 12 September 2025 and 30 September 2025 at R42 D274 (dwelling) to test compliance with permitted noise limits for the Cloghan Wind Farm.

The 43 dB(A) $L_{90(10\text{-minute})}$ wind farm noise limit was exceeded in the morning of 15 September 2025. This was a period of high winds when the Cloghan Wind Farm would be generating most power.

No other period exceeded the permitted 43 dB(A) $L_{90(10\text{-minute})}$ sound level after exclusion of extraneous noise events.

Sound from the Cloghan Wind Farm exhibits impulsive sound characteristics.

Sound from the Cloghan Wind Farm is occasionally tonal.

The survey has shown that the Cloghan Wind Farm is not compliant with its permitted noise emissions.

Prepared by

W Les Huson BSc MSc CPhys MInstP MIoA MAAS

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SUMMARY 15

INTRODUCTION

A noise survey was completed between 12 September 2025 and 30 September 2025 at R42 D274 for the purpose of assessing noise associated with the Cloghan Wind Farm.

The dwelling (R42 D274) is approximately 750m to the north of the nearest wind turbine within the Cloghan Wind Farm.

Measurements were completed in accordance with ISO R1996-1.

MEASUREMENT EQUIPMENT

Sound level meter/logger (Class 1):
SVANTEK 977D s/n 99745
Date next calibration due: April 2026

Rain Logger:
Rainwise Rainlog2.0 s/n 2008478

Field Calibrator:
CEL 120/1 s/n 2221119
Date next calibration due: 15 August 2026

Field calibrations at deployment and survey completion show a drift of less than 0.1 dB

MEASUREMENT LOCATION

The measurement location is shown in Figure 1 having coordinates 29U 575081 E, 5896275 N (WGS84).

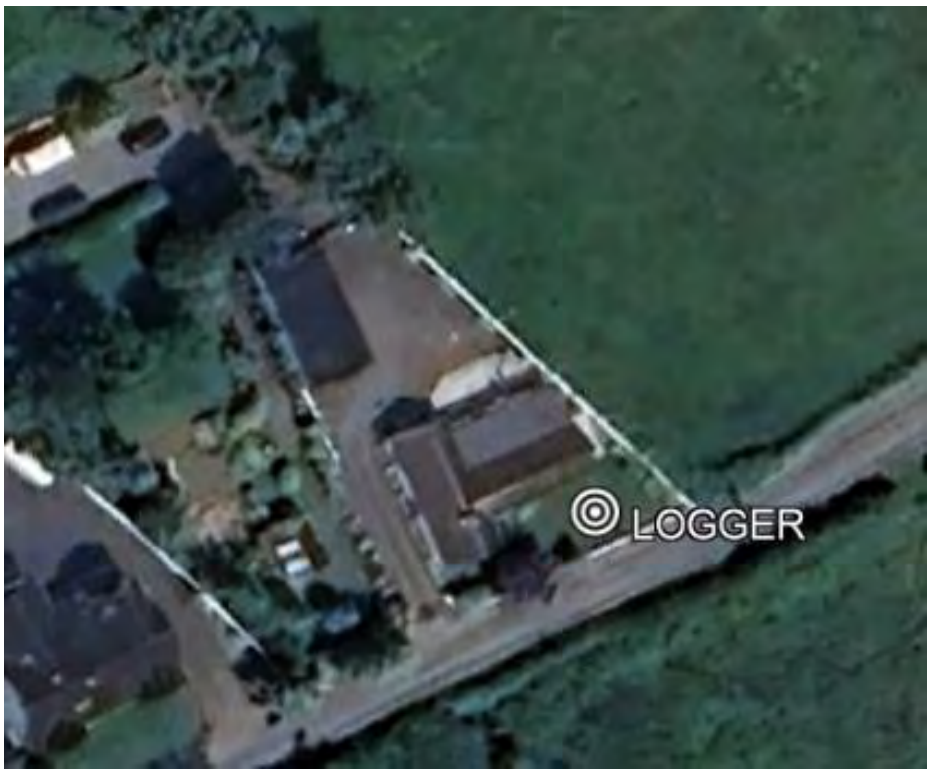


Figure 1: Noise Logger Location, approximately 10m from nearest building

Figure 2 shows the measurement location in relation to the three nearest wind turbines of the Cloghan Wind Farm.

Figure 2 Nearest wind turbine 750m to the measurement location

Figure 3 shows the logger installation looking towards the nearest wind turbine.

Figure 3

PERMIT CONDITIONS

Condition No. 4(a) of Offaly County Council Planning Register PL2/19/404 requires:

Noise levels emanating from wind farm noise when measured at the nearest noise sensitive properties, i.e. dwelling houses, shall not exceed 43 dB(A) $L_{A90(10\ minutes)}$. There shall be no tonal or impulsive noise and measurements shall be made in accordance with ISO recommendations R1996-1 (Acoustics-description and measurement of environmental noise, part 1; basic qualities and procedures).

The 43 dB(A) noise limit always applies, day and night, and is the noise contribution from the wind farm.

The noise limit is not dependent upon the operating conditions of the wind farm.

If sound from the wind farm has a tonal or impulsive character this breaches the permit.

DATA ANALYSIS

Sound level data for the A-weighted, Fast response, L_{90} statistic and L_{eq} over each 10-minute period throughout the survey are shown for each day in Figures 4 to 21. The 43 dB(A) L_{90} noise limit (horizontal line) is also shown in each figure.

The data shown includes periods of rain, passing road traffic and other extraneous sounds.

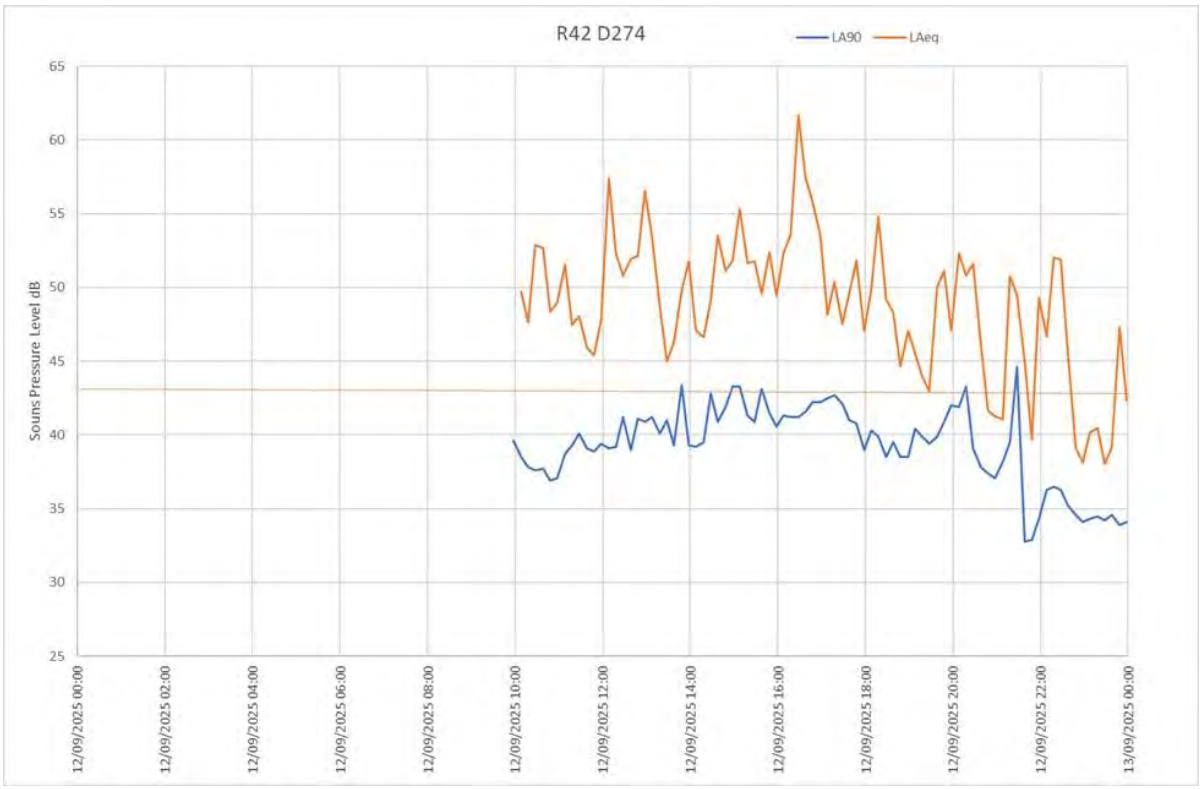


Figure 4

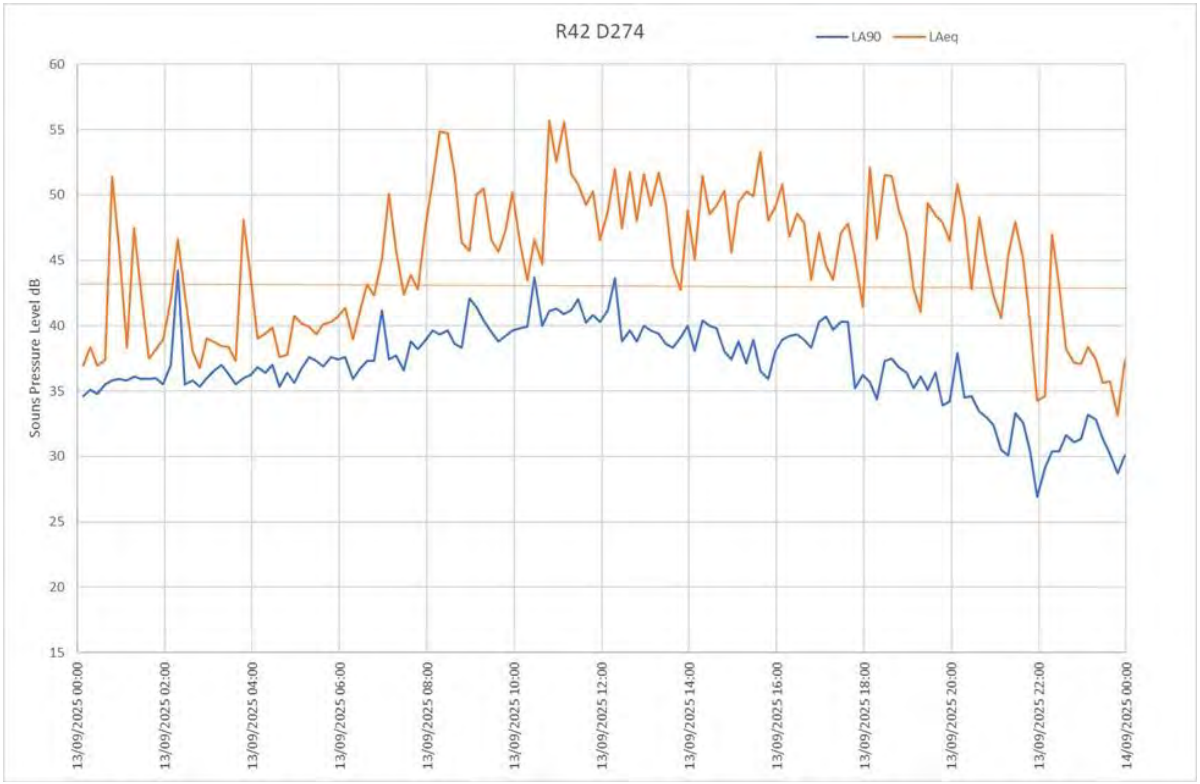
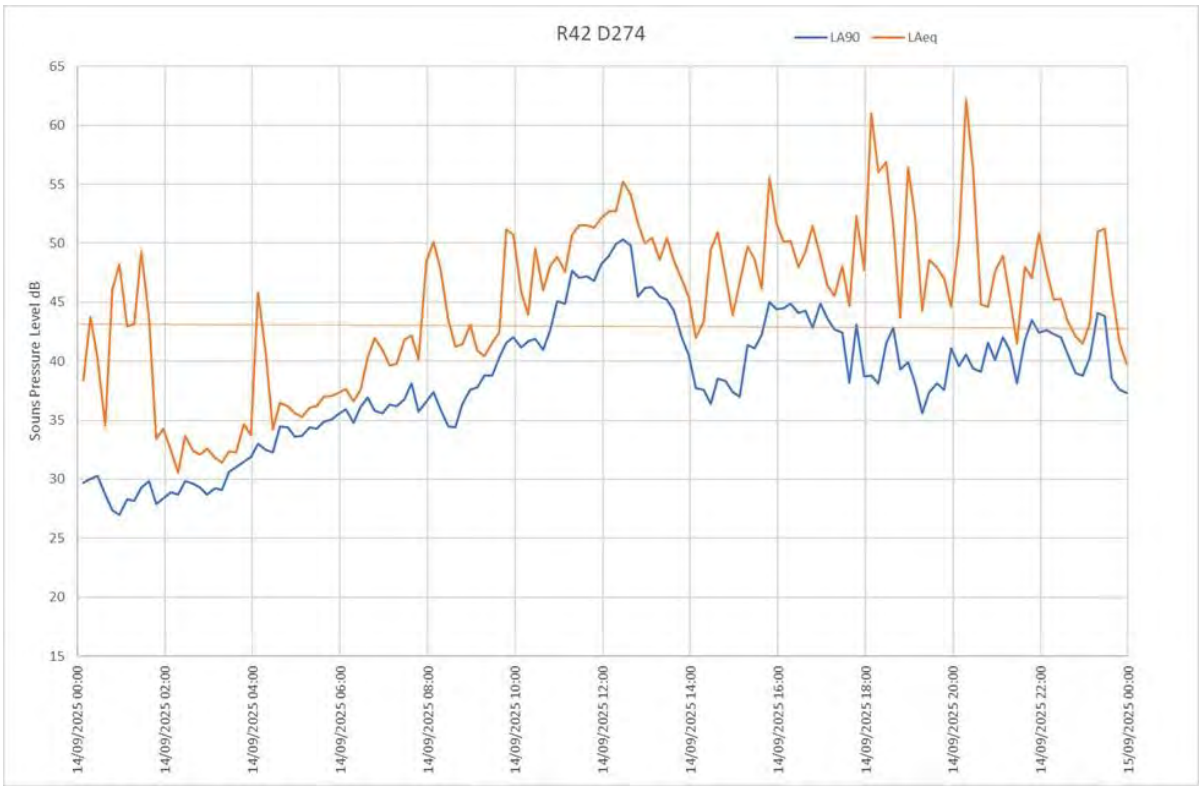


Figure 5



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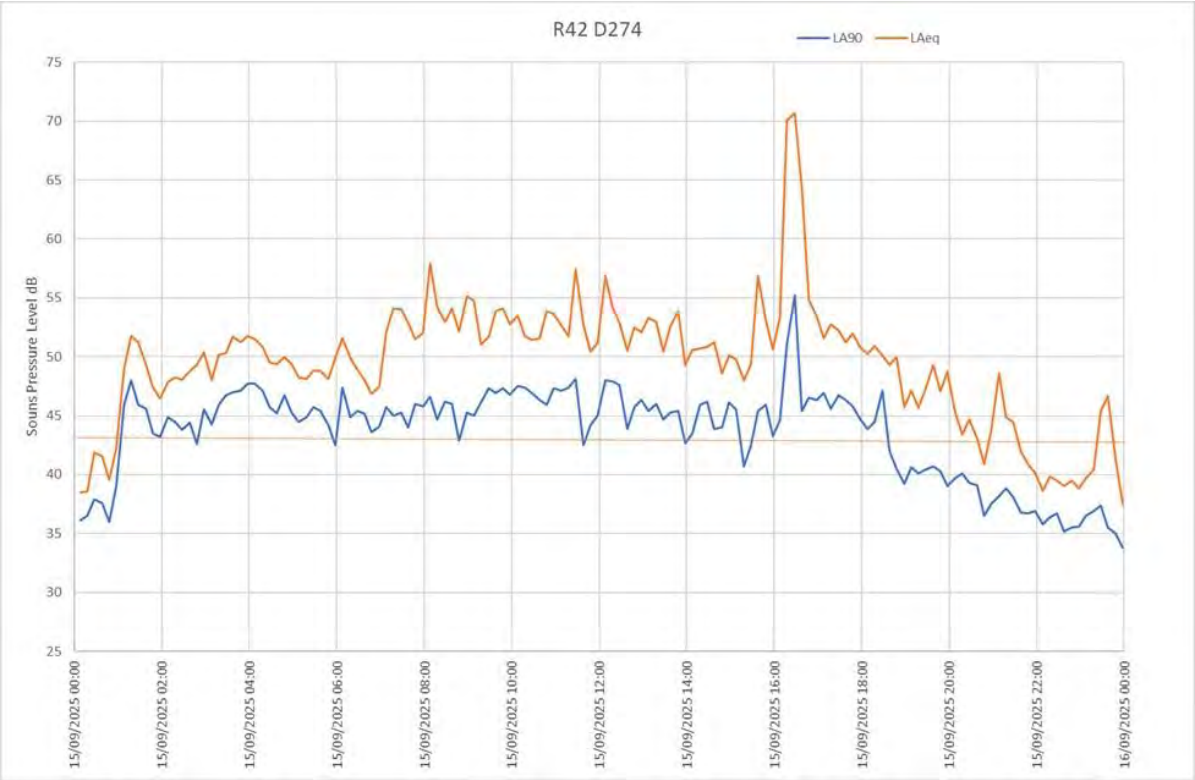

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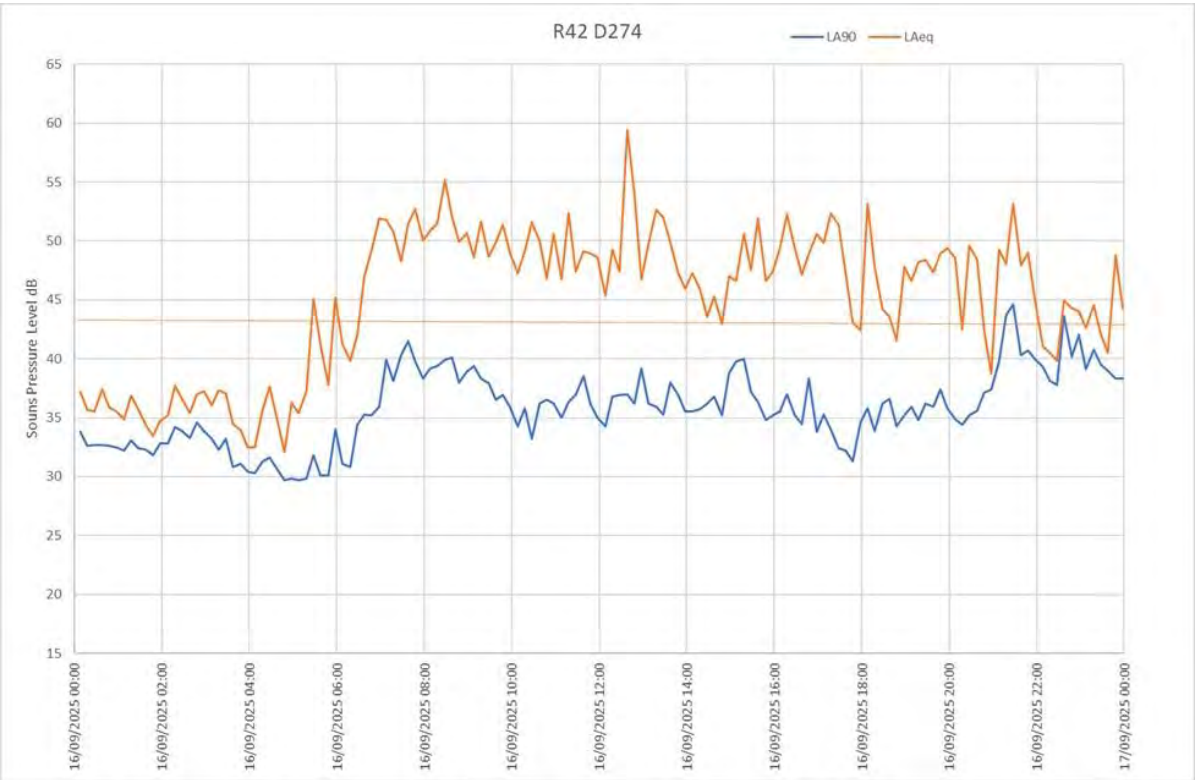

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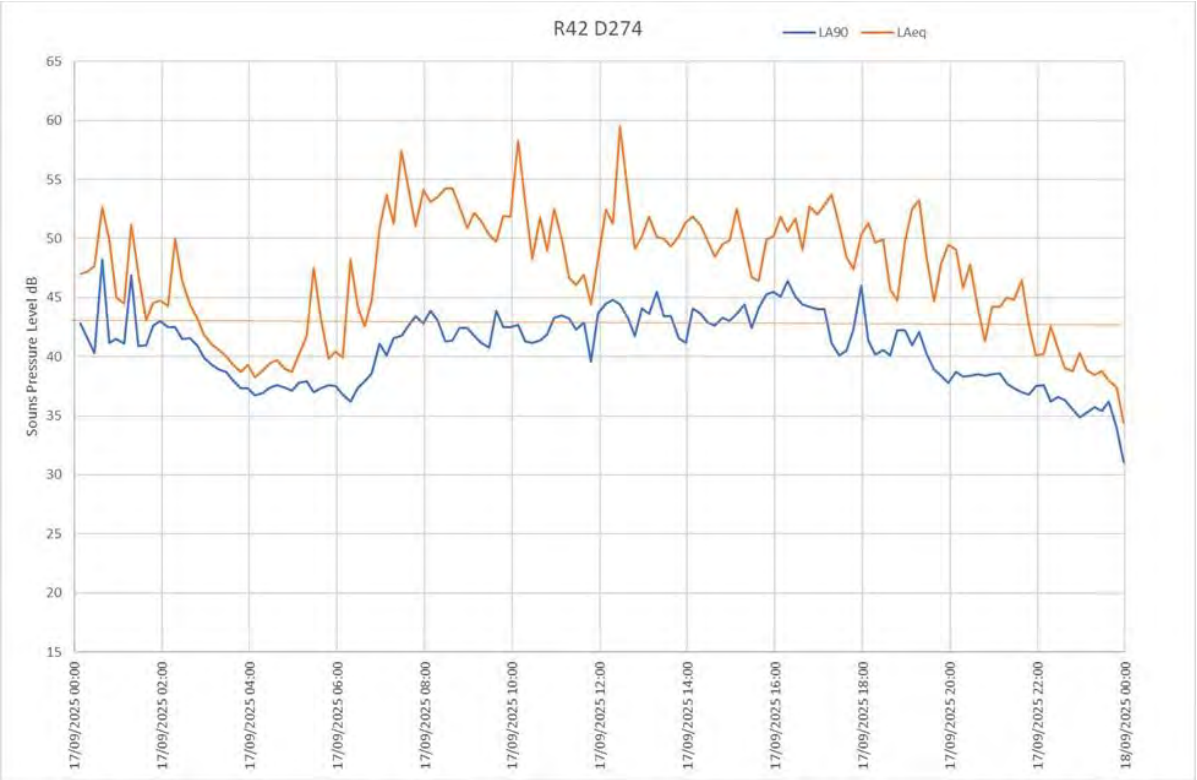

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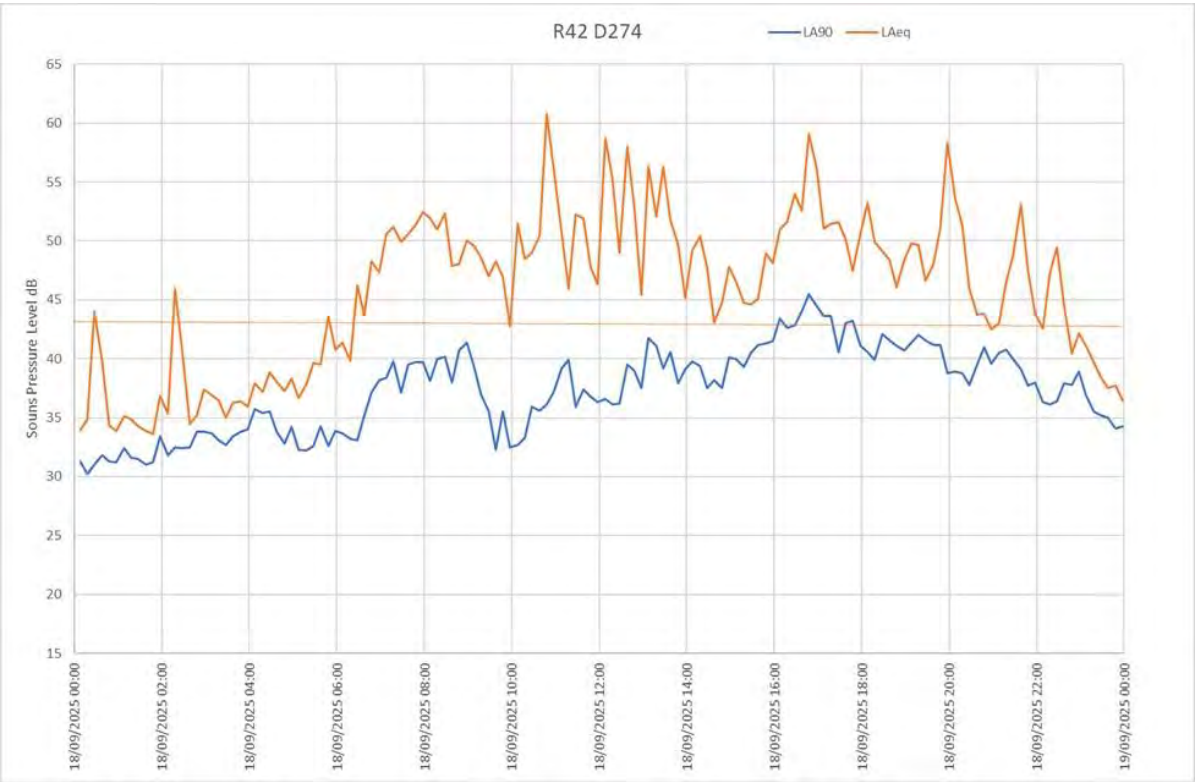

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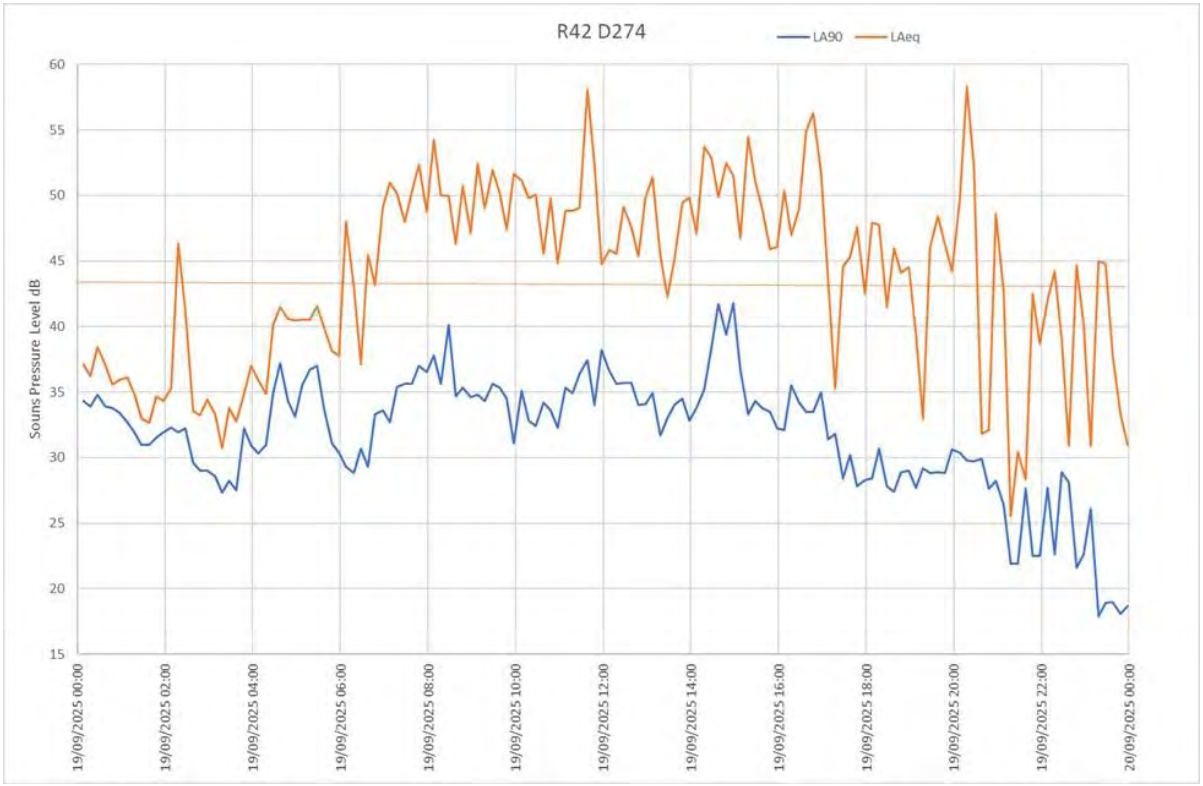

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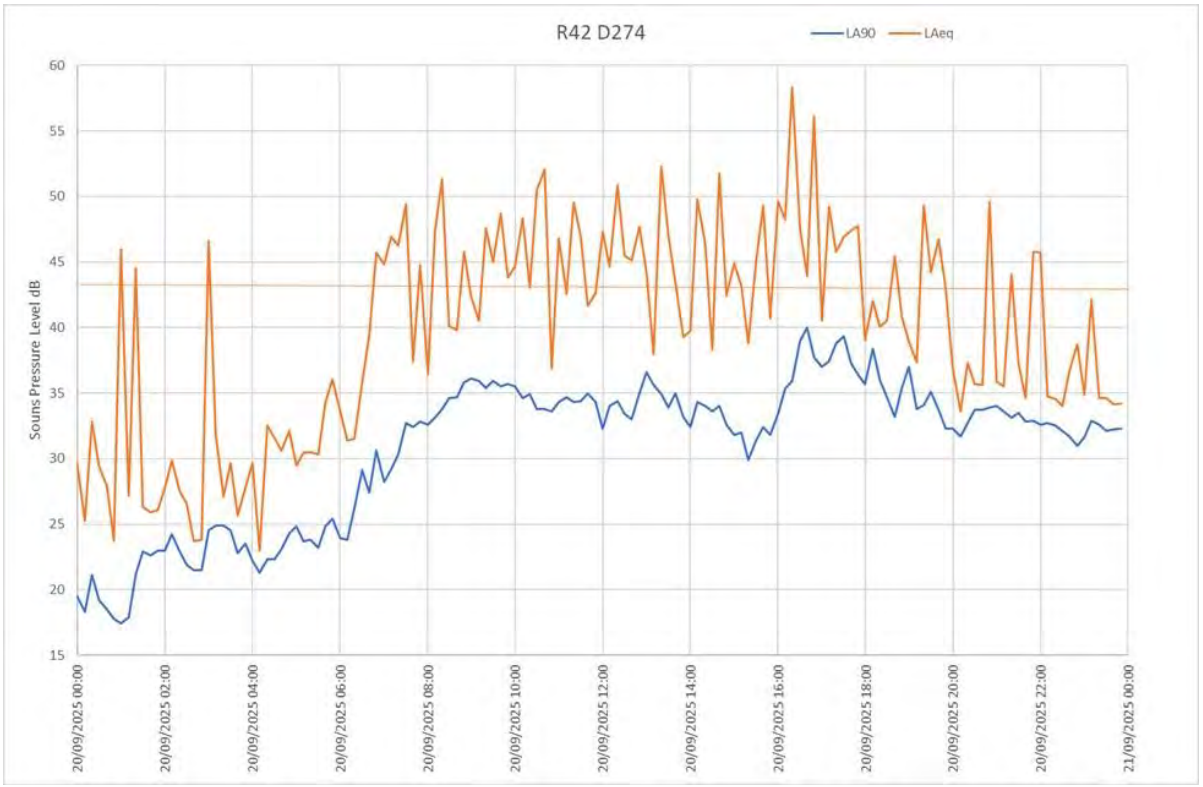

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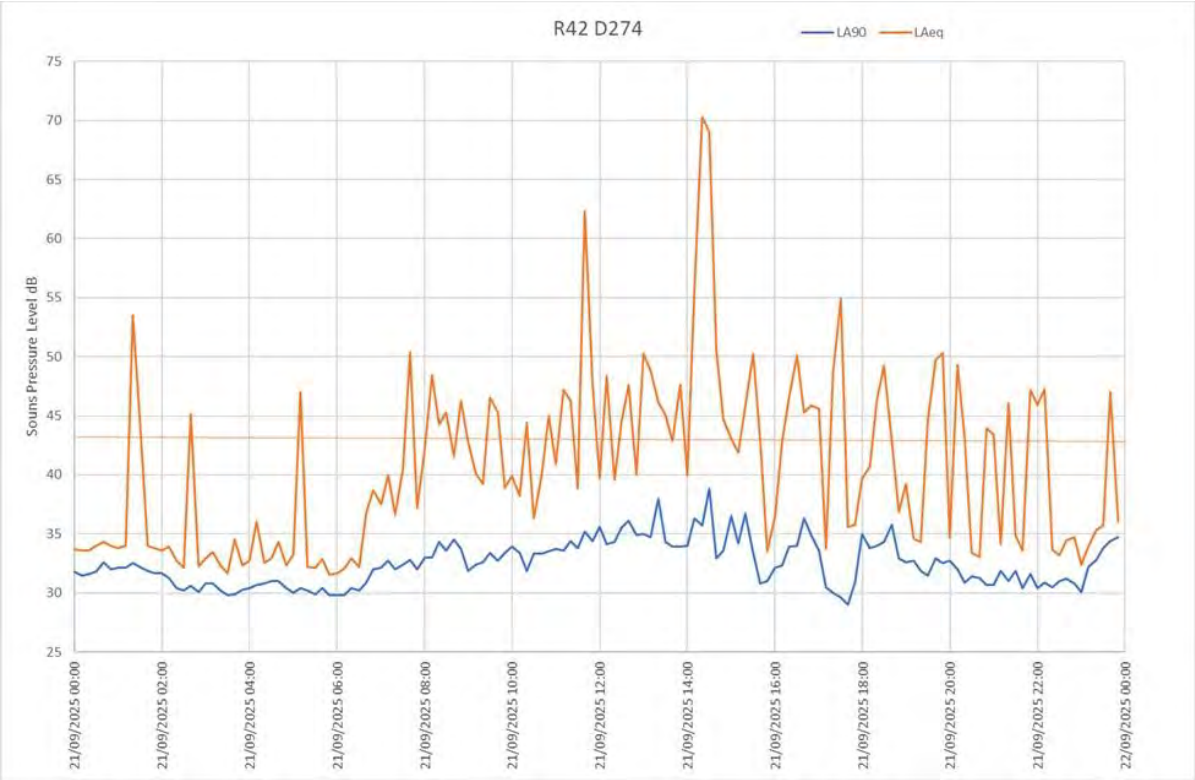

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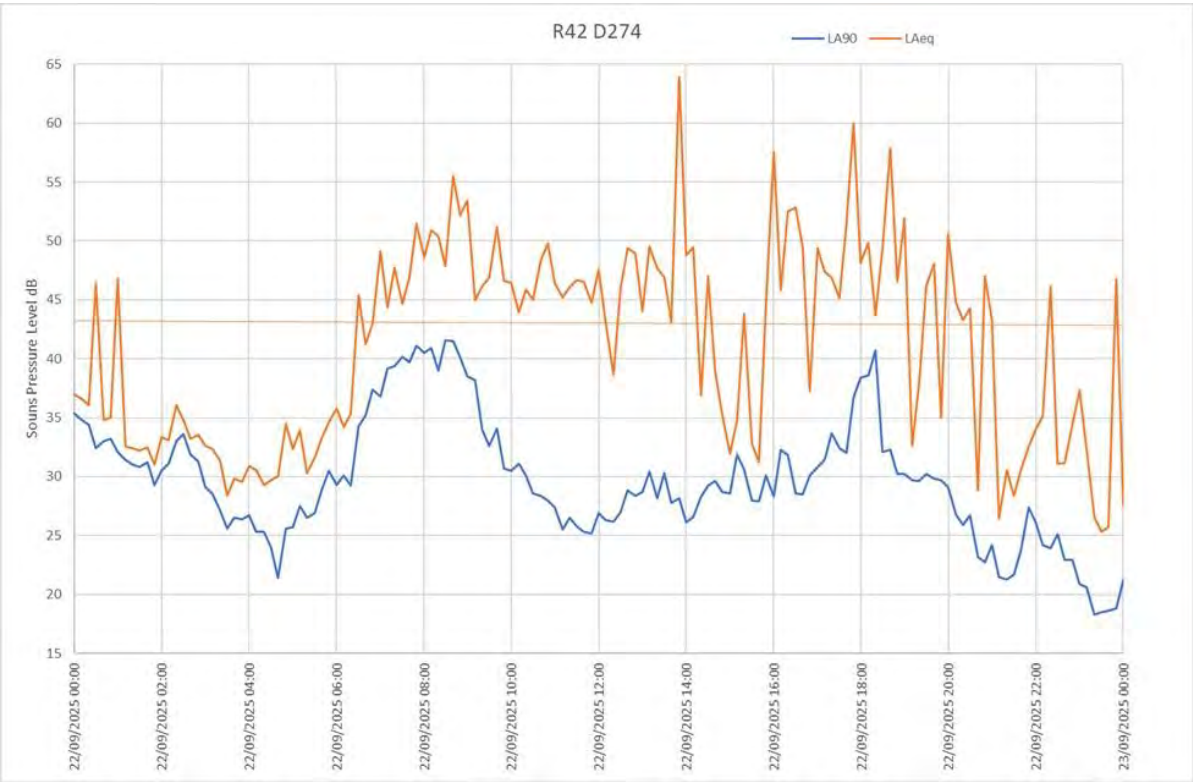

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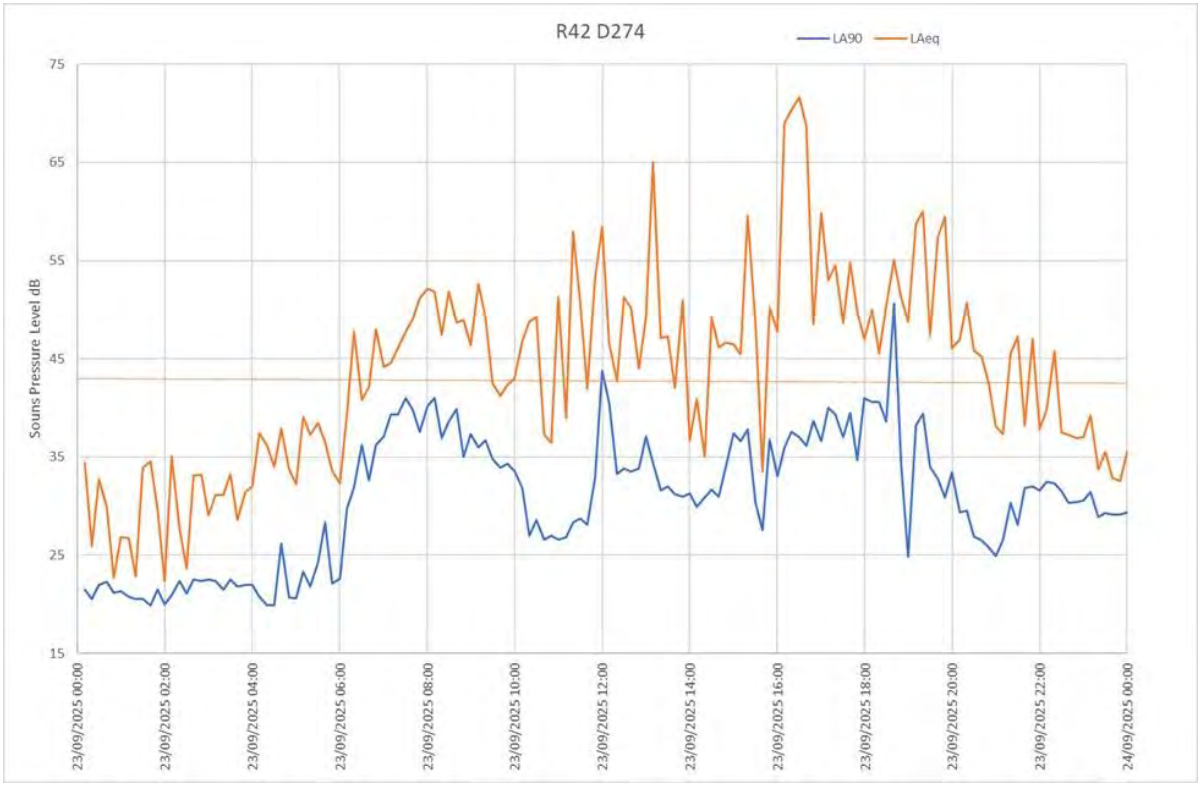

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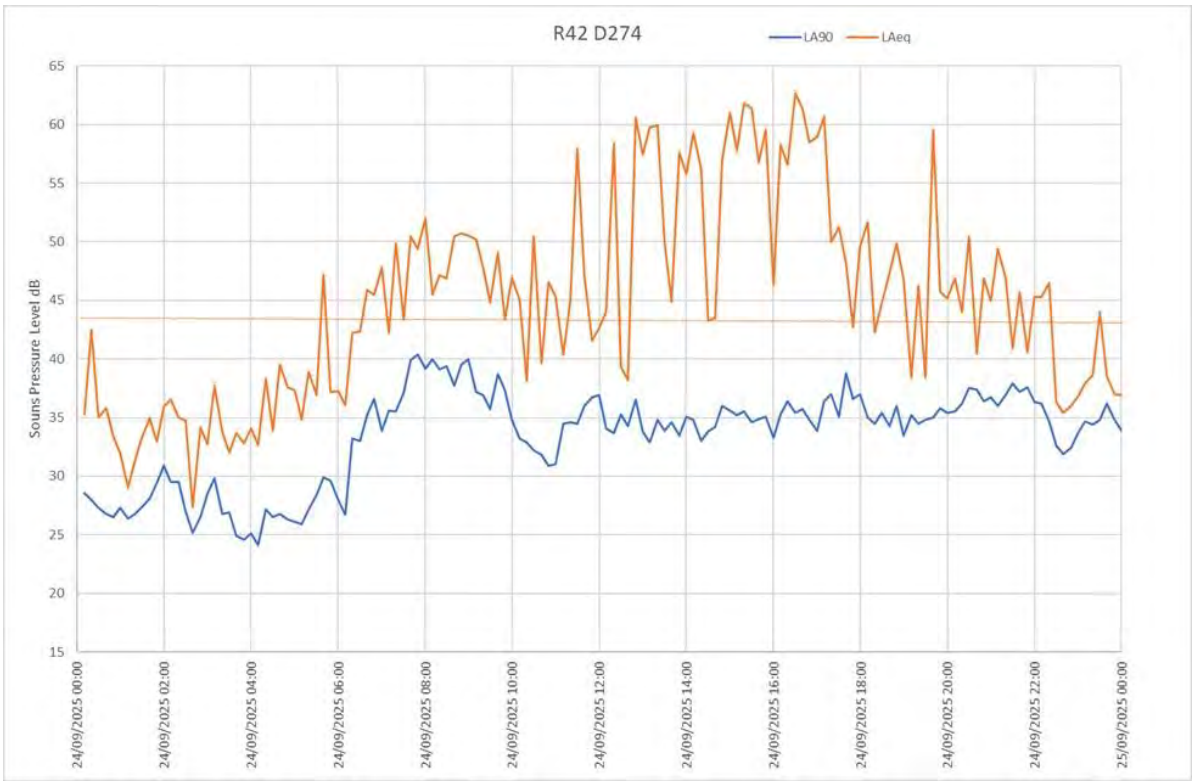

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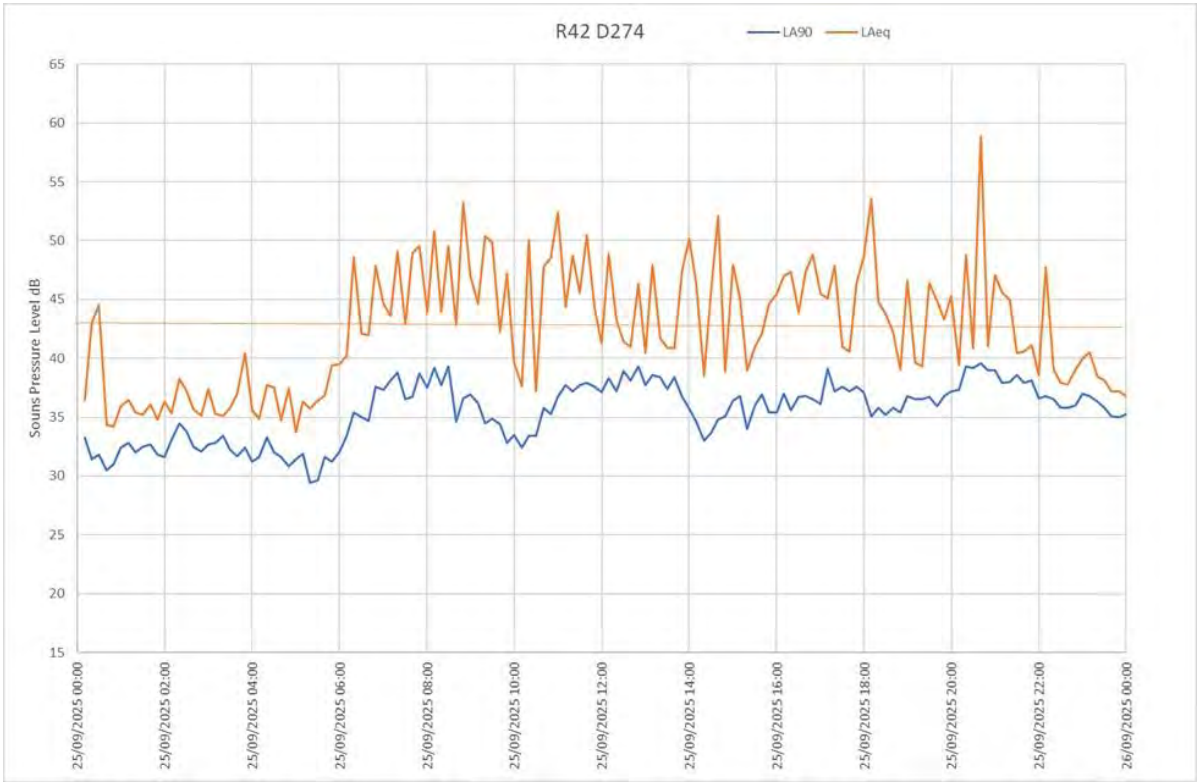

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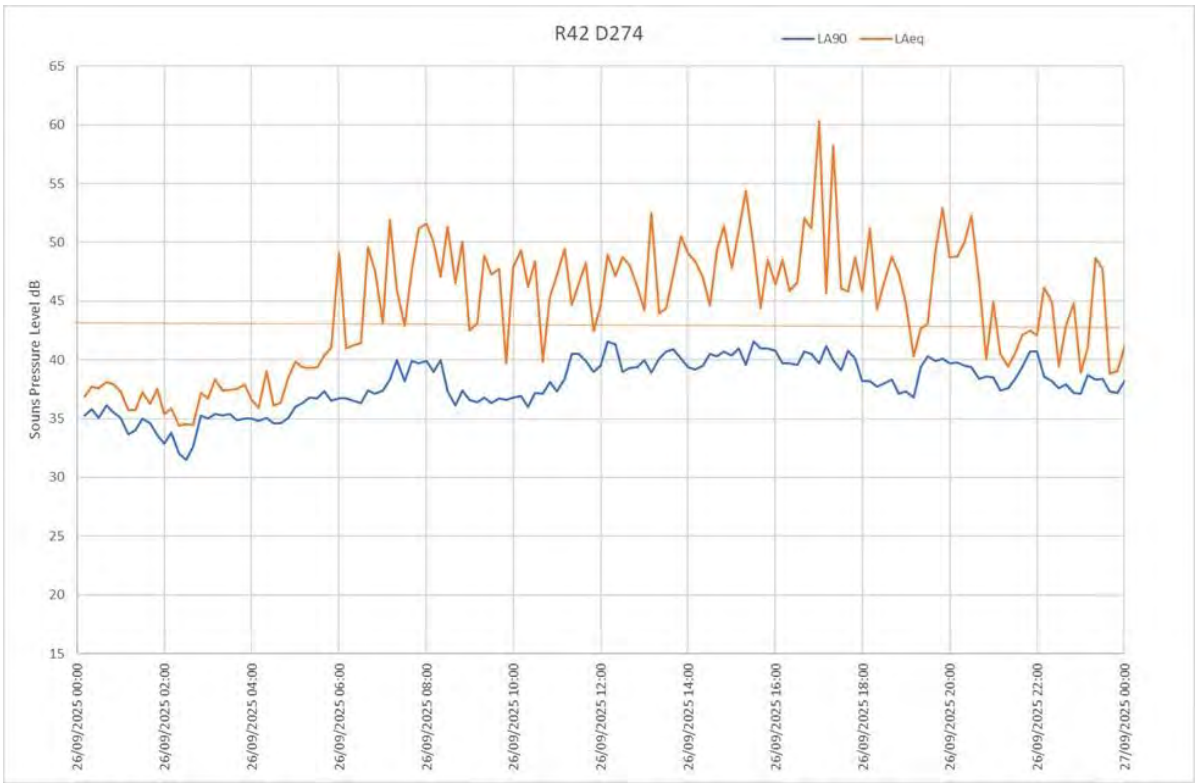

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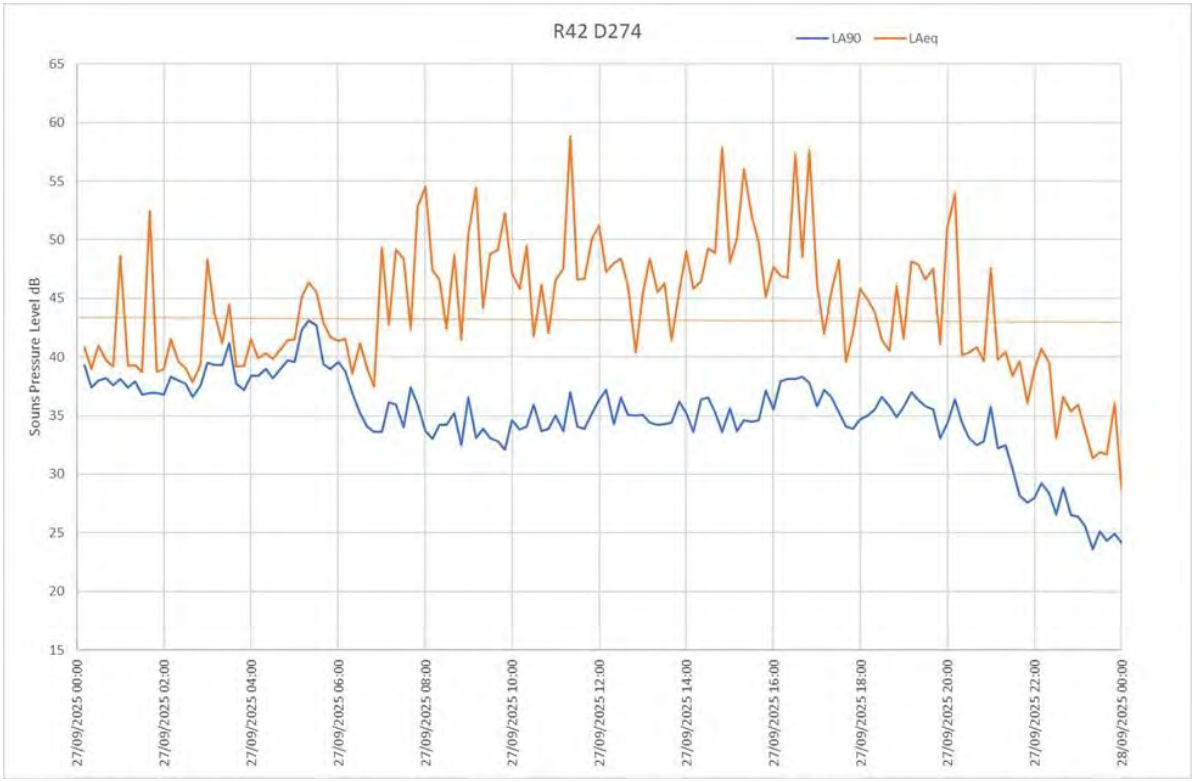

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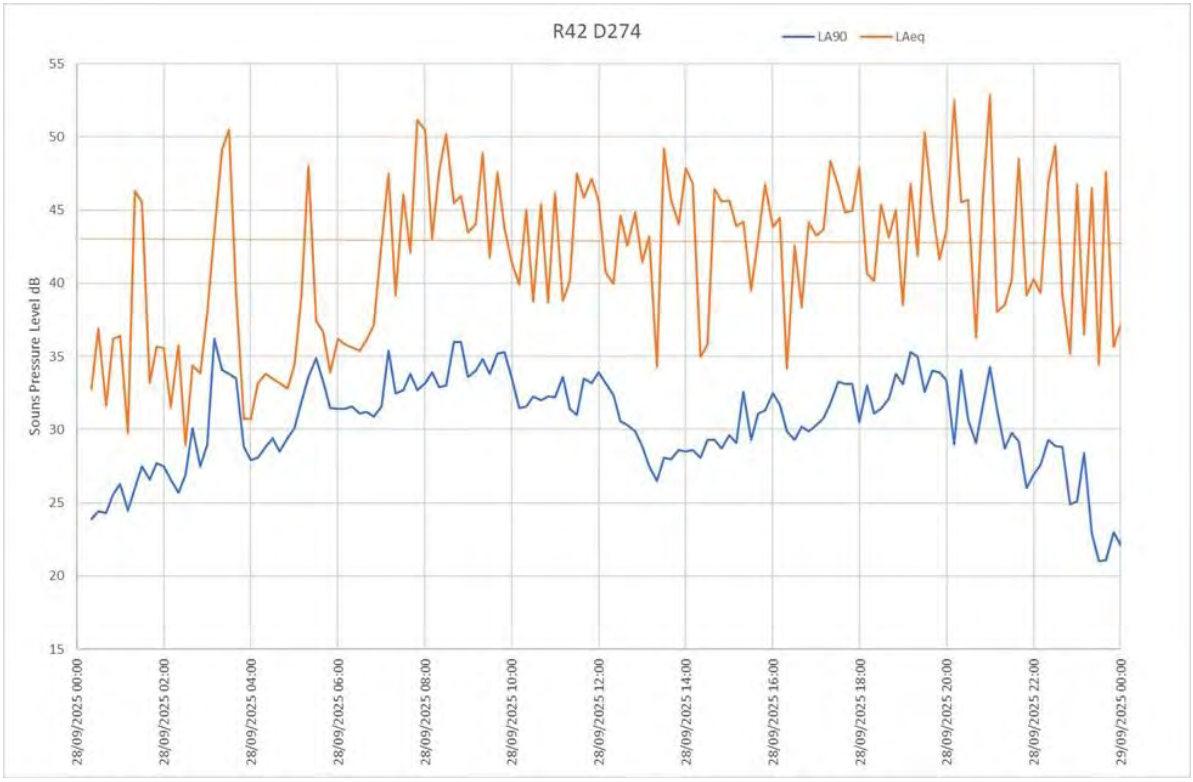

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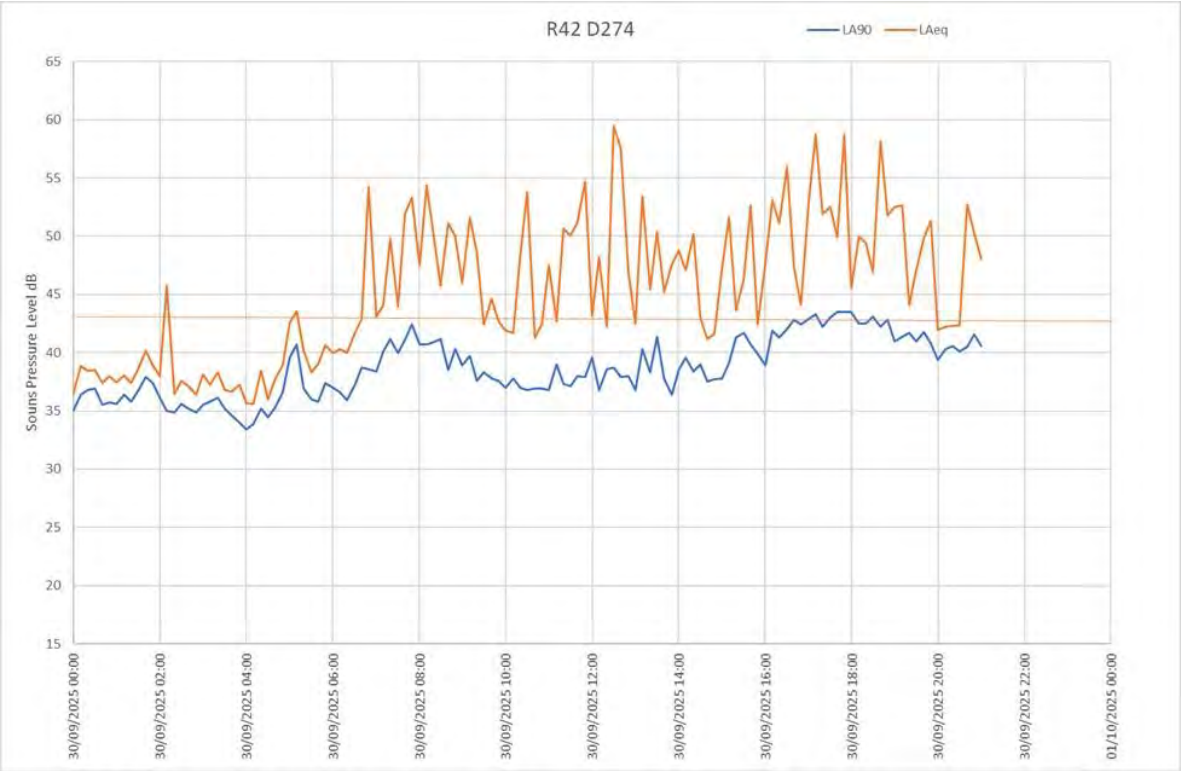

Figure 21

A resident provided diary notes listing nights when noise from the Cloghan Wind Farm was most prominent. The diary also noted times when different individual or all wind turbines were noticed to be inoperative.

SCADA data from the wind farm is presently unavailable for the survey period so the detailed analysis has focussed on one night from 10pm 16 September 2025 to 5am 17 September 2025 that the resident noted disrupted sleep. It is not known if all wind turbines were operating at this time. The diary note mentioned high winds on 15 September 2025.
The permit condition requires an assessment of tonality and impulsiveness.

Analysis was made of continuous audio recordings (10-minute WAV files) and numerous sound level parameters sampled every 100ms.

Tonality
ISO1996-1:2017 refers to an objective test method (ISO/PAS 20065) that was used to assess tonal audibility.

Spectrum analysis shows that there are no constant tones observed in the recordings. However, tonal sounds are observed periodically. One example is a 403Hz tone that has a tonal audibility rating of 5.7 dB that can be seen in the spectrogram in Figure 23 around 4.25am 16 September 2025.

Impulsive sound
BS4142:2019 provides a method to assess impulsive sounds. A sound is impulsive if its level changes by more than 10 dB/second.

Figure 22 shows the dB(A) level changing during a 10-minute period from 4.20am 16 September 2025 that regularly demonstrate impulsiveness.

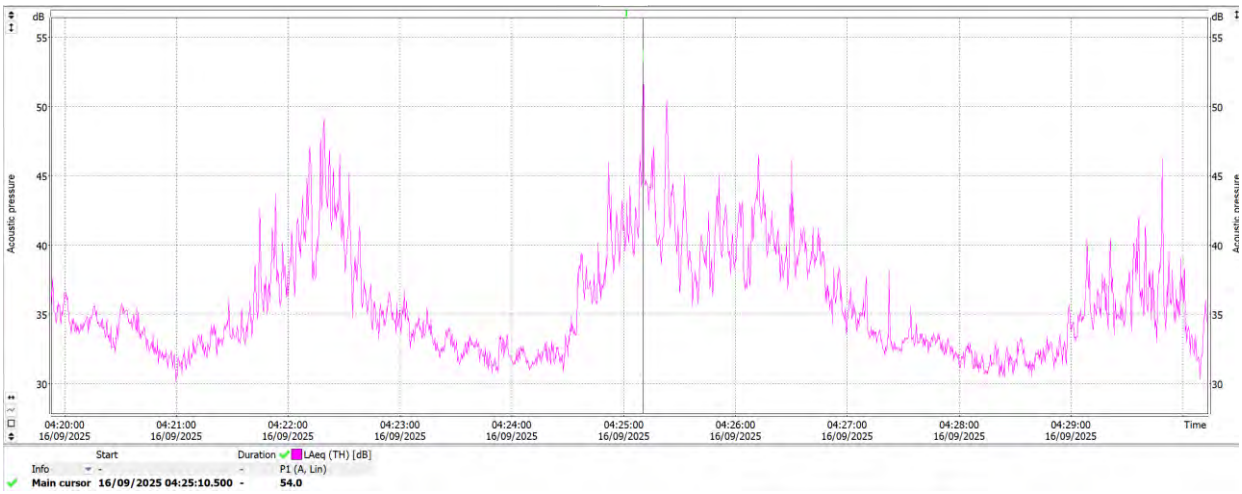

Figure 22

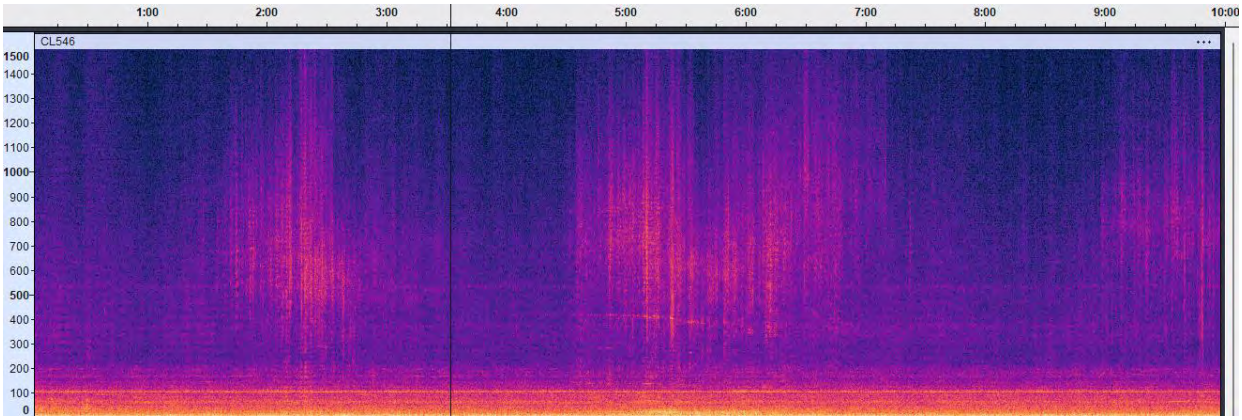

Figure 23 Spectrogram up to 1,500Hz of the data shown in Figure 22

The data demonstrating impulsive and tonal sounds were checked to ensure there was no extraneous noise that could give a false assessment.

SUMMARY

The 43 dB(A) L90(10-minute) wind farm noise limit was exceeded in the morning of 15 September 2025 in high winds.

No other period exceeded the permitted sound level after extraneous noise events were excluded.

Sound from the Cloghan Wind Farm exhibits impulsive sound characteristics.

Sound from the Cloghan Wind Farm is occasionally tonal.

Appendix Two

National Environmental Health Service
Laois Health Campus,
Dublin Road,
Portlaoise,
Co. Laois
Phone: 057 8692675
E-Mail: peho.laoisoffaly@hse.ie

[redacted]
Co. Offaly

12.05.2025

Re: Formal Complaint Regarding Unreasonable Noise Nuisance from Cloghan Wind farm Ltd.

Dear [redacted]

We wish to confirm receipt of your letter of complaint with regard to Cloghan Wind Farm Ltd.

For your information, the National Environmental Health Service (NEHS) does not have a role in the investigation of noise or shadow-flicker related complaints. This would be a matter for the local authority – in this case Offaly County Council.

With regard to the request for a health impact assessment, the NEHS does not carry out health impact assessments, as there is no statutory basis for this. The predicted Human and Population Health impacts are addressed at the planning stage in the Environmental Impact Assessment Report (EIAR).

The operation of windfarms is controlled through the planning process, where planning conditions are set in the interest of public health. With regard to noise, I note in the Letter of Final Grant, that a noise limit has been set not to exceed "a level of 43dB(A) $LA_{90\ (10\ minutes)}$". Noise limits are set in accordance with evidence-based health protection standards and these are set down in the planning conditions for any project such as this. Exceedances of this limit are a matter for the planning authority to investigate and take action accordingly.

Options you may wish to consider to pursue this complaint are as follows:

- There is an option of taking a private action for noise disruption through a summary trial in the District Court under the EPA Act 1992. This can be initiated by contacting your local District Court Clerk.

- If you feel that proper procedures have not been followed by the local authority with respect to investigating your complaint, you can refer this to the Environmental Protection Agency, who will review the investigation and act accordingly.

Yours sincerely,

John Ryan
Principal Environmental Health Officer

HUSON & ASSOCIATES

Peer Review of Proposed Ballinla Wind Farm Planning Application

W Les Huson BSc(Hons) MSc CPhys MInstP MIoA MAAS

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Ballinla Wind Farm Review.docx
OCTOBER 2025

INTRODUCTION

Huson & Associates has been commissioned by the Quinn Family to review an Environmental Impact Assessment Report (EIAR) dated August 2025 prepared by MWP, Engineering and Environmental Consultants for Statkraft Ireland Ltd containing Chapter 10 'Noise and Vibration' (NVA) prepared by AWN Consulting Ltd to support a planning application from Ballinla Wind Farm Ltd for the Ballinla Wind Farm.

The proposed wind farm development has been designated a Strategic Infrastructure Project that is suitable for assessment by An Coimisiun Pleanála.

The Quinn Family have two properties, one of which is called Lumville House, that are within 1000 m of a wind turbine within the proposed wind farm. The second dwelling will be referred to as 'Quinn' and both are shown in Figure 1.

Part of the planning process requires community consultation (Code of Practice for Wind Energy Development in Ireland (2016)) and one such meeting was held at Lumville House on 5 September 2025 to discuss concerns that have been raised about the proposed wind farm development.

This review also considers a technical response by Statkraft Ireland Ltd (email dated 21 September 2025, shown in Appendix A) that was provided in response to issues raised about noise and health at the meeting in Lumville House.

This review has been prepared by W Les Huson BSc(Hons) MSc CPhys MInstP MIOA MAAS (brief CV in Appendix B).

Referenced papers can be made available on request.

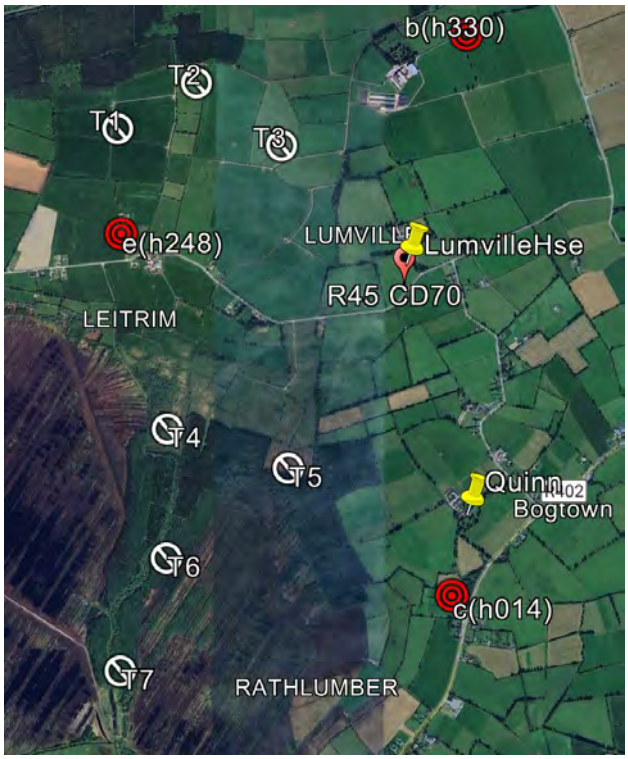


Figure 1

Location of Quinn dwellings, wind turbines and background measurement locations c, b and e

SUMMARY

An Coimisiun Pleanála would be justified in refusing the Ballinla Wind Farm Application for the following reasons:

- The minimum recommended setback of 10 times the rotor diameter has not been applied and the Quinn dwellings are less than 1000m from the nearest proposed wind turbines. This equates to a best practice setback distance of 1.62 km for the proposed wind turbine rotor diameter of 162m.
- The wind turbines are located too close to each other that will result in increased wake turbulence that in turn will increase noise emission and the characteristic of amplitude modulation. The NVA has not considered these effects.
- Technical advice from Statkraft in response to community concerns are misleading and incorrect.
- Noise compliance with WEDG 2006 should have been completed at 7 m/s, not 11 m/s.
- WEDG 2006 target noise limits have been misinterpreted in the NVA to produce higher proposed noise limits.
- Target noise limits should be lower at 35 dB(A) in 7 m/s wind speed at standardised height.
- Predicted sound levels in the NVA are too low.
- When more conservative noise model inputs are used the predicted noise levels shown in the NVA will be at least 2 dB higher.
- The current WEDG 2006 does not reflect best practice and is outdated, but if applied properly, shows that this proposed wind farm would be non-compliant.
- The NVA should not rely on guidelines used to underpin ETSU-R-97 because those guidelines are currently under review and the WEDG 2006 does not refer to them.
- The requirement from WEDG 2006 that '*that there is no significant increase in ambient noise levels at any nearby noise sensitive locations*' has not been addressed in the NVA.
- Ambient sound levels are shown to be below the 17 dB(A) instrument noise floor in wind speeds up to 9 m/s (10m AGL) at H014 compared with sound levels optimistically predicted to be more than 38dB(A) for the Quinn dwellings.
- The soundscape in the area will change dramatically for the Quinn Family and others in the area if the wind farm is approved and this is contrary to the requirement of the WEDG 2006.
- The layout of the seven wind turbines is such that excessive amplitude modulation will arise but the NVA has not accounted for any penalty due this or other special audible characteristics (tonality, impulsive sound).

- Current best practice in assessing wind farm noise should be reflective of target noise limits set in Germany and the Australian States of New South Wales and Tasmania.
- Low frequency noise impact has not been assessed.
- With noise model inputs used in the NVA there will be 184 dwellings that will exceed the correct 35 dB(A) noise limit target at 7 m/s.
- With more conservative noise model inputs 228 dwellings will exceed the correct 35 dB(A) noise limit target at 7 m/s.

COMMUNITY CONSULTATION

In an email from Statkraft (George O.Connor) dated 21 September 2025 there was attached the full text of a technical response following the meeting at Lumville on 5 September 2025, addressing the key technical and community topics discussed.

The response was prepared by Statkraft's technical and environmental team, addressing one of the topics raised, as follows:

- "The "37 dB challenge" referenced in the Gibbot Hill High Court case is acknowledged; however, it is important to note that the Ballinla Wind Farm has adopted stricter limits than those applied in that case, with predicted noise levels at all receptors remaining below 43 dB LA90,10min, even at rated wind speeds.

- The Gibbot Hill case centred on a single fixed threshold of 37 dB LAeq, applied without differentiation between daytime and nighttime conditions or consideration of background noise levels. In contrast, the Ballinla Wind Farm assessment applies dual thresholds; 40 dB LA90,10min during daytime and 43 dB LA90,10min at night, or 5 dB above background noise, whichever is higher. This approach is not only more protective of residential amenity, but also responsive to local acoustic conditions, ensuring that turbine noise remains below perceptible levels in quieter environments."

The response provided by Statkraft is misleading and wrong. The daytime target of 40 dB(A) is only proposed up to a wind speed of 6m/s. Above 6m/s the proposed noise limit during the daytime is 45 dB(A).

It is generally assumed that the numeric difference between an LAeq parameter and an LA90 statistic is 2 dB. That is, for a wind farm without any significant amplitude modulation, LAeq = LA90 + 2dB. This difference increases if higher than expected amplitude modulation occurs.

The Gibbot Hill noise limit of 37 dB, LAeq equates to 35 dB, LA90 at all times of the day or night.

The noise limit adopted by Statkraft during the day is 5 dB *less strict* than that of Gibbot Hill (wind <7m/s), 10 dB *less strict* in winds >6m/s and 8 dB *less strict* at night.

It is incorrect and misleading to state that the noise limits proposed for the Ballinla Wind Farm are 'stricter limits'. On the contrary, the proposed noise limits are between 5dB and 10 dB less strict to the benefit of the wind farm and detriment of the Community.

The proposed noise limits are not more protective of residential amenity compared to the protection provided for residents near the Gibbot Hill Wind Farm.

It is also incorrect to claim that the chosen noise limits ensure 'that turbine noise remains below perceptible levels in quieter environments.' At the chosen noise limits wind turbine noise will be perceptible, even in less quiet environments due to their characteristic noise emissions.

The Statkraft email response also refers to health and wellbeing, as follows:

- "We can confirm that the assessment was carried out in accordance with relevant national and international guidance, including the 2018 World Health Organization (WHO) Environmental Noise Guidelines for the European Region and the Health Service Executive (HSE) Position Paper on Wind Turbines and Public Health (2017). These documents were explicitly referenced and considered in the preparation of the Population and Human Health chapter of the Environmental Impact Assessment Report (EIAR)."

The HSE Position Paper 2017 on wind turbines and public health states: "The developer of a wind energy project should engage in meaningful, structured and extensive consultation with the local community at an early stage in the planning process, in order to minimise misinformation, anxiety and community division."

Clearly, Statkraft are engaging in misinformation with their technical response to the community and their choice of noise limits for the Ballinla Wind Farm.

The HSE position paper also refers to best practice for setback distance from any turbine to a dwelling of 10 times the rotor diameter. This equates to a best practice setback distance of 1.62 km for the proposed wind turbine rotor diameter of 162m.

The closest proposed wind turbine locations are less than 1km from the Quinn family dwellings so best practice has not been applied.

The 2018 World Health Organization (WHO) Environmental Noise Guidelines for the European Region suggests a provisional outdoor target noise limit for wind farm noise of <45 L_{den}. This roughly equates to 37.3 dB, LAeq[1] and supports the noise condition used for the Gibbot Hill Wind Farm, not that proposed in the NVA.

Again, the NVA is not applying best practice.

NVA proposed noise limits

Chapter 10, section 10.5.2 of the NVA outlines a rational for the choice of noise limits that are used in the NVA. The rational to adopt a 40 dB(A), L90 noise limit during the day in winds below 7 m/s and 43 dB(A), L90 at night is incorrect and misleading.

Reference is made to the EPA document 'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)' for guidance on setting an appropriate noise limit for day and night periods.

This section incorrectly states that NG4 suggests that a daytime noise criterion of 45dB(A), Leq applies in 'areas of low background noise'. The parameter referenced in NG4 is a rating value

[1] Davy, J.L., Burgemeister, K., Hillman, D. *et al.* A Review of the Potential Impacts of Wind Turbine Noise in the Australian Context. *Acoust Aust* **48**, 181–197 (2020). https://doi.org/10.1007/s40857-020-00192-4

(LAr), not LAeq. The NVA author has neglected to state that in the Evening this reduces to 40 dB(A), LAr or that at night the criterion reduces to 35 dB(A), Leq.

NG4 also has recommended criteria for Quiet Areas and both properties that are the subject of this review comply with a designation of Quiet Areas for their location. Under these circumstances the criteria changes to noise from the licensed site to be at least 10dB below the average daytime, evening and night time background noise level measured during the baseline noise survey.

If the author of section 10.5.2 wishes to use NG4 as a reference point then the suggested noise criteria for the proposed wind farm are at least 10 dB higher than NG4 recommends at night for both Quiet Areas and 'areas of low background noise'. Likewise, the proposed daytime noise limit of 40 dB(A), L90 is 7 dB higher than the evening period for 'areas of low background noise' and at least 10 dB higher that the NG4 criteria for Quiet Areas.

Section 10.5.2 then refers to license conditions for other wind farms and it is worth noting that each are different, reflecting the fact that the responsible authorities can set different noise criteria as they deem fit.

If WEDG 2006 is to apply to this proposed development then the lower day time noise limit of 35 dB(A), L90 should apply.

In the NVA, Chapter 10, section 10.5.2.1 it has been incorrectly interpreted that when background sound levels become greater than 30 dB(A) at higher wind speeds that the lower range of noise limits suggested in WEDG 2006 (35 to 40 dB(A), L90) do not apply and the limit suddenly reverts to 45 dB(A) L90. This is incorrect. The test of a quiet area is made at lower wind speeds and once determined applies at all higher wind speeds.

As wind farms operate 24/7 the limiting criterion for this development should be 35 dB(A), L90 and predicted noise levels must be compared to this limit to assess if the development acceptable. The Gibbot Hill Wind Farm noise limit is similar.

In summary, the noise criterion suggested in the NVA for the proposed development is too high by at least 5 dB if the WEDG 2006 limits are to be applied.

Under these circumstances the predicted sound levels from the NVA at both Quinn dwellings exceed the appropriate recommended noise limit and An Coimisiun Pleanála will be justified in refusing the proposed development.

The predicted sound levels for this development are overly optimistic. With appropriately set noise model inputs to reflect a conservative assessment the degree of non-compliance would be greater by another 2 dB.

Noise Predictions

Predictions in the NVA are made for the 11 m/s wind speed case. For the 7 m/s wind speed case the predictions are 0.8 dB lower.

Background sound levels that set target noise limits increase with wind speed above 7m/s so the critical noise limit to test compliance is at 7m/s, not 11m/s.

The test from WEDG 2006 for a low noise environment is not separated into that during the Day or Night.

At 7m/s the 24-hour average envelope background noise level is less than 30 dB(A) from NVA Table 10-14 that justifies the area to be classified as a 'low noise environment'. The noise limit at this wind speed is 35 dB(A), not 45 dB(A).

A lower limit from the range 35 to 40 dB(A) from WEDG 2006 is recommended as it matches recommendations in NG4.

At 7m/s the NVA is suggesting that because the Day envelope noise level is 31.5dB(A) that a higher noise limit of 45 dB(A) should apply. I strongly disagree.

Above 7m/s the NVA is suggesting a target noise limit of 45 dB(A) during the Day and 43 dB(A) at night. Again, I disagree.

The target noise limit for both Quinn dwellings should be 35 dB(A) at 7m/s, not 45 dB(A) as claimed in the NVA.

Assuming a 0.8 dB correction for the 7m/s case, compared to 11 m/s wind speed, predictions give sound levels at the Quinn dwellings of 37 dB(A) when applying the noise model inputs used in the NVA.

However, if more conservative noise model inputs are used where the receiver height is 1.5m and the ground absorption value, G, is 0 then the predicted sound level for the Quinn dwellings becomes 39 dB(A).

Under both circumstances the predicted sound level at the Quinn dwellings exceed the 35 dB(A) noise limit at 7m/s.

The NVA has used very optimistic noise modelling and assumed that the sound from the proposed wind farm will not be tonal, impulsive or have any significant amplitude modulation characteristics that, in my experience, often occur.

The planning process cannot direct there to be contractual arrangements (guarantees) between the wind turbine manufacturer and wind farm owners/operators.

PLANNING GUIDANCE ON NOISE FROM WIND FARMS

The Irish Government Department of Environment Heritage and Local Government document '*Wind Energy Development Guidelines, 2006'* (WEDG 2006) detail the current guidelines to set noise limits for wind energy developments.

The NVA has adopted the principles of WEDG 2006 but has added interpretations contained in UK wind farm noise guidance using ETSU-R-97 'The Assessment and Rating of Noise from Wind Farms' with further guidance from the Institute of Acoustics in 2013; 'A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise' (GPG).

It should be recognised that the scope of the GPG was not to examine noise limits described in ETSU-R-97. The GPG states that "The approval of this guide by the IoA Council should not be seen as an endorsement of the noise limits within the ETSU-R-97 document since the setting of these limits is a policy matter for Government."

Furthermore, the GPG is only applicable for those involved in the assessment and rating of wind turbine noise when applying ETSU-R-97 assessment procedures. The GPG may not be appropriate guidance if other assessment procedures are used.

WEDG 2006 requires updating and a DRAFT WEDG 2019 was prepared but not formally adopted as it remains under review.

The limits proposed in the WEDG 2006 broadly align with the UK guidance found in ETSU-R-97 that reflects WHO guidance in 1997. However, noise limits to protect sleep were reduced by 5 dB in subsequent WHO guidance in 1999 that remain current.

WEDG 2006 does not require that ETSU-R-97 be used to assess wind turbine noise.

WEDG 2006 states that "*Good acoustical design and carefully considered siting of turbines is essential to ensure that there is no significant increase in ambient noise levels at any nearby noise sensitive* locations." This requirement is a test that has not been addressed in the NVA.

WEDG 2006 has been drafted to balance the objectives of providing renewable power with acoustic amenity and for quiet areas states; "*in low noise environments where background noise is less than 30 dB(A), it is recommended that the daytime level of the LA90, 10min of the wind energy development noise be limited to an absolute level within the range of 35-40 dB(A)."*

Justice Richards observed the following in a recent Supreme Court nuisance noise case (Uren v Bald Hills Wind Farm S ECI 2020 00471) 25 March 2022 in Australia:

"The *generation of renewable energy by the wind farm is a socially valuable activity, and it is in the public interest for it to continue. However, there is not a binary choice to be made between the generation of clean energy by the wind farm, and a good night's sleep for its neighbours. It should be possible to achieve both.*"

A recent court case in Ireland (Ms Justice Emily Egan) echoes this observation:

"*There is not a binary choice to be made between the generation of clean energy by the wind farm and a good night's sleep for its neighbours. It should be possible to achieve both*."

The NVA, section 10.5.2.1, has chosen to set lenient target noise limits in the daytime at 45 dB(A) L90 or background plus 5 dB, whichever is the greater, where *average* background noise levels were >30 dB(A) from a limited number of residences around the proposed development. These background levels have been used as proxies for all other dwellings.

The test for low noise environments (<30dB(A)) in the NVA has been based on the minimum envelope of average trend line analysis from background measurements at 5 locations separated into Day and Night with an assumption that these measurements also relate to many other properties.

Trend line background sound levels to test for a low noise environment according to WEDG 2006 does not separately consider Day and Night. When the Day and Night envelope background levels are averaged from Table 10-15 it is found that background levels remain below 30 dB(A) up to 7 m/s standardised wind speed.

However, background sound levels regularly fall below 30 dB(A) during the daytime at wind speeds higher than 8 m/s and when consideration is given to the compression of sound level

measurements close to the noise floor of the sound level meter instruments[2] the real average background sound levels at many noise measurement locations (NMLs) above 7 m/s will be below 30 dB(A) and a lower target absolute noise limit between 35 dB(A) and 40 dB(A) is justified at these higher wind speeds too.

Day and night time sound levels show that the sound measurement equipment regularly recorded sound levels at or near the noise floor of the instruments. Sound monitoring equipment is classified under IEC61672. The sound level meters used have a noise floor of typically 17 dB(A). However, the sound level range over which the instrument is linear and compliant with Class 1 generally is some 10 dB higher. Thus, sound levels shown in the background charts between 27 dB(A) and 17 dB(A) are compressed. This means that real background sound levels are often much lower than 17 dB(A) and the average background levels in the NVA are artificially elevated.

This effect is also highlighted in BS 4142:2014+A1:2019, section 8.1 which notes: "*Care is necessary in circumstances where background sound levels are low to ensure that self-generated and electrical noise within the measurement system does not unduly influence reported values, which may be the case if the measured background sound levels are less than 10 dB above the noise floor of the measuring system*."

The NVA states that extraneous noise was removed from the background noise measurement dataset but has not shown the removed data points on the Background scatter charts.

The Background measurement data contains sound from the Mount Lucas and Cloncreen wind farms and the Background sound levels used to set proposed target noise limits will produce higher noise limit targets than would otherwise be the case if these wind farms were not operating.

Nearby Wind Farms

Reference has been made to the noise conditions set for nearby wind farms and with regard to those set for the Mount Lucas Wind Farm the NVA states:

The stated limit of 43dB LAeq,15min in the relevant planning condition is equivalent to a level of 41dB LA90,10min. Therefore, the proposed lower threshold for Ballinla of 40dB LA90,10min at wind speeds at or below 6 m/s is considered robust in terms of conditions placed on other developments in the area.

This interpretation in the NVA is misleading. The Mount Lucas night time limit applies at all wind speeds and the NVA is attempting to hide the fact that the proposed night time limit of 43 dB(A), L90 is 2 dB higher than that allowed for the neighbouring Mound Lucas Wind Farm.

Furthermore, the NVA is proposing noise limits of 45 dB(A) above a 6 m/s wind speed that is 4 dB higher than the limit for the Mount Lucas Wind Farm.

'Guidance Note for Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3)' has been referenced about infrasound but the NVA has not mentioned that it also provides compliance limits in the daytime between 35 dBA and 40 dBA for quiet daytime environments of less than 30 dBA that echoes the limits in WEDG 2006.

[2] Huson, W. Les. "Constraints imposed by and limitations of IEC61672 for the measurement of wind farm sound emissions" 6th International Conference on Wind Turbine Noise, Glasgow 20-23 April 2015

For situations where the *average* background noise level is <30 dB(A) the NVA has elected to apply the least stringent noise limit of 40 dB(A) and no noise sensitive locations (NSLs) have been assigned the 35 dB(A) base noise limit.

The NVA has suggested hopefully and naïvely that:

A warranty will be provided by the manufacturers of the selected turbine to ensure that the noise output will not require a tonal noise correction under best practice guidance.

LA90 statistic or LAeq

Use of the LA90 statistic does not capture short term noise events that are often observed from wind farms. Such noise events are often referred to as 'whump' or 'thump' type sounds thought to be caused by wind flow delamination across the rotor blades when wind conditions change.

The benefit of a condition requiring the LAeq is that such events can reflect the extent of intermittent louder sounds that the LA90 statistic cannot.

However, if an LA90 level is specified as a noise condition then an added provision to prevent impulsive noise or tonality could be applied.

Such a condition was applied for the Cloghan Wind Farm in Offaly, as follows:

Noise levels emanating from wind farm noise when measured at the nearest noise sensitive properties, i.e. dwelling houses, shall not exceed 43 dB(A) $L_{A90(10\ minutes)}$. There shall be no tonal or impulsive noise and measurements shall be made in accordance with ISO recommendations R1996-1 (Acoustics-description and measurement of environmental noise, part 1; basic qualities and procedures).

BEST PRACTICE

WEDG2006 is outdated and not currently 'best practice'.

The most recent (29 July 2025) review of best practice in setting wind farm noise limits has been completed by the EPA of Tasmania, Australia, that has revised its wind farm noise guideline limit and set 35 dB(A), Leq as the appropriate base noise limit to be met. A copy of the Policy is in Appendix E.

Current best practice in wind farm noise guidance is also provided in the Australian States of New South Wales and Queensland where night time target noise limits are set at 35 dB(A) Leq or background plus 5 dB with additional penalties for special audible characteristics such as tonality, impulsiveness, and amplitude modulation.

Germany also has a night time noise level limit of 35 dB(A) Leq.

Wind farms have been approved under these target noise limits and a good balance has been struck to provide renewable energy and protect the nearby population.

A target noise limit of 35 dB(A), Leq approximates to 33 dB(A), L90 that lies 2 dB below the lowest recommended day-time absolute limits in WEDG 2006 for quiet areas and reflects modern expectations for the protection of a nearby community.

NOISE MODEL

The NVA has used the ISO 9613-2 noise model that includes ground absorption.

ISO 9613-2 prediction results are sensitive to the value of ground absorption/attenuation effect, G, that can range between 0 and 1. G=0 indicates no ground absorption and G=1 represents full ground absorption of sound.

A paper by Brittain and Charalampous[3] shows the inadequacy of the ground effect calculations in ISO 9613-2 for a source height of 100m, which conveniently approximates the hub height of the proposed candidate wind turbines in the NVA.

The NVA has used a value of G=0.5 in the ISO 9613-2 noise model for all the ground between the wind turbines and all noise sensitive receivers with an artificial receiver height of 4m (in practice all sound level surveys are completed at a height of between 1.2m to 1.5m).

The peculiarities of the ground effect calculation in ISO 9613-2 show that predicted sound levels for a receiver height of 4m there is a 2 dB difference in predicted sound levels depending on whether G=0 or G=0.5 is used. G=0 produces typically 2 dB higher predicted sound levels than when G=0.5 is used and 4 dB higher compared to G=1.

It is best practice to err on the side of conservatism and use G=0 when using ISO 9613-2.

This point was made by Eric Sloth, one of the authors of the JOULE[4] study in his presentation (Appendix C) where he advises that if ISO 9613-2 is to be used for wind farm noise predictions, then G=0 should be used with additional corrections to account for site effects such as inflow turbulence.

The NVA has not accounted for any site effects that can increase wind turbine sound power levels.

Furthermore, the NVA *assumes* that there will be no special audible characteristics from whatever wind turbine is chosen to be used in the wind farm. Only test results can confirm this assumption but none have been supplied in the NVA.

The ISO 9613-2 noise model has a stated limitation for its calculations in conditions where the source to receiver average height does not exceed 30m and when average propagation enhancement from vector wind does not exceed 1m/s to 5m/s measured at a height above ground between 3m and 11m.

ISO 9613-2 for this wind farm application is being applied well outside of its intended use.

The NVA has not commented on the uncertainty associated with the use of ISO 9613-2. The preferred IEA method recommended in the JOULE report suggests a standard deviation uncertainty of 0.004dB/m.

[3] Brittain, F., Charalampous, P: 'Assessing Accuracy of ISO 9613-2 for Calculating Ground Effects of Stack Height and Distance Using Olive Tree Labs OTL Suite'. NOISE-CON 2016, Providence, Rhode Island, 13-15 June, 2016

[4] Bass, J.,Sloth, E., Bullmore 'Development of a Wind Farm Noise Prediction Model,' JOULE project JOR3-CT95-0051, 1998

For a propagation distance of 1000m this translates to +/-4 dB (+/- one standard deviation). ISO 9613-2 predictions are estimated in Table 5 of the standard to have an uncertainty of +/-3dB at 1000m if all inputs are accurate but notes that:

"The estimates of accuracy in table 5 are for downwind conditions averaged over independent situations (as specified in clause 5). They should not necessarily be expected to agree with the variation in measurements made at a given site on a given day. The latter can be expected to be considerably larger than the values in table 5."

The JOULE study also noted the following:

"As a result of the measurements just described it has been concluded that:

- Noise levels at all distances from the source do vary, even if the source of sound has a constant power level.
- The measured variation in noise levels increases with increasing distance from the source.
- Based on typical wind speed ranges of between $0ms^{-1}$ and $10ms^{-1}$ encountered during the experimental measurements, the one standard deviation spread of noise levels either side the mean level was found to increase at a rate of approximately 0.004dB(A) per meter increase in the source to receiver separation distance."

The fact that wind farm sound levels vary with increasing distance (assuming all wind turbines emit a constant sound level) suggests that the use of the L90 statistic underestimates the true impact of noise from a wind farm.

Whilst it is advantageous to use an L90 statistic to reduce extraneous noise effects on a measurement it unfortunately underestimates the true higher levels of noise caused by the wind farm.

This underestimation can be compensated for by adding the standard deviation of 0.004dB/m measured in the JOULE study, in which case the predictions in the NVA would be increased by about 3 dB for the nearest dwellings.

A more realistic estimation of the higher sound levels from a wind farm is the predicted sound level using the simple IEA model (cut down ISO 9613-2 with corrections) plus the addition of one standard deviation uncertainty.

For a dwelling 1000m away the prediction should use the IEA model output plus 4dB (0.004dB/m at 1000m).

WIND TURBINE LAYOUT

It is customary in the design of a wind farm to take account of the distances between wind turbines to minimise noise emissions and to maximise efficiency. An outline of such design considerations can be found in 'NSW Wind Energy Handbook 2002': Sustainable Energy Development Authority of NSW (SEDA).

From page 53 of the SEDA document:

"A wind-farm layout must take into account that turbines have substantial 'wakes', which interfere with each other depending on wind direction and spacing. The general rule of thumb for spacing (the '5r-8r rule') is five times rotor diameter abreast and eight times rotor diameter downwind."

Appendix B of the IEC61400-11 standard indicates that at high wind speeds, wind turbulence becomes the primary source of sound. It suggests that these effects should be minimized during testing and optionally reported.

A general outline of site layout considerations has been provided by Suzlon Energy. A summary of site effects from Suzlon is provided in Appendix D that suggests the *minimum* wind turbine separations to be 3r-5r.

In the current layout of the Ballinla Wind Farm, the distance between the nearest neighbouring wind turbine towers ranges from 500m to 825m.

The V162 wind turbines have a rotor diameter, 'r', of 162 m. The shortest spacing between the turbines is 3.1 times the rotor diameter (3.1r) to 5.1r, which is significantly less than the recommended 8r spacing to reduce wake turbulence effects.

An increase in wake turbulence from the wind turbines can lead to higher noise emissions and lower efficiency of the wind farm.

The NVA has not considered the potential increase in sound power caused by wake effects.

AMPLITUDE MODULATION (AM)

The NVA discusses AM at length in the NVA (pp. 14 and 15) but reaches no conclusion on a penalty scheme to account for this special audible characteristic. However, NG3 describes AM under the heading of 'Temporal Characteristics' and states for AM that:

"*The mechanism behind this is not clearly understood. However, features which are*

thought to enhance this effect are:

- *close spacing of turbines in linear rows*
- *tower height to rotor diameter ratio less than approximately 0.75*
- *stable atmospheric conditions*
- *topography leading to different wind directions being seen by the blades at different points in their rotation"*

Note that the tower height (104m) to rotor diameter (162m) ratio is 0.64. (V162)

It can safely be assumed that AM *will* be an observable effect at NSLs because the turbine spacing is too close, the tower height to rotor diameter ratio is 0.64 (less than 0.75), and stable atmospheric conditions will occur from time to time.

An Coimisiun Pleanála should consider that AM is to be expected for this wind farm configuration that would warrant an additional penalty to predicted sound levels that have not been applied in the NVA.

ETSU-R-97 incorrectly addressed amplitude modulation and made a sweeping assumption that such a characteristic was rare in modern wind farms. This is not the case and it is now recognised that amplitude modulation is the most significantly intrusive sound characteristic of wind turbines.

The current GPG refers in section 7.2 to ongoing research. Since the publication of the GPG in 2013 there has been much ongoing research and amplitude modulation is known to be a significant concern for residents near modern wind farms.

The following figures illustrate A-weighted sound levels over a 10-minute period that were recorded at a rate of ten samples per second 800 m from two MM82 2MW wind turbines outside a dwelling.

The measurement was taken when the wind turbines were operating in the early hours of the morning when there was no extraneous insect, bird or animal sound but there was sound from wind in trees and foliage. This was confirmed by listening to the audio recordings taken at the same time.

Figure 2 shows the 100ms 'short' LAeq values and a single $L_{A95,10min}$ level for the data.

LA95 was calculated for this figure because the limit for this wind farm is in terms of LA95.

However, the LA90 would only be slightly higher at approximately 38 dB(A).

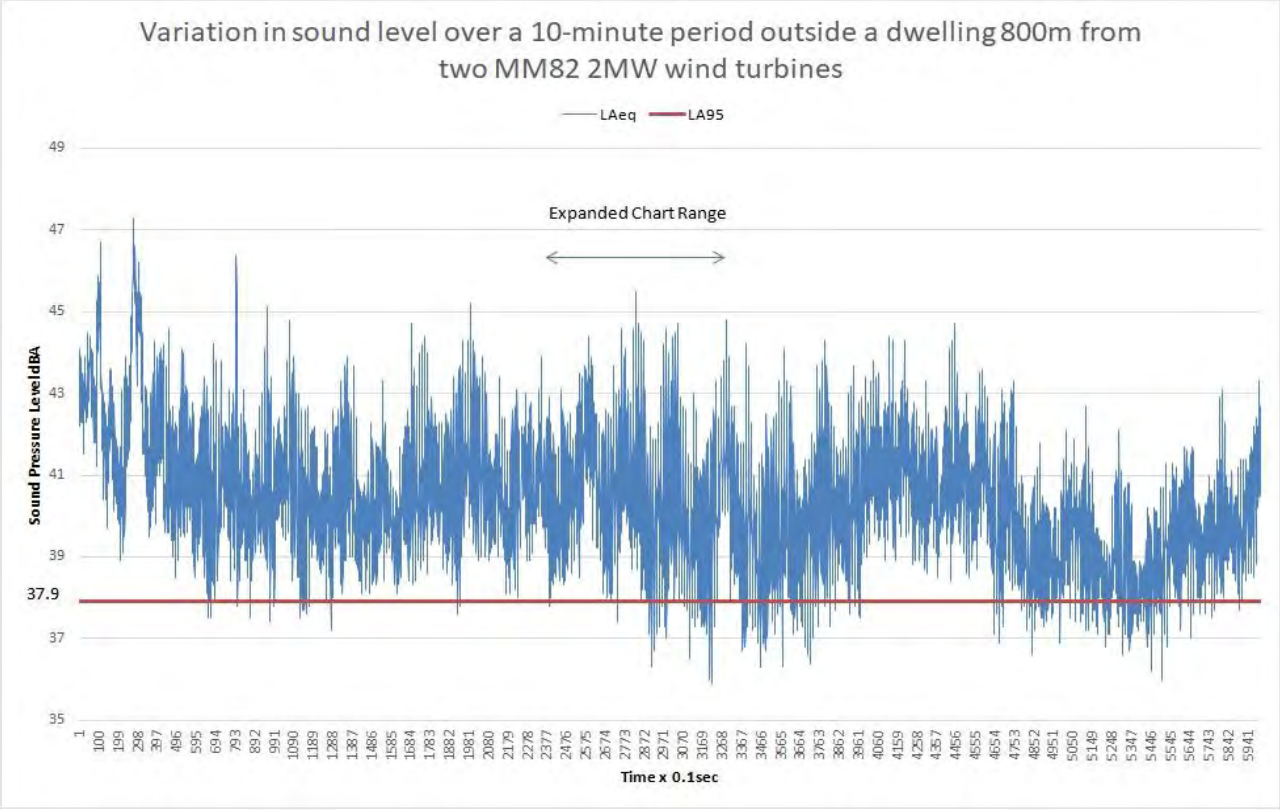


Figure 2

An expanded range from Figure 2 is shown in Figure 3 to provide more detail.

The repetitive variation in sound level is caused by sound from the two wind turbines as the blades rotate.

Sound caused by wind in trees and foliage is random, not repetitive as shown in these two charts.

Each peak and trough repetition can be linked to each time a blade passes through a part of the swept area.

As each wind turbine operates independently of others the small difference in rotation speed between these two wind turbines is causing the peak and trough repetitions to combine yielding a trace that can appear to synchronise at blade passing repetition to the time when the blades are out of synchronisation yielding an apparent doubling of the blade passing repetition.

For a wind farm containing many wind turbines the peak and trough level and repetitions vary randomly.

However, when synchronised the sound levels add together to produce an overall higher sound level compared to when the individual turbine blades lose synchronisation.

Figure 2 shows the interacting effect for two wind turbines where the first part of the 10-second chart shows the turbines to be out of synchronisation with a generally lower sound level variation peak to trough compared to later in the chart where the turbine blade rotations synchronise causing higher overall peak to trough sound level changes.

An unfortunate disadvantage in using the L90 statistic is that the character of sound level changes during any 10-minute measurement are lost and sound level variations are greatly underestimated.

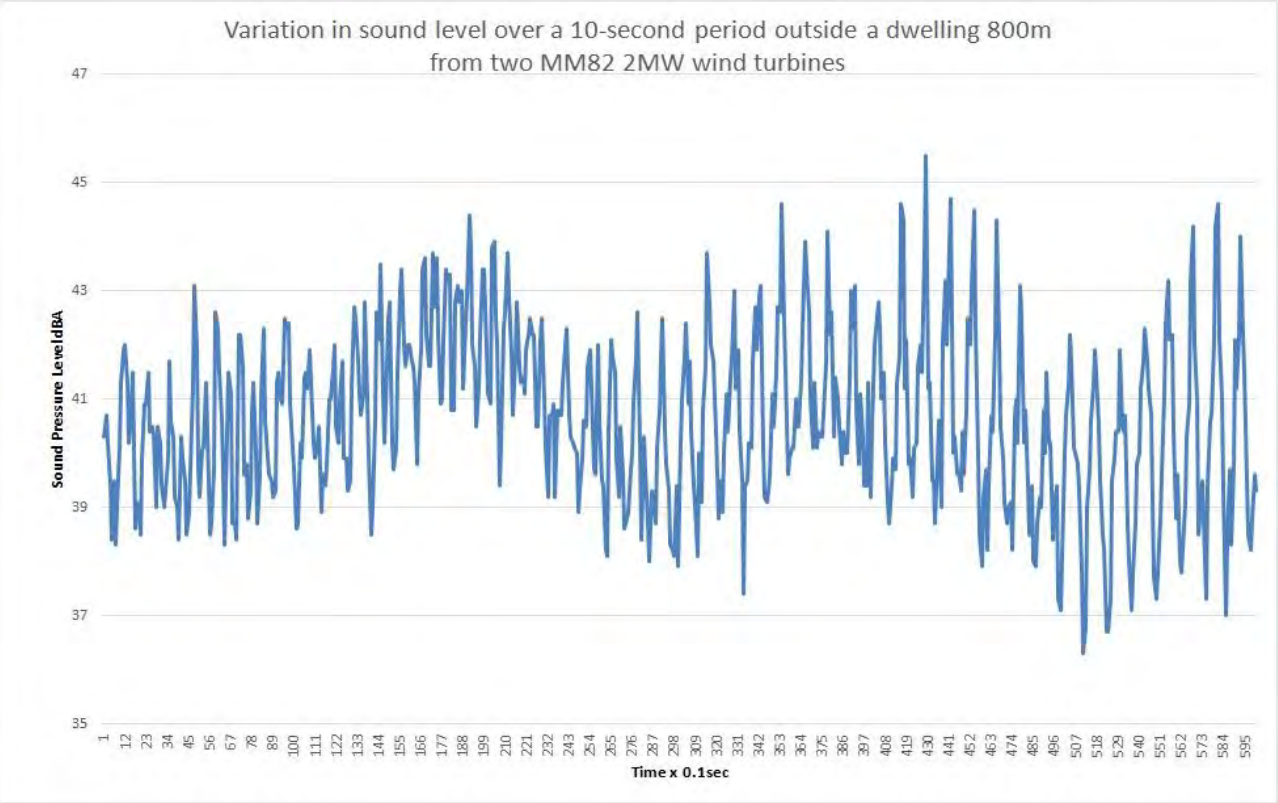


Figure 3

A common observation of unusual sound level change occurs when ‘whump’ or ‘thump’ is described by observers.

Whump and thump are thought to originate from the aerodynamic sound of wind turbine blades when they encounter wind turbulence or are incorrectly adjusted for the incoming wind that causes

a blade to stall temporarily. Placing wind turbines too close to each other will increase wind turbulence and increase AM[5,6] and the instances of 'whump and thump' sounds.

The occasional whump and thump sounds are much louder than normal wind turbine sounds and the fact that they would not occur for more than 9 minutes in any 10-minute recording means that the LA90 centile would not identify such events.

Sound levels vary throughout the measurement period in the 10-minute duration of the chart above (Figure 1) ranging from a maximum level of just over 47 dB(A) to a minimum level of about 36 dB(A). From the 6000 sound level samples the single statistical L95 parameter obtained from this chart is 37.9 dB(A), shown as a red line across the chart.

The L90 centile is only sensitive to the lowest 10 % of sound levels within any 10-minute sample. For example, in the chart above there could be sound levels that reached 100 dB(A) for up to 1 minute that will have no bearing on the calculated L95 value of 37.9 dB(A) or L90 of 38 dB(A).

The IoA AM Preferred Method fails to correctly evaluate AM from just two wind turbines and fares even worse when more than two wind turbines combine to produce AM.

A report[7] was prepared for DEFRA that outlines a wind farm noise statutory nuisance complaint methodology. Section 5.4.5 of this report (NAN-R-277) explains the difference between a centile statistical noise metric such as an L90 and the energy averaging Leq as follows:

> "5.4.5 Noise Indices
>
> By convention wind farm noise in the UK is measured using the LA90,10-minute noise index, as it is argued that this index minimises the influence of extraneous noise. However, excepting ETSU –R-97, there are few if any standards that set noise limits using this index. Additionally, it is argued that because the LA90,10min index focuses on the quietest periods in the measurement period it is relatively insensitive to rapid fluctuations in noise level where the noise varies rapidly over a short period e.g. as with aerodynamic/amplitude modulation, and the impact of such characteristics can be underestimated using the LA90,t noise index.
>
> However, elsewhere in the world the LAeq,t index is preferred for wind turbine noise. Use of the LAeq,t or derivatives for environmental noise measurement is recommended by international standards and bodies e.g. ISO 1996 and the WHO, and British Standards such as BS 4142, BS 7445 and BS 8223. Additionally, there are a range of standards and guidance that offer guideline and recommended values of LAeq.T noise levels against which to weigh any measurement. The energy averaging nature of this index means it tends to be biased towards the highest noise levels that occur during a measurement. The figure below shows an indicative sound pressure level trace of a time varying noise signal (SPL) and the approximate LAeq,t and LA90,t values.

[5] Sinayoko, S. 'On predicting wind turbine noise and amplitude modulation' 6th Int. conf. wind turbine noise, 2015
[6] Buck, S. et al 'Experimental validation of a wind turbine turbulent inflow noise prediction code', AIAA Journal 2016
[7] NANR277 "Wind farm noise statutory nuisance complaint methodology DEFRA (2011)

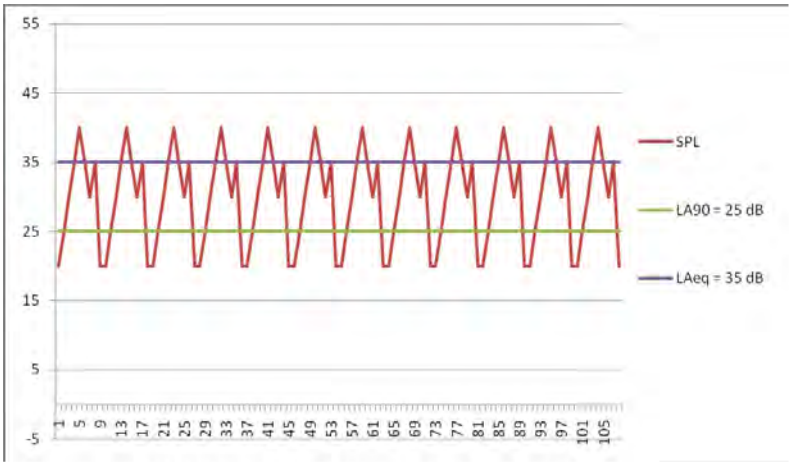


Figure 13 $L_{Aeq,t}$ and $L_{A90,t}$ values of an indicative time varying noise signal"

The current GPG also explains in section 7.1 that the guide cannot provide a definitive set of AM conditions for a wind farm, despite suggesting some options.

There is a current noise condition in force for the Denbrook Wind Farm that addresses AM limits, which has been accepted by the High Court in the UK, as follows:

"Condition 20

At the request of the local planning authority following receipt of a complaint the wind farm operator shall, at its expense, employ a consultant approved by the local planning authority, to assess whether noise immissions at the complainant's dwelling are characterised by greater than expected amplitude modulation. Amplitude modulation is the modulation of the level of broadB(A)nd noise emitted by a turbine at blade passing frequency. These will be deemed greater than expected if the following characteristics apply:

(a) A change in the measured $L_{Aeq,\ 125\ milliseconds}$ turbine noise level of more than 3 dB (represented as a rise and fall in sound energy levels each of more than 3 dB) occurring within a 2 second period.

(b) The change identified in (a) above shall not occur less than 5 times in any one minute period providing the $L_{Aeq,\ 1\ minute}$ turbine sound energy level for that minute is not below 28 dB.

(c) The changes identified in (a) and (b) above shall not occur for fewer than 6 minutes in any hour.

Noise immissions at the complainant's dwelling shall be measured not further than 35 m from the relevant building, and not closer than within 3.5 m of any reflecting building or surface, or within 1.2 m of the ground."

An Coimisiun Pleanála may wish to consider Condition 20 of the Denbrook Wind Farm as an AM condition for any future wind farm that they approve.

Conditions referencing the IoA AM Preferred Method should be avoided for wind farms.

INFRASOUND AND LOW FREQUENCY NOISE (ILFN)

It is recognised that infrasound and low frequency sound is emitted from wind turbines and that the infrasonic pulses are unlike any other environmental sound source.

Figure 4 shows the change in infrasound levels near to the Cape Bridgewater wind farm measured inside a nearby stone dwelling during changes in operation from stopped to 15% and 45% power generation.

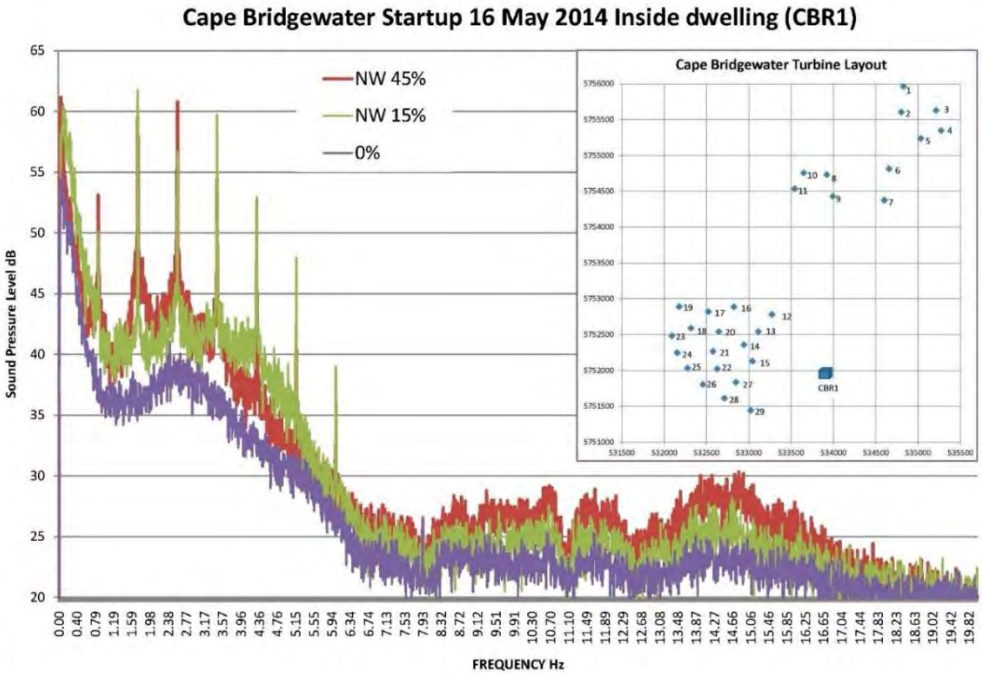


Figure 4

The NVA references several studies in page 13 that have used the dB(G) filter to assess wind farm ILFN. However, the G-weighting filter attenuates the blade pass pulses and the harmonics associated with those pulses (<5Hz).

The Australian National Health and Medical Research Council (NHMRC) awarded a study to two Australian universities, one in South Australia and the other in New South Wales to investigate wind farm infrasound.

Research is ongoing but one of the published papers in 2019 by researchers at Flinders University (Nguyen, D. P., Hansen, K. et al. Wind farm infrasound detectability and its effects on the perception of wind farm noise amplitude modulation, Acoustics 2019) stated in its conclusions that: "Overall these preliminary results suggest that WF noise complaints could potentially be governed to some degree by the presence of infrasound" and that " We found that self-reported noise sensitive individuals can detect the presence of low-level infrasound (48 ± 2 dB(G)) above chance."

The finding that infrasound at levels of 48 +/- 2 dB(G) can be observed by individuals is in stark contrast to the generally used limit of perception of 85 dB(G).

Although the G-weighted filter significantly attenuates the blade pass and associated harmonics from a wind turbine it is worth noting that reference to the 2006 Hayes McKenzie report neglected to show the result of an on/off test in that report, shown below (Figure 12 from reference).

An extract from this report explains that "Wind turbine noise may result in internal noise levels within a dwelling that is just above the threshold of audibility," that was assumed to be 85 dB(G).

The 2019 Flinders University research changes the threshold of audibility of wind farm noise to 48 +/- 2 dB(G) which would change the conclusion in the Hayes McKenzie DTI report; 'The measurement of low frequency noise at three UK wind farms', URN no. 06/1412 from 2006.

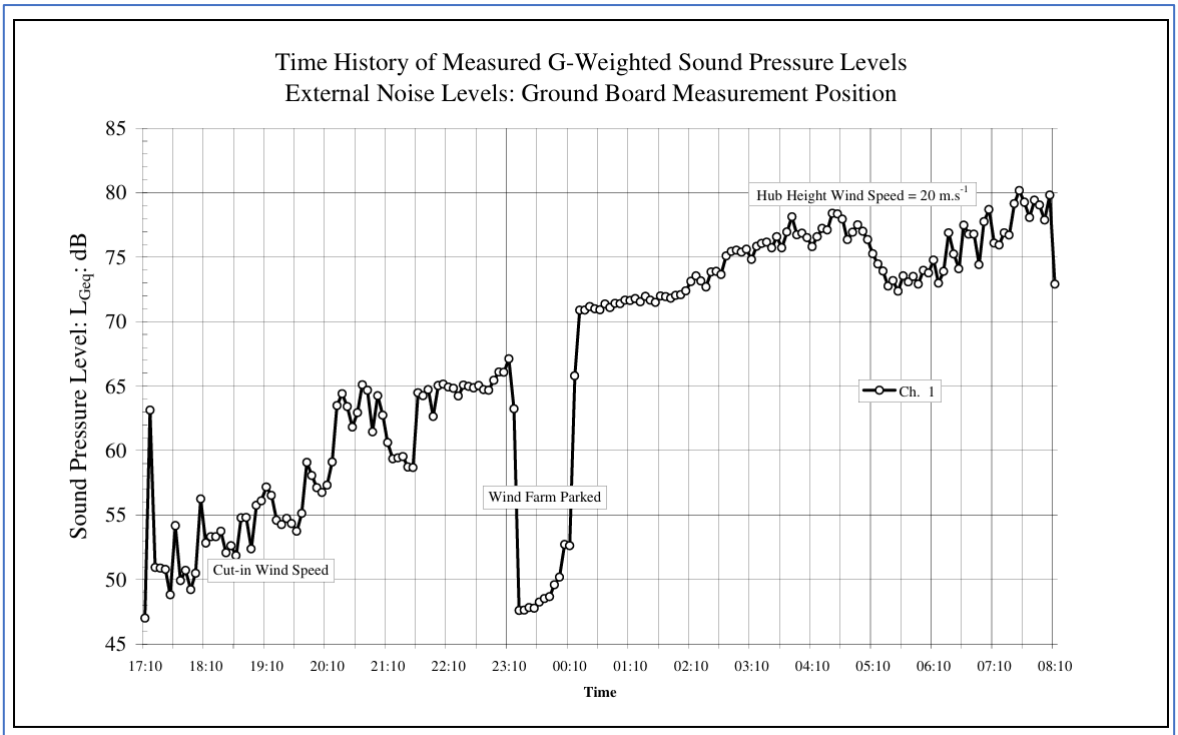


Figure 12: Time History Figure of G-Weighted Sound Pressure Levels for a Wind Farm

Much of the recent research into human response to wind farm generated infrasound has been based on *synthesised* wind farm sound played to subjects in a laboratory. This is the case for the study referenced in the NVA (3.2.12); 'The Health Effects of 72 Hours of Simulated Wind Turbine Infrasound: A Double-Blind Randomized Crossover Study in Noise-Sensitive, Healthy Adults' - PMC (nih.gov). One of the many problems with this study was the inability to replicate the fundamental blade pass frequency in the laboratory. The paper concludes and cautions that "This study suggests that the infrasound component of WTN is unlikely to be a cause of ill-health or sleep disruption, although this observation should be independently replicated."

A paper by Cooper, S. ("The use of synthesised or actual wind turbine noise for subjective evaluation purposes" PROCEEDINGS of the 23rd International Congress on Acoustics 2019) is critical of the use of synthesised wind farm infrasound signals and has noted that it was the change in amplitude of the infrasound signal that was observed to be a significant factor in subject disquiet.

Unfortunately, the issue of adverse health effects from wind farm generated infrasound remains contentious and authorities may wish to consider an appropriate condition when approving future wind farm developments if ongoing Australian, or other relevant international research, finds adverse health effects from infrasound.

My own measurements at the Cape Bridgewater Wind Farm, also confirmed by S Cooper in his 2014 study[8], showed that low frequency sound from the output shaft of the gearboxes to the generators exceeded DEFRA NAN-R-45 indoor recommended guideline values at 32 Hz.

Furthermore, the 32 Hz tones were modulated in frequency and random in level.

[8] Cooper, S. "The results of an acoustic testing program - Cape Bridgewater Wind Farm" The Acoustic Group Report 44.5100.R7MSC, Nov 2014

The NVA has not considered low frequency noise impacts. The A-weighting filter significantly attenuates low frequency noise, which is why DEFRA NAN-R-45 uses unweighted one third octave sound levels in the frequency range from 10 Hz through to 200 Hz.

Low frequency sound is an important issue that should be reported in an EIAR.

I have recently measured low frequency sound outside a dwelling during on/off testing near to a recently constructed wind farm. Figure 5 shows the results of measurements at the dwelling that is approximately 2 km from the nearest 3.6 MW wind turbine.

Measurements of the 40 Hz, 50 Hz, 63 Hz and 80 Hz one third octave unweighted sound levels before, and after the shutdown period, just prior to midnight, show that the threshold values of DEFRA NAN-R-45 were exceeded. Outside measurements were corrected to indoor levels for typical building façade attenuation according to Downey and Parnell (2017).

The occupants of the dwelling had complained about low frequency noise nuisance from the nearby wind farm and in this instance, the complaints were justified.

The NVA has mistakenly dismissed ILFN completely.

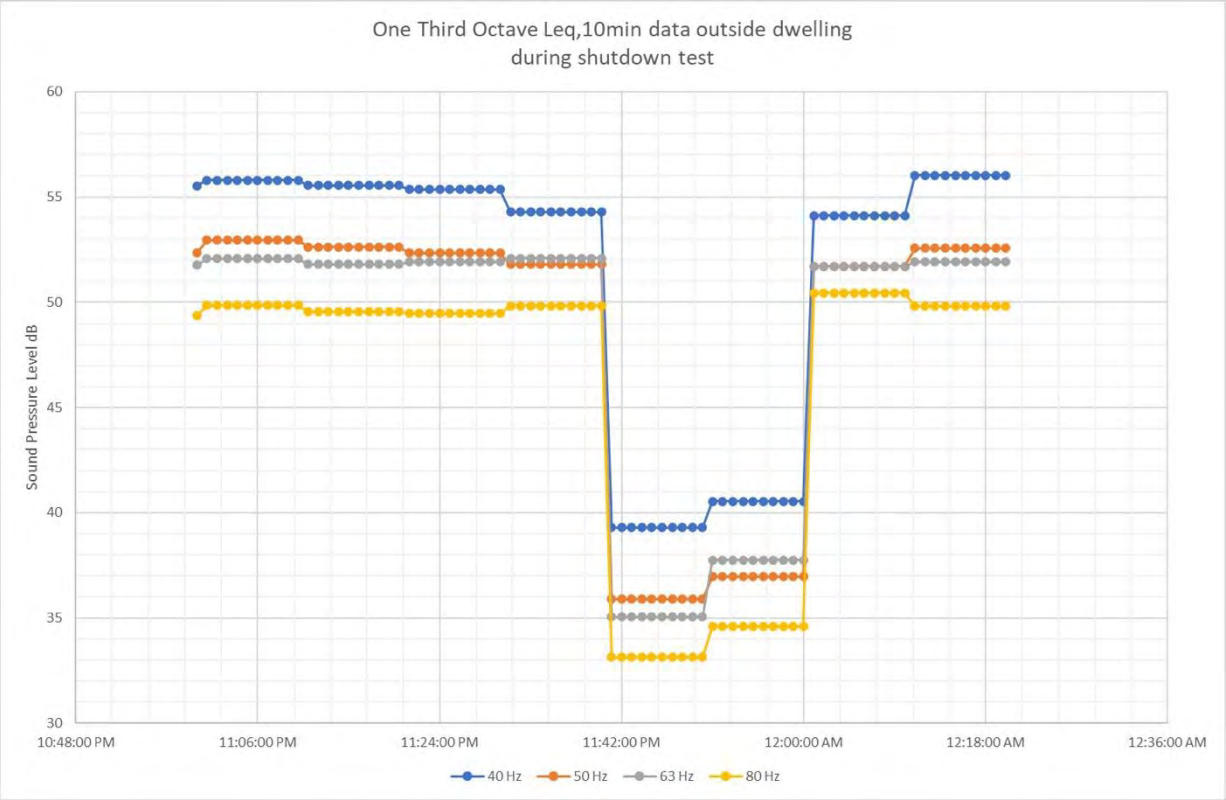


Figure 5

It would be advisable to measure current ambient ILFN at the NSLs to supplement A-weighted Background survey results.

Low frequency noise predictions should also be completed in frequencies below that which ISO9613-2 allows. ISO9613-2 is only applicable for the octave bands from 63 Hz through to 8 kHz.

The NVA is deficient in the assessment of ILFN.

CONCLUSIONS

The NVA does not provide any confidence that an acceptable noise impact will result from the proposed development.

An Coimisiun Pleanála should refuse the Ballinla Wind Farm Application.

The NVA within the EIAR does not consider site effects or audible characteristics such as low frequency, tonality or amplitude modulation.

The assessment methodology adopted in the NVA follows guidelines that have been shown to be deficient and are currently under review.

The WEDG 2006 guidelines recommend a range of acceptable sound levels during the day but the NVA has elected to choose the highest noise limit in the range that could be applied, based upon what I consider to be an incorrect evaluation of the test for a low noise environment.

Appendix A

From: George O'Connor <George.O'Connor@statkraft.com>
Sent: Sunday 21 September 2025 21:28
To: Tina McNabola <tina.mcnabola@colmquinnbmw.ie>; John Lowry <John.Lowry@statkraft.com>
Subject: Re: Email addresses & response to topics raised at Lumville September 5th meeting
Importance: High

Hi Tina,
I am writing to follow up on recent correspondence regarding the Ballinla Wind Farm project.
Firstly, I must express disappointment that, despite the previous request by John, the contact details for Mary have still not been provided. Timely access to relevant contacts is essential for effective communication and transparency.
Please find attached the full text of the memo provided following the meeting on 5 September, addressing the key technical and community topics discussed. We appreciate your engagement and the concerns you have raised. Community input plays a vital role in shaping responsible and sustainable energy infrastructure, and we are committed to maintaining open and transparent dialogue throughout this process.
This response has been prepared by our technical and environmental team, addressing the topics raised.
Key topics covered include:

- **Geotechnical and Hydrogeological Considerations**
- **Wake Effects, Noise and Turbine Parameters**
- **Aviation Lighting**
- **Geological context and fault mapping**
- **Groundwater protection and local well considerations**
- **Vibration impacts and receptor distances**
- **Grid route**
- **Traffic**
- **Community Engagement**
- **Human Health and Wellbeing**

We trust that the enclosed information will provide clarity and reassurance regarding the robustness of the proposed development and the measures in place to safeguard environmental and community interests.

Geotechnical and Hydrogeological Considerations

- A detailed peat stability assessment has been completed for the site, including all proposed infrastructure such as access tracks, turbine bases, and the grid connection corridor. The assessment concluded that there is no risk of peat instability across the development footprint.
  - The NW/SE trending fault identified on GSI maps lies within the same geological unit and represents a change in bedding orientation, not a lithological or structural boundary of concern. This type of faulting is common in sedimentary terrains and does not pose a geotechnical risk to the development. The peat stability and foundation design assessments have accounted for this feature.
  - Volumetric assessments are typically undertaken for developments that involve significant groundwater abstraction or discharge such as quarries and landfills. Wind energy

developments do not fall into this category and are not considered a risk to groundwater resources under EPA or Geological Survey Ireland (GSI) guidance.

- The site is underlain by locally important aquifers with moderate productivity and is not located within a Groundwater Source Protection Zone. While some local wells may be used for domestic or agricultural abstraction, many are unregistered and typically serve low-yield private use. Assessment carried out to date confirm no significant groundwater vulnerability, and no karst features or high-yield aquifers are present.
- The proposed development has been designed to maintain the existing hydrogeological regime, with embedded controls including sustainable drainage systems (SuDS) to mirror existing runoff and infiltration, no groundwater abstraction or discharge, localised dewatering where required. The proposed wind farm will not alter groundwater flow or yield.

Wake Effects, Noise and Turbine Parameters

· While we are unable to provide proprietary modelling software, the understanding of wake effects is well-established in peer-reviewed literature. Wake effects, characterised by reduced wind speed and increased turbulence, are typically confined to short distances downwind of turbines. According to Astolfi et al. (2023), wake-induced power losses and turbulence intensity diminish significantly beyond 10 rotor diameters.

- Peer-reviewed studies using large-eddy simulations and field measurements consistently show that wake-induced changes in near-surface microclimate, such as soil temperature, are localised, minor, and typically less than 0.4°C in magnitude (comparable in magnitude with the natural variability) which are not considered ecologically or agriculturally significant.
- The proposed turbines for the Ballinla Wind Farm are expected to have a tip height of 185m, with rotor diameters in the region of 160m, comprising blades of around 80m in length. Ground clearance will typically be in the range of 25 to 30m, depending on final design. Operational parameters for turbines of this scale generally include cut-in wind speeds of 3–4 m/s, rated output at around 12–13 m/s, and cut-out speeds between 22–25 m/s. Turbine weights vary significantly depending on manufacturer and model, and final specifications will be determined based on commercial availability and procurement at the time of construction. All selected turbines will comply with relevant Irish and EU standards for safety, noise, and environmental performance. These turbines are designed to operate safely across a wide range of wind conditions and are equipped with automatic shutdown protocols in extreme weather.
- We also note that the Strategic Infrastructure Development (SID) designation is determined by the installed rated capacity of the overall wind farm and has undergone a pre-application consultation with An Coimisiún Pleanála, who have formally determined that the project qualifies as SID under Section 37A of the Planning and Development Act 2000 (as amended), based on its scale, strategic importance, and contribution to national renewable energy targets.

Aviation Lighting

· Where required by the Irish Aviation Authority, turbines will be fitted with medium-intensity fixed red obstacle lights (2000 candelas). These lights will be equipped with baffles to direct light skyward, significantly reducing visibility from ground level and mitigating light pollution concerns.

Vibration Impacts

· Vibration effects from wind turbines are not expected to pose any risk to nearby receptors or to soil stability. All residential receptors are located well beyond the range at which ground-borne vibration could be perceptible. Vibration energy from turbine foundations dissipates rapidly with distance and becomes negligible at typical setback ranges.

- The site is predominantly underlain by peat, a soft and damp material known for its natural ability to absorb and attenuate vibration. This significantly limits the transmission of vibration through the ground. Additionally, the site's generally flat topography reduces the potential for vibration to interact with slope dynamics or cause instability.
- Foundation design and construction methods will be tailored to local ground conditions, including peat depth and composition, ensuring that turbine loads are safely distributed. Taken together, the combination of distance, soil characteristics and terrain confirms that vibration will not pose a risk to soil stability or residential amenity.

Grid Route

· The proposed underground grid connection from the Ballinla Wind Farm to the Philipstown Substation is subject to a separate consenting process, which will be progressed in accordance with statutory requirements. However, the route and associated works have been fully considered within the Environmental Impact Assessment Report (EIAR) to ensure transparency and cumulative impact assessment.

- The proposed grid route is primarily located within existing public roads, minimising land disturbance and avoiding sensitive environmental or residential areas. As a statutory undertaker, we are authorised to lay electrical cables within public roads without requiring third-party landowner consent. This is consistent with established legal precedent, including the Crimins case, which addressed similar issues. We appreciate your interest and will continue to engage transparently throughout the planning process.
- The connection remains subject to approval from EirGrid, and all works will be carried out in compliance with their technical and operational standards.

Traffic

· Although automatic traffic counters have not yet been deployed for the proposed development, the Traffic and Transport chapter of the EIAR presents a comprehensive analysis based on baseline traffic volumes sourced from Transport Infrastructure Ireland (TII), projected construction traffic flows, and volume-to-capacity ratios for regional and local roads.

- This assessment concludes that no significant traffic impacts are anticipated during either the construction or operational phases of the development. All roads evaluated are expected to continue functioning within acceptable capacity thresholds, even at peak construction times.
- To further mitigate any temporary disruption, a Traffic Management Plan (TMP) will be implemented, including road condition monitoring and close coordination with Offaly County Council.

Community Engagement

· Our community engagement for the Ballinla Wind Farm has been extensive, transparent and inclusive, as detailed in the Community Engagement Report (Appendix 01-2 of the EIAR).

- To date, we have held 175 face-to-face meetings with residents and 12 meetings with community groups, distributed 756 project booklets and 189 planning notification letters, and launched both a dedicated website and a virtual consultation room to facilitate accessible dialogue.

- Importantly, feedback received through these channels directly influenced the project design, including a reduction in turbine numbers from 10 to 7.
- This approach aligns with the Code of Practice for Wind Energy Development in Ireland (2016) and reflects our commitment to meaningful, responsive engagement with the local community.

Property Valuation

· Research on Wind Turbines and House Prices along the West of Ireland concluded that any impacts "attenuate over time, becoming insignificant beyond 10 years post connection".

- It is also worth noting the limitations of this report in that it looked at just over 64,000 listings, only 225 of which are within 1 km of a turbine, between 2016 and 2021.
- For comparison, a recent 2024 study in the United States looked at 300 million house sales from 1997 to 2020 of which 250,000 transactions are within 1.5 km of a turbine.
- Closer to home a 2016 study in Scotland looked at more than 500,000 property sales between 1990 and 2014. Both of these studies, which are far more comprehensive and carried out over a much longer time, found little to no evidence of a negative impact on property prices.

Human Health and Wellbeing

· We can confirm that the assessment was carried out in accordance with relevant national and international guidance, including the 2018 World Health Organization (WHO) Environmental Noise Guidelines for the European Region and the Health Service Executive (HSE) Position Paper on Wind Turbines and Public Health (2017). These documents were explicitly referenced and considered in the preparation of the Population and Human Health chapter of the Environmental Impact Assessment Report (EIAR).

- The Ballinla Wind Farm has been assessed using best practice guidance, including the 2006 Wind Energy Development Guidelines, ETSU-R-97, and the Institute of Acoustics Good Practice Guide (IOA GPG). The noise criteria adopted for this project are robust and conservative:

o **Daytime noise limits:** 40 dB LA90,10min in quiet environments or 45 dB LA90,10min where background noise exceeds 30 dB.

o **Night-time noise limits:** 43 dB LA90,10min or 5 dB above background, whichever is higher.

- The "37 dB challenge" referenced in the Gibbot Hill High Court case is acknowledged; however, it is important to note that the Ballinla Wind Farm has adopted stricter limits than those applied in that case, with predicted noise levels at all receptors remaining below 43 dB LA90,10min, even at rated wind speeds.
- The Gibbot Hill case centred on a single fixed threshold of 37 dB LAeq, applied without differentiation between daytime and nighttime conditions or consideration of background noise levels. In contrast, the Ballinla Wind Farm assessment applies dual thresholds; 40 dB LA90,10min during daytime and 43 dB LA90,10min at night, or 5 dB above background noise, whichever is higher. This approach is not only more protective of residential amenity, but also responsive to local acoustic conditions, ensuring that turbine noise remains below perceptible levels in quieter environments.
- The EIAR confirms that no significant noise effects are anticipated during either the construction or operational phases. The turbine model used for assessment includes serrated trailing-edge blades to reduce aerodynamic noise, and all predictions incorporate a 2 dB uncertainty margin to ensure compliance.

- The project commits to post-commissioning noise monitoring in line with IOA GPG Supplementary Guidance Note 5. This will include:

o Measurement of turbine noise at representative noise-sensitive locations (NSLs)
  - o Verification against planning conditions and noise criteria
  - o Assessment of tonal characteristics and amplitude modulation, if any

- Should any exceedance or complaint arise, the operator will implement corrective actions, including curtailment or low-noise operational modes. These measures will be managed via the wind farm's SCADA system and verified through follow-up monitoring.
- We acknowledge the concern regarding sleep disturbance and recognise the personal impact described. However, recent research has examined this issue in depth and consistently finds that infrasound generated by wind turbines is well below the threshold of human perception and diminishes rapidly with distance. Studies show that external noise levels from turbines measured up to 46 dBA pose no risk to sleep quality, whether through audible sound, infrasound, or low-frequency components. These findings are supported by controlled trials and acoustic modelling, reinforcing that turbine-related noise at these levels does not disrupt human sleep. It is noted that the Ballinla Wind Farm has adopted more conservative noise limits, with maximum nighttime levels set at 43 dB LA90,10min or 5 dB above background, providing an additional margin of protection for residential amenity.

Regarding a request for access to commercially sensitive data that requires licensed software, I must reiterate that such requests cannot be accommodated—even under a Non-Disclosure Agreement. This policy stands irrespective of whether all contact details for attendees at the 5 September meeting are provided. The data in question is protected for both commercial and regulatory reasons, and access is strictly limited to ensure compliance with statutory and contractual obligations.
For access to further information on this proposal, please visit the project websites:

👉 **Planning files: https://ballinlawindfarmsid.ie or the Ballinla Windfarm dedicated website: https://ballinlawindfarm.ie**

Kind Regards
George O'Connor.
George O'Connor.
Head of Comms and Stakeholder Management,
ENIBA- Project Development, Ireland.
Email: george.oconnor@statkraft.com
Mobile: 087 3521511

Appendix B

CV of William Leslie Huson

QUALIFICATIONS

BSc (Hons) Applied Physics, UK 1975

MSc Sound and Vibration Studies, Institute of Sound and Vibration Research, Southampton, UK 1977

PROFESSIONAL AFFILIATIONS

Chartered Physicist, UK

Member of the Institute of Physics, UK

Member of the Institute of Acoustics, UK

Member of the Australian Acoustical Society

Member of the AV0001acoustics working group for Standards Australia

Australian representative for the International Institute of Noise Control Engineers (I-INCE) Technical Study Group 5 *A GLOBALAPPROACH TO NOISE CONTROL POLICY* (Now disbanded after completion of the scope of work defining this group – see http://www.i-ince.org/data/iince061.pdf)

EXPERIENCE

Since graduating I have been involved in several scientific areas of research and development. My early experience was in constructing a microwave device to measure the temperature of plasma inside a nuclear fusion experimentation device at the UKAEA, Culham Laboratory in the UK. I then worked in research and development of thermal imaging devices prior to completing a Masters in Sound and Vibration Studies. My work since then (1977) has been primarily associated with acoustics and vibration both terrestrial and underwater.

Prior to 1991 I worked as a Sound and Vibration consultant in the UK for 12 years with involvement in a wide range of industries.

For the past 35 years I have worked in Australia as a noise and vibration consultant and have operated through my own consultancy firm for the past 28 years. I am experienced in modelling acoustic propagation from a variety of sources such as railways, roads, aircraft, underwater ordnance, wind farms, pile driving, blasting and numerous types of industry.

I have also prepared the Brisbane Noise Survey in 1998 for the Brisbane City Council and was the author of the Noise Impact Assessment Planning Scheme Policy for Brisbane City Council's City 2000 Planning Scheme.

Of relevance to wind farm related assessment is the work I completed for the Toora Wind Farm in 2002 which involved detailed analysis of pre and post construction noise data using NZS6808 1998 to check compliance with license conditions. NZS6808 is based upon ETSU-R-97. My

experiences in the analysis of wind farm noise data led to a paper that was presented at the joint Australia and New Zealand Acoustics conference in 2006; "Review of the Application of NZS6808 to wind farms in Australia." This paper highlighted the sources of error that were implicit and allowed in the NZS6808, 1998 standard and ETSU-R-97. The latest version of the NZS6808 standard (2010) addresses a number, but not all, of the data analysis error concerns described in my paper. ETSU-R-97 and the Institute of Acoustics Good Practice Guide to the Assessment and Rating of Wind Turbine Noise is regularly referenced when interpreting parts of NZS6808 in Australia and I am familiar with this document and the supporting Supplementary Guidance Notes (GPG).

Over the past twelve years I have been independently gathering sound data in the audible and infrasound parts of the acoustic spectrum at numerous wind farms in Australia, the UK and Ireland. A summary of some of this research work on infrasound was presented in a peer reviewed paper: Huson, W. Les. "Stationary wind turbine infrasound emissions and propagation loss measurements." 6th International Conference on Wind Turbine Noise, Glasgow 20-23 April 2015.

I have investigated the Preferred IoA Method for the assessment of amplitude modulation (AM) in detail and applied it to several wind farm measurements taken outside dwellings near to numerous wind farms in Australia and the UK. The findings of this work are the realisation that the Preferred IoA Method is only suitable for assessing a single wind turbine, that the resulting AM values greatly underestimate short term peak to trough amplitude modulation levels observed, and that the Method is wholly unsuitable to assess AM (peak to trough amplitude modulation) from multiple wind turbines.

Detailed analysis of AM from wind farms has revealed that many AM events also exhibit impulsiveness when evaluated according to BS 4142:2014+A1:2019.

Appendix C

Presentation by E Sloth

Problems related to the use of the existing noise measurement standards when predicting noise from wind turbines and wind farms.

Erik Sloth Vestas

Niels Christian Møller Nielsen VESTAS
Ejler Kristensen BONUS Energy
Bo Søndergaard DELTA

Overview

- Noise Measurements (IEC 61400-11:2002)
  - Short description of the measurement method
  - Use of measurement results, including influence on inaccuracy.

- Noise prediction
  - Terrain and meteorology influence on the actual emitted sound
  - Methods used in noise calculations

- Noise assessment
  - Descriptors
  - Noise limits
  - Further investigations needed

Noise Measurements (IEC 61400-11:2002)

We correct for:

Air pressure
Air temperature

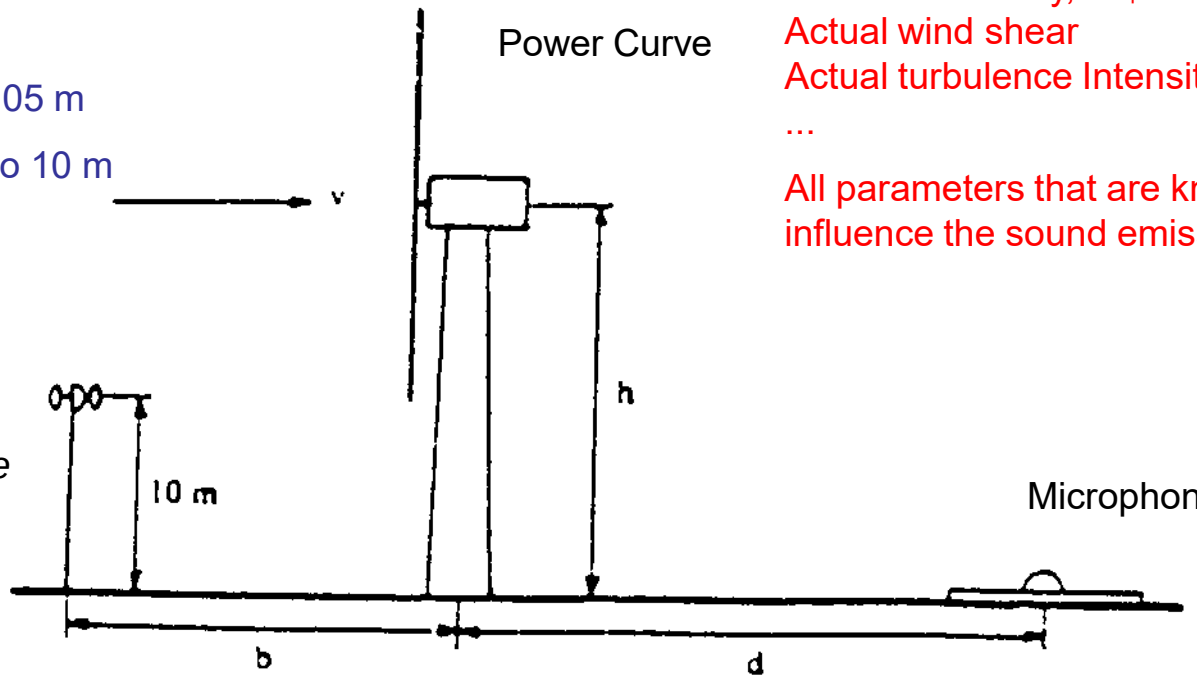
Standard terrain
roughness z = 0.05 m

All recalculated to 10 m
wind speed

We do not correct for

Actual inflow angels
Actual air density, except in the power curve
Actual wind shear
Actual turbulence Intensity
...

All parameters that are known to influence the sound emission



Anemometer
For background noise only

Noise Measurement

- The results are standardized noise levels, which are fairly comparable from measurement to measurement on a given turbine type.
- The wind turbine is used as a wind speed meter through a power curve measured on an ideal site (IEC 61400-12) OBS impossible if actual terrain does not fulfill conditions
- Other parameters influence the noise level: relative humidity, turbulence, inflow angle, wind shear, turbine pitching are not accounted for.

- The result is a fairly good tool for verification of warranties, but not a good tool for predicting noise at imission points where people actually can get annoyed.

- The Sound Power Level related to the produced power or at least the sound power level as a function of hub height wind speed could be a more basic relationship

Typical problems in using the measurement results

- Where do we see the major deviations from standardized conditions during actual use of measurement results

- The wind turbines are almost always raised at sites where roughness differ from the standardized completely flat measurement site.

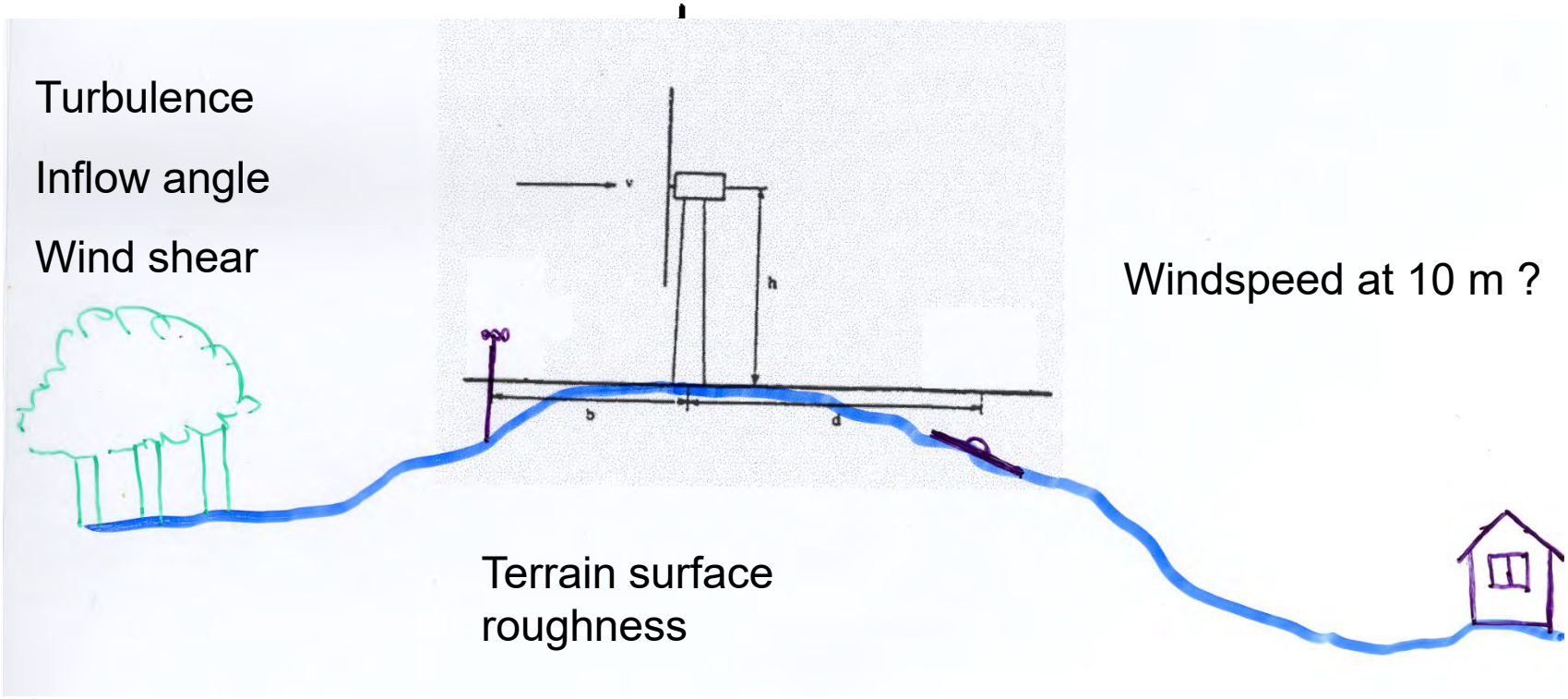
- Further we see different air density
- different wind shear
- different turbulence in inflow air
- different inflow angles

- Finally we often see other hub heights than used during documentation

Use of measurement results

For noise control measurements

For noise level calculations



Conclusion on measurement results

- The differences in site conditions creates differences in emitted sound power level.
- The differences could be both increased and decreased emitted sound power levels in real life applications
- The differences will transfer directly to the imitted sound power levels, and may thereby create increased annoyances in real life

- Therefore – site specific sound power levels should be used unless a good safety margin is present using standardized emission levels.

Uncertainty

- According to IEC 61400-11:2002 the standard deviation of a measurement results is app. 0.9 – 1.5 for an ideal site
- If the measurements are made at a site with considerable turbulence intensity or wind shear the standard deviation can be app. 2.0 dB
- The result is that when used for calculating the noise from a wind farm at an imission point, some WTG will be higher than the expected level and some will be lower.
- To correct for this, the measured inaccuracy cannot be placed upon the total calculated level, but must be included in the calculations.
- The result is that the higher the number of WTG's in the project is, the smaller the resulting inaccuracy.
- If the results are used for calculating the noise from a wind farm the standard deviation should be calculated as the weighted standard deviation

$$\sigma_{res} = \sigma_{method} + \sigma_{source} = \sigma_{method} + \frac{\sqrt{\sum (\sigma_i \cdot 10^{L_i/10})^2}}{\sum 10^{L_i/10}}$$

Solution to the outlined problems

- Accept that different sound power levels should be used in predictions and warranties.
- Avoid using sound power levels that include inaccuracy in predictions unless there is a good safety margin.
- The inaccuracy should be included in the calculation – the higher the number of WTG's the less the probability that all are in the high end of the uncertainty interval
- Use sound power levels that at least are corrected for: hub height, wind shear, air density, turbulence, inflow angle
- Be careful to make sure that the background noise measurements and wind conditions at the turbine positions uses the same reference position.

Noise level calculation models

- There are lots of different noise level calculation models:
  - ISO 9613-2 which is the model that we see the most
  - VDI 2714
  - Concawe
  - BS 5228
  - General Prediction Method (Danish)
  - Danish EPA Guidelines
  - Netherlands Guidelines 1999
  - Swedish method (land/sea)
  - .....

- Most of the methods are developed for noise from Industry, wind speeds below 5 m/s and standard meteorological conditions and must be suspected to give poor results at larger distances.
- ISO 9613-2 is known sometimes to overestimate the terrain effects if soft ground is used
- Manufacturers, developers, consultants and authorities have an interest in a noise level calculation model developed specifically for wind turbine noise

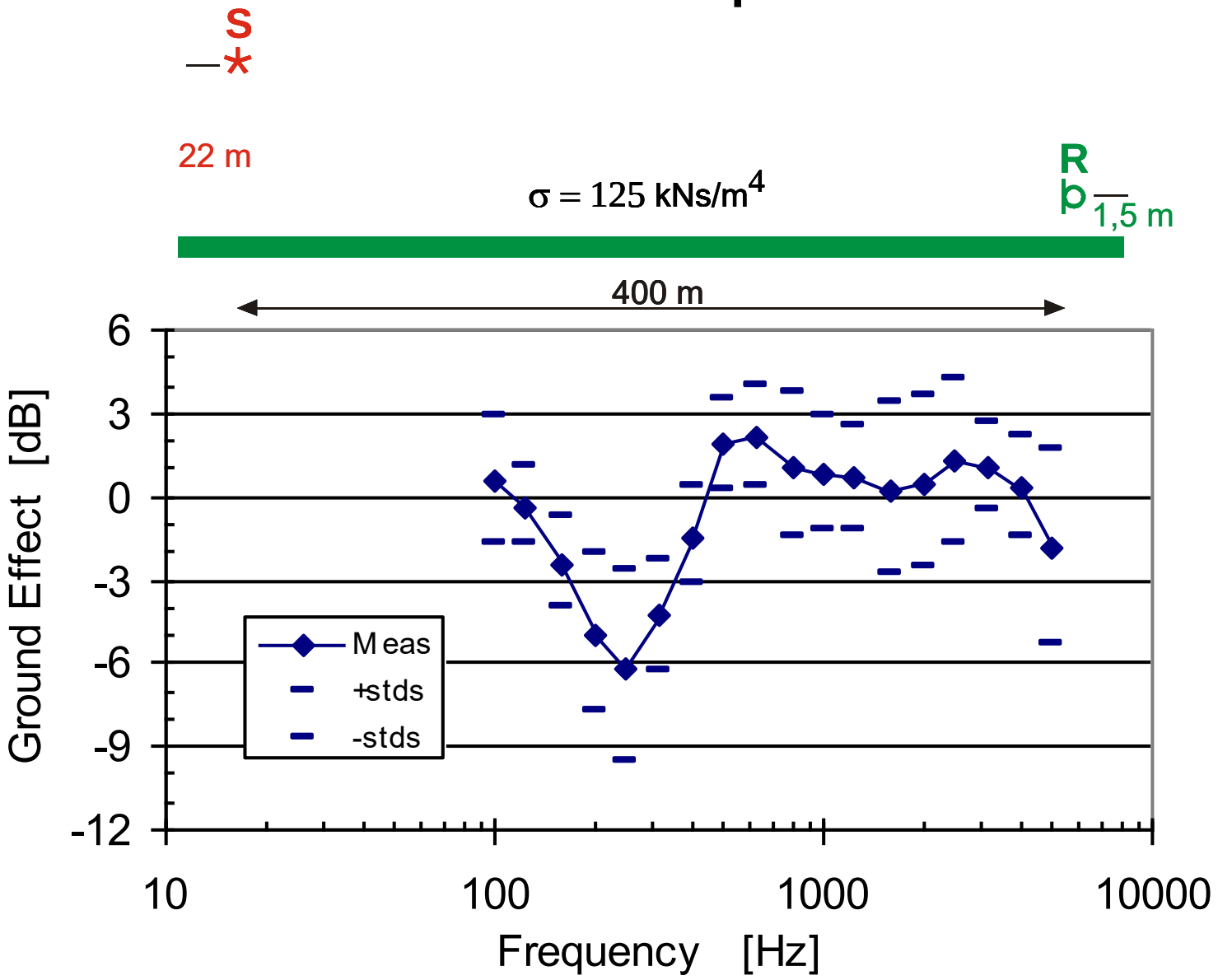
Noise calculation models

- In an EU project JOR3-CT95-0065 a model for wind turbine noise propagation (WiTuProp) was developed giving good results

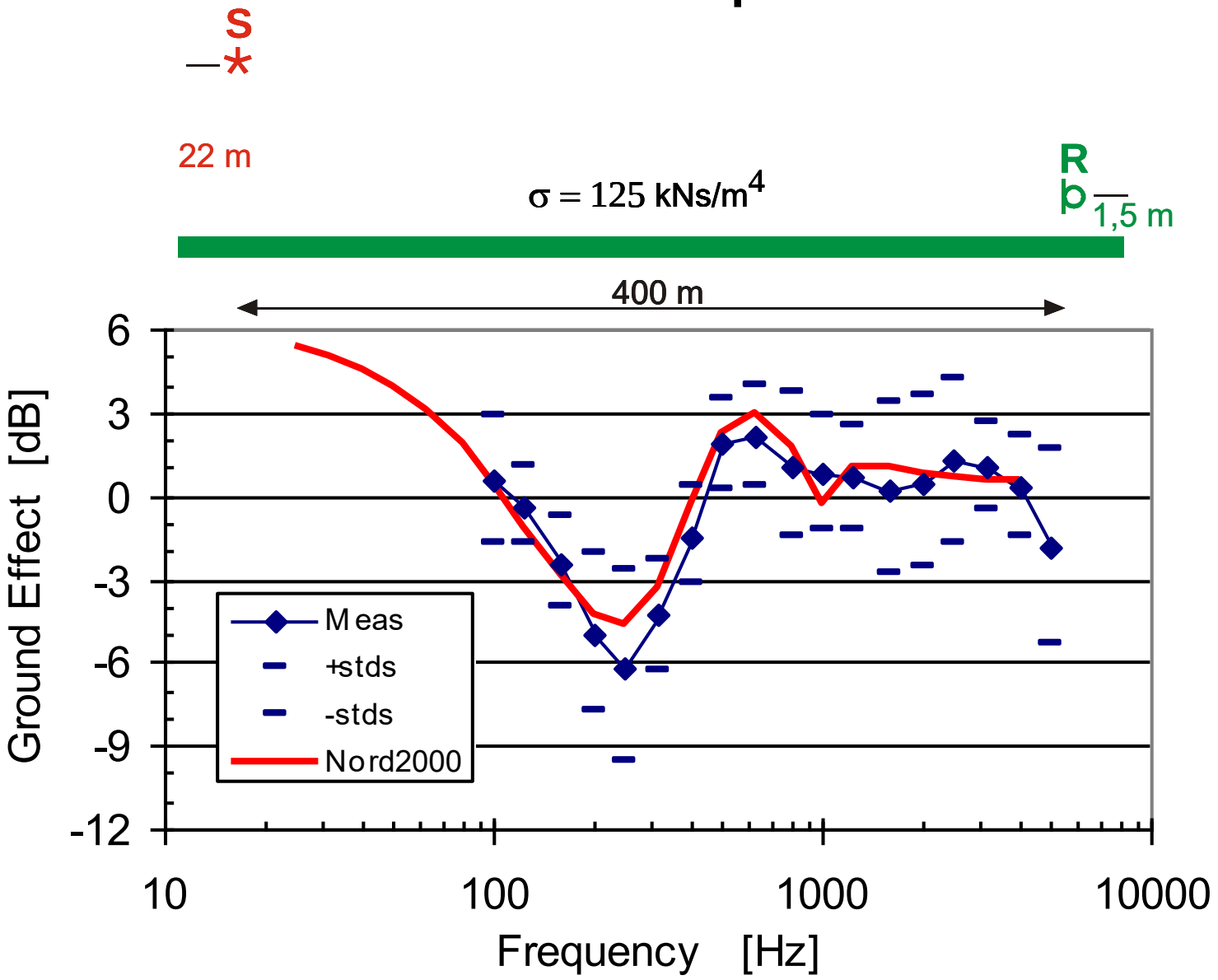
- The WiTuProp model takes into account
  - meteorological conditions:
    - Wind speed / terrrain surface roughness and direction
    - Air temperature and air temperature gradient
    - Relative air humidity
  - The ground type
    - Flow resistivity for grassland and harder surfaces
  - Screening (by terain or screens / barriers)

- WiTuProp is a special case of a more comprehensive model developed later: *NORD2000*

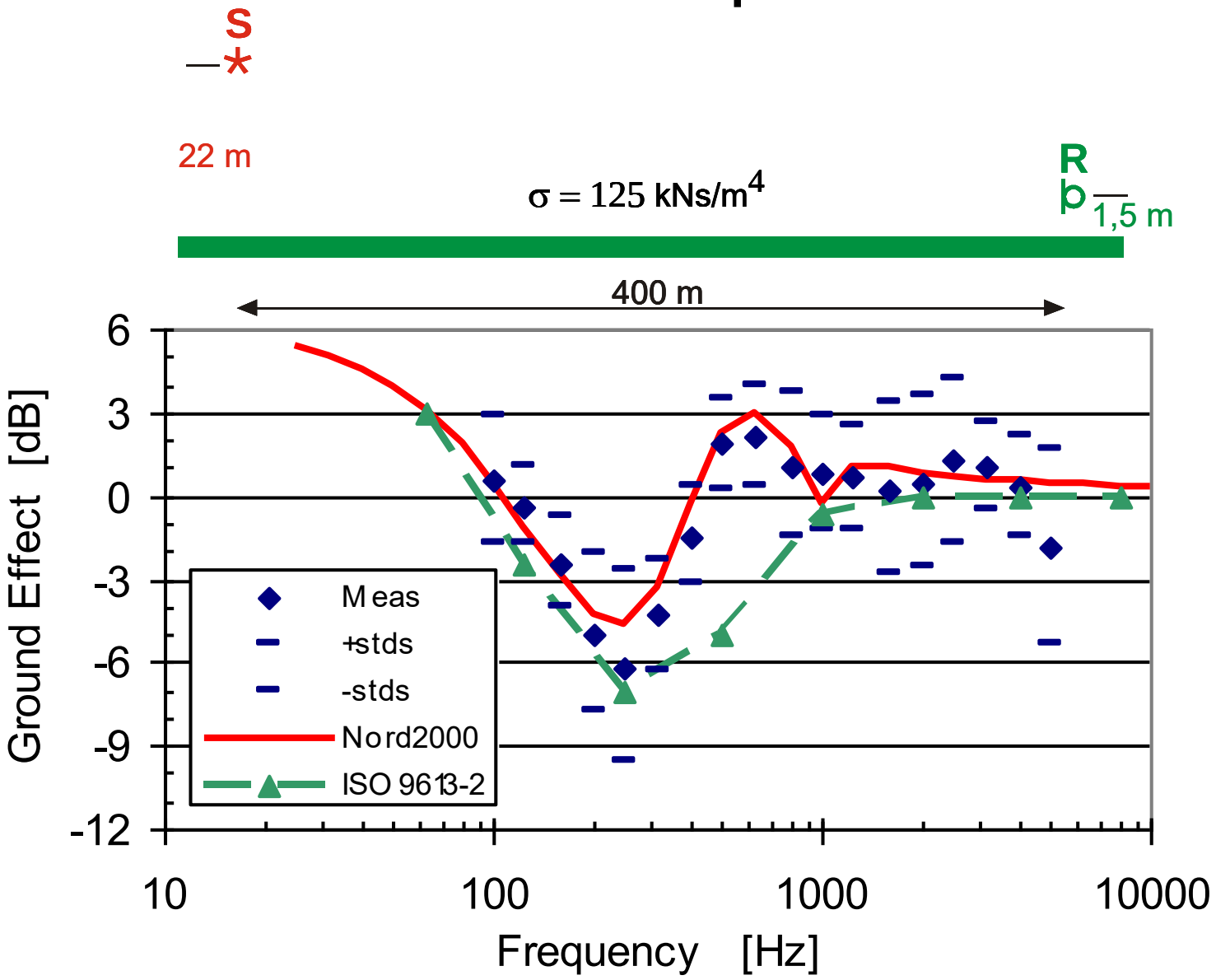
Nord2000 / WiTuProp vs. ISO 9613-2



Nord2000 / WiTuProp vs. ISO 9613-2



Nord2000 / WiTuProp vs. ISO 9613-2



Nord2000 model

- Meteorological conditions are better covered
- Complex terrain profiles (hill/valley)
- Mixed ground
- Terrain roughness
- Improved screen modelling
- 1/3 octave-band results
- Physical model – NOT empirical

Recommendation if the advanced model is not used:

- Use ISO 9613-2
- Make sure that hard terrain is used
- Be careful when defining screening effects from terrain - specially edge effects can be difficult to model

Noise Assessment

- The noise level at the imission points are normally given as an A-weighted noise level at different wind speeds.
- A tonality evaluation is normally included for the receiving points.

What do we know of the annoyance of the noise:

- We know that noise from wind turbines sometimes annoys people even if the noise is below the noise limits.
- Often people complaints on low frequency noise which many investigations often show in not present
- The noise limits are usually adapted from industrial noise limits and are based upon the principle that a given percentage of the population will feel annoyed when the limit is exactly fulfilled.
- Evaluation of tonality in the turbine noise is more based on the reproducibility of the results than on pure knowledge on what is actually annoying

Noise assessment

- Other descriptors need to be investigated to understand the annoyance caused by wind turbines
  - Low frequency noise and Infrasound – we cannot see it in our measurements
  - Modulation – may be the parameter that is heard as low frequency noise
  - Masking – which noise can mask noise from wind turbines
  - Other characteristics
  - ..
- This mean that tape recordings should me made on all sites in order to enable later analysis of up till now unrecognized parameters.
- In order to enable listener tests, artificial head investigations should be made
- We as a producer cannot cover this alone, since the local rules always need to be followed

Our recommended research program

- Artificial head measurements on real turbines of different sizes
- Background noise measurements on real sites
- Listener tests on obtained results
- These measurements are being made on a test basis during our Danish measurements

- General Research that is needed in this area includes
  - Psychoacoustic experiments
  - Listener test
  - Measurements at low frequencies
  - Analysis for other characteristics
  - ..

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Questions ?

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Appendix D

Suzlon Energy – Site effects

Siting of Wind Farms: Basic Aspects

When searching the internet for the definition of the word “layout” I came across following:

Layout in word processing and desktop publishing refers to the arrangement of text and graphics. The layout of a document can determine which points are emphasised and whether the document is aesthetically pleasing. While no computer program can substitute for a professional layout artist, a powerful desktop publishing tool can make it easier to lay out professional looking documents (source: www.webopedia.com)

In principle the same is valid for wind farm planning: The term layout in wind industry is used for choosing optimal locations for wind turbines. Tools like flow models help to identify the best positions, but cannot replace the engineer making the final decision by balancing interests.

So what is that engineering experience, what factors influence the decision?

Jessica Rautenstrauch, wind energy consultant from Anemos, Germany, at work.
© Paul Langrock (www.unendlich-viel-energie.de)

Wind resource

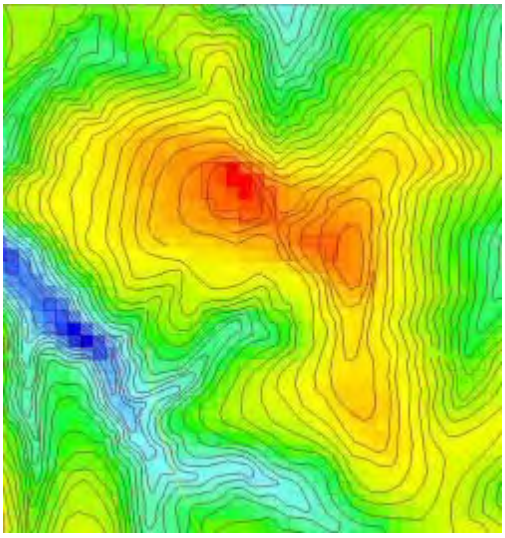
The wind resource is the most obvious factor to concentrate on when choosing a wind turbine location. We have a wide range of options to determine the wind resource of the site. The quality of the tools varies significantly and so does their price.

Common sense is a good starting point. Nature itself helps to guide us to suitable sites. Flagging of trees – permanent flagging and not the temporary bending in the wind – shows us the prevailing wind direction and is a good indicator for the strength of the wind.

However because of the uncertainty involved, using common sense as the only tool is of course insufficient. For any bankable estimate of the energy yield on-site wind speed measurements are required. The number of measurement masts required for a specific site depends next to the size of the project mainly on the complexity of the terrain. The measurement height should be minimum 2/3 of the expected future hub height. An increase in measurement height beyond this leads to a reduction of the uncertainty in the energy estimate. The measurement period must be one year or more to avoid any seasonal bias. Since the wind speed varies also inter-annually typically up to +/-12% a long-term correction is highly recommended.

The measured wind regime is extrapolated across the site to derive a resource map of the site using different flow models /4, 5/. A wind map like the one in Graph 1 can then be used to identify the windiest locations.

However additionally technical constraints should be taken into account when developing a layout /3/. A number of site specific wind load parameters can be extracted from the wind speed measurement. They are used to optimize the technical suitability of the chosen layout and the wind turbine type for the site specific wind regime.



Graph 1: Example Wind Resource Map. The colours denote the energy content of the wind, red high and blue low energy content.

Technical restrictions

Wind turbines are designed for specific conditions. During the construction and design phase assumptions are made about the wind climate that the wind turbines will be exposed to. In rough terms: For very complex sites with high wind speeds “heavy-duty” versions of wind turbines are available, which are sturdier but also more costly. Low wind speed sites in flat terrain do not put so high demands on the on the wind turbine structure, hence the construction can be more light-weight and hence cheaper. The different turbines have been classified by the IEC, class 1 being the highest wind speed class. The following table is a simplified summary of the IEC classification /1/.

IEC class	**I**	**II**	**III**	**IV**
V_{ave} (m/s) annual average wind speed at hub height	10	8.5	7.5	5
V_{ref} (m/s) 50-year maximum 10-minute wind speed	50	42.5	37.5	30

Table 1: IEC classes

But not only the wind speed but also other parameters play a role and have to be checked, when developing a layout for a specific turbine.

One of the most important parameters is the turbulence intensity. Turbulence intensity quantifies how much the wind varies typically within 10 minutes. Because the fatigue loads of a number of major components in a wind turbine are mainly caused by turbulence, the knowledge of how turbulent a site is of crucial importance.

We have to distinguish between two different sources of turbulence. Turbulence is generated by terrain features – which is referred to as ambient turbulence intensity - as well as by neighbouring wind turbines – which referred to as induced turbulence (Figure 1). Sources of ambient turbulence are for example forests, hills, cliffs or thermal effects. Thus ambient turbulence can be reduced by avoiding critical terrain features. But the wake-induced turbulence has far more impact than the ambient turbulence intensity /2/. Decreasing the spacing increases the turbulence induced by the wakes of neighbouring wind turbines meaning that there are limits to how close you can space the turbines. As a general rule the distance between wind turbines in prevailing wind direction should be a minimum of the equivalent of five rotor diameters. The spacing inside a row perpendicular to the main wind direction should be a minimum of three rotor diameters.

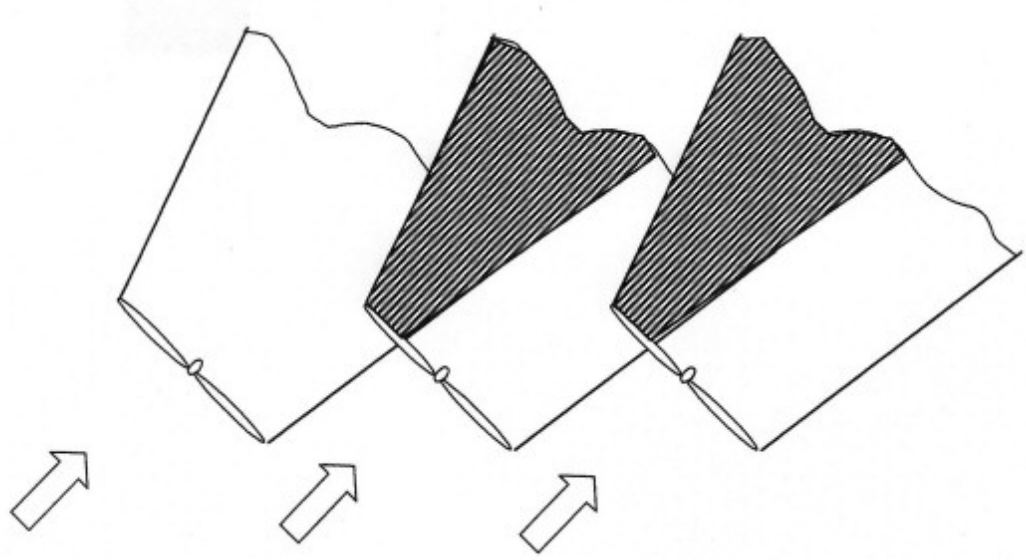


Figure 1: Shadowing in wind farm

If a layout is too close the resulting fatigue loads might be too high. In order to then ensure the lifetime of the main components wind sector management might have to be applied, meaning that some wind turbines might have to be switched off when they are operating in the wake of the neighbouring wind turbine.

Another parameter which has to be checked when developing a layout is the flow inclination, velocity tilt or in-flow angle. When wind turbines are to be placed on steep slopes or cliffs the wind might hit the rotor not perpendicular but at an angle. This angle is related to the terrain slope. With increasing height above ground level the effect of the terrain slope is normally reduced such that the terrain slope is only of indicative use to estimate the velocity tilt. A large in-flow angle will not only reduce the energy production but will also lead to an increased level of fatigue of some of the mayor components.

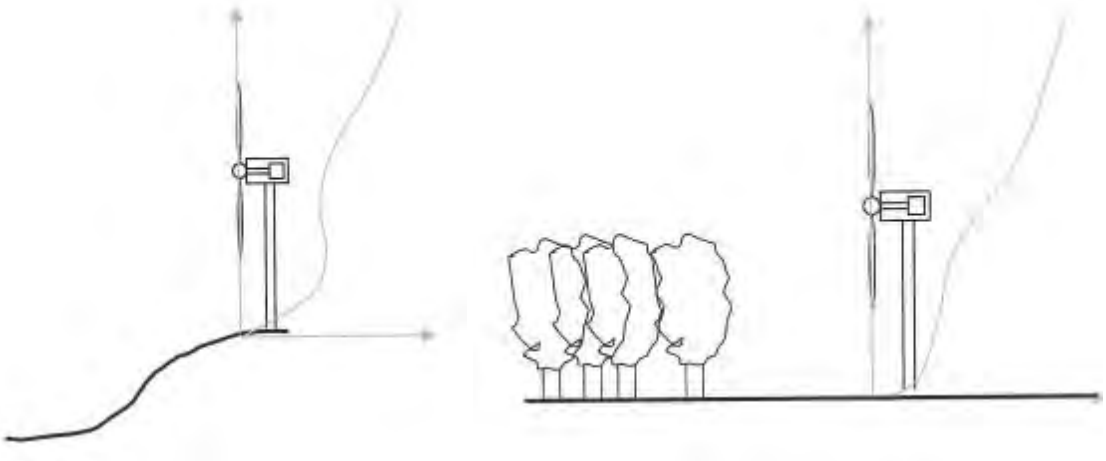


Figure 2: Distorted wind profile at steep slope (left) and behind a forest (right)

Furthermore a steep slope might cause a negative gradient across some parts of the rotor (Figure 2).

Normally the wind speed increases with increasing height. In flat terrain the wind speed increases logarithmically with height. In complex terrain the wind profile is not a simple increase and additionally a separation of the flow might occur, leading to heavily increased turbulence. The resulting wind speed gradients across the rotor lead to high fatigue loads particularly on the yaw system.

Obstacles like forest can have a similar effect on the wind profile and should be thus avoided.

Planning constraints

Next to the wind resource and technical considerations a good layout should also take planning constraints into account. The visual impact is course the most obvious. A layout that follows the shape of the terrain rather than straight rows of wind turbines appears to be less intrusive. Noise is another important parameter to take into account. Next to noise also the impact due to flicker at the nearest inhabited houses should be estimated. The accepted levels vary from country to country.

Electro-magnetic interference can cause problems. Hence placing wind turbines in a transmission corridor should be avoided.

Some areas on site might have to be excluded from development due to other factors related to fauna, flora and archaeology.

Jessica Rautenstrauch, wind energy consultant from Anemos, Germany, at work.
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Summary

A large number of parameters have to be taken into account when developing a layout. Some work can be done using tools, but in the end the balance between financial, technical and planning constraints can be best done by an experiences engineer.

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Appendix E

EPA Tasmania wind farm noise policy

EPA Board Policy
Noise limits for wind energy projects

ENVIRONMENT PROTECTION AUTHORITY

Application

This policy is adopted by the Board of the Environment Protection Authority (EPA Board) for the purpose of assessing wind energy projects and requiring conditions or restrictions in respect to wind farm noise under the *Environmental Management and Pollution Control Act 1994* (EMPCA).

This policy supersedes any previous policy of the EPA Board in respect to operational noise criteria for wind energy projects. This policy does not apply to construction noise.

This policy applies from 31 July 2025 and will apply to all wind energy projects currently under assessment. It remains in place until revoked.

Technical terms

L_{Aeq} means the A-weighted equivalent continuous sound level.

L_{A90} means the A-weighted sound level that is exceeded for 90% of the measurement period.

dB means decibel.

dB(A) means decibel when stating A-weighted sound pressure level.

Design Criteria

The predicted equivalent noise level at any noise sensitive premises should not exceed the greater of:

a) **35 dB(A) $L_{Aeq,\ 10\ min}$; or**
b) **Background (L_{A90}) + 5 dB(A).**

This design criteria applies to all noise emissions from the activity, inclusive of wind turbines and all ancillary infrastructure. It has been set for the protection of sensitive receivers during periods of low background noise.

The background noise for day, evening and night-time must be calculated separately to determine the applicable (lowest) background level, and is not to be averaged across a 24-hour period.

For predictive purposes, a difference of ~2 dB between measured $L_{A90,\ 10\ min}$ levels and $L_{Aeq,10\ min}$ emissions from the activity must be noted. The predicted noise levels should be adjusted for special audio characteristics and/or the applicable adjustment factors must be discussed.

The EPA South Australia *Wind farms environmental noise guidelines 2021* (or the most recent revised version of that document) is to be used for assessing whether a wind farm can meet this design criteria, except where that guideline may be inconsistent with this policy.

Noise Measurements

If approved, wind energy projects will contain conditions and restrictions to enforce the design criteria. The following guidance is provided for the interpretation of EPA Board wind energy project noise requirements:

1. It is generally acceptable for wind turbine noise to be measured in L_{A90}, but note that alternative techniques may be required (including measuring in L_{Aeq}) to better detect special audible characteristics (dominant and intrusive characteristics) and noise fluctuations or intermittent noise.

2. An appropriate conversion factor must be added to the measured L_{A90} level to derive the representative L_{Aeq} noise level. To be representative of L_{Aeq}, generally applying +2 dB(A) conversion factor to the measured L_{A90} level is acceptable.

3. Where special audible characteristics (dominant and intrusive characteristics) are detected from any wind farm noise, a correction factor must be applied in accordance with the *Tasmanian Noise Measurement Procedures Manual*.

4. The EPA South Australia *Wind farms environmental noise guidelines 2021* (or the most recent revised version of that document) is to be used for all wind farm noise measurements, except where that guideline may be inconsistent with this policy.

29 July 2025

Andrew Paul
Chair
Environment Protection Authority Board