Natural Forces Renewable Energy 2 Ltd.

PROPOSED CLOONANNY WIND FARM
CO. LONGFORD

VOLUME III

APPENDICES TO ENVIRONMENTAL IMPACT ASSESSMENT REPORT

RFI Response July 2025

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APPENDIX 1.1
GLOSSARY OF TERMS AND ACRONYMS

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Cloonanny Wind Farm

Glossary of Terms & Acronyms

Alternatives: Description of alternative locations, alternative designs and alternative processes.

Anemometer: Measures the wind speed and transmits wind speed data to the controller.

AA: Appropriate Assessment: An assessment of the potential adverse effects of a plan or project (in combination with other plans or projects) on Special Areas of Conservation and Special Protection Areas.

Blades: The aerodynamic surface that catches the wind. Blades lift and rotate when wind is blown over them, causing the rotor to spin. Most commercial turbines have three blades, most commonly made of glass reinforced plastic or wood epoxy, but can be made of aluminium or steel.

Blade Pitch: The pitch motor turns (or pitches) blades out of the wind to control the rotor speed, and to keep the rotor from turning in winds that are too high or too low to produce electricity.

Blade Pitch Actuator: This adjusts the pitch angle of a rotor blade.

Brake: The brake stops the rotor mechanically, electrically, or hydraulically, in cases of emergency.

Capacity Factor: The average power output of a wind development divided by its maximum power capability, its rated capacity. Capacity factor depends on the quality of the wind at the turbine. Higher capacity factors imply more energy generation. On land, capacity factors range from 0.25 (reasonable) to over 0.40 (excellent).

Cut-in Wind Speed: The wind speed at which a turbine produces a net power output. This is usually at hub height wind speeds of 4-5 metres per second.

DCCAE: Department of Communications, Climate Action and the Environment.

Decommissioning: The final closing down of a development or project when it has reached the end of its operational/useful life.

Development Applications Unit: Unit of the Department of Housing, Local Government and Heritage which coordinates the Department's response to development applications and plans that might have significant effects on either architectural heritage, archaeology and/or nature conservation, including the National Monuments Service, the National Parks and Wildlife Service and the Architectural Heritage Advisory Unit.

DHLGH: Department of Housing, Local Government and Heritage

DHCPLG: Department of Housing, Planning, Community and Local Government.

DHPLG: Department of Housing, Planning and Local Government.

EIA: Environmental Impact Assessment: The process of examining the anticipated environmental effects of proposed project - from consideration of environmental aspects at design stage, through consultation and preparation of an Environmental Impact Assessment Report (EIAR), evaluation of the EIAR by a competent authority, the subsequent decision as to whether the project should be permitted to proceed, encompassing public response to that decision.

EIAR: Environmental Impact Assessment Report: A report or statement of the effects, if any, which the proposed project, if carried out, would have on the environment.

EirGrid: Ireland's electricity transmission system operator, responsible for developing, managing and operating the electricity grid in Ireland.

EPA: Environmental Protection Agency.

ESB: Ireland's electricity distribution system operator

Gearbox: Gears connect the low-speed shaft to the high-speed shaft and increase the rotational speed of the shaft to the speed required by the generator. The gear box is heavy and power losses from friction are inherent in any gearing system.

Generator: A device that produces electricity from mechanical energy, such as from a rotating turbine shaft.

Grid Connection: Refers to the proposed route of connecting the wind farm to the national grid.

Hub height: Height of wind turbine tower from the ground to the centre-line of the turbine rotor.

Megawatt: Used as a measurement of electrical generating capacity. A megawatt (MW) is equal to 1,000 kilowatts (kW) or 1,000,000 watts (W).

Mitigation: Measures designed to avoid, reduce, remedy or compensate for adverse environmental effects that are identified.

Monitoring: Repetitive and continued observation, measurement and evaluation of environmental data to follow changes over a period of time, to assess the efficiency of control measures.

Nacelle: The nacelle sits atop the tower and contains the key mechanical components of the wind turbine including the gearbox, shafts, generator, controller, and brake. A yaw mechanism is employed to turn the nacelle so that the rotor blades face the prevailing wind.

Pitch: The angle between the edge of the blade and the plane of the blade's rotation. Blades are turned, or pitched, out of the wind to control the rotor speed.

Pitch controlled: These are turbine controls included to rotate the angle of the blades depending on the wind speed in order to regulate output and rotational forces.

Rated Wind Speed: The wind speed at which the turbine is producing power at its rated capacity. The rated wind speed generally corresponds to the point at which the turbine can perform most efficiently. Because of the variability of the wind, the amount of energy a wind turbine actually produces is lower than its rated capacity over a period of time.

Renewable Energy: Energy derived from renewable resources such as sunlight, wind, rain, tides and geothermal heat, which are naturally replenished. Fossil fuels, such as coal and oil, are considered non-renewable resources because they are consumed much faster than nature can create them. Fossil fuels, when burned to produce energy, cause harmful greenhouse gas emissions, such as carbon dioxide.

Rotor: Blades and hub together form the rotor.

Rotor Hub: The centre of a turbine rotor, which holds the blades in place and attaches to the shaft.

RMP: Record of Monuments and Places, the county maps showing the archaeological sites and accompanying manuals.

RPS: Record of Protected Structures, a record of protected structures in the functional area of the Planning Authority that contains an identifying number and address for each protected structure and one or more maps which identify the location of each protected structure.

Shaft: The rotating part in the centre of a wind turbine or motor that transfers power.

Shadow Flicker: Term used to describe the short-lived effect of shadows cast by rotating blades of wind turbines when the sun passes behind them, which occurs under certain combinations of geographical positions and time of day.

Substation: Connects the local electricity network to the electrical system of the wind energy project through a series of automatic safety switches.

Temporary Construction Compound: The compound to be developed and used by the appointed contractor(s) for the purposes of constructing the development which will be reinstated following completion of construction.

Tower: The base structure that supports and elevates a wind turbine rotor and nacelle. Made from tubular steel, concrete, or steel lattice, the tower supports the structure of the turbine.

Transformer/Voltage Regulator: This is a device for changing the voltage of the alternating current. Electricity is typically generated at less than 1000 volts by the wind turbine and the transformer "steps up" this voltage to match that of the national grid. This may be housed either inside or alongside the tower.

Turbine Hardstand: The hardstand areas next to each turbine location used by cranes for erection of turbine hub, nacelles and rotor blades.

Turbine Foundation: The concrete base located under ground level and used to support the turbine hub.

Wind Farm Internal Cabling: Refers to the electrical cables connecting the turbines to the Onsite substation.

Wind Turbine: A machine that captures the force of the wind. Also called a Wind Energy Converter when used to produce electricity.

Wind Vane: Measures wind direction and communicates with the yaw drive to orient the turbine properly with respect to the wind.

Yaw: To rotate around a vertical axis, such a turbine tower.

Yaw drive: Orients upwind turbines to keep the turbine rotor facing into the wind as the wind direction changes. Downwind turbines don't require a yaw drive because the wind manually blows the rotor away from it.

Yaw motor: The yaw drive is powered by the yaw motor.

APPENDIX 1.2
CUMULATIVE ASSESSMENT - PROJECTS AND PLANS

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Cumulative Assessment

Cloonanny Windfarm

1. Introduction

This Briefing Note sets out the projects and plans that the project team should consider when carrying out the cumulative assessment sections of individual EIAR chapters and the in-combination section of the Appropriate Assessment Reports for the proposed Cloonanny Wind Farm which, briefly, comprises 2 no wind turbines with an overall tip height of 199.9m, hub height of 112.4m, rotor diameter of 175m, met mast with a height of 32m, and associated sub-station, foundations, and site works.

Cumulative effects are those that accrue over time and space from several development activities – the impact of the Proposed Development should therefore be considered in conjunction with the potential impacts from other projects or activities, which are both reasonably foreseeable in terms of delivery and are located within a realistic geographical scope where environmental impacts could act together with the Proposed Development to create a more significant overall effect.

The cumulative impact assessment should not consider other developments that are already constructed and operating, with the exception of other windfarms in the area, as such existing developments will be accounted for in the baseline conditions established for the individual specialist topics. The requirement of the EIA Directive and Guidelines to consider existing projects is therefore dealt with in the baseline.

Accordingly, the cumulative assessment should consider only proposed developments, being the “permitted or planned projects”.

A fundamental requirement of assessing cumulative/in-combination effects is to identify those projects, plans or activities with which the proposed development may interact and create a cumulative impact. These interactions can arise during the construction, operation and decommissioning phases.

The project team should consult the following resources.

- The ‘Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment’ (Government of Ireland, 2018) provides high-level guidance on assessing cumulative effects.
- The EPA’s ‘Guidelines on the information to be contained in Environmental Impact Assessment Reports’ (EPA, 2022) provides a checklist for assessing cumulative effects, it should be considered whether the EIAR has: ‘described cumulative effects? considered cumulative effects due to cumulation of effects with those of other projects that are existing or are approved but not yet built or operational?’
- The Office of the Planning Regulator (OPRs) Practice Note PN01 “Appropriate Assessment Screening for Development Management” provides the following advice with respect to in-combination assessment,

"In-combination effects must examine plans or projects that are:

- *Projects completed,*
- *Projects approved but not started or uncompleted,*
- *Projects proposed, i.e. for which an application for approval or consent has been made, including refusals subject to appeal and not yet determined,*
- *Proposals in adopted plans and*
- *Proposals in finalised draft plans formally published or submitted for consultation or adoption.*

Plans and projects that are not yet proposed do not generally have to be taken into account in the assessment of in-combination effects, even if they are part of an overarching masterplan. The exception is where the project is considered to be functionally interdependent with the development before the competent authority. An example of this is a grid connection for a proposed wind farm.

The consideration of in-combination effects is not restricted to similar types of plans or projects covering the same sector of activity (e.g. a series of housing projects). All types of plans or projects that could, in-combination with the project under consideration, have a significant effect, should be taken into account."

The scope of this assessment has been reviewed to identify any new relevant planning applications submitted since the original EIAR was prepared and submitted to Longford County Council on 11 December 2024.

Changes to the text are shown in blue, text to be deleted is shown as ~~strikethrough~~.

2. Zone of Influence

The Zone of Influence (ZoI) for each environmental discipline must be defined by the appointed specialist. The basis for selecting the ZoI must be set out in each chapter of the EIAR and in the AA Screening Report.

Projects and plans that are in closest proximity to the Proposed Development Site are generally considered to have the greatest potential to contribute to cumulative effects.

3. Subject Site

A search of committed developments (i.e., ones that have received full or outline planning permission) proximate to the Proposed Development Site was undertaken using

- the An Bord Pleanála Online Planning search tool,
- the web map portal providing spatial information relevant to the planning process in Ireland (myplan.ie) and
- the Longford County Council Online Planning Register.

It revealed no previous planning applications were made on the subject site.

4. Local area

A desktop planning history search for permitted developments in the last five years and within 1.5 km of the Proposed Development was undertaken. Planning applications older than five years have not been assessed as they have been deemed to either have expired or have been constructed (due to the standard five-year life of planning consents).

Within the local area of 1.5km of the proposed development only minor developments listed below were identified.

LCC Reg Ref	Brief Description	Decision
2413	Extension of Duration of LCC19/40 - retention of changes to roof pitch, window design, changes to window and door openings, omission of chimney on existing dwelling and all associated services and retention of domestic garage and planning permission to convert attached garage to ensuite bedroom and alternation to the front elevation of the dwelling	Grant
22177	Retention of the installation of an onsite sewerage treatment system with polishing filter to service an existing dwelling house and the erection of boundary fences and all ancillary works	Grant
21331	Permission for bungalow and associated works.	Grant
21117	Permission for demolition of extension to existing bungalow and construction of a storey and a half extension and associated works.	Grant
19240	Permission for construction of domestic store and garage and all ancillary site works	Grant

Please refer to the planning file on Longford County Councils online planning portal for full details in relation to this application.

5. Surrounding area

5.1 Quary at Rhine, Killoe, Co Longford

LCC Reg Ref 2017

Located c. 4.5km north west of the proposed development

10-year permission for the continuance of

(i) extraction of aggregates on an area of 1.431 hectares;
(ii) processing/loading of aggregates on an area of 0.233 hectares;
(iii) manufacture of ready-mix concrete in existing plant (176m2);
(iv) importation and storage of sand for use in concrete manufacturing (0.008 hectares);
(v) use of existing weighbridge and wheel wash (154m2) and
(vi) existing site entrance and access areas (0.956 hectares), all within 2.661 hectares of the site development authorised under Pl08/529 and all ancillary works.

On 17.06.2020 Longford County Council granted permission for the proposed development subject to 16 conditions. The decision was not appealed.

ePlan - Online Planning Details

➔ The application was not accompanied by an EIAR or NIS.

An **EIA Screening** report concludes: Following this EIAR Screening Assessment using the Screening Checklist as outlined in the Guidance on EIA Screening (Directive 2011/92/EU as amended by 2014/52/EU) (European Commission, 2017), it is concluded that the proposed development is not likely to result in significant effects on the environment and as such, the proposed project will not be required to proceed to the EIA process.

Screening for AA concludes: The existing quarry site at Killoe, County Longford and the current proposals for the site will not have any significant effects upon any Natura 2000 site because of the site's location and significant separation distance from any European Sites. [...] The project can therefore be screened out of any further stages of Appropriate Assessment, and a Stage 2 NIS is not required for this development.

Please refer to the planning file on Longford County Councils online planning portal for full details in relation to this application.

LCC Reg Ref 2023006 *In 2023, Blessington Stone & Concrete Plant Hire also applied for permission in the immediate vicinity of the application above.*

The planning permission is for a 25-year period for the development of a total area of 18.6 hectares and comprises of the following:

(i) *Extraction of rock by blasting means down to a level of 20mOD from an area of approximately 14.2 Hectares.*
(ii) *Erection of a concrete batching plant, processing plant, block yard, storage sheds, workshop, office buildings, weighbridge, wheelwash, settlement lagoon and all other associated ancillary facilities at the proposed manufacturing area of approximately 2.1 Hectares.*
(iii) *Landscaping consisting of planted Berms surround (1.6 Hectares).*
(iv) *Entrance and access road from the public road to the manufacturing area (0.7 Hectares).*
(v) *Landscaping and restoration of the site on completion of extractions.*

This application was accompanied by an EIAR. The Planning Authority was not satisfied that sufficient information was submitted with the EIAR and Application to carry out a full assessment if environmental impacts in respect of the proposed development. The application was therefore deemed invalid.

5.2 Solar Farm at Ballykenny, Co Longford

LCC Reg Ref 19222, ABP Reg Ref 305969

Located c. 6km west of the proposed development

Permission for a solar farm at a 19ha site with an export capacity of c. 9MW.

LCC granted permission subject to 14 conditions on 24.10.2019. The decision was subsequently appealed to ABP by a 3rd Party. On 08.05.2020 An Bord Pleanála granted permission for the proposed development subject to 4 (revised) conditions.

ePlan - Online Planning Details; 305969 | An Bord Pleanála (pleanala.ie)

- The application was not accompanied by an EIAR, however, a NIS was prepared with respect of the proposed development.

Appropriate Assessment Screening: "The Board noted the Natura Impact Statement submitted with the application. The Board accepted and adopted the Inspector's screening assessment and conclusions in respect of the identification of the European sites which could potentially be affected by the proposed development, and the identification and assessment of the potential likely significant effects of the proposed development, either individually or in combination with other plans or projects, on these European sites in view of the sites' conservation objectives. The Board was satisfied that the only European sites that could potentially be affected by the proposed development, individually or in combination with other plans or projects, are the Lough Forbes Complex Special Area of Conservation (site code 001818), and the Ballykenny-Fisherstown Bog Special Protection Area (site code 004101), in view of the sites' conservation objectives."

Natura Impact Statement: "The Board was satisfied that, subject to compliance with the mitigation measures as set out in the submitted Natura Impact Statement, as modified by the Inspector in her report, the proposed development, individually or in combination with other plans or projects, would not adversely affect the integrity of the two European sites, in the light of their conservation objectives and qualifying interests."

Environmental Impact Assessment Screening: ABP concluded that **"**The proposed development is not of any type included in Schedule 5 of the Planning and Development Regulations 2001 (as amended), i.e. development for which mandatory EIA is required nor is it integral to any project that is of a type included in Schedule 5. Having regard to the nature and scale of the development, there is no real likelihood of significant effects on the environment arising from the development. The need for environmental impact assessment can, therefore, be excluded at preliminary examination and a screening determination is not required."

5.3 Solar Farm at Cleggil Co Longford

LCC Reg Ref 17/47, ABP Reg Ref 248470

Located c. 4.5km west of the proposed development

10- year permission for a solar farm on a 19 ha site with an export capacity of 11.1MW.

LCC refused permission subject to 3 reasons on 12.04.2017. The decision was subsequently appealed to ABP by the applicant. On 22.03.2018 An Bord Pleanála granted permission for the proposed development subject to1 13 conditions.

ePlan - Online Planning Details; 248470 | An Bord Pleanála (pleanala.ie)

- The application was not accompanied by an EIAR or NIS.

Appropriate Assessment Screening: ABP considered that "it is reasonable to conclude that based on the information on file, which I consider adequate to issue a screening determination, that the proposed development, individually or in combination with other plans or projects, would not be likely to have a significant effect on any designated European site in view of those sites' conservations objectives and that a Stage 2 Appropriate Assessment (and submission of an NIS) is not therefore required."

Environmental Impact Assessment Screening: ABP concluded "Solar farms are not listed as a class of development under Part 1 or 2 of Schedule 5 of the Planning and Development Regulations 2001-2017, as amended, whereby a mandatory EIA and the submission of an

EIS is required. [...] I also consider that the subject development is a not 'sub-threshold development' for the purpose of EIA and an EIS is not required for the development."

5.4 Solar Farm at Lisnageeragh, Edgeworthstown, Ballinalee Road Co. Longford

LCC Reg Ref 16/81, ABP Reg Ref 246850

Located c. 11.5km south east of the proposed development

10-year permission for a solar farm on a site of c.14.5 ha with an export capacity of approximately 4.2MVA and all associated works.

LCC granted permission subject to 16 conditions on 09.06.2016. The decision was subsequently appealed to ABP by a 3rd Party. On 07.11.2016 An Bord Pleanála granted permission for the proposed development subject to 16 (revised) conditions. Compliance submissions were made to Longford County Council in 2023.

ePlan - Online Planning Details; 246850 | An Bord Pleanála (pleanala.ie)

- The application was not accompanied by an EIAR or NIS.

Appropriate Assessment Screening: The Board agreed with the Inspector, and is satisfied that, having regard to the separation distance between the subject site and the nearest European sites and to the lack of potential for connectivity with those sites, the proposed development, including the grid connection, either individually or in combination with other plans or project would not be likely to have significant effects on the European Sites having regard to the conservation objectives of these sites.

5.5 Bloomfield Park SHD at Bracklin Road, Edgeworthstown, Road Co Longford

ABP Reg Ref 313318

Located ca. 11km south east of the proposed development

The Strategic Housing Development comprises the demolition of an existing building and the construction of 100 no. residential units (50 no. houses, 50 no. apartments) and associated site works at a site located within Edgeworthstown's urban boundary, c.1km northwest of the town centre.

On 12.09.2023 An Bord Pleanála granted permission for the proposed development subject to 28 conditions. 313318 | An Bord Pleanála (pleanala.ie)

- The application was not accompanied by an EIAR or NIS.

Appropriate Assessment Screening: The Board completed an Appropriate Assessment screening exercise in relation to the potential effects of the proposed development on designated European Sites, taking into account the nature, scale and location of the proposed development, the Ecological Impact Assessment and Appropriate Assessment submitted with the application, the Inspector's Report, and the submissions on the application. In completing the screening exercise, the Board adopted the report of the

Inspector and concluded that, by itself or in combination with other developments in the vicinity, the proposed development would not be likely to have a significant effect on any European Site in view of the Conservation Objectives and qualifying interests of such sites, and that a Stage 2 Appropriate Assessment is not, therefore, required.

Environmental Impact Assessment Screening: The Board completed a preliminary examination in relation to the requirement for an Environmental Impact Assessment, taking into account the nature and scale of the proposed development, the location of the site on zoned and serviced lands within an existing built-up area, and outside of any sensitive and or designated location, the existing pattern of residential development in the vicinity, and the criteria set out in Schedule 7 of the Planning and Development Regulations 2001, as amended. In completing the preliminary examination, the Board adopted the report of the Inspector and concluded that there is no real likelihood of significant effects on the environment arising from the proposed development, and that the need for an environmental impact assessment and the submission of an Environmental Impact Assessment Report for the proposed development would not, therefore, be required.

6. Other Windfarms

The closest operating windfarm to the subject site is Sliabh Bawn Wind Farm in County Roscommon, ca 20km west of the subject site.

Additionally, an application for a single wind turbine in Lissanore, Co Longford, ca. 14 km southeast of the subject was granted permission by An Bord Pleanála in June 2024.

Furthermore, an application for the Derryadd Wind Farm (c. 12km southeast of the site) has been granted by ABP in 2020. The decision has subsequently been quashed by Order of the High Court in 2022. ~~However, it is understood that the applicant is currently in the progress to prepare a new application at this site.~~ A revised application for this Wind Farm has been submitted in May 2025, for further detail see Section 6.3 below.

6.1 Sliabh Bawn Wind Farm at Strokestown, Co Roscommon

ABP PL 20.239743 and RCC Ref 10/507

An Bord Pleanála (pleanala.ie); ePlan - Online Planning Details; Home - Sliabh Bawn Windfarm

- The Sliabh Bawn Wind Farm comprises 20 no. 3.2MW turbines.
- The project has a maximum export capacity of 58 MW.
- A substation was constructed at the northeastern end of the site and the wind farm connects into the existing 110kV power line which crossed the site.
- Development commenced in 2015 in accordance with the planning permission that was granted for the project by An Bord Pleanála in March 2012.
- On 17th August 2018 the county council planning office confirmed that the development is operating in compliance with the conditions set in the original Grant of Permission.
- The site is of north/south orientation, approximately three kilometres in width and seven kilometres in length. The total site area is approximately 833 hectares and ranges in elevation from 70 metres to 262 metres OD (Malin Head).

6.2 Lissanore, Co Longford

LCC Reg Ref 2360010, ABP Reg Ref 317459

Permission for the construction of one Enercon E138 Wind Energy Converter on an 81m tower with an electrical rating of 4.2MW and an overall tip height of 149.38m.

LCC granted permission subject to 16 conditions on 08.06.2023. The decision was subsequently appealed to ABP by 3 no. 3rd Parties. Permission was granted by ABP in June 2024

ePlan - Online Planning Details; 317459 | An Bord Pleanála (pleanala.ie)

- The application was not accompanied by an EIAR or NIS.

Appropriate Assessment Screening: LCC's Planners Report states: "Having assessed the submitted Appropriate Assessment Screening report the Planning Authority is satisfied that the proposed development individually or in combination with other plans or projects, will not have a significant effect on any European sites."

Environmental Impact Assessment Screening: LCC's Planners Report states: "Schedule 5 of the Planning & Development Regulations 2001 (as amended); Part 2 Para 3 (j) relates to the applicable thresholds for the proposed development. The development of a single wind turbine with an output of c.4.2 megawatts (not exceeding 5 megawatts) does not exceed either of the above thresholds and the proposed development does not fall into the mandatory requirement under the EIA Directive for the preparation of and Environmental Impact Assessment Report. "

The EIA Screening carried out by the applicant states that "having regard to the limited nature and scale of the proposed development, the absence of any significant environmental sensitivity in the vicinity of the proposed development and the absence of connectivity to any sensitive environment. There is no real likelihood of significant effects on the environment. As the purpose of thresholds within the EIA Directive is to distinguish between those projects which are likely to have significant environmental effect and those that are not, it can therefore be concluded that, as the proposed development does not exceed the relevant EIA threshold, it is unlikely to have any likely significant effects on the environment."

6.3 Derryadd Wind Farm

A 10-year planning permission for the construction of a wind farm comprising 24 no. wind turbines, 1 no. 110kV substation and all related works was sought in 2019. Permission granted by ABP in 2020. The decision has subsequently been quashed by Order of the High Court in 2022. ~~However, it is understood that the applicant is currently in the progress to prepare a new application at this site.~~

A revised application for this Wind Farm has been submitted in May 2025.

ABP Planning references:

- 31.01.2019 - SID Application 303592 | An Bord Pleanála (pleanala.ie)
- 26.10.2022 - Determination that proposed development is Strategic Infrastructure 314965 | An Bord Pleanála (pleanala.ie)
- 01.02.2024 - Request to enter into pre-application consultation 318974 | An Bord Pleanála (pleanala.ie)
- 09.05.2025 – New SID Application 322485 | An Coimisiún Pleanála accompanied by an EIAR and NIS

- ➔ ~~The 2019 application was accompanied by an EIAR and NIS. It can be expected that this will also be the case for the new application.~~

The final preferred layout for the new application was published in June 2023 and comprises 22 turbines. A review of the current layout submitted with the Derryadd Wind Farm application has confirmed it remains consistent with the June 2023 version.

June 2023 Layout: Derryadd-Wind-Farm-Final-Layout-Infrastructure-Map.pdf (derryaddwindfarm.ie)

Further information can be found here: Bord na Móna Wind Farm | Derryadd Wind Farm, and www.derryaddwindfarmplanning.ie

7. Plans

7.1 Longford County Development Plan 2021-2027

The subject site is located within the functional area of Longford County Council and is governed by the Longford County Development Plan 2021-2027 (LCDP), which was adopted by the members of Longford County Council (LCC) on the 19th of October 2021. The Plan came into full effect on the 30th of November 2021.

7.2 Longford Local Area Plan 2023-2029 / 2025 - 2031

Longford County Council ~~is preparing~~ prepared a new 6-year Local Area Plan (LAP) for Longford Town, originally for the period 2023-2029, but revised to 2025-2031. The LAP is a statutory document prepared by the Planning Authority, in accordance with the requirements of the Planning and Development Act 2000 (as amended). The LAP sets out a land use strategy for the proper planning and sustainable development of the town to comply with the provisions of the Longford County Development Plan 2021—2027.

~~The Draft LAP was issued for consultation in September 2024 and Public Consultation closed on October 18th.~~ The Longford LAP 2025-2031 has come into effect on the 3rd June 2025.

Based on the Draft LAP, the proposed development site is located outside the LAP boundary and the LAP makes no reference to the proposed development site or the development of renewable energy projects in the vicinity of Longford Town.

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APPENDIX 1.3

COMMUNITY REPORT

VOLUME III

APPENDICES TO

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

RFI Response July 2025

Community Report

Cloonanny Wind Farm

Last Updated: 11/10/2024

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Contents

Introduction

This Community Report was prepared by Natural Forces Renewable Energy 2 Limited (Natural Forces).

The report outlines the approach taken by Natural Forces to inform and engage with the local communities during the development stage of the proposed development.

Natural Forces have adhered to the Guidelines for Community Engagement 2016[1], the Draft Revised Wind Energy Development Guidelines 2019[2] (the draft WEDG 2019), and the 2012 Best Practice Guidelines for the Irish Wind Energy Industry[3], which sets the standards for community engagement for developers .

A Communication Plan has been included (Appendix A) and outlines the methods and mediums Natural Forces will implement to ensure the community are kept informed with regards the proposed development.

Proposed development Overview

The proposed development will be located in the townlands of Gorteenorna, Derryharrow, Corragarrow, Cloonanny Glebe, Co. Longford. The proposed development will involve the construction of two Enercon E175 EP5 E2 Wind Energy Converters, each with an electrical rating of 7 MW. These turbines will have a rotor diameter of 175 metres, a hub height of 112.4 metres, and a blade tip height of 199.6 metres.

Additionally, the development will include a 20 kV substation compound, comprising two prefabricated modular substation buildings, battery storage containers, and associated infrastructure.

A full proposed development description is provided in Chapter 02 Development Description of this EIAR.

Purpose

As per the 2012 Best Practice Guidelines for the Irish Wind Energy Industry, local engagement should begin before a planning application is submitted. The purpose of this Community Report is to summarise Natural Forces engagement efforts to date, including the materials presented, offering a comprehensive overview of stakeholder interactions.

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[1] https://www.gov.ie/en/consultation/8f3c71-public-consultation-on-the-revised-wind-energy-development-guideline/
[2] https://www.gov.ie/en/publication/9d0f66-draft-revised-wind-energy-development-guidelines-december-2019/
[3] https://windenergyireland.com/images/files/9660bdfb5a4f1d276f41ae9ab54e991bb600b7.pdf

Background

Natural Forces is a private, independent power producer that develops, constructs, owns, and operates wind, solar, and hydro proposed developments in Ireland, Canada, and France. The company has extensive experience developing renewable energy proposed development and working with communities, to inform and involve them in proposed development.

Natural Forces acknowledges that traditional information sharing methods are not always effective. Consequently, the organization has spent several years developing alternative engagement strategies to reach all stakeholders. The strategies, implemented by the proposed development team in the development of the proposed development, are detailed throughout this report.

Geographical area for Engagement

According to the draft WEDG 2019, the appropriate geographic scope for engagement is determined by the proposed development's scale. To effectively encompass the site and its surrounding areas, a buffer zone extending 1.75km around each turbine and equal to 10 times the turbines' rotor diameter has been established. This buffer zone forms the Zone of Influence (ZoI) and represents the geographical area for engagement.

Figure 1 –Zone of Influence

Engagement Process

Natural Forces recognises the importance of community engagement for the proposed development. Various communication strategies were employed, tailored to the specific needs of each stakeholder group. Based on the Communication Plan (Appendix A), the following individuals were identified as key stakeholders to the proposed development:

- Immediate neighbours
- Local residents
- Community register signatories

Immediate Neighbours

Immediate neighbours are defined as residents living along roads L5046 and L50461 (Figure 2).

Figure 2 – Immediate neighbours

Natural Forces began working on the proposed development in Q4 2021 early 2022. First engagements were made with the immediate neighbours in April 2022, This engagement involved members of the Natural Forces team calling door-to-door, distributing informational leaflets and speaking directly to residents about the proposed development and planned installation of a met mast scheduled for the following month (Appendix B).

During these visits, members of the Natural Forces team addressed residents' concerns and gathered valuable feedback. This direct engagement with the community was crucial in understanding their perspectives and helped inform the overall design of the proposed development . Based on the feedback received, the original layout was modified, and the number of turbines was reduced from four to two turbines to minimise the overall impact of the development on the local area.

Between Q4 2021 and September 2024 the Natural Forces team along with specialist consultants undertook extensive survey and assessment of the proposed development site and surrounding environs as a part of the EIAR process.

The team met Longford County Council through a pre- planning submission consultation in April 2024. The purpose of that meeting was to outline the progress made with the proposed development, the revised site layout and the findings of third party consultant assessments. The meeting with the county council served as a forum for the council to raises any concerns they had in relation to the proposed development and outline areas where they felt further assessment or attention was required. It was agreed that further community engagement was essential in advance of a planning submission for the proposed development.

On Friday 27th September 2024, Natural Forces undertook door to door visits with the immediate neighbours to provide further updates. During course of this engagement effort neighbours were provided with an information leaflet outlining the progress made in relation to the proposed development and invited to a further information session.

For those not at home during the door to door visits, an information pack was put through the letterbox for them. The pack contained details about the proposed development, contact information, and an invitation to attend an information session 09/10/2024 (Appendix C).

Residents within the Zone of Influence (ZoI)

In addition to the door to door visits which took place on Friday 27th September 2024, the same information package containing details about the proposed development, contact information, and an invitation to attend an information session on the 09/10/2024 (Appendix C) were distributed by post on the 01/10/2024 to all 184 residential dwellings within the Zone of Influence (ZoI) (nFigure 1 –Zone of Influence).

Proposed Development Information Session

The Natural Forces team held an information session on the proposed development. The session was held on 09/10/2024, at The Old Forge in Kiernan's Cross, between 14:30 & 20:00 This location was chosen due to its proximity to the proposed development and convenient parking.

In addition to the invitations sent to immediate neighbours and Residents within the Zone of Influence (ZoI), the event was advertised on the our website (Appendix D).

The session, designed as a walk-in event, and followed the 2016 Guidelines for Community Engagement, Approximately 50 residents attendees the information session which presented details relating to the proposed development layout & design, the project's benefits and potential impacts, Maps, photomontages, and other visual materials were displayed. (Appendix E).

Attendees had the opportunity to ask questions directly to the Natural Forces team, planning consultants from McCutcheon Halley, and environmental and engineering specialists.

During the event, the most frequently asked questions were about noise, shadow flicker, traffic and transport, and community benefits. In response, the website's FAQ section (https://www.naturalforces.ie/projects/cloonanny-wind-project/) was updated to address these common concerns.

Community Register Signatories

At the information session, attendees had the chance to give feedback and join the Community Register Signatories by adding their names to the sign in sheet or by scanning a QR code that linked to a survey (Appendix F). This survey allowed participants to share their thoughts on the project and, by joining the registry, they ensured they would receive the latest project updates through their preferred communication method, whether by email or text message. 24 people were added to the registry during the information session.

Community Benefits

Natural Forces acknowledge that the Guidelines for Community Engagement 2016 stipulates that wind energy developers should identify the benefit to the communities concerned from the proposed development. These benefits which were expressed in the leaflets and the information session, are explained further in the sections below.

Community Benefit Fund

A mandatory Community Benefit Fund (CBF) is required for all projects that are successful in a RESS auction. This fund is currently set at €2/MWh generated for approximately 15 years. For a project involving two turbines, with an average wind speed of 6 m/s and utilising the Enercon E175 power curve, the anticipated CBF would be approximately €76,000 annually. This estimate is similar to what can be anticipated for the Cloonanny Windfarm.

This fund will specifically target and incentivise investments in the wider economic, environmental, social and cultural well-being of the local community. There is a potential to use the CBF to develop a walkway and cycleway around the windfarm, along with interpretive signage, outdoor exercise equipment, and a learning hub. This hub could be used by school and college groups for educational purposes and day trips. Other examples of projects that have been funded through CBFs include scholarships, community centres, energy upgrades in sports clubs and community centres, education programmes and disability access projects.

Local Infrastructure and Job Creation

The proposed development will involve significant investments in local infrastructure, such as roads and electrical systems. This investment will not only improve the overall quality of local infrastructure but also create employment opportunities in construction and related industries. Furthermore, the proposed development will contribute to contracting opportunities at various stages, including development, construction, operation, and decommissioning. These employment opportunities will have a positive impact on the local economy, providing a boost to businesses in the area and increasing revenue through project-related activities.

Environmental Advantages

Replacing fossil fuels with renewable energy sources such as wind helps reduce emissions of greenhouse gases and other pollutants. This reduction in air pollution can enhance the quality of life for residents, alleviating the prevalence of diseases such as stroke, heart disease, lung cancer, chronic respiratory illnesses, and acute respiratory conditions like asthma.

Next Steps

Engagement at All Stages

Community engagement will be sustained throughout all phases of the proposed development, from construction through the entire operational phase and into decommissioning. Similar approaches, based on the Communication Plan (Appendix A), will be employed at each stage.

The Appointment of a Community Liaison Officer

Once the proposed development receives planning permission, a Community Liaison Officer (CLO) will be appointed. The CLO will be responsible for providing full, clear, and comprehensive information about the development at key milestones, using methods outlined in the communication plan. All relevant stakeholders will have access to the CLO's contact details. The CLO will record, investigate, respond to, and address queries and complaints throughout all stages of the development.

Conclusions

Natural Forces has actively engaged and maintained dialogue with the local community from an early stage, during the pre-application stage of this project. The process has been an extremely valuable exercise and has provided a detailed and enhanced understanding of the key issues and concerns of the local community, which have ultimately helped shape the final design of the proposed development.

Appendices

Appendix A – Communication Plan

Appendix B – Met Mast Information Leaflet

Appendix C – Project Information Leaflet/Information Session Invitation (Information Pack)

Appendix D – Advertisement on Webpage

Appendix E – Information Session Material (Posters & Photomontage Booklet)

Appendix F - Survey QR Code

Appendix A – Communication Plan

Communication Plan

Cloonanny Wind Farm

Last updated: 11/10/2024

Natural Forces
3rd Floor, Hampton House,
27 Mount Street Lower,
Dublin, D02 FC43

www.naturalforces.ie

Natural Forces

Natural Forces

Contents

Introduction

This Communication Plan was prepared by Natural Forces Renewables Ireland Limited 2 (Natural Forces).

The purpose of the plan is to outline the strategies and procedures for engaging with all stakeholders throughout the life of the Cloonanny Wind Farm (the proposed development).

The communication plan adheres to the Guidelines for Community Engagement 2016[1] and the Draft Revised Wind Energy Development Guidelines 2019[2], which sets the standards for community engagement for developers. This plan is a live document and will be updated and refined over time and made available via the Project's webpage.

Project Overview

The proposed development will be located in the townlands of Gorteenorna, Derryharrow, Corragarrow, Cloonanny Glebe, Co. Longford. The proposed development will involve the construction of two Enercon E175 EP5 E2 Wind Energy Converters, each with an electrical rating of 7 MW. These turbines will have a rotor diameter of 175 metres, a hub height of 112.4 metres, and a blade tip height of 199.6 metres.

Additionally, the development will include a 20 kV substation compound, comprising two prefabricated modular substation buildings, battery storage containers, and associated infrastructure.

A full proposed development description is provided in Chapter 02 Development Description of this EIAR.

Purpose

The purpose of this Communication Plan is to serve as a guide for effectively engaging with local residents and stakeholders.

[1] https://www.gov.ie/en/consultation/8f3c71-public-consultation-on-the-revised-wind-energy-development-guideline/
[2] https://www.gov.ie/en/publication/9d0f66-draft-revised-wind-energy-development-guidelines-december-2019/

Background

Natural Forces is a private, independent power producer that develops, constructs, owns, and operates wind, solar, and hydro proposed developments in Ireland, Canada, and France. The company has extensive experience developing renewable energy proposed development and working with communities, to inform and involve them in proposed development.

Natural Forces acknowledges that traditional information sharing methods are not always effective. Consequently, the organization has spent several years developing alternative engagement strategies to reach all stakeholders. The strategies, implemented by the proposed development team in the development of the proposed development, are detailed throughout this plan.

Local Residents & Stakeholders

As outlined in the draft WEDG 2019, the geographic scope for stakeholder engagement is based on the scale of the project. To adequately cover the site and its surrounding areas, a buffer zone has been established, extending 1.75 km from the proposed development, equivalent to 10 times the turbines' rotor diameter.

Zone of Influence

This buffer zone defines the Zone of Influence (ZoI), representing the geographical area within which stakeholder engagement will take place.

Figure 1 –Zone of Influence

Methods of Communication

As the proposed development progresses, the Natural Forces team will adopt a combination of communication methods to ensure residents and stakeholders are kept informed and engaged.

The following methods will be implemented:

- **Door-to-Door Visits**: Direct communication with residents in the immediate area.
- **Newsletters/Leaflets**: Distributed to nearby residents to provide updates on the project timeline, key milestones, and opportunities for engagement.
- **Emails/Texts**: will be sent to individuals who sign the community register, to ensuring they receive regular updates.
- **Project Website**: The dedicated project website (Natural Forces Cloonanny Wind Project) will be continuously updated with key information, planning documentation, and relevant links.
- **Dedicated Email Address**: A specific email (info@naturalforces.ie) will be available to facilitate direct communication, enabling real-time discussions and quick resolutions of any concerns.
- **Public Information Meetings**: Held in venues near the proposed development, such as The Old Forge, Kiernan's Cross, allowing residents to participate and discuss the project.
- **Consultation with Neighbours**: Regular communication will occur with immediate neighbours, particularly residents along roads L5046 and L50461
- **Signage**: Information boards will display key project details, such as construction schedules and Natural Forces contact information.
- **Community Liaison Officer (CLO)**: A CLO will be appointed to act as a central contact point, with their contact details shared via leaflets and the company website.

Construction-Phase Specific Communication Methods:

1. **Construction Bulletins**: Regular updates on construction progress, timelines, and potential disruptions will be communicated through door to door visits, newsletters, emails, or flyers.
2. **Construction Notification Letters**: Regular letters will be sent to residents, informing them of specific activities that may affect them, such as increased traffic or abnormal load deliveries.
3. **Information Meetings**: If necessitated information meetings will be organised provide updates on construction progress and address any concerns or schedule changes.
4. **Interactive Maps**: Digital or printed maps will be provided to show construction progress and highlight areas affected by ongoing activities.

Conclusion

This plan outlines Natural Forces communication strategy across all stages of the proposed development. By adhering to the Guidelines for Community Engagement 2016 and the Draft Revised Wind Energy Development Guidelines 2019, and utilising various communication methods, the transparent and effective communication with all stakeholders is achieved.

Appendix B – Met Mast Consultation Cloonanny

Natural Forces

Who we are

Natural Forces is a Private Independent Power Producer (IPP) headquartered in Halifax, NS, Canada, with teams in New Brunswick, New York, and Ireland

Natural Forces has wind, solar, energy storage and hydro projects in development throughout Canada, Ireland, and New York state.

We develop projects in partnerships with First-Nations communities, universities, and corporations.

Natural Forces develop, finance, construct, operate and own projects.

Natural Forces are looking to develop several wind energy projects across Ireland.

Natural Forces are currently progressing a number of community owned single turbine projects through-out Ireland in line with the Department of the Environment, Climate and Communications renewable energy support scheme (RESS).

Proposed Project

Natural Forces have identified the lands within Cloonanny Glebe, County Longford as potentially suitable for the development of a wind energy project. Natural Forces are at the early stages of our development cycle with this project, which involves carrying out various assessments such as environmental surveying, technical assessments, wind resource monitoring etc.

To better understand the wind resource in the area of Cloonanny Glebe, Natural Forces plan on erecting a wind monitoring mast (Met Mast) in May 2022.

This mast will simply record the wind speed and direction at the site at different elevations using a cup anemometer and wind vane.

The data collected during the monitoring period will enable us to understand whether the conditions at the site are suitable for the development of a wind energy project.

Contact us

As the project progresses, Natural Forces will host a number of public consultation meetings in the local area.

If you would like to get in contact with anyone from our team, please contact us using the following details.

Name: Jonathan Wagner Coffey
Position: Development Manager
Email: jcoffey@naturalforces.ie
Phone: +353 87 63 52172

Appendix C – Information Pack

Natural Forces

27 Mount Street Lower,

Dublin 2,

Ireland,

D02 FC43

Date: 27/09/2024

Invitation for an Information Session about the Proposed Cloonanny Wind Farm

To whom it may concern,

We are pleased to invite you to a drop in information session to discuss the proposed Cloonanny Wind Farm. As a local resident, we want to ensure you are informed about the project and provide an opportunity for you to ask any questions you may have.

Event Details:

- **Date:** Wednesday 9th October 2024
- **Time:** 14:30 – 20:00
- **Location:** The Old Forge, Kiernan's Cross, Carriglass, Co. Longford (N39 A7N6)

Your feedback is important to us, and we look forward to sharing information about the benefits and details of the project. If you are unable to attend, please refer to the information leaflet enclosed with this invitation, which includes contact details for any questions you might have.

We hope to see you there.

Best regards,

Jonathan Wagner Coffey | Managing Director

Phone: +353 87 635 2172

Email: info@naturalforces.ie

NATURAL FORCES

Natural Forces, an independent power producer, intends to submit a planning application to Longford County Council in late 2024 for a wind farm in Cloonanny Glebe, Co. Longford. Founded in 2001 in Halifax, Nova Scotia, Natural Forces partners with Indigenous communities, universities, and municipalities to develop, construct, own, and operate renewable energy projects. Currently the company manages approximately 300MW of wind, solar, and hydropower projects across Canada, Ireland, and France.

PROJECT DETAILS

The project will involve constructing two Enercon E175 EP5 E3 Wind Energy Converters, each with a rotor diameter of 175m, a hub height of 112.4m, a blade tip height of 200m, and an electrical rating of 7 MW. Additionally, the project will include the construction of a 20kV substation compound comprised of two pre-fabricated modular substation buildings and containerised battery storage modules placed on concrete plinths and associated works, such as underground cabling to connect to the national grid.

LOCATION

The 21.66-hectare site is made up of several private land parcels and is located in an agricultural area, 3.3km northeast of Longford Town. Nearby settlements include Clonbalt Wood and Newtown Forbes. The N4 National Road and the River Camlin lie to the south of the site, while the R194 Regional Road runs to the west.

SITE LAYOUT

WHY THIS SITE

The site is considered suitable for wind development in as per Longford's County Development Plan 2021-2027. It is not designated as a NATURA 2000 site, Special Area of Conservation (SAC), Special Protection Area (SPA), or Natural Heritage Area (NHA). The site also benefits from high annual average wind speeds and allows for a substantial 800m setback between turbines and residential properties, aligning with the Draft Wind Energy Guidelines 2019.

ENVIRONMENTAL IMPACT ASSESSMENT

An Environmental Impact Assessment Report (EIAR) will be submitted as part of the planning application. The EIAR assesses a wide range of topics, including human health, biodiversity, birds, bats, archaeology, shadow flicker, noise and vibration, water and hydrology, wind resource, landscape and visual aspects, geology, and traffic and transport.

BENEFITS

Financial

During peak construction, approximately 50 jobs will be created, benefiting local businesses that can provide services like materials, labour, and accommodation.

Once operational, the project will pay commercial rates to Longford County Council, supporting local services including road upkeep, fire services, street lighting, footpath maintenance etc.

If the project is successful in a RESS auction, a Community Benefit Fund will be established. The fund is set at €2 per MWh generated over approximately 15 years. This means that if the project generates 40,000 MWh annually, the fund will amount to €80,000 per year. This fund aims to support local initiatives in energy efficiency, education, sustainability, and safety.

Environmental

The project is expected to generate emission-free electricity, sufficient to power almost 9,000 homes annually, representing over 45% of county Longford's residences.

Switching from fossil fuels to renewable energy sources reduces greenhouse gas emissions. This shift can significantly improve residents' quality of life by reducing the incidence of diseases such as stroke, heart disease, lung cancer, and respiratory illnesses.

CONTACT DETAILS

Natural Forces

- Email: info@naturalforces.ie
- Telephone: 087-635-2172
- Website: https://www.naturalforces.ie/projects/cloonanny-wind-project/

Independent Advisory Bodies

- Longford County Council: www.longfordcoco.ie
- Sustainable Energy Authority: www.seai.ie
- Environmental Protection Agency: www.epa.ie
- Geological Survey of Ireland: www.gsi.ie
- National Parks and Wildlife Service: www.npws.ie
- Inland Fisheries Ireland: www.fisheriesireland.ie

CLOONANNY WIND FARM

Information Leaflet

Natural Forces

Appendix D – Webpage Screenshot

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around the country. Factors other than the strength and consistency of the wind must be taken into account when considering a site, such as proximity to the electricity grid, road access, ecology, archaeology, and cultural significance, proximity to residential dwellings, and health concerns.

The location of the Cloonanny Wind Project was selected after a thorough review of all of these factors.

Community Engagement

Natural Forces is committed to engaging with the public, stakeholders, and stakeholder groups throughout the lifetime of the project. We are both keen to ensure the community understands the project details and is aware of project activities, and to accept input and feedback from community members. Below is information about the major public and stakeholder engagement activities that have taken place to date, including summaries of the information that has been shared at our open houses.

Information Session

An information session for this project will place on **Wednesday 9th October 2024** at The Old Forge, Kiernan's Cross, Carriglass, Co. Longford (N39 A7N6). The event will follow a drop-in format, running from 14:30 PM to 20:00 PM.

What is the process?

1 Development	• Assess the wind resource • Survey for environmentally sensitive features • Optimize turbine location to capture the wind efficiently and minimize impact on sensitive features • Begin consultation with regulators and the public

Appendix E – Consultation Posters

Natural Forces

Information Session Ahead

Cloonanny Windfarm

Wednesday 9th October 2024

2:30—8:00pm

RECEIVED: 09/07/2025

Project Details

Cloonanny Windfarm

Natural Forces

Natural Forces, an independent power producer, intends to submit a planning application to Longford County Council in late 2024 for a wind farm in Cloonanny Glebe, Co. Longford. Founded in 2001 in Halifax, Nova Scotia, Natural Forces partners with Indigenous communities, universities, and municipalities to develop, construct, own, and operate renewable energy projects. Currently the company manages approximately 300MW of wind, solar, and hydropower projects across Canada, Ireland, and France.

Project Description

The project will involve constructing two Enercon E175 EP5 E3 Wind Energy Converters, each with a rotor diameter of 175m, a hub height of 112.4m, a blade tip height of 200m, and an electrical rating of 7 MW. Additionally, the project will include the construction of a 20kV substation compound comprised of two pre-fabricated modular substation buildings and containerised battery storage modules and associated works, such as underground cabling to connect to the national grid.

Location

The site is made up of several private land parcels and is located in an agricultural area, 3.3km northeast of Longford Town. Nearby settlements include Clonbalt Wood and Newtown Forbes. The N4 National Road and the River Camlin lie to the south of the site, while the R194 Regional Road runs to the west.

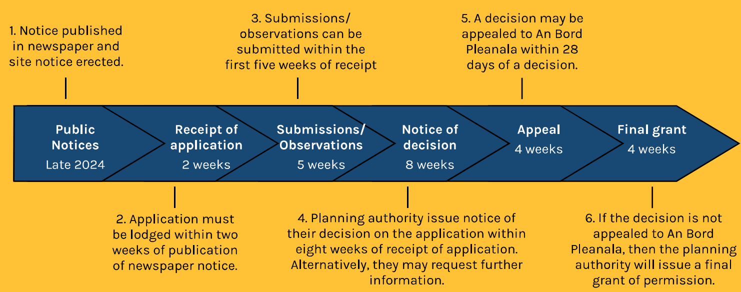
Why wind energy?

Utilising clean, renewable energy such as wind is a crucial step in addressing climate change [1]. If the rate of global warming continues to increase and the climate continues to change there could be severe adverse effects on Ireland[2] including:

- The spread of invasive species threatening Ireland's native wildlife
- Decreases in productivity for some agricultural crops
- Exposure to sea level rise, storm surges and coastal erosion
- Increases in both floods and droughts, with impacts for water resources and water quality
- Risk to built environments and heritage sites from extreme weather events
- Failures in critical infrastructure needed for public services and other sectors
- Negative impacts on health and wellbeing, with critical health infrastructure like hospitals and care homes facing increased risks from heat and flood extremes
- Unmanaged increases in tourism due to warmer summers creating damaging and unsustainable pressures on sensitive heritage sites and environments.

1. https://www.seai.ie/home-energy/take-climate-action/start-saving-energy/
2. https://www.epa.ie/environment-and-you/climate-change/what-impact-will-climate-change-have-for-ireland/#:~:text=By%20the%20middle%20of%20this,expected%20to%20occur%20more%20frequently.

Timescale for most planning permission cases



Contact Information

Natural Forces

- Email: info@naturalforces.ie
- Telephone: 087-635-2172
- Website: https://www.naturalforces.ie/projects/cloonanny-wind-project/

Independent Advisory Bodies

- Longford County Council: www.longfordcoco.ie
- Sustainable Energy Authority: www.seai.ie
- Environmental Protection Agency: www.epa.ie
- Geological Survey of Ireland: www.gsi.ie/en-ie/Pages/default.aspx
- National Parks and Wildlife Service: www.npws.ie
- Inland Fisheries Ireland: www.fisheriesireland.ie

Community Benefit Funds

Cloonanny Windfarm

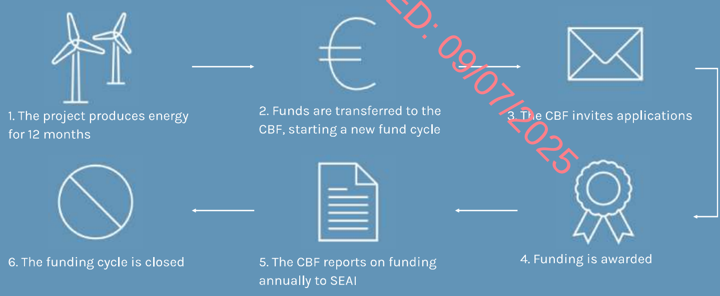
About the Community Benefit Fund

A key feature of projects that are developed under the Renewable Electricity Support Scheme (RESS) is the requirement for a mandatory Community Benefit Fund (CBF) to be established and dispersed within the local community on an annual basis for the duration of the RESS contract, approximately 15 years.

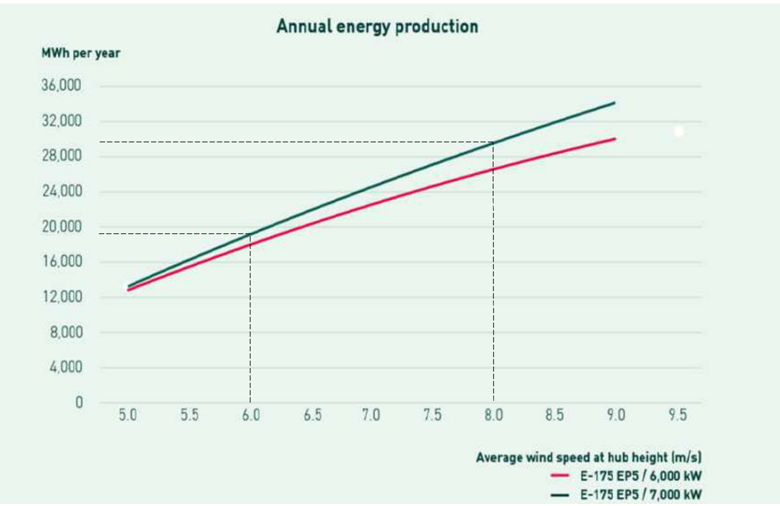
The contribution is to be set at €2 per Megawatt hour of generation produced by the RESS project. After 12 months of operation, the fund is calculated from total electricity generated from the project and is then advertised for community groups to apply.

This means there are real and quantifiable funds being made available annually for the benefit of the local community. The CBF will be aligned to incentivise investment in local renewable energy, energy efficiency measures and climate action initiatives[1].

The Funding Cycle[2]



How the Community Benefit Fund is Calculated and Allocated



Enercon's Power Curve for E175 EP5 / 7000kW[3]

Under the current terms and conditions, the calculation for a CBF is total electricity generated (MWh) x €2. To illustrate how this calculation works in practice, consider two hypothetical windfarm sites with different wind speeds. The Enercon Power curve, which outlines the expected power output relative to wind speed, is displayed on the left for reference.

Example	Average Wind Speed (m/s)	Generation	€/MWh	No. Turbines	Expected CBF per annum
Site A (moderate wind speeds)	6.0	19,000	2	2	19000 x 2 x 2 = €76,000
Site B (high wind speeds)	8.0	30,000	2	2	30,000 x 2 x 2 = €120,000

Example of how a CBF of €120,000 (Site B) is distributed after allocating €1,000 to each household within a 1-kilometer radius of the project[4].

Description	% of Fund	Annual Amount
Initiatives and projects that support Sustainable Development Goals within the local area	Minimum 40%	€48,000
Administration	Maximum 10%	€12,000
Local clubs, societies and near neighbours	Remainder (50%)	€60,000

What can a Community Benefit Fund Support?

The CBF can support not-for-profit community enterprises where the focus is aligned with UN Sustainable Development goals, further details can be found in the Good Practice Principles[3] published by The Department of Environment, Climate and Communications. Additionally, a near-neighbour payment will be paid to those living within 1km of the site through this fund. Examples of projects and initiatives that have been funded through CBFs include scholarships, community centres, energy upgrades in sports clubs and community centres, education programmes and disability access projects[2].

Case Studies

Hazelwood Tennis Club[5]

Hazelwood Tennis Club in Hazelwood, Newtwopothouse in Mallow, Co. Cork has been able to upgrade its club and accommodate new members thanks to the Castlepook CBF. Upgrades carried out included, replacing existing light bulbs with LED bulbs, adding a new seating area with recycled materials, and resurfacing 'Court 2'. The total cost of the project came to €22,500, with €16,500 covered by the Castlepook CBF.

An Súgán[6]

The establishment of An Súgán, the Museum of the Irish Language and Gaelic Revival in Ballingeary, Co. Cork, has been supported by grants totalling €28,000 from nearby CBFs. These funds were contributed by ESB's Grousemount Windfarm and SSE Renewables' Coomacheo & Curragh Windfarm in Cork and Kerry since 2020. Upon its opening, the museum aims to serve as a valuable educational resource and cultural tourism destination in Ballingeary village. It is projected to attract up to 8,000 visitors annually and will also host community events, thereby creating local employment opportunities.

1. https://www.seai.ie/community-energy/community-benefit-funds/
2. https://www.seai.ie/CBFs-for-Communities.pdf
3. https://www.enercon.de/en/turbines/e-175-ep5
4. https://www.gov.ie/en/publication/5f12f-community-projects-and-benefit-funds-ress/
5. https://www.youtube.com/watch?v=NotZ28d0fxY&t=25s
6. https://www.seai.ie/case-studies/an-sugan_cbf/

Environmental Background

Cloonanny Windfarm

Natural Forces

RECEIVED: 09/07/2025

Surveys

As part of the planning application, independent consultants conducted environmental surveys. These surveys cover built services and ecology, and include the following:

Magnitude of Impact			
No Impact	Low	Medium	High

Built Services

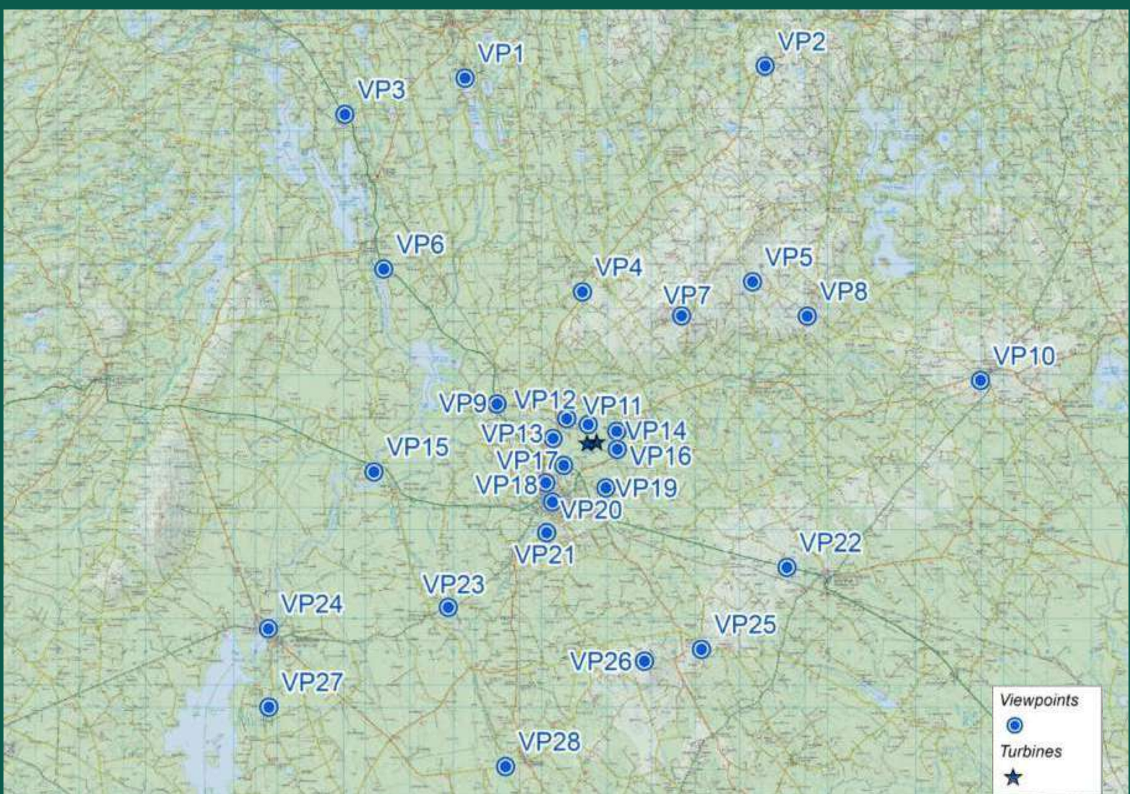
Survey	Description	Impact
Shadow Flicker	Assesses sunlight strobing effects from the sun shining through the rotating blades of a turbine on nearby properties.	A shadow shutdown system will turn off the turbines if shadow flicker is detected.
Noise	Analyses the sound levels generated by the turbines on the surrounding community and potential for noise disturbance.	Third-party experts AWN Consulting concluded that noise from construction, operation, and decommissioning activities will not be significant.
Aviation	Investigates how the turbine structures may interfere with aircraft flight paths, radar systems, and safety.	Third-party experts AiBridges concluded that the project is unlikely to affect nearby aviation systems.
Telecommunication	Evaluates potential disruptions the location of turbines might cause to radio, television, mobile, and other communication networks.	The turbine locations do not interfere with telecommunication lines.
Landscape Visual Impact	Assesses how the presence of turbines alters the visual character and aesthetic value of the surrounding environment.	Third-party experts Macroworks concluded that the project will have no significant impact on the landscape or visual amenity.

Ecology

Survey	Description	Impact
Biodiversity	Conducts a study of flora and fauna to assess the current biological conditions at the site and the potential impacts of the development on nearby ecosystems.	Mitigation and reinstatement efforts will result in only a temporary loss of biodiversity in the area.
Hydrology	Examines how water flows within the landscape, analysing baseline and adjacent hydrological conditions, and includes a flood risk assessment.	Turbine 2 is in an area with a 1% chance of an extreme flooding event occurring within 100 years, which could pose challenges during construction.
Ornithology and Bats	Studies bird and bat populations in the area, evaluating their activity to understand the potential impacts of the development on wildlife and includes a collision risk model.	Third-party experts ID Environment Consultants concludes that with mitigation and a bat management plan, there is no risk to bird or bat species.
Soils and Geology	Analyses soil and geological hazards that may arise from the construction of turbines, access tracks, and other infrastructure throughout the project's lifespan.	Third-party experts Whiteford Geoservices determined that the turbines are rated as low on their hazard scale.
Archaeology	Assesses potential archaeological sites and artifacts in the area to ensure that the development does not adversely impact historical and cultural resources.	Test trenching on the site found no features.

Photomontages

Viewpoint locations selected for the photomontages:



- VP1: Rinn Lough (17.4 km)
- VP2 R198 at Legga (18.6 km)
- VP3: N4 at Fearnaght (18.6 km)
- VP4: R198 at Drumlish (10.3 km)
- VP5 L1035 at Drumderg (11.3 km)
- VP6: R371 at Osprey Park (12.1 km)
- VP7: L1031 at Corn Hill (6.3 km)
- VP8: L1051 at Gelsagh (11.1 km)
- VP9: N4 at Newtown Forbes (4.5 km)
- VP10: Granard Motte and Bailey (17.7 km)
- VP11: L50461 at Derryharrow (1.1 km)
- VP12: L1018 at Melview (1.4km)
- VP13: R198 at Melview (1.4 km)
- VP14: Lane at Kiltybegs (1.1 km)
- VP15: Termonbarry Lock (9.8 km)
- VP16: R194 at Carrickglass Demesne (1.0 km)
- VP17: N4 at Camlin River, Longford (1.4 km)
- VP18: R198 at Abbeycartron, Longford (2.6 km)
- VP19: L1071 at Corrabaun, Longford (2.1 km)
- VP20: St Mel's Cathedral, Longford (3.1 km)
- VP21: L1127 at Aghafad, Longford (4.4 km)
- VP22: N4 at Edgeworthstown (10.3 km)
- VP23: N63 at Royal Canal (9.7 km)
- VP24: Harbour Lane, Ballyleague (16.7 km)
- VP25: St Patrick's Church, Ardagh (10.5 km)
- VP26: L5209 at Lisduff (10.1 km)
- VP27: L1167 at Carrowroe (18.7 km)
- VP28: L1136 at Mosstown Harbour (15.0 km)

Photomontages cont.

Baseline: Montage:

VP11:


VP13:


VP14:


VP17:


VP26:


macroworks

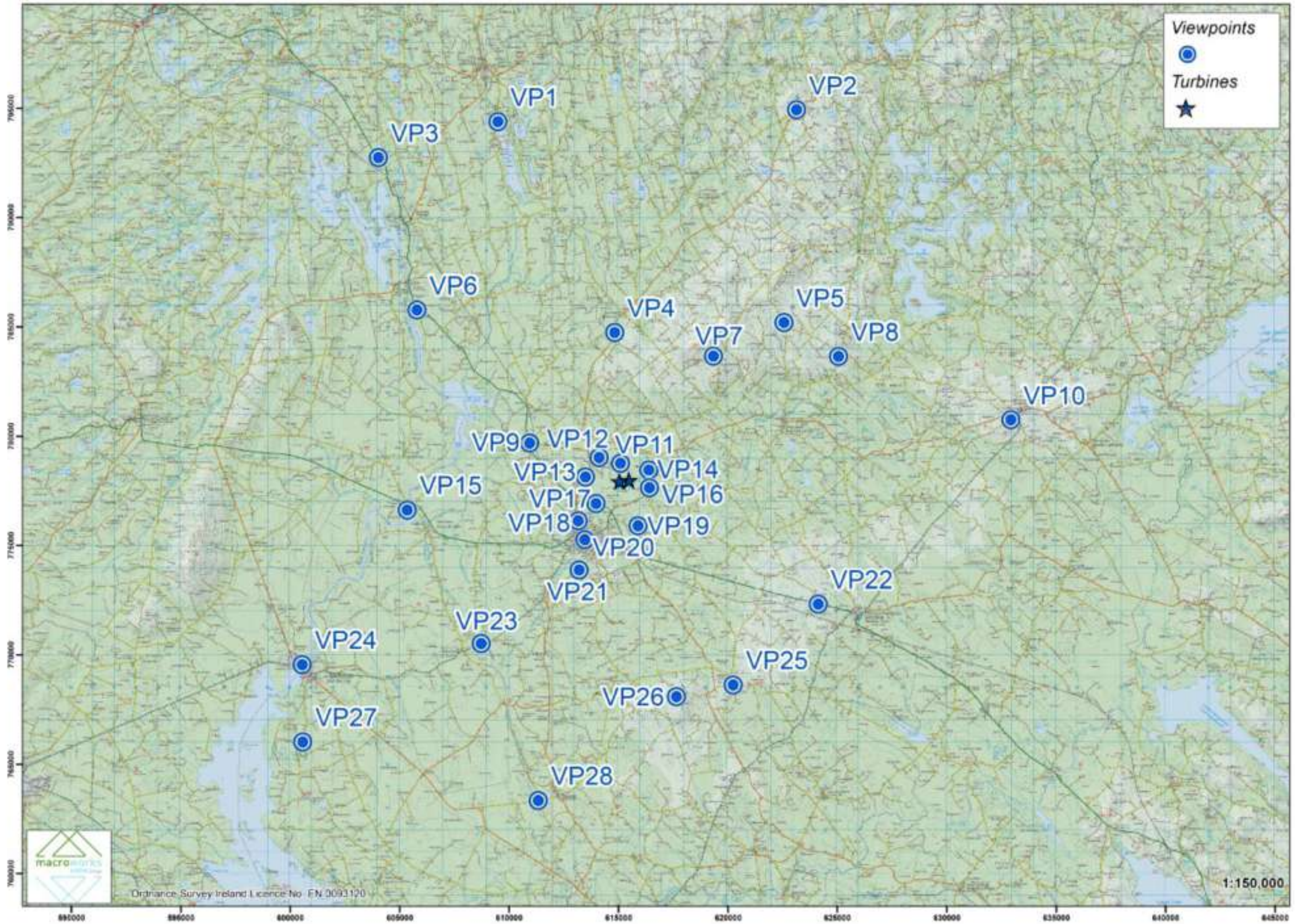
LVIA PHOTOMONTAGES

Cloonanny Wind Farm

This book contains imagery for the viewpoints chosen for the LVIA study

September 2024

Viewpoint (VP) Locations Selected



VP1: Rinn Lough

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VP8: L1051 at Gelsagh

VP9: N4 at Newtown Forbes

VP10: Granard Motte and Bailey

VP11: L50461 at Derryharrow

VP12: L1018 at Melview

VP13: R198 at Melview

VP14: Lane at Kiltybegs

VP15: Termonbarry Lock

VP16: R194 at Carrickglass Demesne

VP17: N4 at Camlin River, Longford

VP18: R198 at Abbeycarton, Longford

VP19: L1071 at Corrabaun, Longford

VP20: St Mel's Cathedral, Longford

VP21: L1127 at Aghafad, Longford

VP22: N4 at Edgeworthstown

VP23: N63 at Royal Canal

VP24: Harbour Lane, Ballyleague

VP25: St Patrick's Church, Ardagh Village

VP26: L5209 at Lisduff

VP27: L1167 at Carrowroe

VP28: L1136 at Mosstown Harbour

VP1:

Before

After

VP2:

Not visible from this VP

VP3:

VP4:

Not visible from this VP

VP5:

Before

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VP6:

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VP10:

VP11:

VP12:

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VP16:

VP17:

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VP18:

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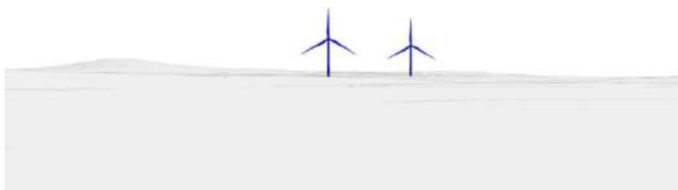

VP19:

VP20:

VP21:

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VP22:

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VP23:

VP24:

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VP25:

Before

After

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VP26:

VP27:

VP28:

Not visible from this VP

Appendix F – Survey QR Code

Natural Forces

We would love to hear your feedback. Scan the QR code with your phone to complete an optional survey.

APPENDIX 2.1

TURBINE SPECIFICATIONS

VOLUME III

APPENDICES TO
ENVIRONMENTAL IMPACT ASSESSMENT REPORT

RFI Response July 2025

RECEIVED: 09/07/2025

Technical description

ENERCON E-175 EP5 wind energy converter

ENERCON
ENERGY FOR THE WORLD

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Applicable documents

The titles of the documents listed are the titles of the original language versions, with translations of these titles in brackets where applicable. The titles of superordinate standards and guidelines are indicated in the original language or as an English translation. Document IDs always refer to the original language versions. If the document ID does not contain a revision, the most recent revision of the document applies. This list contains documents concerning optional components if necessary.

Document ID	Document
D02766054	Technische Daten E-175 EP5 (Technical specifications – E-175 EP5)

Table of contents

List of abbreviations

CFRP	Carbon fibre reinforced plastic
FACTS	Flexible Alternating Current Transmission System
FT	FACTS Transmission (electrical configuration with FACTS properties)
FTQ	FACTS Transmission with Q+ option (electrical configuration with extended reactive power range)
FTQS	FACTS Transmission with Q+ option and STATCOM option (electrical configuration with extended reactive power range and STATCOM option)
FTS	FACTS Transmission with STATCOM option (electrical configuration with STATCOM option)
GFRP	Glass-fibre reinforced plastic
SCADA	Supervisory Control and Data Acquisition
STATCOM	Static compensator

1 Product overview

Fig. 1: Product overview

The wind energy converter generates electrical energy from the wind. Wind flowing towards the wind energy converter causes the rotor to rotate clockwise. This rotational movement is converted into electrical energy. The wind energy converter operates automatically.

The wind energy converter essentially consists of the tower, the rotating nacelle with adjustable rotor blades and electrical components for generating and conditioning the electrical energy.

Gearless

The wind energy converter drive system comprises very few rotating components. The hub and the rotor of the generator are directly interconnected without a gear to form one solid unit. This reduces mechanical load and increases the technical service life. It reduces maintenance and service costs and also keeps operating costs to a minimum. Since there are no gears or other fast-rotating parts, the energy loss between generator and rotor as well as sound emissions are reduced.

Active pitch control

The active pitch control limits rotor speed and the amount of power extracted from the wind. The maximum output of the wind energy converter can then be limited to nominal power, even at short notice. Pitching the rotor blades into the feathered position stops the rotor without any load on the drive train caused by the application of a mechanical brake. The energy supply for emergency pitching of the rotor blades is located in the pitch control cabinets.

Indirect grid connection

The electrical power produced by the generator is fed via a full-scale converter into the grid. The full-scale converter decouples the generator completely from the grid and the electrical properties of the generator are irrelevant to the behaviour of the wind energy converter on the grid. The grid feed system with full-scale converter ensures maximum energy yield with excellent power quality.

The generator can be operated at an optimum operating point, e.g. speed, power, voltage, at any wind speed, by decoupling it from the grid.

2 Components of the ENERCON wind energy converter

2.1 Rotor blades

The rotor blades are made of GFRP, CFRP, balsa wood and foam and are a major factor in the wind energy converter yield and sound emissions. The shape and profile of the rotor blades were designed with the following criteria in mind:

- High power coefficient
- Long service life
- Low sound emissions
- Low mechanical loads
- Efficient use of material

The rotor blades of the wind energy converter were specially designed to operate with variable pitch control and at variable speeds. A polyurethane-based surface coating protects the rotor blades from environmental influences such as UV radiation and erosion. This coating is visco-hard and highly resistant to abrasion.

Microprocessor-controlled pitch units adjust each of the 3 rotor blades independently of each other. 2 blade angle measurements constantly monitor the set angle of each blade, and the 3 blade angles are adjusted individually. This enables quick and precise setting of the blade angles according to the prevailing wind conditions.

2.2 Nacelle

The hub rotates around the fixed axle pin on 2 rotor bearings. Among other components, the rotor blades and the generator rotor are attached to the hub. The slip ring unit is located at the tip of the axle pin. It transmits electrical energy and data between the stationary and rotating parts of the nacelle via sliding contacts.
The stator support is the load-bearing element of the fixed generator stator. The stator support is firmly connected to the main carrier. The stator supports the electrical windings in which the electric current is induced.
The main carrier is the central load-bearing element of the nacelle. All parts of the rotor and generator are attached to it either directly or indirectly. The main carrier rotates on the tower head by means of the yaw bearing. The entire nacelle can be rotated by the yaw drives so that the rotor is always optimally aligned with the wind.
The machine house casing comprises multiple sections and is fastened to the nacelle floor by means of steel profiles.

2.2.1 Generator

A permanently excited synchronous generator of internal rotor design is used in the wind energy converter. The wind energy converter operates at variable speeds in order to optimally exploit the wind energy potential at all wind speeds. The annular generator therefore produces alternating current with fluctuating voltage, frequency and amplitude.

The windings in the stator of the generator form several independent three-phase systems. These systems are actively rectified in the nacelle. The inverters then reconvert them into three-phase current whose voltage, frequency and phase position conform to the grid. The transformer in the nacelle converts the voltage generated to the level of the grid into which the current is fed. The transformer is connected to the receiving grid via the medium-voltage switchgear.

Consequently, the generator is not directly connected to the receiving grid of the utility and is decoupled from the grid by the full-scale converter.

2.3 Tower

The tower of the wind energy converter is a tubular steel tower, hybrid steel tower or hybrid tower.

The tubular steel tower is a sheet steel tube consisting of a small number of large steel sections. Depending on the tower version, the lowermost steel section may be in one piece or subdivided into several longitudinal elements. The longitudinal elements are first joined at the installation site to form a single steel section. Flanges with drill holes for assembly are welded onto the ends of the steel sections. The steel sections are stacked on top of one another and bolted together at the installation site. They are linked to the foundation by means of a foundation basket.

The hybrid steel tower is a sheet steel tube consisting of a small number of large steel sections. The lower steel sections are subdivided into a number of edged section plates. The upper steel sections are in one piece. The edged section plates are first bolted together to form steel sections at the installation site. The individual steel sections are stacked on top of each other and bolted together at the installation site. This is done for the longitudinally-divided steel sections by connection plates and for the one-piece steel sections by flange joints. They are linked to the foundation by means of a foundation basket.

The lower part of the hybrid tower is made of concrete segments and the upper part of steel sections. The concrete segments are assembled from precast elements that are stacked on top of each other at the installation site. The upper steel sections are placed onto the concrete segments and bolted in place. The concrete segments are prestressed vertically by means of prestressing steel tendons. The prestressing tendons run either vertically through ducts in the concrete segments or externally along the interior tower wall. They are anchored to the tower foundation.

All towers receive the final paint top coat or weather and corrosion protection at the factory. This means that ideally no further work is required on the tower surface after installation.

3 Grid management system

The permanent magnet synchronous generator is coupled to the grid via the grid feed system. This system essentially consists of a modular rectifier and inverter system with a common DC link each.

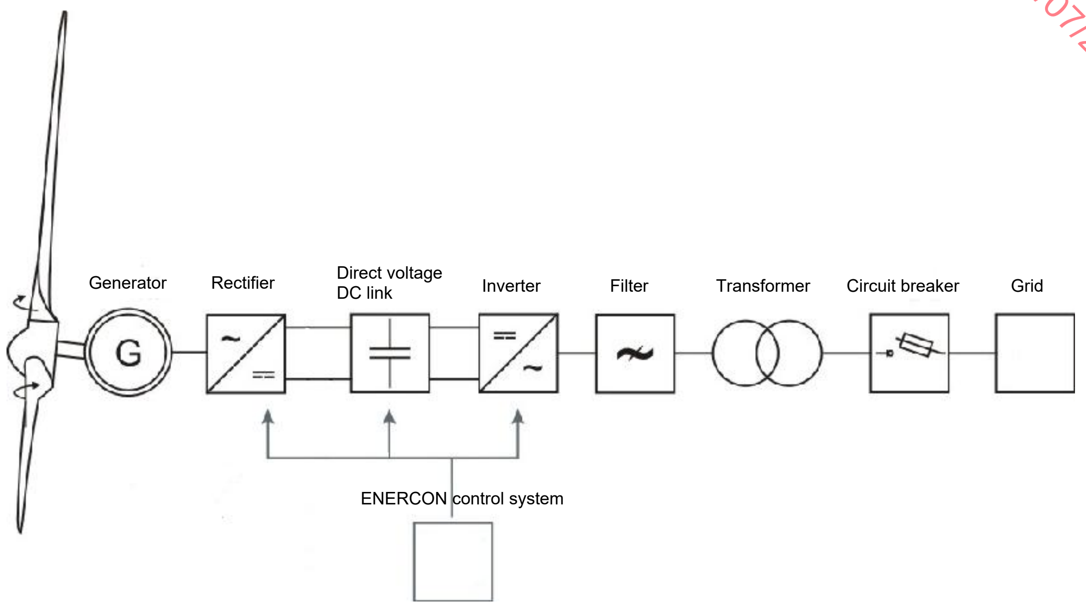

Fig. 2: Simplified electric diagram of a wind energy converter

The grid feed system and pitch control are managed by the control system to achieve maximum energy yield and excellent power quality.

Optimum power transmission is achieved by decoupling the generator from the grid. Any sudden changes in wind speed are translated into controlled changes in the power fed into the grid. In a similar way, any disruptions from the grid have virtually no effect on the mechanics of the wind energy converter. The electric power fed in by the wind energy converter can be precisely regulated from 0 kW up to the nominal power.

In general, grid operators specify the characteristics required for a certain wind energy converter or wind farm to be connected to a receiving grid. To meet different requirements, ENERCON wind energy converters are therefore available in a range of configurations.

The inverter system in the nacelle is designed according to the particular configuration of the wind energy converter. A transformer in the nacelle converts the low voltage to the desired medium voltage.

Reactive power

If necessary, a wind energy converter equipped with the standard FACTS open-loop control system can supply reactive power in order to contribute to the reactive power balance and to maintaining voltage levels in the grid. The maximum reactive power range varies, depending on the configuration of the wind energy converter.

FT configuration

By default, the wind energy converter comes equipped with FACTS technology that meets the stringent requirements of specific grid codes. It is able to ride through grid faults of a few seconds (undervoltage, overvoltage, automatic reclosing, etc.) and thus to remain connected to the grid during a fault.

If the voltage measured at the reference point exceeds a defined limit value, the wind energy converter changes from normal operation to a special fault operating mode.

Once the fault has been cleared, the wind energy converter returns to normal operation and feeds the available power into the grid. If the voltage does not return to the operating range admissible for normal operation within an adjustable time frame, the wind energy converter is disconnected from the grid.

While the system is riding through a grid fault, various fault modes using different grid feed strategies are available, including feeding in additional reactive current during the grid fault. The control strategies include different options for setting fault types.

Selection of a suitable control strategy depends on specific grid code and project requirements that must be confirmed by the particular grid operator.

FTS configuration

FT configuration with STATCOM option
Same as FT configuration; however, the STATCOM option additionally enables the wind energy converter to output and absorb reactive power regardless of whether it is generating and feeding active power into the grid. It is thus able to actively support the power grid at any time, similar to a power plant. Whether or not this configuration can be used needs to be determined on a project-by-project basis.

FTQ configuration

FT configuration with Q+ option

The FTQ configuration has all of the features of the FT configuration. In addition, it offers an extended reactive power range.

FTQS configuration

FT configuration with Q+ and STATCOM options

The FTQS configuration has all of the features of the FTQ and FTS configurations.

Frequency protection

ENERCON wind energy converters can be used in grids with a nominal frequency of 50 Hz or 60 Hz.

The range of operation of the wind energy converters is defined by a lower and upper frequency limit value. Overfrequency and underfrequency events at the reference point of the wind energy converter trigger frequency protection and cause the wind energy converter to shut down after the maximum delay time of 60 seconds has elapsed.

Power-frequency control

If temporary overfrequency occurs as a result of a grid fault, the wind energy converter can reduce its power feed dynamically to contribute to restoring the balance between the generating and transmission networks.
As a pre-emptive measure, the active power feed can be limited during normal operation. During an underfrequency event, the power reserved by this limitation is made available to stabilise the frequency. The characteristics of this control system can be adapted to various specifications in a flexible manner.

4 Safety system

The wind energy converter comes with a large number of safety features whose purpose is to permanently keep the wind energy converter inside a safe operating range. In addition to components that ensure safe stopping of the wind energy converter, these include a complex sensor system. This system records all relevant operating states of the wind energy converter on an ongoing basis and makes the corresponding information available through the ENERCON SCADA remote monitoring system.

The control system of the wind energy converter detects a fault with the sensors and attempts to continue operating the wind energy converter with reduced power. If this does not control the defect causing the fault, the wind energy converter is brought into the safe state by the safety control system.

4.1 Safety equipment

Emergency stop button

In the wind energy converter, there are emergency stop buttons on the control console in the tower base, on the nacelle control cabinet and, if necessary, in the tower entrance area as well as at other locations. Actuating an emergency stop button activates emergency pitching of the rotor blades. This brakes the rotor aerodynamically. An emergency stop renders the wind energy converter only partially dead.

Power is still supplied to the following:

- Beacon system components
- Lighting
- Sockets

4.2 Sensor system

Checking the sensors

Proper functioning of all sensors is either regularly checked by the wind energy converter control system itself during normal wind energy converter operation or, where this is not possible, in the course of wind energy converter maintenance work.

A large number of sensors continuously monitors the current status of the wind energy converter as well as all the relevant surrounding parameters. The sensor system provides the relevant information via a remote monitoring system. The wind energy converter control system analyses the signals and regulates the wind energy converter to optimally exploit the available wind energy at any given time and to ensure operating safety at the same time.

Redundant sensors

Redundant sensors are installed for some operating states to allow plausibility checks by comparing the reported values. Defective sensors are reliably detected and can be repaired or replaced through activation of a back-up sensor. The wind energy converter is thus usually able to continue safe operation without the need for immediate service work.

Speed monitoring

The wind energy converter control system regulates the rotor speed by adjusting the blade angle in such a way that the nominal speed is not significantly exceeded, even if the wind is very strong. If the nominal speed is exceeded by a defined value, however, the wind energy converter control system stops the wind energy converter. The wind energy converter can be restarted via the remote monitoring system.

If a fault occurs, the wind energy converter is stopped by an emergency pitching motion.

Air gap monitoring

The air gap between the rotor and stator of the generator must not be less than a specified width. The air gap is monitored by dedicated sensors. If the air gap falls below a specified value, the wind energy converter is stopped. The wind energy converter can be restarted as soon as the cause has been eliminated.

Temperature monitoring system

Some components of the wind energy converter are cooled. Temperature sensors also continuously measure components that need to be protected from high temperatures.

In the event of high temperatures, the wind energy converter's power is reduced or the wind energy converter is stopped, if necessary.

Some measuring points are equipped with additional overtemperature switches. The overtemperature switches similarly cause the wind energy converter to be stopped once a certain temperature has been exceeded. When it has cooled down, the wind energy converter can be put back into operation once the reason for the overtemperature has been investigated.

Cable twisting monitoring

The tower cables have plenty of space in the upper tower area enabling the nacelle to be turned left and right without damaging and/or overheating the tower cables. Depending on the degree of twisting and level of the wind speed, the wind energy converter open-loop control system decides when the tower cables require untwisting.

5 Open-loop control system

The wind energy converter open-loop control system is based on a programmable logic controller that uses sensors to query all wind energy converter components and collect data such as wind direction and wind speed. Using this information, it adjusts the operating mode of the wind energy converter accordingly. The wind energy converter display in the tower base and in the nacelle shows the current status of the wind energy converter and any faults that may have occurred.

5.1 Yaw system

The yaw bearing with a gear rim is located on the tower head. The yaw bearing allows the nacelle to rotate, thus allowing yaw control of the nacelle.

When the difference between the wind direction and the rotor axis direction exceeds the maximum permissible value, the yaw drives are switched on and align the nacelle with the wind direction. The yaw motor open-loop control system ensures smooth starting and stopping. The open-loop control system monitors the yaw control. If it detects any irregularities, yaw control is deactivated and the wind energy converter is stopped.

5.2 Pitch control

Functional principle

The pitch unit changes the position of the rotor blades and thus the angle of attack at which the air strikes the blade profile. Changes to the blade angle change the lift at the rotor blade and therefore also the force with which the rotor turns.

In automatic mode (normal operation), the blade angle is adjusted to ensure optimal exploitation of the wind's energy while avoiding overload of the wind energy converter. Any boundary conditions, such as noise optimisation, are also observed. In addition, the pitch unit is used to decelerate the rotor aerodynamically.

If the wind energy converter achieves its nominal power and the wind speed continues to increase, the pitch unit turns the rotor blades just far enough out of the wind to keep the rotor speed and the amount of energy extracted from the wind, i.e. the energy to be converted by the generator, within or just slightly above the nominal values.

Blade angle

Special rotor blade positions (blade angle):

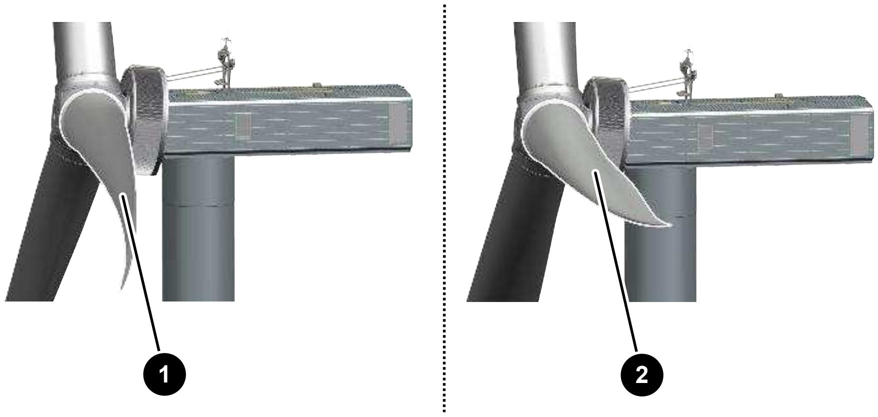

Fig. 3: Special rotor blade positions

Rotor blade position	Explanation
1	Position in partial load operation. The rotor blades generate maximum lift. The rotor turns.
2	Feathered position. The rotor blades do not generate lift. The rotor is braked aerodynamically and comes to a standstill or rotates only minimally.

5.3 Start of the wind energy converter

5.3.1 Start lead-up

As long as the main status is > 0, the wind energy converter remains stopped. As soon as the main status changes to 0, the wind energy converter is ready and the start-up process is initiated. If certain boundary conditions for start-up, e.g. charging of the emergency stop capacitors, have not been fulfilled yet, status `0:3 Start lead-up` is displayed.

During start lead-up, a wind measurement and alignment phase of 150 seconds begins for the wind energy converter.

5.3.2 Wind measurement and nacelle alignment

After completing start lead-up, status `0:2 Turbine operational` is displayed.

If the open-loop control system is in automatic mode, the mean wind speed is above approx. 1.8 m/s and the wind direction deviation is sufficient for yawing, the wind energy converter starts alignment with the prevailing wind direction. The wind energy converter goes into idle mode approx. 60 seconds after completing start lead-up. The rotor blades are pitched slowly into the wind while a check is performed on the emergency stop capacitors.

If the wind energy converter is equipped with rotor blade load control sensors, the rotor blades stop at an angle of 70° and adjust the rotor blade load control sensors, which may take several minutes. During this time, the status `0:5 Calibration of load control` is displayed.

If the mean wind speed during the wind measurement and alignment phase of approx. 150 seconds is above the current cut-in wind speed, the start-up process is initiated (status `0:1`). Otherwise, the wind energy converter remains in idle mode (status `2:1 Lack of wind: Wind speed too low`).

Power consumption

As the wind energy converter is not generating any active power at that moment, the electrical energy required for the wind energy converter's own power consumption is taken from the grid.

5.3.3 Power feed

As soon as a sufficient DC link voltage is available, the feed-in process is initiated. After the speed has increased due to sufficient wind and with a power setpoint > 0 kW, the line contactors (low-voltage side) are closed and the wind energy converter starts feeding power into the grid.

The power increase gradient (dP/dt) after a grid fault or a regular start-up can be defined in the open-loop control system within a certain range.

5.4 Operating modes

After completion of the start-up process, the wind energy converter switches to automatic mode (normal operation). While in automatic mode, the wind energy converter constantly monitors wind conditions, optimises rotor speed and generator power, aligns the nacelle position with the wind direction and records all sensor states.

In order to optimise power generation under diverse wind conditions when in automatic mode, the wind energy converter changes between 3 operating modes, depending on the wind speed. In certain circumstances, the wind energy converter stops if provided for by its configuration. In addition, the utility into whose grid the generated energy is being fed can be given the option to directly influence the behaviour of the wind energy converter by remote control, e.g. for temporary reduction of the grid feed.

The wind energy converter switches between the following operating modes:

- Full load operation
- Partial load operation
- Idle mode

5.4.1 Full load operation

Wind speed ≥ nominal wind speed

At wind speeds at and above the nominal wind speed, the wind energy converter uses pitch control to maintain the rotor speed at its setpoint, thereby limiting the power to the nominal value.

5.4.2 Partial load operation

Cut-in wind speed ≤ wind speed < nominal wind speed

During partial load operation (i.e. the wind speed is between cut-in wind speed and nominal wind speed), the maximum possible power is extracted from the wind. The rotor speed and the power output are determined by the current wind speed. Pitch control already starts as the wind energy converter approaches full load operation in order to ensure a smooth transition.

5.4.3 Idle mode

Wind speed < cut-in wind speed

At wind speeds below the cut-in wind speed, no current can be fed into the grid. The wind energy converter runs in idle mode, i.e. the rotor blades are turned almost completely out of the wind (blade angle ≥ approx. 60°), and the rotor turns slowly or stops completely if there is no wind at all.

Slow movement (idling) puts less load on the rotor bearings than longer periods of complete standstill; in addition, the wind energy converter can resume power generation and grid feed more quickly as soon as the wind picks up.

5.5 Safe stopping of the wind energy converter

The wind energy converter can be stopped by manual intervention or automatically by the control system.

The causes are divided into groups by risk.

Stopping the wind energy converter by means of pitch control

In the event of a malfunction that is not safety-relevant, the wind energy converter open-loop control system pitches the rotor blades out of the wind, causing the rotor blades not to generate any lift and bringing the wind energy converter to a safe stop.

Emergency pitching

The emergency stop capacitors store the energy required for emergency pitching and are kept charged and undergo continuous testing during wind energy converter operation. For emergency pitching, each pitch motor is supplied with energy by the associated emergency stop capacitors. The rotor blades move in a controlled manner into a position in which no lift is generated; this is called the feathered position.

Since the 3 pitch units are interconnected but also operate independently of each other, if one component fails, the remaining pitch units can still function and stop the rotor.

Emergency braking

If an emergency stop button is pressed, or if the rotor lock is actuated while the rotor is turning, the control system initiates an emergency braking procedure.

Here, the emergency pitching of the rotor blades brakes the rotor from nominal speed virtually to standstill within a maximum of 60 seconds.

6 Remote monitoring

By default, all ENERCON wind energy converters are equipped with the ENERCON SCADA system that connects them to Technical Service Dispatch. Technical Service Dispatch can retrieve each wind energy converter's operating data at any time and instantly respond to any irregularities or malfunctions.

All status messages are also sent via the ENERCON SCADA system to Technical Service Dispatch, where they are permanently stored. Practical experience gained from long-term operation can then be incorporated into the further development of ENERCON wind energy converters.

Connection of the individual wind energy converters is through the ENERCON SCADA Server that is usually located in the substation or the transmission substation of a wind farm. An ENERCON SCADA Server is installed in every wind farm.

At the operator/owner's request, monitoring of the wind energy converters can be performed by a third party.

7 Maintenance

To ensure long-term safe and optimum operation of the wind energy converter, maintenance is required at regular intervals.

The wind energy converters are regularly serviced, once a year, depending on requirements.

During maintenance, all safety-relevant components and functions are checked, e.g. the pitch unit, yaw control, safety systems, lightning protection system, anchorage points and safety ladder. The bolt connections on load-bearing joints (main components) are checked. All other components are visually inspected to check for any irregularities or damage. Lubrication systems are refilled.

Maintenance intervals and scope may vary, depending on regional guidelines and standards.

Technical description

ENERCON E-175 EP5 E2 / 7000 kW wind energy converter

Early Customer Information Package

ENERCON
ENERGY FOR THE WORLD

Publisher

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D02885203	Übersichtszeichnung E-175 EP5 E2-HST-132-FB-C-01 (Layout drawing E-175 EP5 E2-HST-132-FB-C-01)
D02885451	Übersichtszeichnung E-175 EP5 E2-HT-162-ES-C-01 (Layout drawing E-175 EP5 E2-HT-162-ES-C-01)
D03011491	Übersichtszeichnung E-175 EP5 E2-HST-112-FB-C-01 (Layout drawing E-175 EP5 E2-HST-112-FB-C-01)
D03011510	Übersichtszeichnung E-175 EP5 E2-HT-175-ES-C-01 (Layout drawing E-175 EP5 E2-HT-175-ES-C-01)

List of abbreviations

CFRP	Carbon fibre reinforced plastic
DIBt	Deutsches Institut für Bautechnik (German institute for civil engineering)
FACTS	Flexible Alternating Current Transmission System
FTQS	FACTS Transmission with Q+ option and STATCOM option (electrical configuration with extended reactive power range and STATCOM option)
GFRP	Glass-fibre reinforced plastic
HST	Hybrid steel tower
HT	Hybrid tower
IEC	International Electrotechnical Commission
SCADA	Supervisory Control and Data Acquisition
STATCOM	Static compensator

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1 Preliminary remarks

This document is provided for informational purposes only. Any guarantees, promises, obligations, assurances, promises or liabilities arising from the content cannot be derived from this document – neither at the expense of ENERCON GmbH nor at the expense of its affiliated companies or at the expense of the respective legal representatives. The contents of this document are not binding. They will only become binding if they are explicitly made the subject of a written contractual agreement.

This document is neither a statement of work nor a technical data sheet. The purpose of this document is solely to provide the user with assistance in assessing the fundamental suitability of the wind energy converter described for the site and its approximate yield. The information contained in this document is based on the technical information available as of the date of issue of this document.

2 Product overview

Fig. 1: E-175 EP5 E2/7000 kW wind energy converter

The new E-175 EP5 E2 wind energy converter with a nominal power of 7000 kW is a top-of-the-line model that is more powerful and has a higher yield.

With the E-175 EP5 E2, the current EP5 platform for low-wind sites has been further optimised on the basis of the E-nacelle with integrated electrical engineering.

The E-175 EP5 E2 is designed for wind class S or II (IEC) and a service life of 25 years. The wind energy converter is offered by ENERCON worldwide in all its markets. The requirements of DIBt wind zone S or DIBt wind zone 2 are met for ENERCON's core market, Germany.

Different tower versions with hub heights of up to 175 m are available for the E-175 EP5 E2. Depending on the size of the project, it is also possible to develop site-specific towers.

3 Technical specifications

General data	
Manufacturer	ENERCON GmbH Dreekamp 5 26605 Aurich Germany
Type designation	E-175 EP5 E2
Nominal power	7000 kW
Rotor diameter	175 m
Horizontal distance between tower centre and lowest blade position	26.44 m
Horizontal distance between tower centre and highest blade position	8.23 m
Swept area	23,840.5 m^2
Swept ground area (eccentricity area)	24,784.1 m^2
Cut-in wind speed	2.5 m/s
Nominal wind speed (simulated value, power-optimised operation)	12.5 m/s
Start of storm control (power reduction wind speed)	21 m/s
Cut-out wind speed	25 m/s (10-minute mean)
Design service life	25 years

Tower data	E-175 EP5 E2-HST-112-FB-C-01	E-175 EP5 E2-HST-132-FB-C-01	E-175 EP5 E2-HT-162-ES-C-01	E-175 EP5 E2-HT-175-ES-C-01
Hub height above ground level[1]	Max. 113 m	Max. 133 m	Max. 163 m	Max. 176 m
Total height above ground level[1]	Max. 200 m	Max. 220 m	Max. 250 m	Max. 263 m
Type	Hybrid steel tower	Hybrid steel tower	Hybrid tower	Hybrid tower
Foundation diameter of deep foundation/ shallow foundation	Under development/24.7 m	Under development/under development	Under development/under development	Under development/under development

[1] The maximum value is specified to avoid any inconsistencies caused by rounding.

Subject to technical change without prior notice.

Design (tower-specific)					
	E-175 EP5 E2-HST-112-FB-C-01	E-175 EP5 E2-HST-132-FB-C-01	E-175 EP5 E2-HT-162-ES-C-01	E-175 EP5 E2-HT-175-ES-C-01	
Characteristic	**Value**	**Value**	**Value**	**Value**	**Unit**
Wind class (IEC 4th edition)	II	S	S	S	
Turbulence category (IEC 4th edition)	A	A	A	A	
Wind zone (DIBt 2012)	WZ S	WZ S	WZ 2	WZ S	
50-year extreme wind speed at hub height (10-minute mean) (IEC 4th edition)	42.50	42.50	42.50	42.50	m/s
Corresponds to a load equivalent of approx. (3-second gust)	59.50	59.50	59.50	59.50	m/s
50-year extreme wind speed at hub height (10-minute mean) (DIBt 2012)	42.50	42.50	42.50	42.50	m/s
Annual average wind speed at hub height (IEC 4th edition)[2]	8.50	7.20	7.80	7.20	m/s
Annual average wind speed at hub height (DIBt 2012)	8.50	7.20	7.80	7.20	m/s
c value of extreme turbulence model	2	2	2	2	
Form parameter of Weibull function k	2	2	2	2	
Wind shear	0.10 to 0.20	0.20	0.20	0.20 to 0.40	

Design (cross-tower)	
Flow inclination	8°
Relative air humidity	≤ 95 %
Maximum solar irradiance	1000 W/m^2
Standard air density	1.225 kg/m^3
Normal temperature range	-10 °C to +40 °C

Subject to technical change without prior notice.

2 An increase in the annual average wind speed at hub height is being tested for various towers.

Design (cross-tower)	
Extreme temperature range	-20 °C to +50 °C

Generator rotor with pitch unit	
Type	Upwind rotor with active pitch unit
Rotational direction	Clockwise (viewed from upwind)
Number of rotor blades	3
Rotor blade length	85.98 m
Rotor blade material	GFRP sandwich structure with CFRP spar booms
Conical angle	-5°
Incline of rotor axis to horizontal	6°
Pitch unit	One independent electrical pitch unit per rotor blade with dedicated emergency power supply

Drive train with generator	
Wind energy converter concept	Gearless, variable speed, full-scale converter
Hub	Rigid
Bearing	2 tapered roller bearings
Generator	Direct-driven, permanent magnet synchronous generator

Brake system	
Aerodynamic brake	Aerodynamic via 3 independent pitch units with emergency power supply
Rotor holding brake	E-brake
Rotor lock	Latching in 30° steps

Yaw control	
Yaw system	Electromechanical yaw system
Yaw brake	Electromechanical

Wind energy converter control system	
Type	Programmable logic controller (PI-CS)
Grid feed	Full-scale converter with integrated micropro-cessor control system
Remote monitoring system	ENERCON SCADA Edge system
Uninterruptible power supply (UPS)	Integrated

4 Power values and sound power levels

Site characteristics

The power and c_t curves as well as the corresponding sound power levels have been calculated for the conditions stated in the following table with undamaged rotor blade leading edges and clean rotor blades.

Site characteristics (10-minute mean)	
Standard air density	1.225 kg/m³
Relative air humidity	70 %
Temperature	10 °C
Wind shear exponent	0.0 to 0.3
Maximum difference in wind direction between upper and lower blade tip	10°
Maximum flow inclination	± 2°
Terrain	According to IEC 61400-12-1:2017
Snow/ice	No
Rain	No

Otherwise, the framework conditions according to IEC 61400-12-1:2017 apply.

4.1 OM-0-0 operating mode

The OM-0-0 operating mode represents the optimum mode of operation for standard design conditions in order to achieve the maximum yield within the framework of the design specifications and the sound setpoint.

4.1.1 Calculated power, cp and ct values in OM-0-0 operating mode

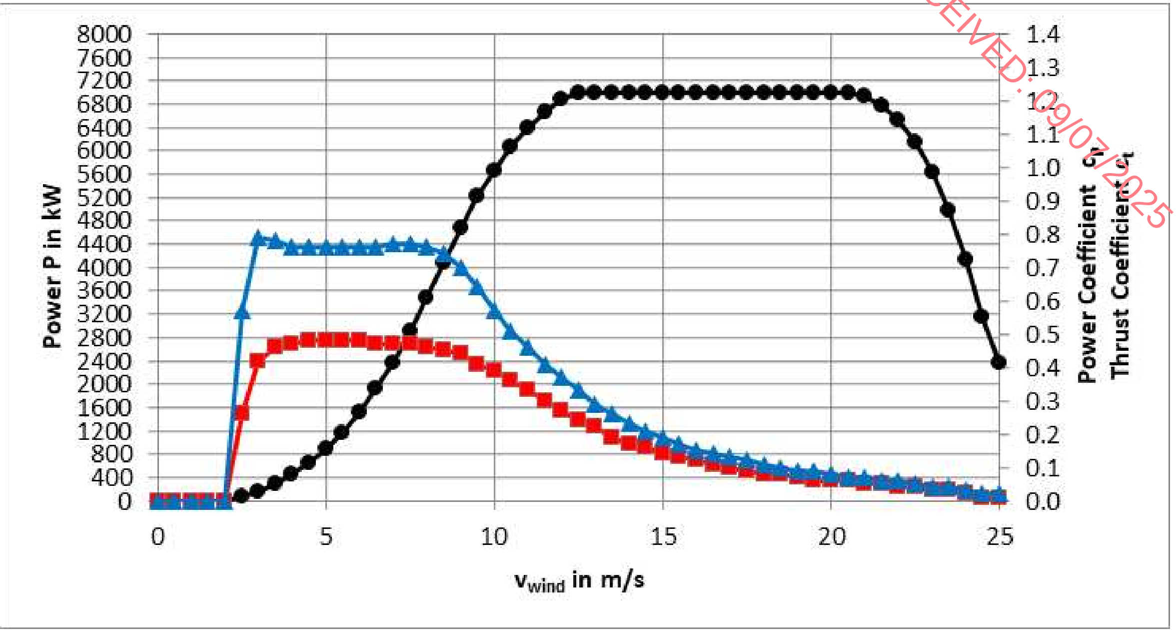

Fig. 2: Power, c_p and c_t curves for E-175 EP5 E2 / 7000 kW in OM-0-0 operating mode

◆—◆—◆	Power P in kW
▲—▲—▲	c_t value
■—■—■	c_p value

Tab. 1: Calculated power, c_p and c_t values for E-175 EP5 E2 / 7000 kW in OM-0-0 operating mode

Wind speed v in m/s	Power P in kW	c_p value	c_t value
0.00	0	0.00	0.00
0.50	0	0.00	0.00
1.00	0	0.00	0.00
1.50	0	0.00	0.00
2.00	0	0.00	0.00
2.50	60	0.26	0.57
3.00	165	0.42	0.79
3.50	287	0.46	0.78
4.00	444	0.47	0.76
4.50	644	0.48	0.76
5.00	885	0.48	0.76
5.50	1174	0.48	0.76
6.00	1515	0.48	0.76
6.50	1913	0.47	0.76
7.00	2373	0.47	0.77

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Wind speed v in m/s	Power P in kW	c_p value	c_t value
7.50	2897	0.47	0.77
8.00	3478	0.46	0.76
8.50	4090	0.45	0.74
9.00	4684	0.44	0.70
9.50	5214	0.41	0.64
10.00	5665	0.39	0.57
10.50	6053	0.36	0.51
11.00	6392	0.33	0.46
11.50	6677	0.30	0.41
12.00	6892	0.27	0.37
12.50	6997	0.24	0.33
13.00	7000	0.22	0.29
13.50	7000	0.19	0.26
14.00	7000	0.17	0.23
14.50	7000	0.16	0.21
15.00	7000	0.14	0.19
15.50	7000	0.13	0.17
16.00	7000	0.12	0.15
16.50	7000	0.11	0.14
17.00	7000	0.10	0.13
17.50	7000	0.09	0.12
18.00	7000	0.08	0.11
18.50	7000	0.08	0.10
19.00	7000	0.07	0.09
19.50	7000	0.06	0.09
20.00	7000	0.06	0.08
20.50	7000	0.06	0.07
21.00	6936	0.05	0.07
21.50	6780	0.05	0.06
22.00	6519	0.04	0.06
22.50	6142	0.04	0.05
23.00	5636	0.03	0.04
23.50	4977	0.03	0.04
24.00	4137	0.02	0.03
24.50	3138	0.01	0.02

Wind speed v in m/s	Power P in kW	c_p value	c_t value
25.00	2371	0.01	0.02

4.1.2 Calculated sound power level in OM-0-0 operating mode

The highest sound power level to be expected in the nominal power range is 106.9 dB(A). After reaching the nominal power, the sound power level will not increase further.

Wind speed at hub height v_H in m/s	Sound power levels in dB(A)
5.0	97.6
5.5	98.6
6.0	99.8
6.5	101.1
7.0	102.4
7.5	103.8
8.0	105.2
8.5	106.5
9.0	106.9
9.5	106.9
10.0	106.9
10.5	106.9
11.0	106.9
11.5	106.9
12.0	106.9
12.5	106.9
13.0	106.9
13.5	106.9
14.0	106.9
14.5	106.9
15.0	106.9

5 Grid performance

The values given in this chapter refer to the FTQS configuration.

General data	
Nominal frequency	50 Hz/60 Hz
Nominal active power	7000 kW
Rated reactive power	4410 kvar
Rated apparent power	8300 kVA
Nominal voltage	750 V
Nominal current	5389 A

Reactive power (export/import)	
Maximum reactive power (export)	4410 kvar
Minimum reactive power (import)	-4410 kvar

Operating voltages	
Max. continuous operating voltage	120 % U_n
Min. continuous Operating Voltage	85 % U_n
Temporary minimum voltage	80 % U_n

Frequency range	Nominal grid frequency 50 Hz	Nominal grid frequency 60 Hz
Maximum frequency	53 Hz	63 Hz
Nominal frequency	50 Hz	60 Hz
Minimum frequency	47 Hz	55.5 Hz

Fault Ride Through behaviour

The wind energy converter is equipped with a Fault Ride Through capability that enables it to remain in operation in the event of fault-related undervoltage (Undervoltage Ride Through) and overvoltage (Overvoltage Ride Through).

6 Safety and protection

Additional information on the following chapters will be created and made available in separate documents during the further development process of the wind energy converter.

Lightning protection

In order to prevent damage from lightning strikes and to ensure safe operation, the wind energy converter is fitted with a lightning protection system.

The lightning protection system (lightning protection level/LPL) is classified from IV (low) to I (high). The wind energy converter is designed to meet the requirements of LPL I. In some cases, modifications to the earthing system may be necessary. This is dependent on the conductivity of the soil at the location which is investigated as part of the project-specific soil investigations.

Fire safety

Numerous technical and organizational fire protection measures are being taken for the wind energy converter that minimise the probability of a fire occurring, the spread of fire and smoke and damage to persons and property.

Ice detection

To reduce the dangers of ice throw, ice detection based on the ENERCON power curve method is employed as standard in the wind energy converter. If ice build-up is detected on a running wind energy converter, the wind energy converter stops at the end of the set detection time.

Remote monitoring system/SCADA

The wind energy converter is connected as standard to Technical Service Dispatch via the ENERCON SCADA Edge System. Technical Service Dispatch can retrieve the operating data of the wind energy converters at any time and instantly respond to any irregularities or faults.

At the operator/owner's request, monitoring of the wind energy converters can be performed by a third party.

Functional safety

The safety-related part of the wind energy converter control system is developed in accordance with DIN EN ISO 13849-1.

Protection against emissions

Various sound-reduced operating modes are available for the wind energy converter. The various sound-reduced operating modes differ in the level of sound reduction they offer and serve to satisfy the requirements applicable at the installation site with regard to permissible sound emissions.

The shadow shutdown function stops the wind energy converter in line with requirements to minimise or prevent immissions caused by periodic shadow flickering at relevant locations.

Technical description

Trailing edge serration (TES)

ENERCON
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Description of trailing edge serration

Introduction

Different flow speeds prevail on the suction and pressure sides of the rotor blade. As a result, turbulence occurs at the trailing edge and the noise level rises when the wind energy converter is in operation.

To reduce this noise level, a serrated profile is mounted on the trailing edge. This profile is known as a trailing edge serration (or TES for short).

The figures in this document show a trailing edge serration on rotor blades with a curved blade tip by way of example. The shape of the blade tip has no influence on the arrangement or the function of the trailing edge serration.

Development of trailing edge noise

The principal cause of trailing edge noise is the formation of a turbulent boundary layer on the rotor blade surface in which eddies develop. Proportional to their size, these eddies interact with the trailing edge inducing a fluctuating pressure field, which emits aerodynamic broadband noise.

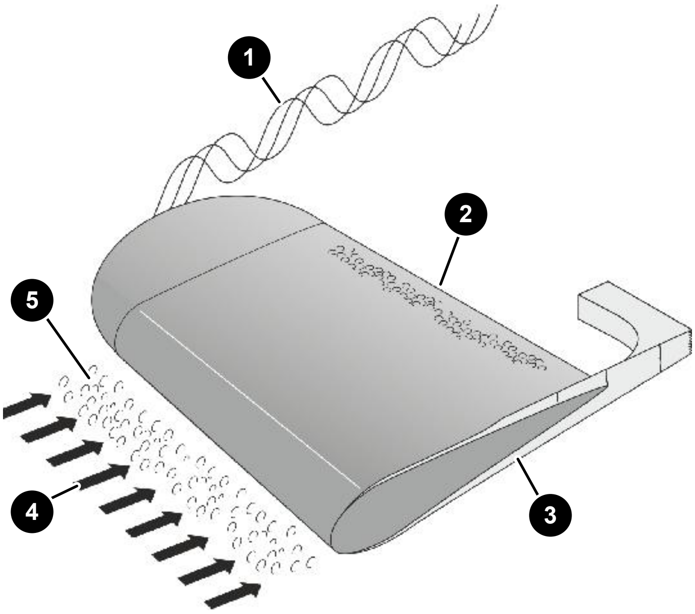

Fig. 1: Schematic illustration of air flow on the rotor blade

1	Blade tip turbulence	2	Eddies at the trailing edge
3	Boundary layer	4	Oncoming flow
5	Eddies in oncoming flow		

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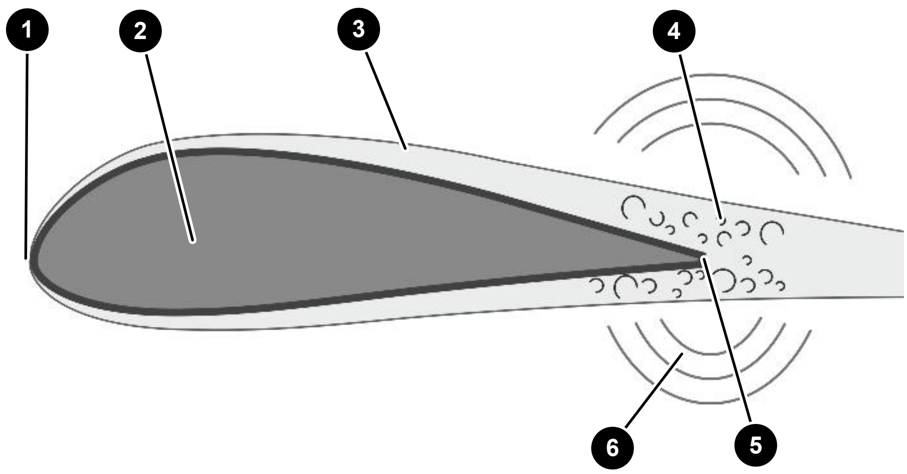

Fig. 2: Mechanism of trailing edge noise

1	Leading edge	2	Cross section of rotor blade
3	Boundary layer	4	Eddy
5	Trailing edge	6	Trailing edge noise emission

Functional principle of the trailing edge serration

A serrated extension of the trailing edge mitigates noise emission by effectively breaking up the eddies on the tooth flanks into smaller eddies. The intensity of the pressure fluctuations is reduced, which mitigates noise emission. Since the intensity of the noise emission is largely dependent on the local flow speed, trailing edge serrations are only installed in the outer rotor blade area where the rotary speed is the highest.

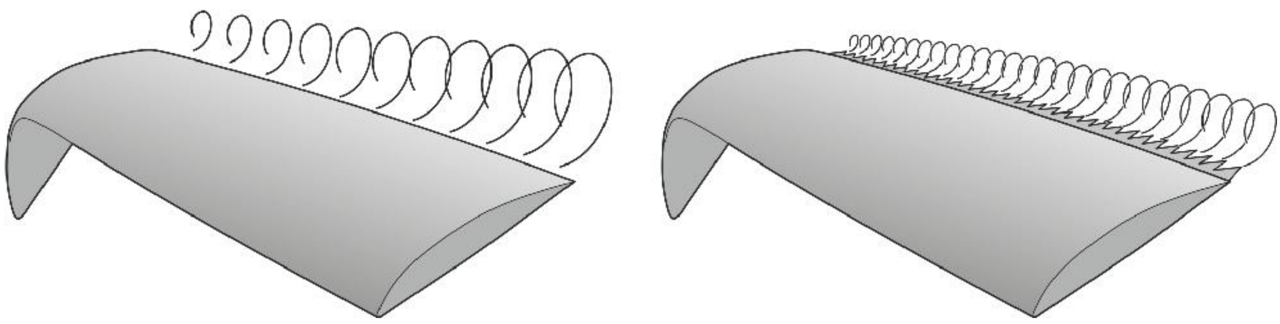

Fig. 3: Turbulence without trailing edge serration (left) and with trailing edge serration (right)

Since the flow conditions along the rotor blade vary, the size and spacing of the serrations has to be adapted to meet the local oncoming flow conditions. The patented continuous distribution of the different-sized serrations along the rotor blades of ENERCON wind energy converters results in optimally reduced noise emission.

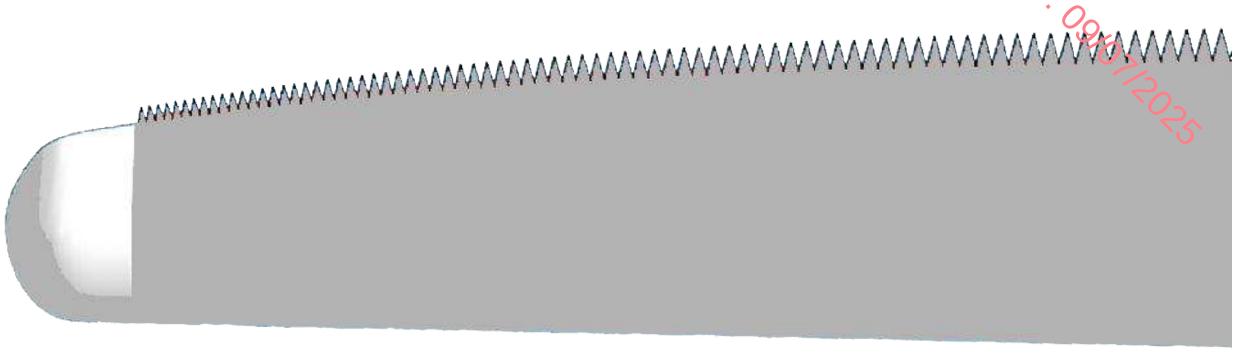

Fig. 4: Trailing edge serration

Effects on power, c_t and c_p characteristic curves

The trailing edge serration has no effect on the power curve or the c_t and c_p characteristic curves. The sole purpose of the trailing edge serration is to reduce noise.

Technical specification

Access Road and Construction Site Areas

ENERCON wind energy converter
E-175 EP5 112 m steel tower

Prototype

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Applicable documents

The titles of the documents listed are the titles of the original language versions, with translations of these titles in brackets where applicable. The titles of superordinate standards and guidelines are indicated in the original language or as an English translation. Document IDs always refer to the original language versions. If the document ID does not contain a revision, the most recent revision of the document applies. This list contains documents concerning optional components if necessary.

Higher-level standards and guidelines

Document ID	Document
DIN 18134	Soil - Testing procedures and testing equipment - Plate load test
DIN 4017	Subsoil – Calculation of design bearing capacity of soil beneath shallow foundations
DIN 4019:2015	Soil - Analysis of settlement

Associated documents

Document ID	Document
D02108591	Baustellenordnung (Construction site regulations)
D02768819	Anforderungen Zusatzbelastung Fundamentanschüttung und Fundamentauflast für Servicetätigkeiten (Additional load requirements for foundation soil cover/load for service activities)

Table of contents

List of abbreviations

Abbreviations

CM	Construction Manager
GPM	General Project Manager
LHV	Abnormal load
SPMT	Self-propelled modular transporter
WEC	Wind energy converter

Variables, units, formulas

D_{Pr}	Degree of compaction after Proctor compaction test
E_{V1}	Calculated deformation modulus of the first load cycle of a static plate load test
E_{V2}	Calculated deformation modulus of the second load cycle of a static plate load test

1 Introduction

Meticulous planning and design of construction site infrastructure are the basis for cost-effective construction work. Transport routes and construction site areas in the wind farm must ensure safe and cost-effective construction site traffic. Trouble-free functionality must be ensured throughout the entire period of use.

Deviations from this specification may affect the installation and logistics concept. This will result in extra costs, longer construction times and possibly delays in the course of the project. If deviations from the standards described here occur, they must be coordinated with the ENERCON GPM. An alternative solution can be offered by ENERCON for standards from this specification that may not be capable of being implemented for topographical reasons. This must be commissioned through the ENERCON GPM. The customer shall bear the resulting additional costs.

This specification applies to the transport and installation, using a standard large crane, of a WEC with the tower designation:

- E-175 EP5-ST-112-FB-C-01

This specification describes the requirements for access roads and construction site areas for the wind farm infrastructure. In addition to this information, the following documents must also be included in the planning.

- Foundation data sheet for the applicable foundation version of the tower type
- Technical description of the tower type
- Data sheets on weights and dimensions of tower type, nacelle and rotor blades
- D02108591 ‘Baustellenordnung’ (Construction site regulations)
- D02768819 ‘Anforderungen Zusatzbelastung Fundamentanschüttung und Fundamentauflast für Servicetätigkeiten’ (Additional load requirements for foundation soil cover/load for service activities)

2 WEC installation

The ENERCON WEC is assembled in several stages: Foundation construction, deep foundation where necessary, and installation and assembly of the tower and nacelle. Depending on the wind farm size, project-specific installation concepts are developed to ensure economically efficient execution and to permit completion of the WEC in the shortest possible time. As such, the work steps described in the following subchapters can be performed in parallel in the wind farm.

2.1 Delivery of the tower and WEC components

The manner of delivery depends on the installation concept for the intended construction site area. The tower and the WEC components are delivered in advance. They are stored in accordance with a predefined stowage plan. The necessary areas must be dimensioned and set up precisely in accordance with this specification.

2.2 Tower installation

Depending on the type of tower and installation concept, assembly can be performed in different ways. Depending on tower type, pre-assembly may be necessary that is performed in a separate work section directly on the planned construction site area. The pre-assembled sections are temporarily stored on the construction site or assembled directly after pre-assembly. Tower assembly is carried out with suitable crane equipment, depending on the installation concept and tower.

2.3 Nacelle installation

The nacelle components are delivered directly to the designated construction site areas (e.g. assembly area). Once pre-assembly is complete, the pre-assembled nacelle is lifted using the designated crane equipment and mounted on the tower.

3 Crane equipment

3.1 Cranes used

The relevant crane type is selected during the planning phase of the wind farm concept. The max. permissible soil bearing pressure under the crane tracks or outriggers is limited with load distribution plates and must be verified via geotechnical calculations. If crawler cranes are used, it may be possible, among other things, to move from site to site in an assembled state. Prior to this, the bearing capacity of the soil and the loading gauge must be tested on the crane routes.

3.2 Installing the crane with a lattice tower

A lattice tower crane is used to install the WECs. This crane technology places specific demands on the crane platform and requires sufficient space to assemble the lattice tower. The basic unit and the individual crane parts (e.g. lattice tower parts, ballast, fixtures) are delivered to the wind farm in the required quantities by truck. The number of truck transports required depends on the crane type and mast length. The lattice tower crane is assembled in the following individual stages:

- Delivery of the basic unit and auxiliary cranes
- Alignment of the basic unit on the crane platform
- Positioning of Superlift ballast
- Lattice tower assembly

To assemble the lattice tower, the existing access road to the crane platform is used. If the access road cannot be used, a temporary site road is needed. The technical framework conditions for assembling the crane and jib will be explained in this document.

4 Transport and logistics

4.1 General information

The installation of a WEC requires a large number of abnormal loads. These abnormal load transports are needed to deliver the tower and WEC components and crane equipment, and for subsoil improvement measures and foundation construction. These abnormal load transports require approval in some cases and are subject to country-specific and official regulations. The resultant max. transport weights and axle loads must be taken into account.

4.2 Construction and logistics concept

Specific installation and logistics concepts are necessary for large wind farms and for WECs erected at sites with special requirements (e.g. industrial sites, dikes, hills). In order to enable optimal project execution, the local conditions must be incorporated directly into the concept. Depending on the WEC type and the installation and logistics concept, there may be additional areas required, e.g. a logistics area and/or rotor blade storage area. The additional logistical costs are borne by the customer. If necessary, contractually agreed deadlines must be adjusted by the contractor.

4.3 Use of SPMT

If an SPMT is used, there may be changes in the following areas, depending on the component and system platform:

- Width of road
- Loading gauge
- Curve radii and swept paths
- Lateral gradient on straight routes and in curves

These points must then be agreed with ENERCON and the transport service provider.

5 Access roads

Access roads in the wind farm are an integral part of the supply of material to the respective WEC sites. In addition, access roads ensure cranes can move around the wind farm. Access roads are used over the entire course of the project as the access for all transport types. In addition, the access roads are also needed for service and to dismantle the WECs. The access road and construction site area concept and the construction work shall be designed in accordance with this specification.

5.1 Routeing

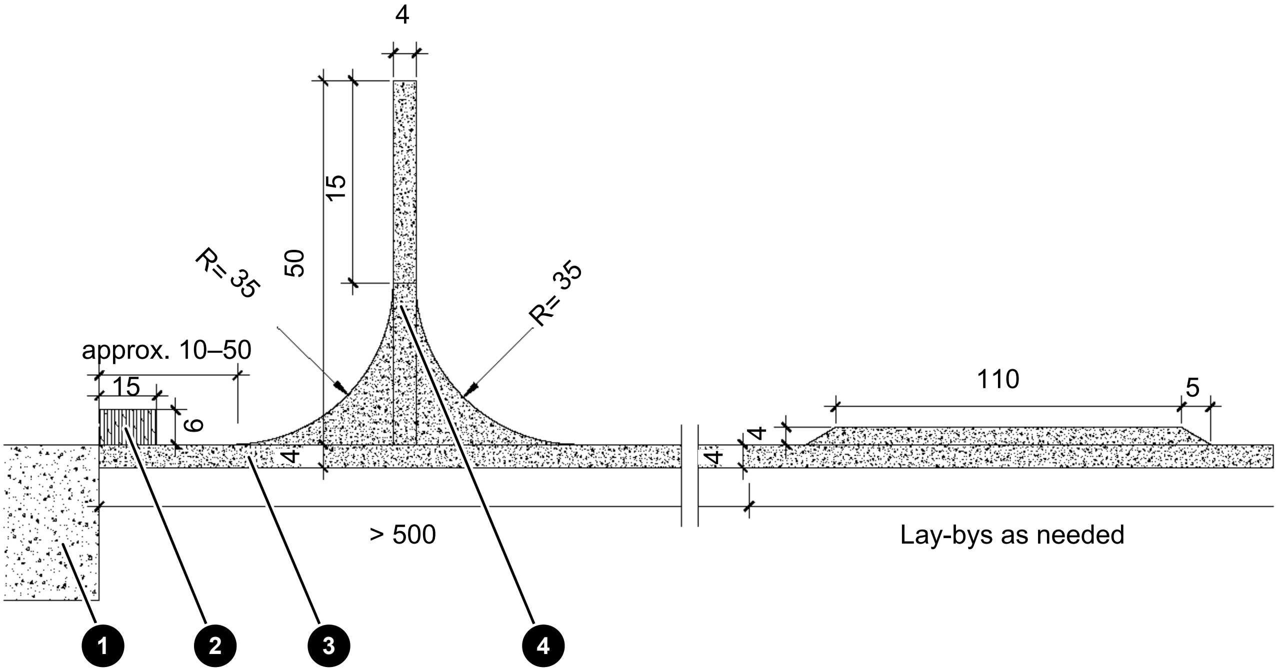

Fig. 1: Routing elements (all dimensions in metres)

1	Crane platform	2	Parking area
3	Access road	4	Turning area

The use of large and abnormal loads presents special challenges for the internal wind farm access roads, at intersections and curves, wind farm entrances and public roads.

Routing elements

In most cases, transport vehicles with a high total weight and excess width are used to transport components to the construction site. Due to the major transport requirements and the transport costs, the routing of the access roads in the wind farm must be kept short and straight. The routes must be selected so that transport vehicles carrying abnormal loads are not forced to travel in reverse. If WEC sites are located in a dead-end position that has an access road longer than 500 m, a turning area for empty transports must be provided. The turning area must have a minimum length of 50 m. Depending on the location, turning areas may also be needed at shorter intervals (less than 500 m). This is decided by the ENERCON GPM. On long access roads, lay-bys and/or parking bays in sufficient number and length must be planned in consultation with the ENERCON GPM in order to guarantee flowing traffic and free rescue routes.

Wind farm entrance

If there are wind farm entrances from public roads, we recommend asphalting the first 50 m of the entrance. This enables vehicles exiting the site to clean their wheels before accessing the public road. Depending on the number of access roads to the wind farm and the number of trucks driving into the wind park, other options may be explored, such as wheel washing facilities. This requirement shall be checked in consultation with the ENERCON GPM according to local conditions. Regulatory specifications must be observed.

Parking areas for long transports

In the wind farm or in the immediate vicinity, one or more areas must be identified on which at least 3 long transports can be parked on an interim basis. This ensures that waiting transport vehicles do not impede the other construction site traffic. Long transports include the transport of rotor blades or steel sections of towers. For instance, lay-bys are suitable areas.

Obstacles on the route

Any particular obstacles to be crossed on the route must be clearly indicated with the appropriate markings, so that they can be detected by traffic. If lines must be crossed (e.g. pipelines, gas lines), a prior investigation must be carried out to make sure that it is possible to drive over them. The results of the investigation shall be submitted to the ENERCON GPM for inspection. In addition, approval to drive over them must be obtained from the pipeline operator. Lines must be secured by construction of special superstructures. To avoid contact with the construction traffic passing beneath, overhead lines must be clearly indicated by means of height limitation markings (e.g. wooden frames).

5.1.1 Intersections and curves

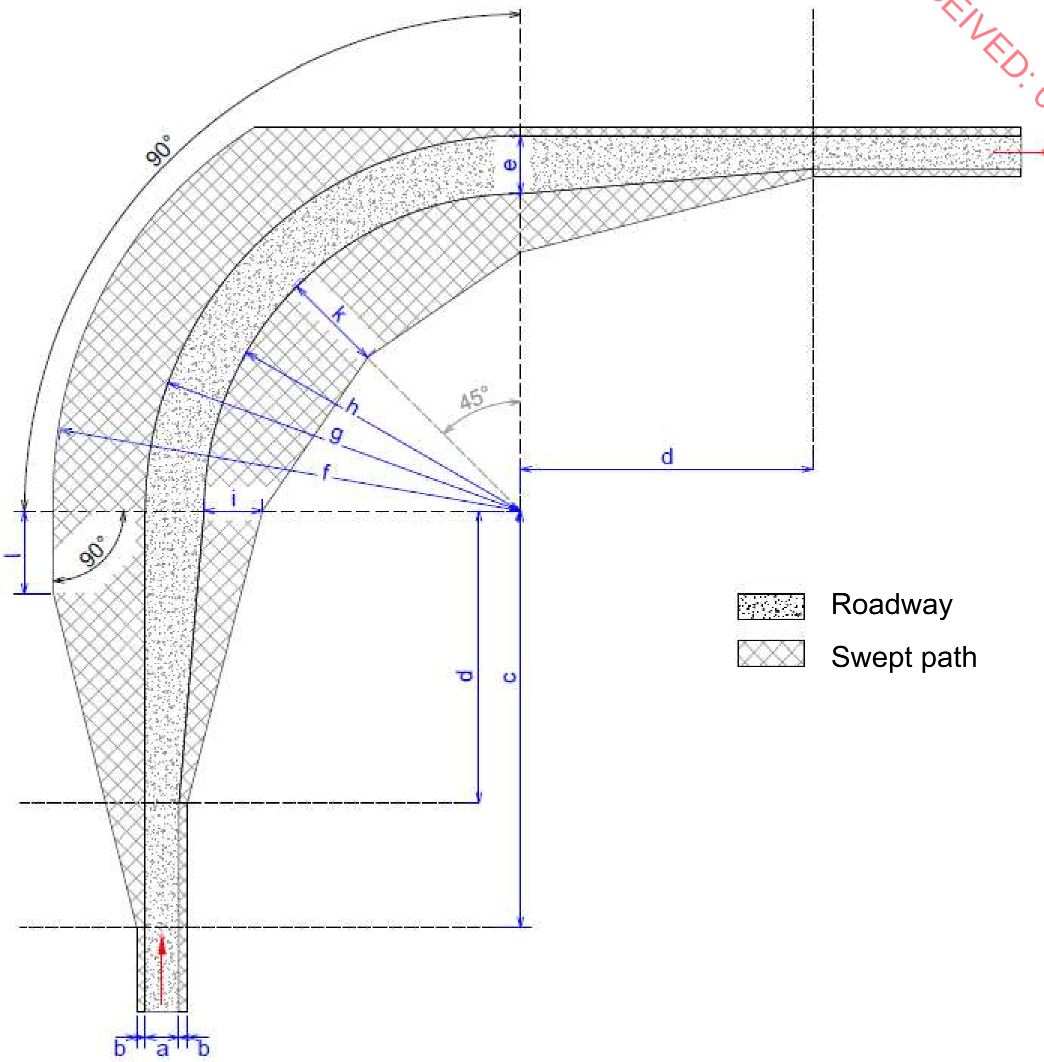

Fig. 2: 90 degree curve (construction diagram)

	90 degree curve	60 degree curve			90 degree curve	60 degree curve	
a	4 m		Drivable width of road in straight line	b	1.5 m		Lateral swept path including safe distance
c	60 m		Start of outer swept path at curve entry	d	40 m		Start of inner swept path at curve entry
e	7 m		Drivable width of road in curves	f	70 m	69 m	Outer radius of outer swept path
g	60 m	60 m	Outer radius of curve	h	53 m	53 m	Inside radius of curve
i	7 m	7 m	Dimension 1 of inner swept path	k	13 m	12 m	Dimension 2 of inner swept path
l	10 m	10 m	Dimension 3 of outer swept path				

The longest transport combination is decisive for curve dimensioning. The curves and swept paths are implemented structurally in accordance with the dimensions indicated in the drawing. If this radius cannot be maintained due to local conditions, it is imperative that the ENERCON GPM is consulted to find an alternative solution.

Swept paths

Transport combinations with flatbed and/or swing-out load must be able to pass through curves without problem. Obstacles in the swept paths must be removed for this purpose if these obstacles exceed a certain height.

- Obstacles in the inner swept path must not protrude by more than 0.15 m max. above the level of the roadway.
- Obstacles in the outer swept path must not protrude by more than 1.25 m max. above the level of the roadway.

Fig. 3: Rotor blade transport overhang

a	100 m	b	10 m

5.1.2 Crests, sags and gradients

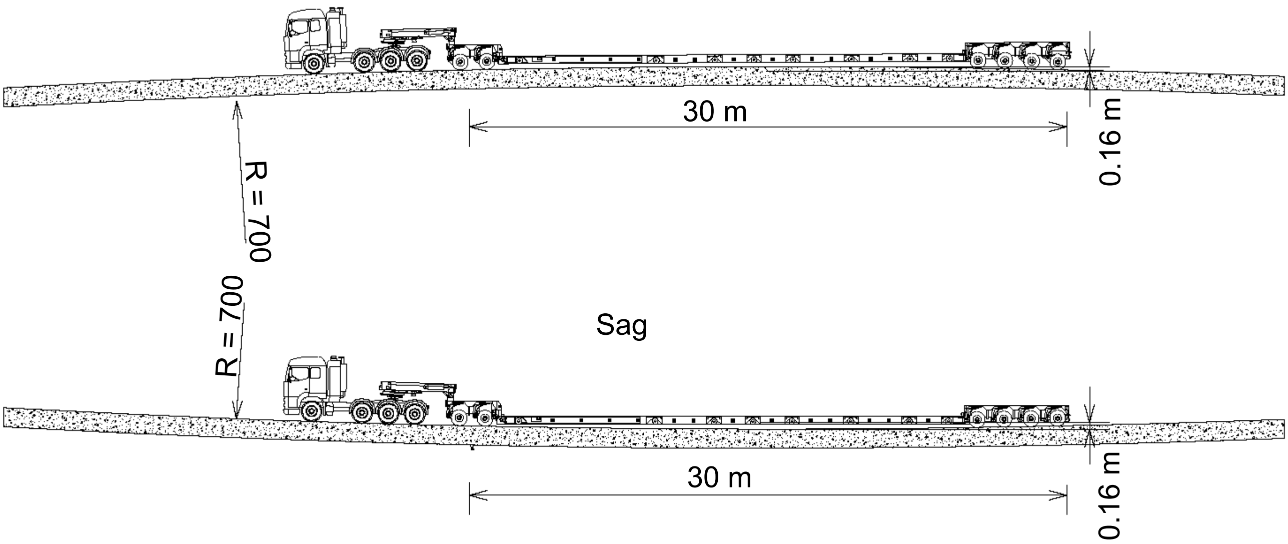

Fig. 4: Crest and sag (R = 700 m)

Vehicles with a maximum total length of 100 m are used to transport components to the construction site. For these transport vehicle combinations with excess length, the access roads must fulfil crest and sag radii of 700 m. This prevents the transports from hitting the ground, e.g.in the case of flatbed transport vehicle combinations.

In specific instances, the radius can be reduced to R = 400 m. However, this requires specific transport vehicles that can lift the flatbed to a minimum height of 45 cm. R = 400 m corresponds to a camber (crest) or depression (sag) of 0.26 m over a length of 30 m.

Uphill and downhill gradients

Abnormal loads are only able to travel on access roads with maximum uphill and downhill gradients of ≤ 12 %. With gradients of 7 % or more, a bonded surface course (e.g. asphalt, concrete) is installed. This ensures nonpositive traction for the transport vehicles. In individual instances, traction vehicles may be required (hilly or mountainous locations). This is clarified in advance in detail with the ENERCON GPM. The ENERCON GPM must evaluate the economic and scheduling effects to be borne by the customer.

For curves with gradient > 7 %, the width of the road must be adapted to the local conditions. The planning must take any such adjustments into account and the plans must be checked and approved by ENERCON.

When planning the access route around bends and intersections with inclines and declines, make sure that the torsion between the towing vehicle and trailer or trailer is ≤ 5 %.

Tab. 1: Requirements for the longitudinal profile of the access road

Parameter	Requirement
Gradient, loose surface course	≤ 7 %
Gradient, paved surface course	≤ 12 %
Ground clearance of transport vehicles	0.10 m
Radius of hilltop/bottom of valley	700 m

5.1.3 Loading gauge

For abnormal loads, there must be a specific loading gauge above the access roads. Complying with this loading gauge ensures unhindered access by all vehicles on the access roads. This area must be kept free from obstacles of any kind (e.g. structures, power supply cables, masts, trees, and branches) during construction.

The loading gauge may vary depending on the country, vehicle technology or delivery concept. If the specified loading gauge cannot be implemented, consult with the ENERCON GPM regarding an alternative solution.

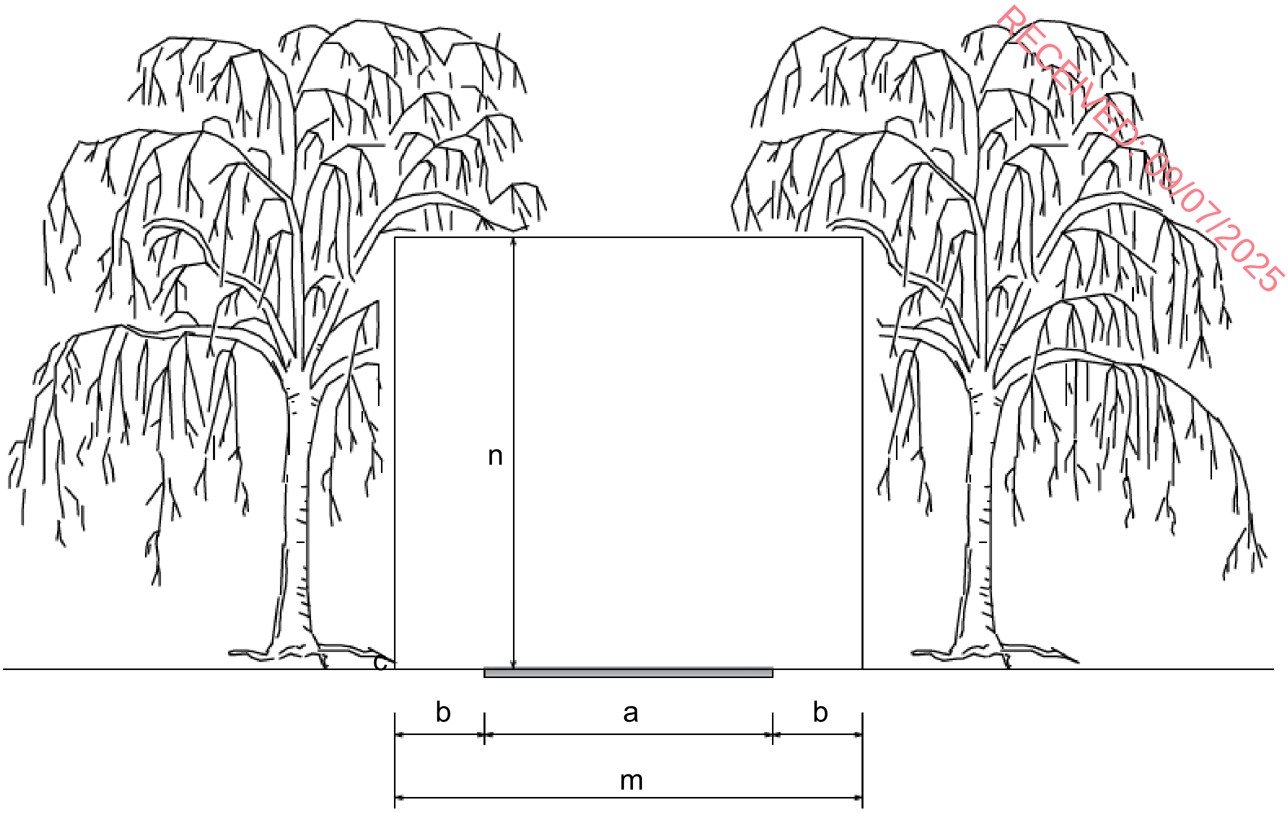

Fig. 5: Loading gauge

a	4 m	Drivable width of road in straight line	b	1.5 m	Lateral swept path including safe distance
m	7 m	Clearance width	n	4.8-6 m	Clearance height

5.2 Structure of access roads

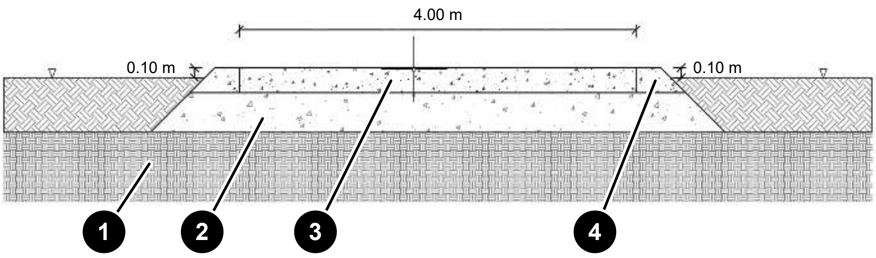

Fig. 6: Schematic structure of access roads

1	Load-bearing subsoil	2	Binder course
3	Surface course	4	Side area (shoulder)

The upper surface course is contoured with a cross slope or a straight crossfall. This ensures drainage to the sides. A drivable width of 4 m must be ensured. The construction of the side area (shoulder) is dependent on the subsoil and load transfer angle of the binder course.

The actual design is sized and determined by the traffic engineer in accordance with the local soil conditions and coordinated with the ENERCON GPM before implementation. A drivable width of 4 m must be ensured for the access road. More comprehensive expansion works may be required in order to ensure correct load transfer.

5.2.1 Lateral slopes: crown and camber

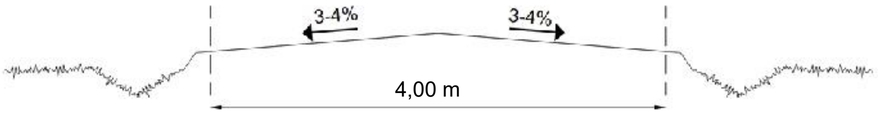

Fig. 7: Cross slope

In general, the access road must be created with a camber (cross slope) and an incline of 3–4 %. This cross slope on the road ensures that rainwater flows away from the road surface, minimising erosion, pothole formation and wheel ruts. If the road surface is paved (with concrete or asphalt), a cross slope of 2 % is sufficient to ensure adequate drainage.

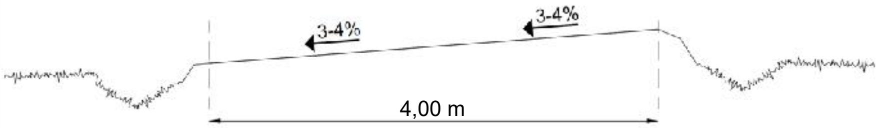

Fig. 8: Lateral slope

If the topography of the area makes it impossible to build the road with a cross slope, the lateral slope must be no more than 3–4 % over the whole width. In this case, the section regarding transitions to lateral slopes applies.

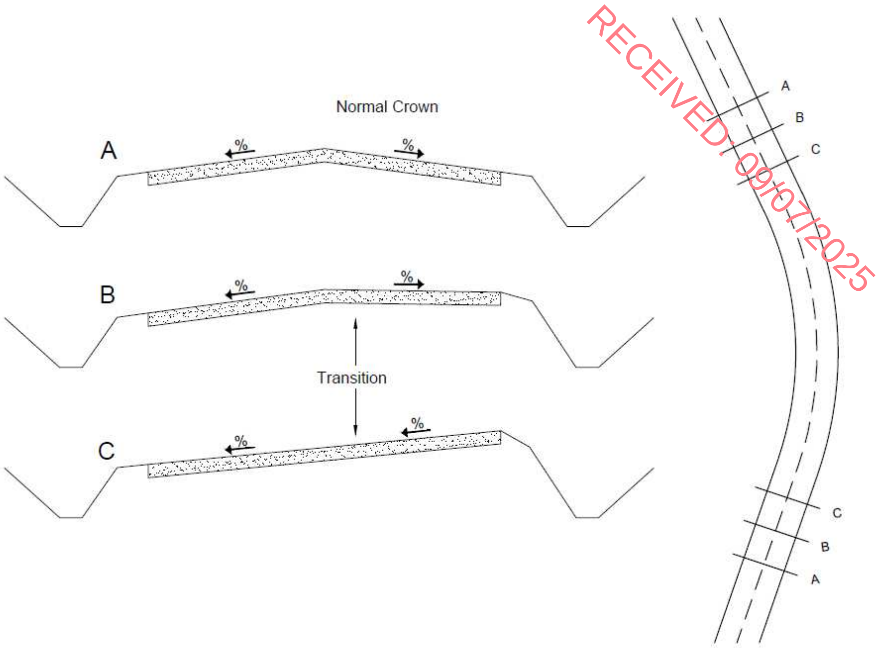

Fig. 9: Transition to lateral slope

When transitioning from a cross slope to a lateral slope, the normal crown profile must be taken out and converted to a camber profile. As a result, the surface can transition from the camber (highest point on the profile on the outer side of the curve) to the crest (highest point on the profile on the road axis). The lateral slope must be max. 2.5 % for double curves. The torsion between the towing vehicle and semitrailer/trailer must not exceed 5 %. If this cannot be realised, at least one vehicle length of the longest vehicle must be planned between the curves.

5.2.2 Road classifications

Within the wind farm, 3 different road types are used, depending on the starting situation for the road and the works required during construction: All 3 road types must fulfil the requirements with respect to the form, strength and bearing capacity as stated in this document.

Existing roads in good condition

Any existing roads within the wind farm with good surface and profile properties (sufficient bearing capacity, lateral incline and roughness) and a drivable width of at least min. 4 m. If these parameters are met, no additional works must be performed on these roads. The usual maintenance works on the road network after the start of the installation phase are mandatory.

Existing roads in need of expansion

Any existing roads within the wind farm that do not meet the requirements with respect to the road surface, the road profile, or the drivable width. Additional works to improve the road conditions are required for these roads. By using the existing road platform, the extent of the works to be performed is significantly reduced.

New roads

New roads to be build on natural ground. For these roads, all construction works must be performed:

- Clearing of vegetation
- Levelling
- Removal of topsoil
- Earthwork
- Alignment of strata
- etc.

5.2.3 Requirements

Soil investigation

The structural design of the access road is dependent on the properties of the subsoil and the expected stress from traffic. The subsoil must be investigated adequately by subsoil exploration drill holes and probing. The number and depth of the probes must be defined by the geotechnical expert, depending on the subsoil structure. The expected abnormal loads must be estimated for each relevant road section. In these estimations, the abnormal loads for each WEC must be taken into account that result from the construction of the road and paved surfaces, and from the delivery of WEC components and WEC assembly. The number of WECs operated on the relevant road section must also be considered. The structural design of the access road is defined based on the results of the soil investigations and the expected traffic.

Suitability for use

The access roads are designed with sufficient bearing capacity with consideration to the expected traffic loads, so that they will remain usable throughout the duration of their use. Suitability for use and bearing capacity must be ensured even in heavy rainfall. It must be ensured that the surface course remains permanently free of potholes. The max. wheel rut depth is limited to 7.5 cm. The design of the construction site areas must include plans for drainage on access roads. In the event of snow or ice, the operator/customer must ensure safe working and driving conditions through use of gritting and snow clearance services. The implementation plan as well as all specifications for testing, examinations, evaluations and verifications must be submitted to the ENERCON GPM for inspection unsolicited.

5.2.4 Subsoil and pavement

In order to ensure safe, effective and economical traffic conditions during the construction phase, the following geometric requirements with respect to road construction must be fulfilled.

Tab. 2: Minimum requirements for the access road

Parameter	Requirement
Drivable width of access road	4 m
Max. permitted depth of ruts	7.5 cm
Max. lateral incline of the access road on straight stretches and in curves	3-4 %

Parameter	Requirement
Height of the road surface above the natural ground	10 cm

5.2.4.1 Requirements relating to compaction and bearing capacity

In order to ensure safe, effective and economical transport during the construction phase, the following requirements relating to the bearing capacity of the road must be fulfilled.

Tab. 3: Minimum requirements for the access road

Parameter	Requirement
Max. axle load	12 t
Max. total weight of transport combination	210 t
Surface course, deformation modulus	$E_{V2} \geq 100$ MN/m^2
Surface course, Proctor density	$D_{Pr} \geq 100$ %
Binder course, deformation modulus (if required)	$E_{V2} \geq 80$ MN/m^2
Binder course, Proctor density	$D_{Pr} \geq 100$ %
Ratio E_{V2}/E_{V1}	≤ 2.3

The construction firm must inspect and document the specified deformation moduli for each stratum constructed. If the specified values are not achieved, improvement measures must be implemented. Generally, a static plate load test is recommended for each stratum constructed.

The required values for the second deformation modulus (E_{V2}) and the ratio E_{V2}/E_{V1} reflect the plate load tests performed in accordance with German standard DIN 18134. This document summarises various aspects of the inspection to be performed, such as the plate diameter, max. pressure, load levels, E_V calculation formula, etc. Plate load tests that are performed on the basis of differing standards are not directly comparable.

Depending on the results of the geotechnical expert report, a static plate load test must be performed every 200 to 500 m along the access road. Static plate load tests must also be performed at transitions between existing roads and site roads, at crossings, and at junctions.

For existing roads in good condition, it is recommended to inspect the bearing capacity of the road by way of plate load tests, whereby the same requirements apply as with other road types.

The following points shall be checked and the results recorded:

- Structure of access roads (material and installation thickness)
- Sufficient compaction of the construction material
- Bearing capacity of access roads

- Bearing capacity of bridges
- Bearing capacity of culverts and pipework
- Distances to ditches, pits and bodies of water
- Distances to cable routes and overhead lines
- Feasibility of crossing installed lines (e.g. pipelines)

It may be advisable (e.g. in the case of long traffic routes or poor subsoil) to not dimension the access road based on the specified deformation modulus but instead based on the traffic load with consideration of the axle transitions.

A drivable width of 4 m must be ensured for the access road. Depending on the load transfer and subsoil properties, more extensive expansion works may be required.

5.2.4.2 Subsoil and ground

The load-bearing subsoil is the basis for supporting high levels of surface pressure that can occur as a result of unusual loads or the cranes used. Therefore, the topsoil and any soft strata must be excavated until the first load-bearing stratum of natural ground has been reached. If cohesive and organic soils are not load-bearing, these are exchanged or replaced with layers of a suitable compacted filling material (e.g. sand). Alternatively, other technical methods can also be used (e.g. injecting, geogrid).

The bearing capacity of the subsoil must be verified. The required load distribution angle of the planned access roads is taken into account when excavating the width of the road.

5.2.4.3 Binder course

The binder course for the access roads within the wind farm consists of loose materials, such as sand, gravel, moraine, or a mixture thereof.

The proportion of fine aggregate cannot exceed 6 % of the total amount.

The gravel material for the binder course generally consists of larger stones with a much smaller proportion of clay or fine materials than the gravel material for the surface course. This is necessary in order to achieve the required strength and good drainage properties in the binder courses. Equally, the binder course material requires low plasticity index values.

The live loads are transferred to the subsoil via this binder course. The binder course must withstand the climatic and mechanical loads. The material used must be approved for use in road construction. The grading curve of the materials used must comply with whichever national regulations are applicable. The suitability of the material must be evidenced before installation by presenting valid inspection certificates. The required bearing capacity is guaranteed by way of graded grain size distribution, which must be agreed upon in coordination with the geotechnical expert.

Brick fragments are not used as bulk material for the binder course. The material is pulverised by moisture and loses its strength.

The binder course must be properly compacted in layers.

5.2.4.4 Surface course

Material The proportion of fine aggregate cannot exceed 10 % of the total amount. The gravel material for the surface course generally contains a finer aggregate than the gravel for the binder course. Aggregate that is too coarse will make maintenance more difficult and result in a rough road surface. A higher proportion of fine aggregate and a higher plasticity index are also required in order to be able to create a binding property and a smooth road surface in the surface course. In order to account for the stress resulting from high live loads, the surface course must be correctly compacted in layers.

The grading curve of the materials used must comply with whichever national regulations are applicable. The suitability of materials must be evidenced before installation by presenting valid inspection certificates. The surface course is constructed to be as even as possible, with a minimum height offset of 10 cm above the adjacent land. The minimum layer thickness is 25 cm.

Surface course If the access road has a pitch of 7 % to a maximum of 12 %, the surface course has a hydraulic or bituminous bond. The surface course provides a friction fit that prevents the wheels of vehicles with abnormal loads from spinning.

6 Construction site areas and foundation

6.1 Work area at the WEC site

6.1.1 General information

Different jobs are performed on the construction area at the site of the WEC to be erected. These range from foundation construction, storage of components, pre-assembly and WEC assembly through to grid connection and commissioning. The construction area is divided into different areas that are used for assembly and storage of the WEC components. Different requirements apply to these areas. The construction site areas must therefore be sufficiently dimensioned and have sufficient bearing capacity to ensure safe and cost-effective progress of the project.

Differences in level

In order to ensure a smooth sequence of construction, the following differences in level must be observed:

- Between construction site areas and surrounding terrain: If the height difference between the construction site areas and the surrounding area is > 0.30 m, the side areas need to be sloped with a gradient of 45°. Depending on the height of the slope, there is a circumferential strip around the perimeter on which loads must not be placed. If necessary, the area must be increased in size in order to create the required useful area.
- Between access road, crane platform, storage area and assembly area: A height difference or offset is not permitted.
- Between crane platform and foundation top edge: The permissible height difference can be found in the foundation data sheet.

If height differences are necessary due to the topographical conditions, the point ‘Slopes’ must be taken into account and coordinated with the ENERCON GPM.

- If the construction area is built into an elevation or a hill, an edge strip of 4 m must be planned, which means that the base area is increased by this edge strip. In this case, sufficient drainage must be guaranteed. This regulation applies to the edge area as well as to elevations within the construction area.

Slopes

In the case of slopes, the safety zone that must not be loaded must be taken into account. The base area is thus increased by the safety zone. This regulation applies to the edge area as well as to slopes within the construction area. The safety zone must be determined by the geotechnical expert.

Storing spoil

Spoil generated during the construction phase that will not be re-used is to be stored exclusively in heaps outside of the work area. When creating heaps of earth, take into account the planned cable route and cable bushing from and to the WEC. The minimum distance from the heaps of earth to the work area is 4 m. So as not to impede delivery of the tower and WEC components, spoil must not be stored in the swept path of the transport vehicles. The same applies along the crane jib assembly area. If not used, excess spoil is to be completely removed by the customer. For orientation, observe the fig. 12, p. 32.

Locations for winches

In order to guide the WEC components during lifting, they are held in position with ropes and winches. The position of the winches depends, among other factors, on the component to be lifted and the wind situation and is coordinated shortly beforehand with the ENERCON CM or installation team. The winches are positioned at a minimum distance of 1 hub height in metres from the tower base.

The winch location must be accessible with a telescopic handler. The owner of the plots of land in question must be notified of the activities, and in some cases, their permission may be required. Driving over the land with a telescopic handler can cause damage to it. This must be borne by the customer to a reasonable extent.

Depending on the local forest density, additional areas may have to be cleared. In the case of forest locations, the winch location must be agreed with ENERCON at an early stage.

6.1.2 Foundation

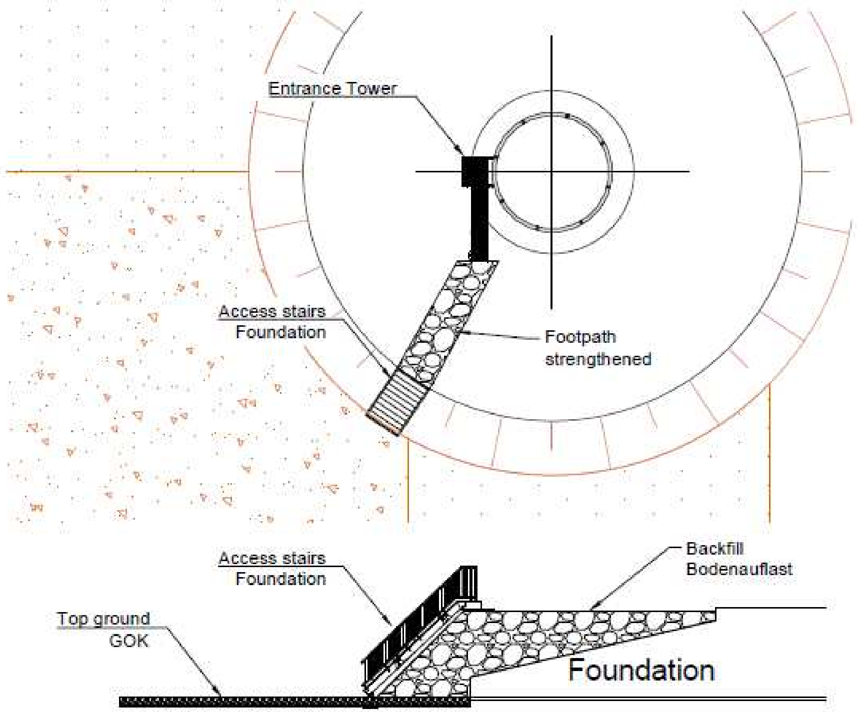

Fig. 10: Foundation at GL with soil load

For operation of the WEC, the foundation requires a soil cover that must be applied before the start of construction of the WEC. Here the outer diameter of the slope must not be greater than the foundation outside edge +< 3 m.

If there are differences between the specified height levels, such that the distance between the foundation top edge and ground level is greater or smaller than the prescribed standard, this must be agreed with ENERCON. The space required for the soil cover and adapted entrance stairs must be taken into account in the plans.

Once the soil cover is in place, entrance stairs must be installed for access. This stairway is included in the scope of delivery of the WEC and is installed by the assembly team. If the customer prefers to install their own stairs, this must be agreed with ENERCON in advance. Height differences other than those specified on the foundation formwork plan must be taken into account. The standard stairway is only adapted if there are height differences > 0.4 m. If the stairway is too short, gravel will be used at the bottom end to compensate for the height difference. If the stairway is too long, the bottom end will be dug in or shimmed above the soil cover.

For HSTs, a temporarily drivable strip 3 m wide must be planned around the soil cover. A telescopic work platform will be driven onto this strip during pre-assembly of the foundation section. The strip can be made from e.g. steel plates.

Other than the soil cover, additional loads on foundations are not covered by the scope of the type testing. Additional loads require approval from ENERCON.

- Prohibited additional loads during the installation phase:
  - Storing or driving any kind of vehicle or crane on the area
  - Any soil density properties for the materials or soil cover properties that deviate from the formwork plan
  - Unloading and storage of crane components and weights
  - Unloading or storage of brickwork, stone or concrete foundation curbs
  - Erecting transformer stations, etc.
- Permissible additional loads during the installation phase:
  - Laying down cables and small tools required for assembly
  - Access by installation and service personnel

Sequence of construction

1. Creating the entire substructure of the crane platform and assembly area. The surface course is applied up to a distance of +3 m from the outside edge of the foundation.
2. Creating the foundation.
3. Applying and sloping the foundation slope according to the specifications, whereby the slope outer diameter must not exceed +3 m from the outside edge of the foundation.
4. Installing a stairway with handrail at the slope, in the direction of the crane platform. Here, the safety and construction regulations that currently apply in the region must be complied with.
5. Using gravel to secure the foundation from the entrance stairs to the crane platform up to the access to the outer tower stairs in order to ensure safe and clean access routes.
6. Reworking and profiling the entire building area as per minimum requirements.

6.1.3 Building area

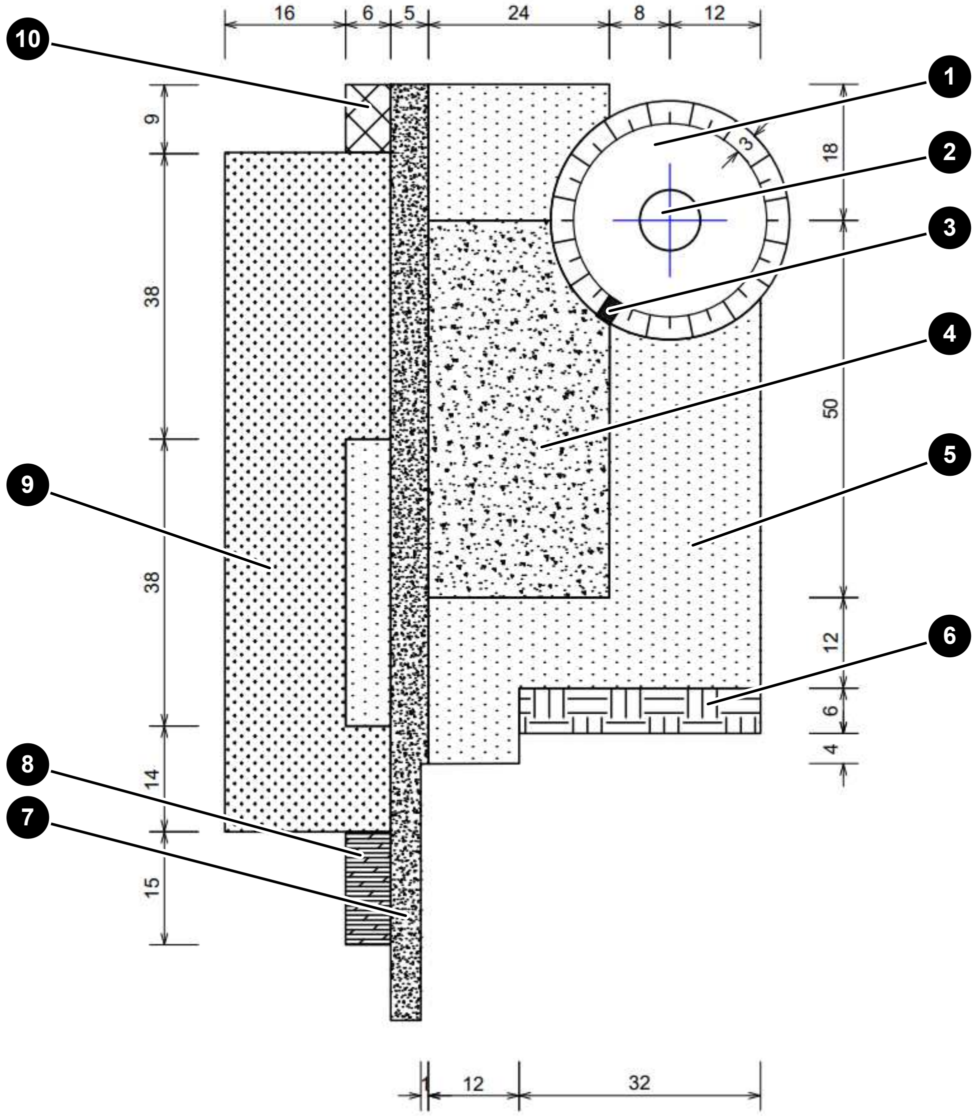

Fig. 11: Working area dimensions at the WEC site (all dimensions in metres)

1	Foundation	2	Tower
3	Stairs	4	Crane platform
5	Assembly area	6	Container area
7	Access road	8	Parking area
9	Storage area	10	Waste collection point

Soil investigation

The structural design of the crane platform and assembly area may differ, depending on the nature of the subsoil. The subsoil must be investigated adequately by subsoil exploration drill holes and probing. All strata relevant to settlement and soil failure must be recorded during this process. The number and depth of the explorations must be specified by the geotechnical expert in relation to the subsoil structure. The structural design of the crane platform and assembly area is then determined based on the results of the soil investigations.

Suitability for use The construction site areas are designed with sufficient bearing capacity with consideration to the expected loads, so that they will remain usable throughout the duration of their use. Suitability for use and bearing capacity must be ensured even in heavy rainfall. The max. wheel rut depth is limited to 7.5 cm. The design of the areas must include an option for drainage. In the event of snow or ice, the operator/customer must ensure safe working and driving conditions through use of gritting and snow clearance services. The implementation plan as well as all specifications for testing, examinations, evaluations and verifications must be submitted to the ENERCON GPM for inspection unsolicited.

6.1.3.1 Material

Certified crushed bulk materials, e.g. gravel or similar, that fulfil the requirements may be used as a material for the surface course. The minimum layer thickness is 25 cm. The following considerations apply to materials that will be used both on the crane platform and in the assembly area.

6.1.3.2 Subsoil and soil

The load-bearing subsoil is the basis for supporting high levels of surface pressure that can occur as a result of unusual loads or the cranes used. Therefore, the topsoil and any soft strata must be excavated until the first load-bearing stratum of natural ground has been reached. If cohesive and organic soils are not load-bearing, these are exchanged or replaced with layers of a suitable compacted filling material (e.g. sand). Alternatively, other technical methods can also be used (e.g. injecting, geogrid).

Binder course The binder course for the crane platforms and hardstands can consist of loose materials, such as sand, gravel, moraine, or a mixture thereof. The proportion of fine aggregate cannot exceed 6 % of the total amount. The gravel material for the binder course generally consists of larger stones with a much smaller proportion of clay or fine materials than the gravel material for the surface course. This is necessary in order to achieve the required strength and good drainage properties in the binder courses. Equally, the binder course material requires lower plasticity index values.

The live loads are transferred to the subsoil via this binder course. The binder course must withstand the climatic and mechanical loads. The material used must be approved for use in road construction and building construction. The grading curve of the materials used must comply with whichever national regulations are applicable. The suitability of the material must be evidenced before installation by presenting valid inspection certificates. The required bearing capacity is ensured by way of graded grain size distribution, which must be agreed upon in coordination with the geotechnical expert.

Brick fragments are not to be used as bulk material for the binder course. This material is pulverised by moisture and loses its strength. It must be ensured that the compaction is correct.

Surface course Certified crushed bulk material, e.g. gravel or crushed stone, is used as material for the surface course. An aggregate of 0/32-0/45 mm is used. The proportion of fine aggregate cannot exceed 10 % of the total amount. The gravel material for the surface course generally contains a finer aggregate than the gravel for the binder course. Aggregate that is too coarse will make maintenance more difficult and result in a rough road surface. A higher proportion of fine aggregate and a higher plasticity index are also required in order to be able to create a binding property and a smooth road surface in the surface course. The grading curve of the materials used must comply with whichever national regulations are applicable. The suitability of materials must be evidenced before installation by presenting valid inspection certificates. The minimum layer thickness is 25 cm. In order to account for the stress resulting from high live loads, the surface course must be well compacted in layers.

6.1.3.3 Crane platform

The crane is set up on the crane platform. This is where the main works are carried out. This area is subjected to the highest levels of stress as a result of live loads and distributed loads. An improperly designed or dimensioned crane platform may result in unforeseen movements or toppling of the crane.

Tab. 4: Crane platform minimum requirements

Parameter	Requirement
Surface evenness	≤ 0.25 %
Minimum bearing capacity	220 kN/m²
Surface course, deformation modulus	E_{V2} ≥ 120 MN/m²
Surface course, Proctor density	D_{Pr} ≥ 103 %
Binder course, deformation modulus (if required)	E_{V2} ≥ 100 MN/m²
Binder course, Proctor density	D_{Pr} ≥ 100 %
Ratio E_{V2}/E_{V1}	≤ 2.3

The bearing capacity of the crane platform must be verified by soil failure calculations or, on slopes, by slope failure calculations in accordance with DIN 4017. Settlement calculations are required in order to prevent the crane from standing at an incline that is greater than the maximum permitted by DIN 4019:2015. The crane loads are reduced to the specified permissible soil pressure by load distribution plates underneath the crawlers or outriggers.

The required geotechnical verifications of the load distribution shall be provided in each case for an area with the following dimensions:

- 2 m x 10 m
- 5 m x 10 m

The construction firm must check and document the specified deformation moduli for each stratum constructed. If the specified values are not achieved, improvement measures must be implemented. Generally, a static plate load test is recommended for each stratum constructed. The recommended values for the second deformation modulus (E_{V2}) and the ratio E_{V2}/E_{V1} reflect the plate load tests performed in accordance with German standard DIN 18134. This document summarises various aspects of the inspection to be performed, such as the plate diameter, max. pressure, load levels, E_V calculation formula, etc. Plate load tests that are performed on the basis of differing standards are not directly comparable.

The following points shall be checked and the results recorded:

- Structure of the construction site area (material and installation thickness)
- Sufficient compaction of the construction material
- Distances to ditches, pits and bodies of water
- Distances to cable routes and overhead lines

For the compaction test of the crane platform, a minimum of 3 plate load tests should be performed that provide a representative result of the condition of the surface. Plate load tests in the edge area must be avoided. If there are doubts with respect to the suitability for use of the crane plate, further tests must be performed if necessary.

6.1.3.4 Assembly area

The assembly area serves as a work area for pre-assembly and assembly purposes and for storing WEC and tower components. This area is required during construction and can be restored to its original state after work in the wind farm has been completed. In the case of component replacement or dismantling, a section of this area must be restored. The size and position of this section must be agreed upon in coordination with the ENERCON GPM.

Tab. 5: Minimum requirements for the assembly area

Parameter	Requirement
Surface evenness	≤ 1 %
Minimum bearing capacity	135 kN/m^2
Surface course, deformation modulus	E_{V2} ≥ 120 MN/m^2
Surface course, Proctor density	D_{Pr} ≥ 103 %
Binder course, deformation modulus (if required)	E_{V2} ≥ 80 MN/m^2
Binder course, Proctor density	D_{Pr} ≥ 100 %
Ratio E_{V2}/E_{V1}	≤ 2.3

The bearing capacity of the assembly area must be verified by soil failure calculations or, on slopes, by slope failure calculations in accordance with DIN 4017. Settlement calculations are required in order to prevent the crane from standing at an incline that is greater than the maximum permitted by DIN 4019:2015. The crane loads are reduced to the specified permissible soil pressure by load distribution plates underneath the crawlers or outriggers.

The required geotechnical verifications of the load distribution shall be provided in each case for an area with the following dimensions:

- 1.5 m x 5 m
- 3 m x 5 m

The construction firm must check and document the specified deformation moduli for each stratum constructed. If the specified values are not achieved, improvement measures must be implemented. Generally, a static plate load test is recommended for each stratum constructed. The recommended values for the second deformation modulus (E_{V2}) and the ratio E_{V2}/E_{V1} reflect the plate load tests performed in accordance with German standard DIN 18134. This document summarises various aspects of the inspection to be performed, such as the plate diameter, max. pressure, load levels, E_V calculation formula, etc. Plate load tests that are performed on the basis of differing standards are not directly comparable.

The following points shall be checked and the results recorded:

- Structure of the construction site area (material and installation thickness)
- Sufficient compaction of the construction material
- Distances to ditches, pits and bodies of water
- Distances to cable routes and overhead lines

At least 1 plate load test per assembly area must be performed for the compaction check of the assembly area.

6.1.3.5 Storage area

The storage area serves to store assembly materials, containers, flat racks and rotor blades, among other things. This area is set up to the side of the crane platform. It does not have to be surfaced but it must be level, smooth and free of roots, trees and shrubs. Drainage measures must be in place. Practicability for telescopic handlers must be ensured.

Additional measures may be required for the correct mounting of the rotor blades. These additional measures, such as ballast surfaces, steel plates or load distribution plates, vary depending on the rotor blade and must be agreed with the ENERCON GPM.

6.1.3.6 Working levels (where necessary)

The carrier device used for constructing pile foundations or for ground improvement measures through vibro replacement/vibro compaction is located on the working level.

Tab. 6: Minimum requirements for the work area

Parameter	Requirement
Form: Circle	Coordination with ENERCON GPM
Surface evenness	≤ 1 %
Minimum bearing capacity	Coordination with ENERCON GPM

Parameter	Requirement
Binder course, deformation modulus (if required)	E_{V2} ≥ 80 MN/m²
Binder course, Proctor density	D_{Pr} ≥ 100 %
Ratio E_{V2}/E_{V1}	≤ 2.3

The following tests must be carried out and recorded:

- Compaction (static plate load tests, dynamic probing)
- Distances to ditches, pits and bodies of water
- Distances to cable routes and overhead lines
- Surface gradients for drainage

ENERCON
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6.1.4 Clearing and safety area

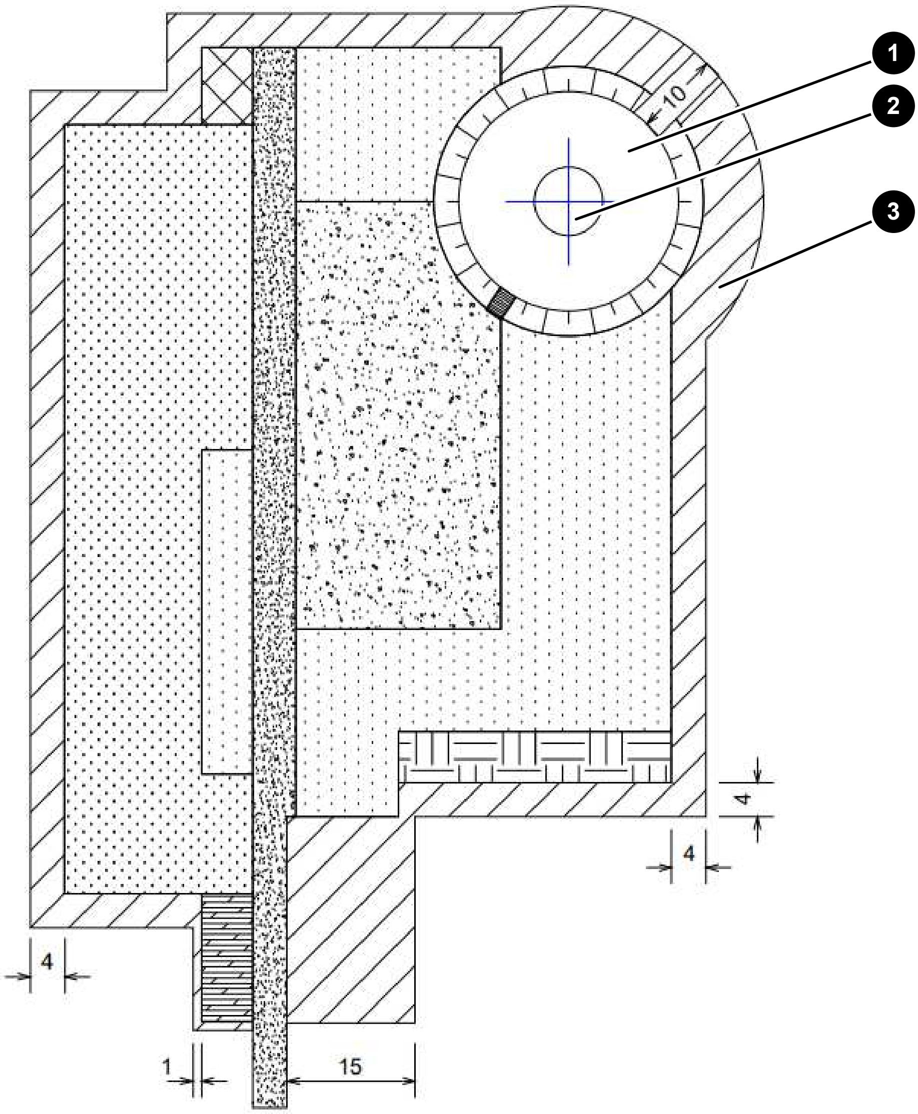

Fig. 12: Site clearing and safety area, dimensions (all dimensions in metres)

1	Foundation	2	Tower
3	Site clearing and safety area		

When erecting the WEC, a safety area must be kept clear around the foundation and the construction area, or the area must be cleared. No excavated soil may be stored in the clearing and safety area during construction work. The clearing and safety area can be partly reforested after the WEC has been installed. In the event of component replacement or dismantling, a section of this area must be kept clear or cleared again. The size and dimensions of this section must be agreed upon in coordination with the ENERCON GPM.

6.2 Crane jib assembly area

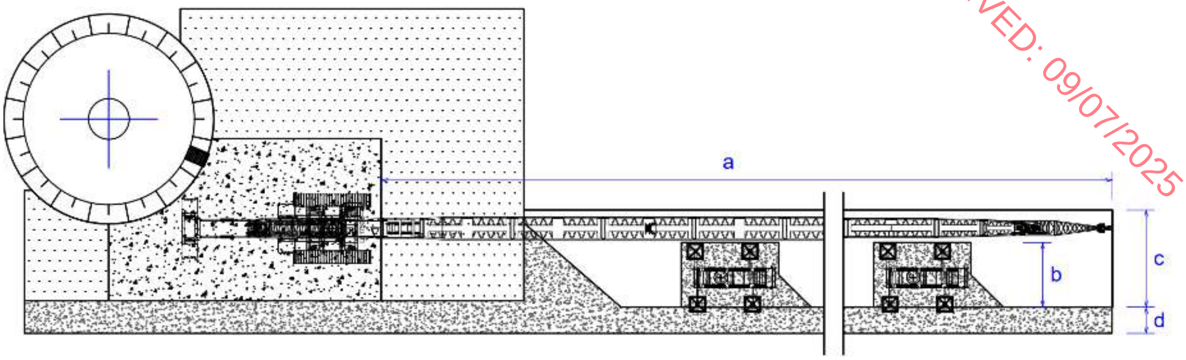

Fig. 13: Crane jib assembly area

a	140 m	Length of crane jib assembly area, starting from crane platform	b	10 m	Width of auxiliary crane platform
c	15 m	Total width of crane jib assembly area	d	4 m	Drivable width of road

The lattice tower jib of the main crane is assembled from individual components. It must be ensured that the lattice tower for the large crane can be set down in the event of rising wind speeds during assembly as well. This requires a clearing that is the same length as the lattice tower jib, which is the same height as the crane platform as standard. Lattice tower jibs can be installed only up to a certain gradient. If there are height differences in the crane jib assembly area, consult with the ENERCON GPM. This particularly applies to gradients between the basic unit and the lattice tower jib.

Auxiliary crane areas

The lattice tower jib of the large crane is assembled and erected with the support of an auxiliary crane. The auxiliary crane is positioned to the side of the lattice tower tip. In order to facilitate consecutive assembly of the individual jib components, a paved roadway is required for the auxiliary crane. If the access road to the crane platform is straight, long enough and if local conditions make lattice tower assembly possible, it is used for that purpose. If not, a temporary auxiliary road will be built. Approval by an authority may be required for the construction of the temporary road for lattice tower assembly. The customer must check in advance if this approval is necessary. In order to support the auxiliary crane and distribute its loads, auxiliary crane platforms measuring 10 m in width must be established at certain intervals, immediately adjacent to the access road or auxiliary road. The number and location of auxiliary crane areas is coordinated with the ENERCON GPM and crane service provider. If a crawler crane is used as an auxiliary crane, the access road must be widened correspondingly for the crane. This can be realised with gravel or plates, depending on the ground conditions.

Tab. 7: Requirements for the crane jib assembly area

Parameter	Requirement
Bearing capacity of the access road or auxiliary road	12 t axle load

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Parameter	Requirement
Surface pressure of the auxiliary crane platforms	min. 135 kN/m^2

6.3 Alternative construction area

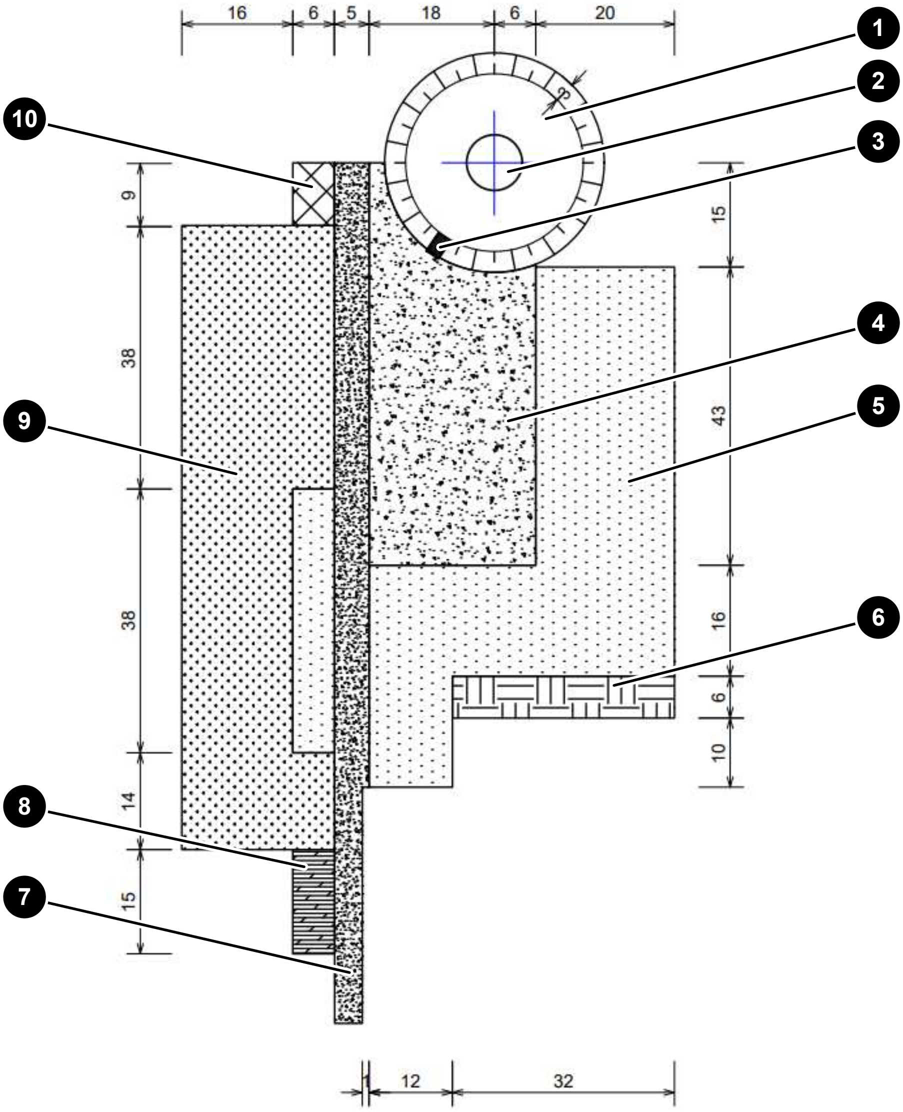

Fig. 14: Alternative working area at the WEC site, dimensions (all dimensions in metres)

1	Foundation	2	Tower
3	Stairs	4	Crane platform
5	Assembly area	6	Container area
7	Access roads	8	Parking area
9	Storage area	10	Waste collection point

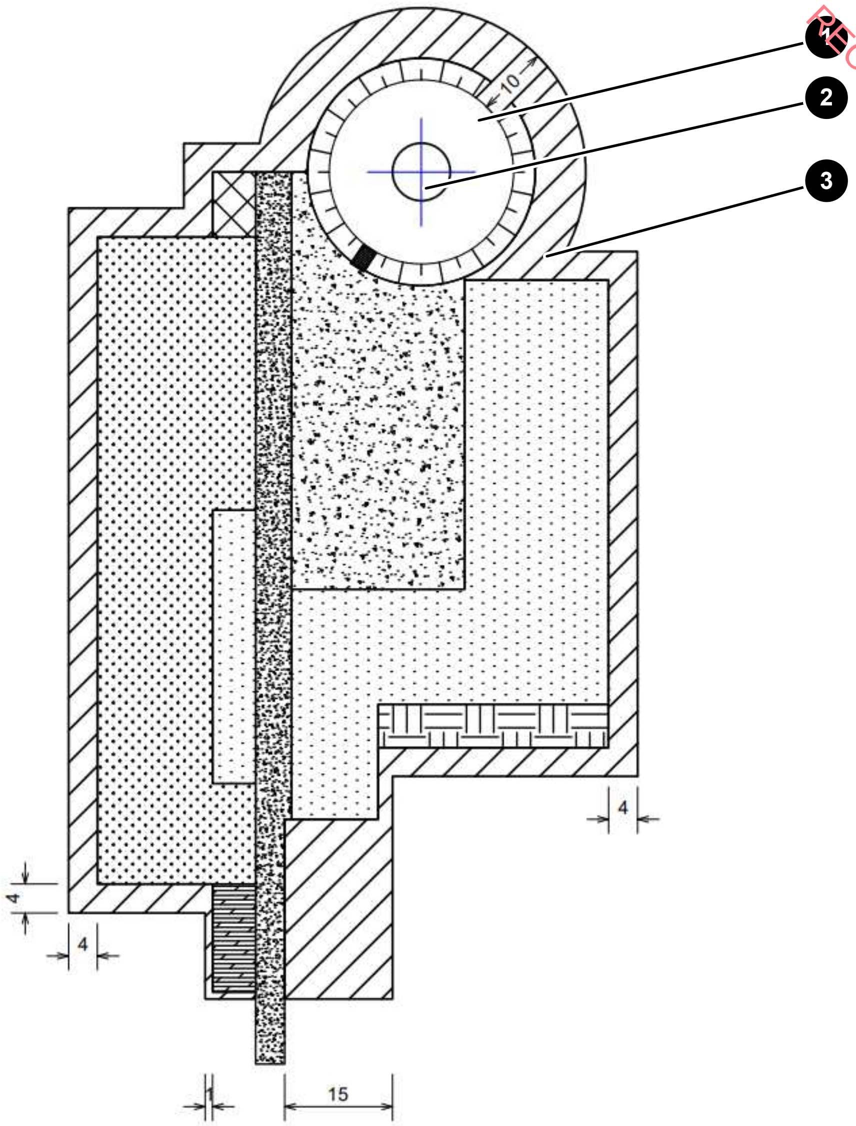

Fig. 15: Alternative site clearing and safety area, dimensions (all dimensions in metres)

1	Foundation	2	Tower
3	Site clearing and safety area		

The alternative construction areas shown here meet the same requirements for delivery and assembly as in the standard shown (fig. 11, p. 26 and fig. 12, p. 32). There are restrictions to the assembly direction of the jib: namely, here it can only be assembled in the direction opposite to the tower. Use of the alternative construction areas must be agreed with ENERCON.

6.4 Optional rotor blade storage area

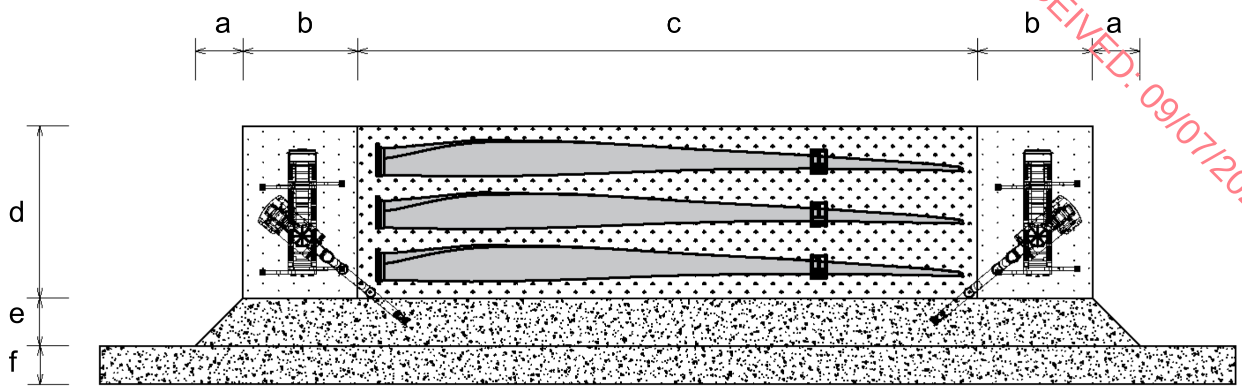

Fig. 16: Rotor blade storage area (construction diagram)

a	5 m	Length of funnel lay-by	b	12 m	Width of auxiliary crane platform
c	90 m	Length of rotor blade storage area	d	18 m	Width of rotor blade storage area/ length of auxiliary crane platform
e	5 m	Width of lay-by	f	4 m	Drivable width of road

The rotor blade storage area serves as temporary storage for rotor blades. The area can also be used for transferring rotor blades. The rotor blade storage area is located in a lay-by along the access road. The storage area is free of stumps and roots. An auxiliary crane is located on each of the two front sides of the storage area for moving the rotor blades. The rotor blade storage area does not replace the parking spaces for excess length transport vehicles required to be specially indicated (see *Parking areas for long transports*, p. 12).

The rotor blade storage area is included in the plans if no storage area can be constructed at the WEC location or if no just-in-time delivery of the rotor blades is possible due to the installation and logistics concept. The size of the rotor blade storage area and its position within the wind farm are derived from the installation and logistics concept and are agreed upon with the ENERCON GPM. The additional logistical costs are borne by the customer. If necessary, contractually agreed deadlines must be adjusted by the contractor.

Tab. 8: Requirements for the rotor blade storage area

Parameter	Requirement
Bearing capacity of the lay-by	12 t axle load
Minimum load-bearing capacity of the auxiliary crane platforms	min. 135 kN/m^2

7 Central contact point

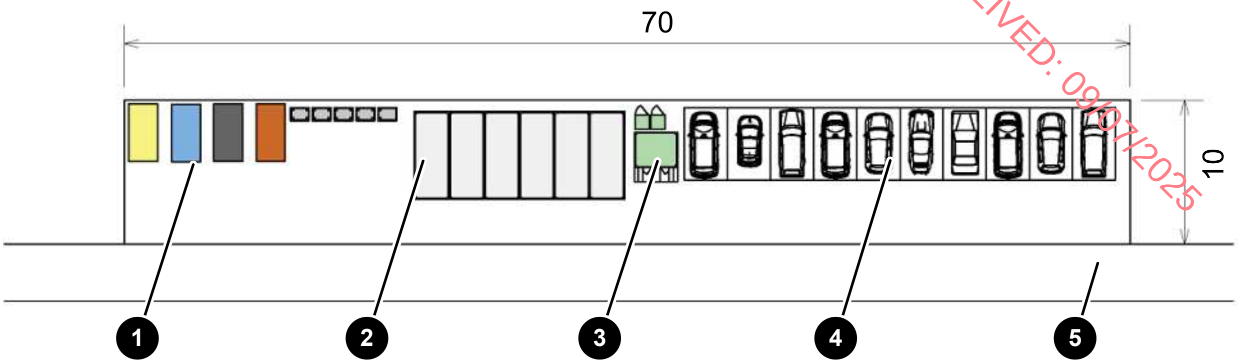

Fig. 17: Central contact point (all dimensions in metres)

1	Waste containers	2	Construction site containers
3	Sanitary facilities	4	Car parking spaces
5	Access road		

Central infrastructure is required in every wind farm. The central infrastructure includes the office container of the ENERCON CM, car parking spaces, waste containers and sanitary facilities. A dedicated space can be created for this to serve as a central facility. Existing spaces may also be used and may require adaptation. The office containers and waste containers do not have to be located in the same area. The waste containers must be accessible for loading and unloading by truck.

The area of the central contact point is gravelled or covered with steel or composite panels. The bearing capacity of the area is dimensioned for vehicles with an axle load of 12 t.

The construction site equipment, the location within the wind farm as well as dimensions and distances on the area are coordinated on a project-specific basis with the ENERCON GPM. Local conditions and country-specific regulations must be taken into account.

8 Access for service vehicles after commissioning

Once the WEC has been commissioned, ENERCON Service needs access (a ramp) for service vehicles, in order to bring heavy components such as yaw gears to the WEC. This ramp can be installed at the same time as dismantling the temporary assembly areas. When doing so, the specifications document D02768819 'Anforderungen Zusatzbelastung Fundamentanschüttung und Fundamentauflast für Servicetätigkeiten' (Additional load requirements for foundation soil cover/load for service activities) must be taken into account. This specification applies only for servicing after commissioning a WEC.

It is not permitted to have a ramp during the assembly phase.

APPENDIX 2.2

FIRE RISK ASSESSMENT

VOLUME III

APPENDICES TO ENVIRONMENTAL IMPACT ASSESSMENT REPORT

RFI Response July 2025

Cloonanny Wind Farm

FIRE RISK ASSESSMENT

Natural Forces
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Cloonanny Wind Farm
Fire Risk Assessment

Document History

Doc Name	Rev	Details	Author	Approved
FRA	0	Fire Risk Assessment	Emma Harris	Jonathan Coffey

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Table of Contents

1. Introduction

The purpose of this Fire Risk Assessment is to assess the hazards associated with a fire in or near the proposed development. The assessment aims to identify the key fire risks associated with a battery energy storage system within the substation compound.

2. Responsibilities (Control of the Plan)

It is the responsibility of the site developer, to ensure the actions set out in this assessment is complied with. The developer is charged with the overall responsibility of ensuring the mitigation measures proposed within this Fire Risk Assessment and all planning conditions issued by a relevant planning authority or statutory body are adhered with throughout the construction and operational phase of the proposed development detailed below.

3. Development Description

A detailed description of the Proposed Development is contained within Chapter 2 of this EIAR and the Planning Statement that accompanies the planning application.

A 10-year permission is being sought by Natural Forces Renewable Energy 2 Limited (Natural Forces) for the development of a 14MW wind farm to be located in the townlands of Gorteenorna, Derryharrow, Corragarrow, Cloonanny Glebe, Co. Longford.
The development will consist of:

i. The Construction of two Enercon E175 EP5 wind energy converters, each with an electrical rating of 7MW, an overall ground-to-blade tip height of 199.9 metres, a rotor blade diameter of 175 metres, hub height of 112.4 metres, associated foundations and hard-standing areas;
ii. Construction of an 800m permanent internal site access road which will run from the L50462 to the wind energy converter hardstanding areas including a 9.1m clear span bridge crossing a local stream;
iii. Construction of 1 No. 20kV substation compound comprising 2 No. modular substation buildings, a battery energy storage system (BESS) associated electrical works, foundation and hardstanding area;
iv. A meteorological mast (met mast) with a height of 32 metres, and associated foundation and hardstanding area;
v. Temporary alterations to the turbine component haul route, including junction accommodation works and temporary access roads to facilitate deliveries to the site entrances on the L50462 and the L5046;
vi. Upgrade of the existing entrance on the L50462 for provision of a construction stage site entrance;
vii. Installation of underground collector circuit and communications cabling which will run in underground cable trenches (c. 1m deep), from the proposed wind energy converters to the proposed substation compound;

viii. Demolition of a single storey derelict shed structure (c. 93 sqm GFA) to facilitate the turbine haul route
ix. A temporary construction compound;
x. All associated and ancillary site development, construction and operational works such as excavation, construction, wind turbine and electrical component repair replacement and maintenance, site reinstatement works , including the provision of a temporary construction compound, site drainage, spoil management, and hedge and tree trimming and cutting .

The proposed development has a total site area 17.28ha and will have an operational lifespan of 35-years from the date of commissioning

4. International Standards

The proposed development will be constructed in line with the International Standard sets International Electrotechnical Commission (IEC)[1].

The International Electrotechnical Commission (IEC)[2] is a global, not-for-profit membership organization that brings together more than 170 countries and coordinates the work of 20,000 experts globally.

The IEC work underpins quality infrastructure and international trade in electrical and electronic goods. Their work facilitates technical innovation, affordable infrastructure development, efficient and sustainable energy access, smart urbanization and transportation systems, climate change mitigation, and increases the safety of people and the environment.

The IEC provides a global, neutral and independent standardization platform to 20,000 experts globally. It administers 4 Conformity assessment systems whose members certify that devices, systems, installations, services and people work as required.

The IEC publishes IEC International Standards which together with conformity assessment provide the technical framework that allows governments to build national quality infrastructure and companies of all sizes to buy and sell consistently safe and reliable products in most countries of the world. IEC International Standards serve as the basis for risk and quality management and are used in testing and certification to verify that manufacturer promises are kept.

They provide instructions, guidelines, rules or definitions that are then used to design, manufacture, install, test & certify, maintain and repair electrical and electronic devices and systems.

[1] https://www.iec.ch/about-us
[2] https://www.iec.ch/about-us

IEC International Standards are essential for quality and risk management; they help researchers understand the value of innovation and allow manufacturers to produce products of consistent quality and performance. IEC International Standards are always used by technical experts; they are always voluntary and based on the international consensus of experts from many countries.
International standards also form the basis for testing and certification.
International standards are also often adopted by countries or regions to become national or regional standards. For example, close to 80% of European electrical and electronic standards are in fact IEC International Standards.

On the other side, regulations are rules or directives that are made and maintained by a national or regional authority. Generally, compliance with regulations is a must.
It is quite common for technical regulations to refer to international standards because standards help avoid that the law becomes too detailed or descriptive. This approach allows laws to stay current because standards are regularly reviewed and updated.

Standards provide the technical frameworks, metrics and specifications regulators can reference in legislation. As technologies evolve, standards are revised, and legislation remains up to date.

Standards also provide governments with technical references in public tenders, lending confidence that products meet commonly agreed rules that match the requirements of many.

By incorporating IEC International Standards and testing and certification into their regulations, policy makers and regulators provide a platform that encourages the cooperation of competitors under common rules. This avoids island solutions and improves safety, affordability and interoperability.

5. Fire Risk Assessment

The key fire risks identified in relation to the substation and BESS compound are identified as;

- Component Failure
- Poor Operation and Maintenance Practices

6. Substation & BESS Compound Fire Risks

No. 1 20kV Substation and BESS compound (hereafter referred to as the compound) has been proposed within the development.

The compound will be made up of 2No. Modular Substations and 3 No. Bess Units Each BESS unit in the proposed development contains of 6 battery modules and 3No. Transformer and Inverters Units. This technology has been chosen due to strict safe regulations governing energy storage facilities / Lithium-Ion. Due to their design BESS containerised lithium-Ion units are easily installed and due to their technical characteristics, work well as energy storage systems for improving the penetration of renewable energy generation, as well as providing grid stability See Figure 1 Compound Layout below.

Figure 1 Compound Layout

The energy storage compound will be compliant with all regulations and health and safety requirements governing energy storage facilities in the Republic of Ireland.

The BESS solution manufacturer will also comply with international standards such as:

- UN 38.3 (Transportation Testing for Lithium Batteries)
- UL 1642 (Standard for Safety – Lithium-ion Batteries)
- IEC 62619 (Secondary cells and batteries containing alkaline or other non-acid electrolytes Safety requirements for secondary lithium cells and batteries, for use in industrial applications).

Furthermore, the energy storage compound will also comply with standards such as;

- UL 1973 (Batteries for Use in Stationary Applications)
- IEC 62619-2017 including thermal runaway non-propagation and safety zone region operation limits and a failure mode analysis.
- The design will be compliant with UL 9540 (Energy Storage Systems and Equipment): this standard defines the safety requirements for battery installation in industrial and grid connected applications.

The containerised Lithium-Ion battery units used in the energy storage compound will be similar to that presented in Figure 2 BESS Container below, other infrastructure to be located within the energy storage compound includes, 1 No. battery switchgear containers and 2 No. Inverter & Transformer Units components pose a very minimal fire risk

Figure 2 BESS Container

The main risk at the development is fire of the battery cells within the BESS container. Each container has a built-in fire detection and suppression system. This system continually monitors the batteries and in an unlikely event of a fire it suppresses the fire using inert gas, see Figure 3 Typical BESS Fire Detection & Suppression System. The energy storage compound has been designed to ensuring there is adequate spacing between containers, the chance of a fire spreading between containers (which are made of metal and thus not easily flammable) is minimal.

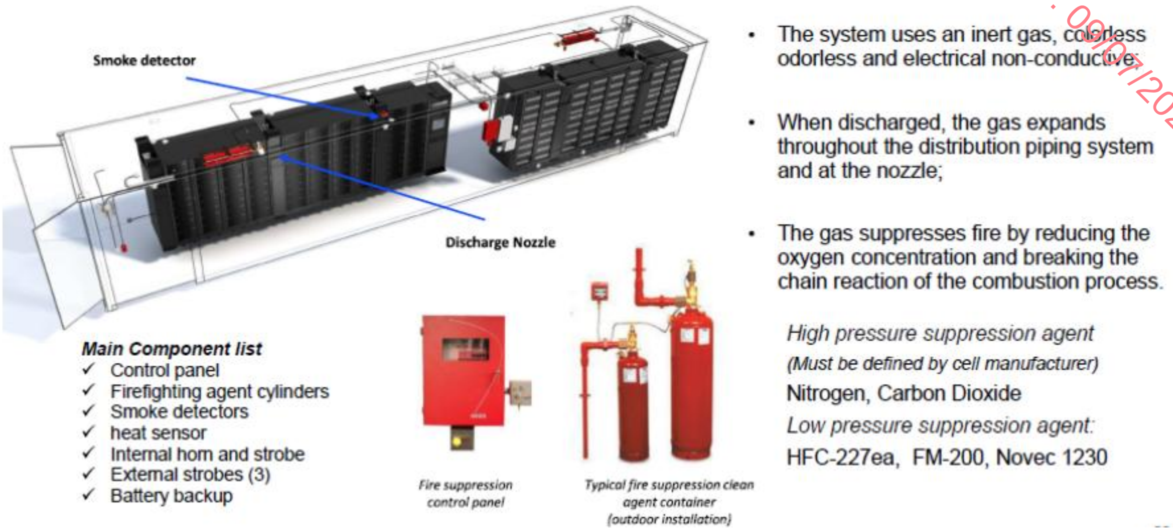


Figure 3 Typical BESS Fire Detection & Suppression System

7. Preventing Thermal Runaway in Batteries

Technology is available to make batteries safer and prevent the thermal runaway.

Proper Storage Temperature

One of the simplest ways to prevent thermal runaway is to store batteries at safe temperatures. The ideal storage temperature for most lithium-ion batteries. Most lithium-ion battery packs include a built-in battery management system (BMS). This BMS serves as the control center for the battery pack. It ensures that the battery is operating under safe conditions.

Battery management systems (BMS) monitor and manage cell voltage, cell current, cell temperature, cell charge balancing, charge control, and internal short circuit detection.
Essentially, the BMS is an electronic system that manages either a single cell or an entire battery pack. It monitors the state of the battery and reports the data. It also protects the battery (or cell) by controlling or balancing the environment of the battery (or cell).
For example, if the BMS detects that the temperature is too hot, it can regulate the temperature by controlling cooling fans. Alternatively, if the battery or cell cannot be cooled and safe conditions restored, the BMS shuts down necessary cells to protect the entire system.

8. Mitigation

Fire Mitigation Measures to be implemented during the design, construction and operation of the proposed development include but are not limited to:

Design;

- The project will be designed in compliance with international standards
- A BMS will be included in the project design

Construction;

- All works to take place in electrical areas will be risk assessed to ensure that the works being carried out will be safe and that the works will not result in a fire occurring.
- Any hot works that maybe carried out will be done under supervision and care to ensure that no fire is started. There will also be suitable fire extinguishers on standby to extinguish any small fire should it occur.
- Arc proof clothing, gloves and face visor to be worn as deemed necessary for the works being carried out.
- The proposed development has been designed and will be installed with multiple layers of safety and protection to meet IEC and local regulations / standards.
- The electrical installations at the proposed development will be installed, tested, commissioned and maintained by a competent electrician.
- All electrical components will be installed, tested, commissioned, stored, charged, maintained and used in accordance with the manufacturer's instructions.
- The design and construction of the development will be in full compliance with Eirgrid and ESB safety requirements and the developer will obtain a Fire Safety Certificate in accordance with the requirements of the Building Control Act.

Operations:

- All electrical inputs to main components will have circuit breakers and fuses to stop current flow if design specifications were to be exceeded.
- The inverters will be fitted with overvoltage and surge protection both on the DC generator side and the AC grid side. These protections will shield the proposed development from the potential impacts of faults on the national grid or lightning strikes at the site.
- Inverters will be monitored continuously for current leakage, ground faults, and the overall system insulation resistance to earth
- A Battery Management System (BMS) will be installed which will detect problems using cell and module voltage measurements and select temperature measurements within the batteries. Automatic disconnect of the batteries will occur if any unusual parameters are measured
- Thermal management systems will be installed to ensure all electrical installations are operating at their optimal temperature and will automatically reduce power input

if safe temperature ranges are exceeded. In addition, there will be 2 Heating, ventilation and air conditioning units servicing each BESS container within the energy storage compound.

- In the event of damaged cables or short circuits resulting from defective or damaged components, the inverters will automatically disconnect, and an alarm will be triggered which will alert an operations and maintenance team who will be responsible for the maintenance and safe operation.
- Key components will have continuous monitoring to ensure operation stays within the design rating.
- Operation and Maintenance activities on site will reinforce remote monitoring with bi-annual visual surveys of the entire farm and annual thermographic inspections of key components.
- The site will be a no smoking site both during construction and operation stages of the development.
- A CCTV security system will form part of the proposed development and will be monitored continuously. The proposed site will have perimeter security fencing and security gates.
- Fire extinguishers to be installed as per IS 291:2015. Additionally, at least 1 CO_2 extinguisher to be provided next to each emergency exit.
- Continuous 24-hour remote monitoring of containers, including video surveillance and alert on detection of fire. Monitoring party to call emergency services where required
- Security or other responsible staff on site who may be called to take action in an emergency should be made aware of the location of the charging area, the means for isolating the power and the action to take in an emergency.
- Any battery that has been damaged, dented or pierced to be taken out of service immediately, segregated from other batteries and stored separate from flammable material while awaiting safe disposal
- A preventative maintenance schedule to be put in place on all electrical equipment.
- Good housekeeping will be maintained to prevent the build-up of any flammable materials on the site. This would also include appropriate landscaping to prevent a build-up of dry dead materials such as leaves, grass, etc.

  No storage of flammable materials will take place within the proposed buildings on the site. Any oil required to be topped up in the transformers is to be brought to site during servicing of the equipment and any remaining or old oils are to be removed from site following completion of the servicing works.

9. Fire Brigade Access

The map included in Annex 1 of this Fire Risk Assessment provides an indicative access route to be utilise by the emergency services in the unlikely event of a fire. Before operations of the proposed development commence the developer will work with the local Authority, first responders and fire services to develop a plan how best to work together to deal with any problem that might arise at the development. This should involve incident pre-planning and the arranging of a site visit before the facility is operational.

10. Conclusion

Based on the findings of this risk assessment and the mitigation measures proposed the hazards associated with a fire in or near the proposed development is considered to be very low. This is due to the strict regulations for certification of the battery energy storage components and the applicable European and International standards for execution of electrical installations.

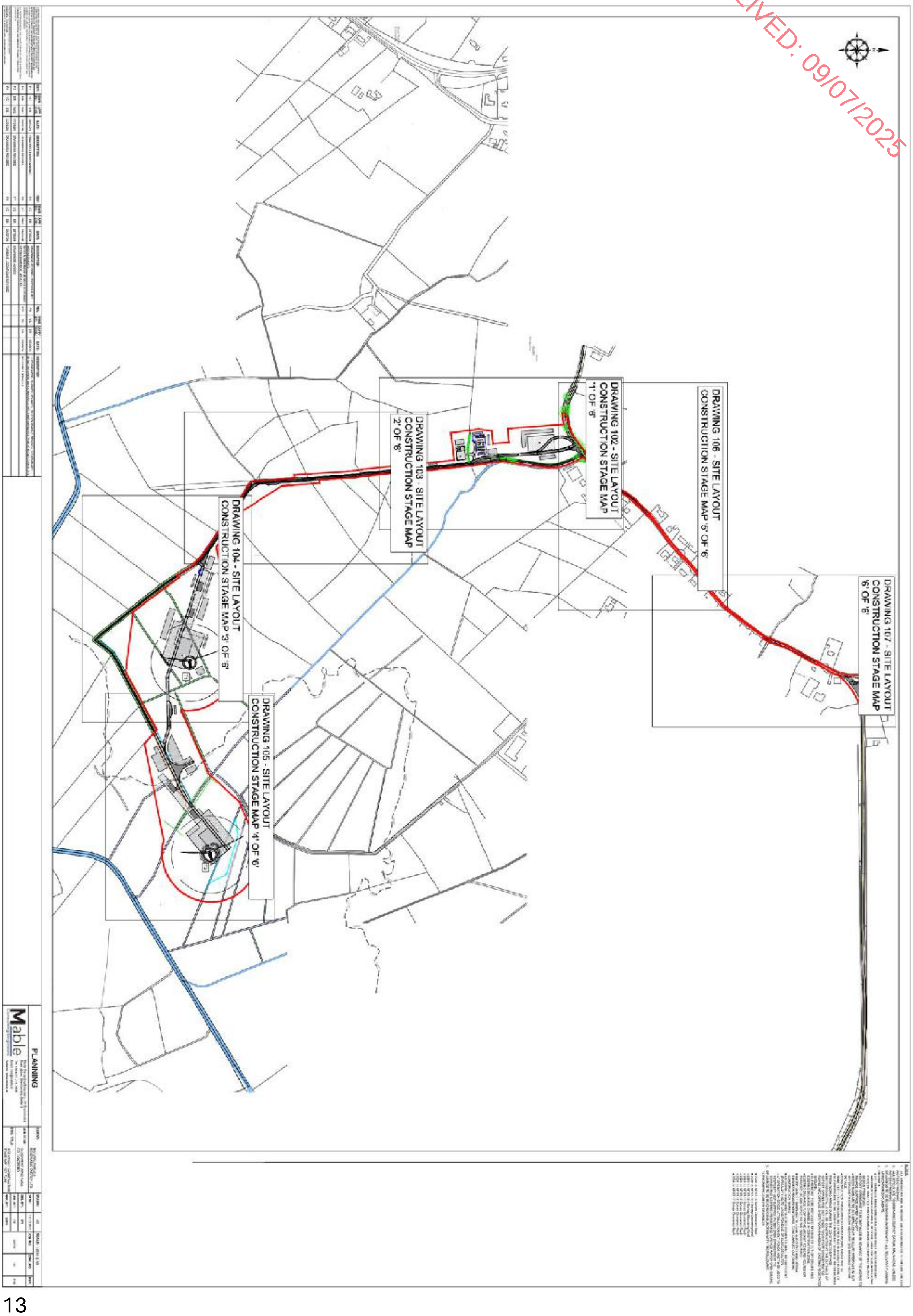
The proposed development will be unmanned and poses no potential danger to personnel likewise the nearest neighbouring property to the development is located over 100m from the site boundaries.

The development has been designed to reduce the risk of fire spreading throughout the development in the unlikely event of a fire in energy storage compound.

Likewise, energy storage has also been setback from the site boundaries to reduce the risk of fire spreading outside the confines of the site.

It is considered given the separation distance between the proposed project infrastructure and the nearest neighbouring properties that in the unlikely event of a fire there would be no potential fire risk outside of the proposed development boundaries

Appendix 1: Site Access in the Event of a Fire


DRAWING 102 - SITE LAYOUT CONSTRUCTION STAGE MAP '1' OF '6'
DRAWING 103 - SITE LAYOUT CONSTRUCTION STAGE MAP '2' OF '6'
DRAWING 104 - SITE LAYOUT CONSTRUCTION STAGE MAP '3' OF '6'
DRAWING 105 - SITE LAYOUT CONSTRUCTION STAGE MAP '4' OF '6'
DRAWING 106 - SITE LAYOUT CONSTRUCTION STAGE MAP '5' OF '6'
DRAWING 107 - SITE LAYOUT CONSTRUCTION STAGE MAP '6' OF '6'
PLANNING
Mable

Appendix 2: Safety of Grid-Scale Battery Energy Storage Systems

APPENDIX 2.3
DECOMMISSIONING AND REINSTATEMENT PLAN

VOLUME III
APPENDICES TO ENVIRONMENTAL IMPACT ASSESSMENT REPORT

RFI Response July 2025

Cloonanny Wind Farm

Decommissioning and Reinstatement Plan

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Doc Name	Rev	Details	Author	Approved
DCOM01	Rev1	Decommissioning Report	Emma Harris	Jonathan Coffey

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Table of Contents

1. Introduction

The purpose of this report is to outline the decommissioning and reinstatement techniques to be adopted at the proposed development for site access roads, turbine foundations, crane hard standings and ancillary equipment.

Decommissioning and reinstatement works will be completed at the end of the wind farm life whereupon the turbines and structures will be removed and the landscape reinstated using appropriate present-day decommissioning and reinstatement practices and applicable future practices.

A Reinstatement Timetable is also included in section 4 of this document outlining the major stages during the decommissioning and reinstatement process.

2. Decommissioning Technique

The decommissioning of the wind farm project at the end of its life will be carried out in two phases. The precise timing and combination of these methods may vary according to future decommissioning techniques which are likely to undergo further development during the life of the wind farm.

The decommissioning phases are:

- Removal of above ground structures including wind turbine
- Removal of underground structures including foundations and cables.

2.1 Wind Turbine Removal

The removal of the wind turbines will primarily be a reversal of the erection of the turbines and will comply with the procedures and methods used in the erection of the turbines in terms of health, safety and environmental protection. The turbines will be dismantled to their constituent components using similar cranes to the erection process and transported from site using similar methods to that used during the erection phase of the project. The main turbine components including the steel towers, electrical cables, generators and unit transformers will have a retained financial value and will be sent for recycling for both the environmental and financial benefit. Non-recyclable components will be disposed of in a suitable licensed facility.

2.2 Additional Above Ground Structures

The modular substations and BESS units will be dismantled and removed from site. The area will then be reinstated and revegetated.

2.3 Turbine Foundations

Following removal of the wind turbines the turbine foundations will be removed in line with the requirements of the County Council. Based on current techniques this removal is likely to consist of stripping and storage of the overburden, removal of the foundation using rock breaking and mechanical demolition equipment, and replacement of the stored overburden. Reinstatement is covered further in Section 3 of this report. It is envisaged that current or future techniques for separation of the steel and concrete components of the foundations will be adopted, with the concrete being recycled for road-base, construction fill or similar purposes, and the reinforcement steel sent to an appropriate facility for recycling.

2.4 Crane Hardstanding's

Following the decommissioning of the above ground structures the crane hardstandings will no longer be required for the project. The stone shall be removed and recycled as road base or construction fill material and the area reinstated as described in section 3

2.5 Access Tracks

Access Tracks shall be grubbed up to a depth of 0.5m below ground level and the excavated material shall be used to regrade the hardstand area to match existing ground contours and profile. Additional inert material derived from demolition in other areas of the site may be used if sufficient material is available. Once the area has been profiled to match the surrounding ground, 200-300mm of topsoil shall be spread over the reinstated area. This area shall then be seeded out. If it is decided not to retain the access tracks on site for agriculture purposes, then these shall be removed using a similar method

2.6 Cables

The cables will be pulled back through the ducting and wound onto cable reels and removed from site for re-use elsewhere or recycled as appropriate. The ducting will be left in situ.

2.7 Met Mat

The decommissioning of the meteorological mast will involve the removal of wind measuring equipment, the separation of the lattice mast sections and their removal from the site for re-use in other projects or for recycling. The mast foundations shall be grubbed up to a depth of 1m below ground level and the excavated material shall be used to re-grade the area to match existing ground contours and profile. Excavations shall be backfilled with excavated material, soiled over and seeded out.

3. Reinstatement Technique

Two principle methods will be adopted to restore vegetation cover. The precise combination of these methods may vary according to the feature being reinstated (track, base or hard standing) and their application is described below under separate prescriptions. The reinstatement techniques are:

Topsoiling using material obtained from the area during excavation. Topsoil shall be lifted by mechanical excavator and laid along the route. Reseeding as per the surrounding area, in addition to invasion of bare ground by native species colonization from adjacent habitats. This process can be assisted by providing a roughened surface, which can trap seeds and soil to provide initial regeneration niches.

3.1 Site Access Roads

Upon decommissioning of the wind farm, the stone imported to the site for use in construction of the roads will be removed from site and recycled for use as road base material in line with best environmental practices. The subsoil, if present, shall be aerated and a layer of topsoil material gained during the construction of the project will be spread over the excavated area and this will either be encouraged to regenerate from the seed-bank within the topsoil or reseeded with an appropriate seed mix of local native species and land use. The area will be profiled to match the existing contours and to prevent ponding of rainwater. The developer will monitor the re-growth of vegetation and if necessary appropriate actions will be taken to ensure full re-growth, for example, protecting it from over-grazing. In areas where natural reseeding or restoration cannot reasonably be undertaken or has been unsuccessful, reseeding may be necessary. Wherever possible, a reseed mix will attempt to emulate the original vegetation cover and land use at time of decommissioning as closely as possible and an appropriate seed mix shall be approved, with the additional requirement for rapid ground cover to reduce erosion.

An alternative option that may be explored with the consent of the Planning Authority at the time of decommissioning is to leave the roads on site if the land use at time of decommissioning would benefit from doing so. The option is commonly favorable among farmers as it gives access to areas that would not normally be accessible. This option reduces the amount of excavation works required and minimizes the disruption to the surrounding area during decommissioning. All costings within this plan have been based on completely removing and reinstating the access roads.

3.2 Turbine Foundations

Following removal of the turbine bases the overburden shall be spread over the area of the turbine foundation. Any additional subsoil removed and stored during the construction of the bases shall be returned to the area and the original contours restored. The turbine foundation areas shall be reinstated with a minimum of 150 mm of topsoil removed from the area to form a level reinstatement between the adjacent unaffected land and the area of the turbine base profiled to match the existing contours and prevent ponding of rainwater. Re-vegetation shall be completed in a similar manner to roads reinstatement. The alternative to complete removal of the foundation is partial removal of the turbine foundation. The turbine foundation is made up of two sections/parts, the lower base and the upper base. With partial removal of the turbine foundation the upper base is removed to a depth of approximately 0.7 meters below ground level and the lower part of the base is left in place. The remaining foundation will be covered by soil and re-sodded with the same vegetation as exists in the surrounding area. This option reduces the amount of excavation works required and minimises the disruption to the surrounding area. This option would only be explored with the consent of the Planning Authority. All costings within this plan have been based on completely removing and reinstating the turbine foundation. The reinstatement of the turbine areas shall be conducted following decommissioning and removal of the turbines.

3.3 Crane Hardstands

Should the land use upon decommissioning of the wind farm be consistent with present land use and the hardstands would not benefit any future land use then the stone imported to the site for use in construction of the hardstands will be removed from site and recycled for use as road base material in line with environmentally friendly practices. Any stone from within the site which was used for road construction will be returned to its original location. The subsoil, if present, shall be aerated and a layer of topsoil material gained during the construction of the project will be spread over the excavated area and this will either be encouraged to regenerate from the seed-bank within the topsoil or reseeded with an appropriate seed mix of local native species and land use. The area will be profiled to match the existing contours and to prevent ponding of rainwater. The developer will monitor the re-growth of vegetation and if necessary appropriate actions will be taken to ensure full re-growth, for example, protecting it from over-grazing. In areas where natural reseeding or restoration cannot reasonably be undertaken or has been unsuccessful, reseeding may be necessary. Wherever possible, a reseed mix will attempt to emulate the original vegetation cover and land use at time of decommissioning as closely as possible and an appropriate seed mix shall be approved, with the additional requirement for rapid ground cover to reduce erosion. All costings within this plan have been based on completely removing and reinstating the crane hardstands.

3.4 Drainage

The aim of any drainage works carried out during the construction of the wind farm will be to maintain the existing hydrology of the site and protect the integrity of the works. Following the decommissioning and removal of the structures the drainage may be optimised for the follow on use of the land, or remain in place to maintain the hydrology of the area prior to the construction of the windfarm.

3.5 Reseeding

There may be areas where the preferred method of natural re-vegetation may be less effective or impractical, resulting in erosion problems. In these cases, reseeding may be necessary.

Wherever possible, a reseed mix will attempt to emulate the original vegetation cover and land use as closely as possible, with the additional requirement for rapid ground cover to reduce erosion and aid soil stabilisation.

4. Decommissioning and Reinstatement Timetable

Description	Expected Duration
Remove wind turbines	3 weeks
Remove turbine foundations	6 weeks
Remove electrical cables	1 week
Remove any ancillary structures, (modular substations and BESS Units)	1 week
Reinstate turbine foundation area	2 weeks
Reinstate hardstanding area *	2 weeks
Reinstate roads *	4 weeks
Reseeding	1 week

Note: the above tasks may take place concurrently *unless agreed with Planning authority to be retained for future land use.

APPENDIX 3.1

ALTERNATIVES MAPS

VOLUME III

APPENDICES TO ENVIRONMENTAL IMPACT ASSESSMENT REPORT

RFI Response July 2025

Site Prospecting Initial Turbine Locations

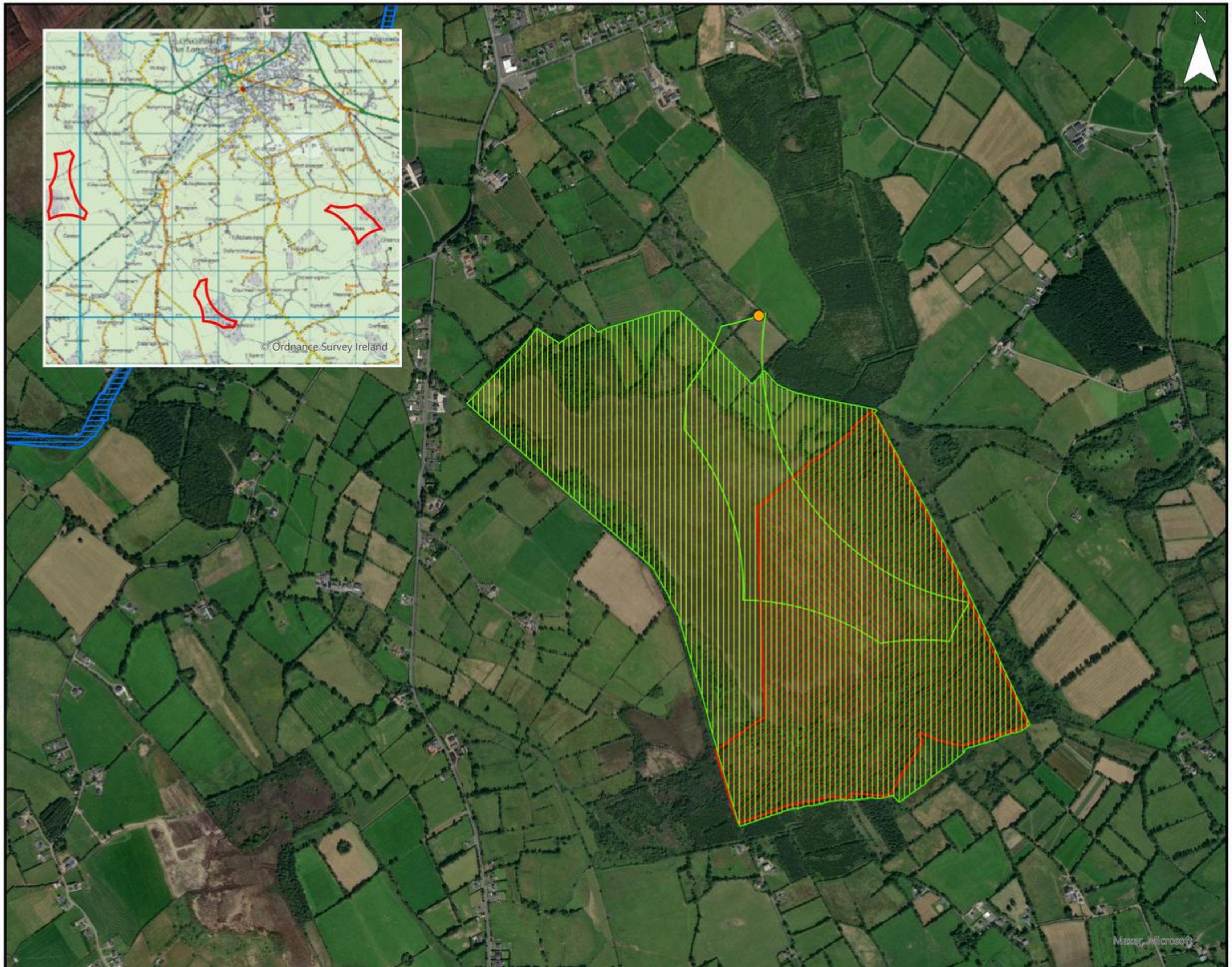
Option 1:

This option was not selected due to significant challenges posed by access and soil conditions, as well as its location adjacent to the Royal Canal pNHA.

Legend

- Site Prospecting Initial Turbine Locations
- proposed Natural Heritage Area (pNHA)
- 800m Setback

Production Date: Nov 20, 2024
Production Time: 11:16
Prepared By: Michael Nolan



Natural Forces

Site Prospecting Initial Turbine Locations

Option 2:

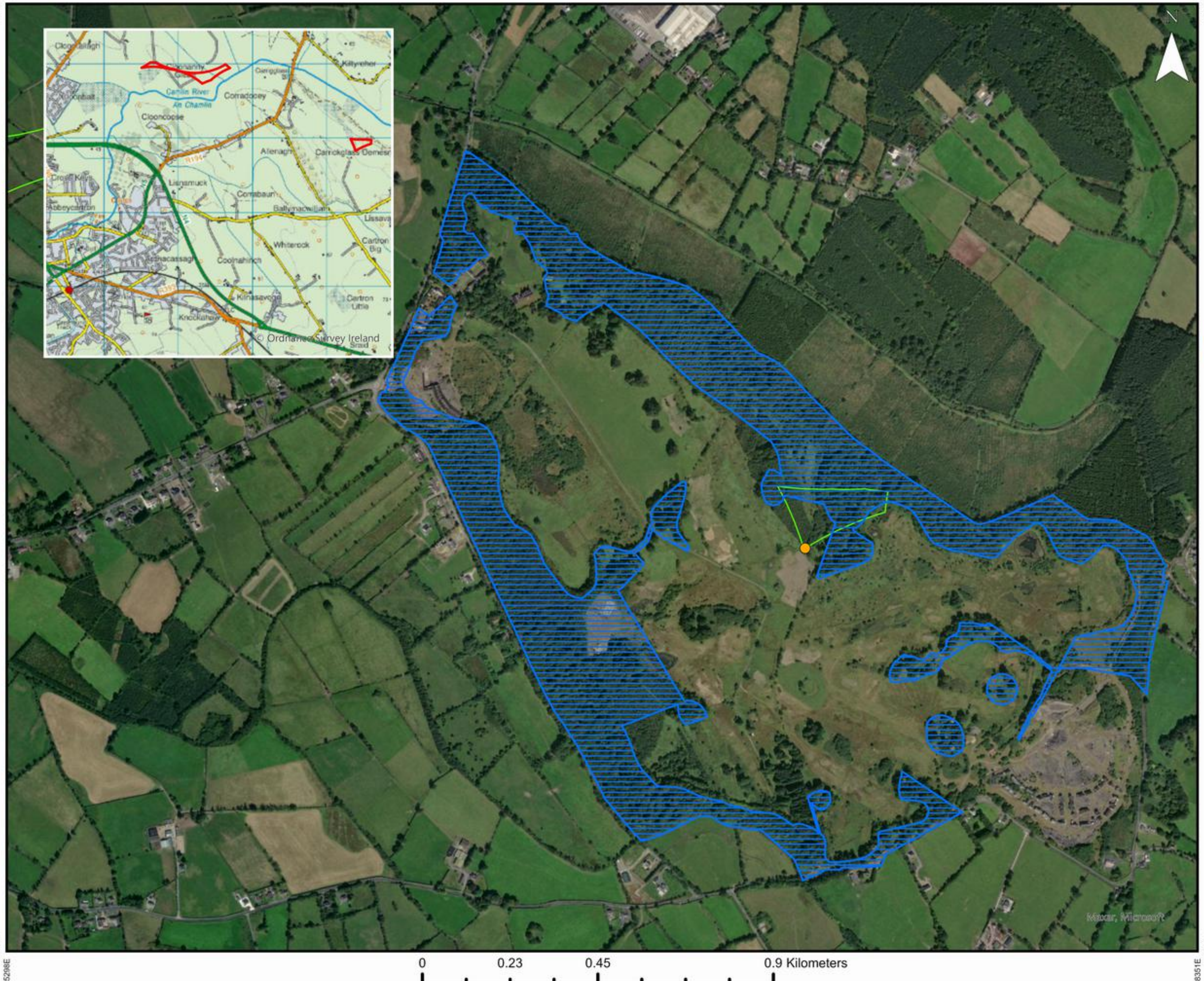
This option was not selected due to significant challenges related to access. Additionally, the nearest substation is located at an impractical distance.

Legend

- Site Prospecting Initial Turbine Locations
- proposed Natural Heritage Area (pNHA)
- Natural Heritage Area (NHA)
- Special Area of Conservation (SAC)
- 800m Setback

RECEIVED: 09/07/2025

Production Date: Nov 20, 2024
Production Time: 11:03
Prepared By: Michael Nolan



Natural Forces

Site Prospecting Initial Turbine Locations

Option 3:

This option was not selected due to access constraints and its proximity to the Carrickglass Demesne pHNA.

Legend

- Site Prospecting Initial Turbine Locations
- proposed Natural Heritage Area (pHNA)
- 800m Setback

Production Date: Nov 20, 2024
Production Time: 11:09
Prepared By: Michael Nolan

Cloonanny Renewable Energy Project

Draft 4 Turbine Layout

- Draft 4 Turbine Layout
- 87.5m Turbine Rotor Diameter
- 800m Setback

Production Date: Nov 20, 2024
Production Time: 10:32
Prepared By: Michael Nolan

Cloonanny Renewable Energy Project

Draft 3 Turbine Layout

- Draft 3 Turbine Layout
- 87.5m Turbine Rotor Diameter
- 800m Setback

Production Date: Nov 20, 2024
Production Time: 10:29
Prepared By: Michael Nolan

Natural Forces

Cloonanny Renewable Energy Project
Draft 3 Turbine Layout Telecom Links

- Draft 3 Turbine Layout
- 87.5m Turbine Rotor Diameter
- Three Ireland Telecoms
- Imagine Broadband Telecoms
- Eir Telecoms
- 2RN Telecoms
- Vodafone Link 4 (F1) (Cairn Hill - Cablecomm)
- Vodafone Link 3 (F1) (Cairn Hill - Longford ESB)
- Vodafone Link 2 (F1) (Cairn Hill - Longford Garda Stn)
- Vodafone Link 1 (F1) (Corlea - Brian Fallon HW)
- Enet Link 3 (F2) (Cairn Hill - Longford CoCo)
- Enet Link 2 (F2) (Cairn Hill - Bluebac)
- Enet Link 1 (F2) (Cairn Hill - Abbott)
- 800m Setback

RECEIVED: 09/07/2025

Production Date: Nov 20, 2024
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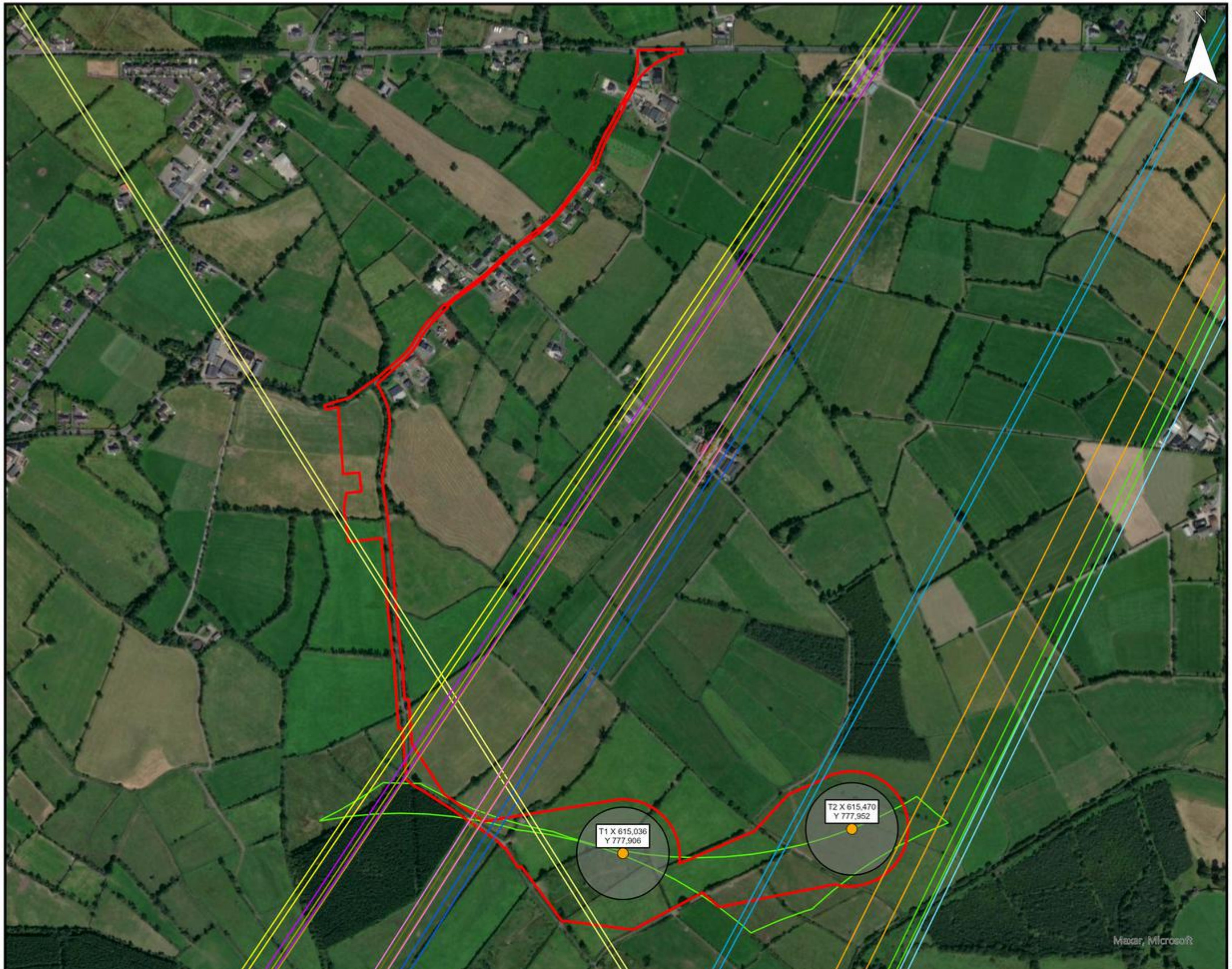

Natural Forces

Cloonanny Renewable Energy Project
Final Iteration Telecom Links

- Proposed Turbine Locations
- 87.5m Turbine Rotor Diameter
- Three Ireland Telecoms
- Imagine Broadband Telecoms
- Eir Telecoms
- 2RN Telecoms
- Vodafone Link 4 (F1) (Cairn Hill - Cablecomm)
- Vodafone Link 3 (F1) (Cairn Hill - Longford ESB)
- Vodafone Link 2 (F1) (Cairn Hill - Longford Garda Stn)
- Vodafone Link 1 (F1) (Corlea - Brian Fallon HW)
- Enet Link 3 (F2) (Cairn Hill - Longford CoCo)
- Enet Link 2 (F2) (Cairn Hill - Bluebac)
- Enet Link 1 (F2) (Cairn Hill - Abbott)
- Planning Boundary
- 800m Setback

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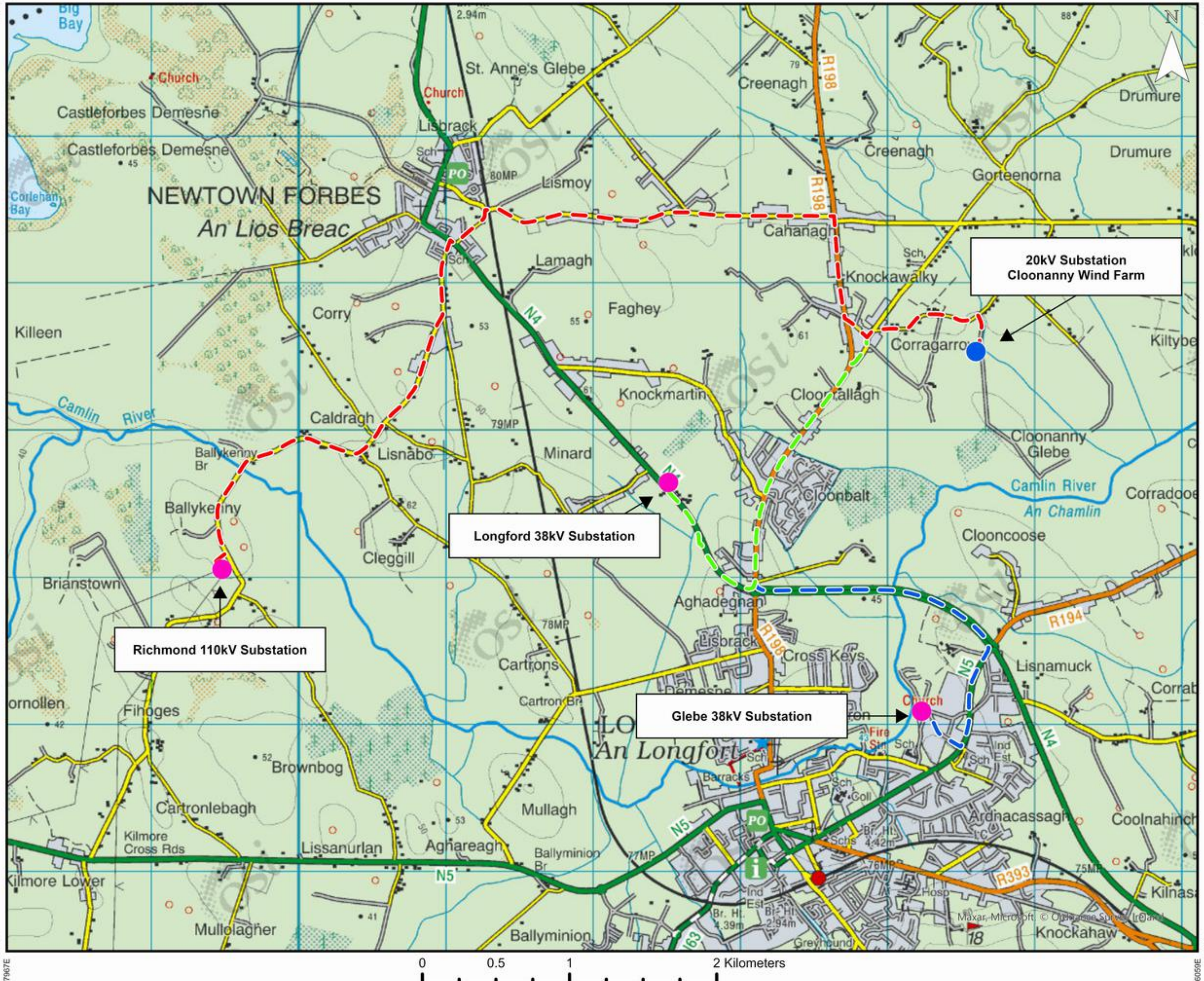
Production Time: 10:13
Prepared By: Michael Nolan



Cloonanny Renewable Energy Project
Grid Study

- Glebe 38kV Substation
- Longford 38kV Substation
- Richmond 110kV Substation
- 20kV Substation - Cloonanny Wind Farm
- Cloonanny to Richmond 110kV Substation (8.03km)
- Cloonanny to Longford 38kV Substation (3.96km)
- Cloonanny to Glebe 38kV Substation (5.85km)

Production Date: Nov 20, 2024
Production Time: 09:31
Prepared By: Michael Nolan

Cloonanny Renewable Energy Project

Grid Study

- On-Site Substation Location
- Cloonanny to Glebe 38kV Substation (5.85km)
- Planning Boundary

Production Date: Nov 20, 2024
Production Time: 10:01
Prepared By: Michael Nolan

Cloonanny Renewable Energy Project
Grid Study

- On-Site Substation Location
- Cloonanny to Richmond 110kV Substation (8.03km)
- Planning Boundary

Production Date: Nov 20, 2024
Production Time: 09:59
Prepared By: Michael Nolan

Cloonanny Renewable Energy Project Grid Study

Production Date: Nov 20, 2024
Production Time: 09:58
Prepared By: Michael Nolan

APPENDIX 4.1
SHADOW FLICKER ASSESSMENT

VOLUME III
APPENDICES TO ENVIRONMENTAL IMPACT ASSESSMENT REPORT

RFI Response July 2025

Cloonanny Wind Project

Shadow Flicker Report

Date: 28/07/2024

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Document History

Doc Name	Rev	Details	Author	Approved
Shadow Flicker Report	I	Cloonanny Shadow Report Summary	Emma Harris	Jonathan Coffey

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………………………………………………………………………………………..
This document has been prepared by

Emma Harris
Natural Forces

………………………………………………………………………………………..
This report has been approved by

Jonathan Coffey

Natural Forces

Contents

1. Introduction

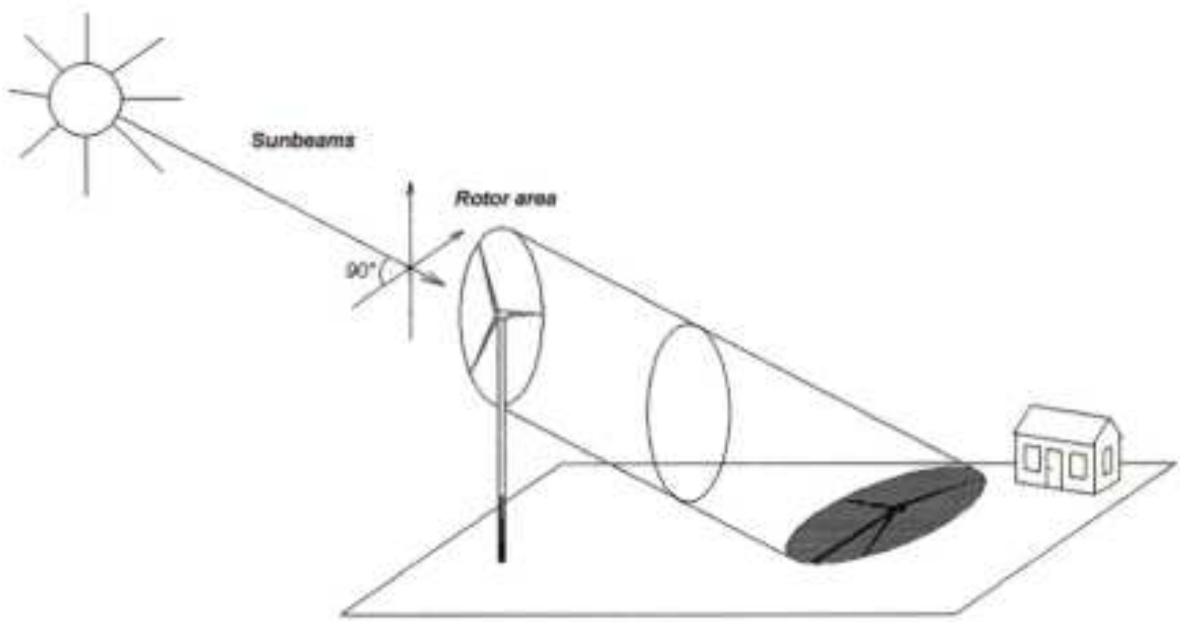
This report presents an investigation into potential shadow flicker impact at nearby receptors from the operation of the Cloonanny Wind Farm. The assessment has been undertaken by ENERCON GmbH on the behalf of Natural Forces Renewable Energy 2 Limited.

1.1 Background to Shadow Flicker

Like any solid or opaque objects, wind energy converters (WEC) cast shadows on the surrounding areas due to direct sun rays. The rotation of the blades generates an effect called shadow flickering by chopping the sunlight.

The effect of shadow flickering on certain areas surrounding the WEC depends on the position of the sun and the intensity of the sunbeams, the direction of the wind (i.e. position of nacelle) and the position of the WEC. Furthermore, shadow flickering can only be observed when the blades rotate.

Figure. 1: Presentation of the periodical shadow flicker caused by rotor blades of a turbine



1.1 Objectives

The objectives of this chapter are to describe:

- the relevant legislation and guidance;
- the methodology of the assessment;
- the existing environment;
- the potential impacts;
- the need for mitigation measures;
- any residual impacts.

2. STATEMENT OF COMPETENCE

This report has been prepared by Natural Forces. Since 2001, the company has developed, constructed, owned, and operated renewable energy projects across Canada, the United States, Ireland, and France, with approximately 300 MW currently in operation.

The shadow flicker modelling and assessment to inform this report has been prepared by Dipl.-Phys. Henriette Labsch and Christian Wiedenhöft M. Sc from the ENERCON GmbH Project Engineering / Wind & Site Engineering team. Both have significant experience in preparing technical studies including shadow flicker assessments for projects under development.

Jonathan Coffey, a Project Manager at Natural Forces, has reviewed the chapter. With over eleven years of experience in renewable energy development, Jonathan holds a BSc in Planning & Environmental Management from Technological University Dublin. He brings considerable expertise in project managing wind energy developments and conducting shadow flicker impact assessments.

3. RELEVANT LEGISLATION AND GUIDANCE

There are various sources of guidance regarding the assessment and management of shadow flicker impacts caused by wind turbines. Irish guidance relevant to the proposed development is outlined below.

3.1 Wind Energy Development Guidelines (2006)

The 2006 Guidelines state that:

'Careful site selection, design and planning, and good use of relevant software, can help avoid the possibility of shadow flicker in the first instance. It is recommended that shadow flicker at neighbouring offices and dwellings within 500m should not exceed 30 hours per year or 30 minutes per day.

At distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low. Where shadow flicker could be a problem, developers should provide calculations to quantify the effect and where appropriate take measures to prevent or ameliorate the potential effect, such as by turning off a particular turbine at certain times.

'Shadow flicker is not usually critical. However, in unusual circumstances, where the calculations indicate that occupied dwelling houses would be significantly affected, a condition requiring the nonoperation of turbines at times when predicted shadow flicker might adversely impact on any inhabited dwelling within 500m of a turbine may be appropriate. Conditions may also address limits on the number of hours per year or minutes per day that the shadow flicker should affect an inhabited dwelling.'

3.2 Draft Revised Wind Energy Development Guidelines (2019)

In December 2019, the Department of Housing, Planning, and Local Government published the draft revised Wind Energy Development Guidelines for public consultation. These proposed to fully eliminate the occurrence of shadow flicker at all surrounding receptors through the installation of automated turbine shut down software. However, as the 2019 Guidelines remain in draft form, and have not been formally adopted, the 2006 Guidelines remain the applicable guidelines under which all wind energy developments must currently be assessed.

4. METHODOLOGY

In order to establish the extent of shadow flicker on receptors within the vicinity of the proposed wind farm, a detailed shadow flicker assessment was carried out on the basis of the 2006 Guidelines and current industry best practice.

The shadow calculation programme WindPRO, in particular the module “Shadow” from the company EMD International A/S, Denmark was used to undertake this shadow flicker assessment.

4.1 Inputs

Emission Source

The following table shows the coordinates of the planned WEC. The parameters are also provided and are based on information provided by Enercon, the turbine supplier.

Table. 2: Coordinates of the planned WECs and parameters

				Irish Grid (IG) IRELAND65 (IE)		
WEC (No.)	**Type**	**Hub Height [m]**	**Rotor Diameter [m]**	**Easting**	**Northing**	**Altitude [m]**
WEC 01	E-175	112	175	615036	777906	47
WEC 02	E-175	112	175	615470	777952	44

It should be noted that if the locations or the hub heights of the planned WEC changes, the calculation is no longer valid and has to be recalculated.

Shadow Receptors

When completing this assessment 403 address points (potential shadow receptors) were considered, this represents address points within 10 rotor dimeters of any wind energy converter.

The shadow receptors (SR) are defined as follows within the shadow flicker assessment:

Table. 1: Shadow Receptor

Direction Mode	**Width [m]**	**Height [m]**	**Height a.g.l [m]**	**Degrees from south cw [°]**	**Slope of window [°]**
Fixed Direction	1.0	1.0	2.0	-	0

Please see Appendix A for details of the shadow receptors and impacts.

4.2 Worse-case Scenario

The assessment for the proposed wind turbine was calculated on the basis of 'worst case scenario' given by the following assumptions:

- For the shadow calculation the program WindPRO (Version 3.6.361), in particular the module "Shadow" from the company EMD International A/S,Denmark is used.
- The minimum affecting angle is 3° above horizon.
- The maximum distance for shadow flicker are listed in Tab. 2: Summary of turbine parameters. This value equals the distance to the turbine in which 20 %of the surface area of the sun is covered by the rotor blade. In greater distance to the turbine the shadow is too diffuse to cast a disturbing shadow.
- The coordinates of the nearby shadow receptors (SR) are provided by the customer and considered in the calculation. In the written part of the report are only shown the receptors with exceeding limits.
- The contour height (z-level) of the terrain is considered.
- Further obstacles like forests or buildings remain unconsidered in the calculations. Therefore, a sight survey has to be done.
- The calculation was performed as "worst case" with following assumptions:
    - The sun shines always
    - The turbines operate perpendicular to the sun at all times.
    - The requirements of a worst-case scenario for a tolerable shadow flickering are 30 hours/year and 30/min per day within 500 m to the WEC.
- In addition, the "real case" was calculated with the following assumptions:
    - The average daily sunshine hours based on data of the meteorological Station CLONES.
    - The angle and operational times of the rotor plane are taken from customers calculations.

5. DESCRIPTION OF THE ENVIRONMENT

Shadow flicker is a phenomenon caused by wind turbines, where the rotating blades intermittently block sunlight, casting moving shadows on the ground and nearby structures. This effect occurs primarily when the sun is low on the horizon, and the turbine blades pass between the sun and an observer, creating a strobe-like effect of light and shadow., 403 receptors potential location were assessed, this represents all dwelling houses within a 10 rotor dimeters of the proposed wind turbines. This location data was gathered from the Eircode database and verified via aerial images. It is important to note that there are no buildings within 500m of the turbines, ensuring compliance with the 2006 Guidelines and avoiding the most significant shadow flicker impact. The closest dwelling is situated c.800m away from the site.

6. STATEMENT OF POTENTIAL IMPACTS

The modelled results of the shadow flicker assessment identified 26 no. shadow flicker receptors exceeding the 30 minutes per day or 30 hours per year. The results indicated that shadow flicker may be experienced at receptive locations as indicated in the table below,

SR	X	Y	Worst Case Total Shadow Flicker (hours / year)	Worst Case Total Shadow Flicker (hours / day)	Real Case Total Shadow Flicker (hours / year)	Distance to T1	Distance to T2
CW	616006	777242	22.38	0.31	**03.47**	1.17	0.89
CZ	616136	777274	**33.03**	0.33	**05.54**	1.27	0.95
HX	616485	778067	21.28	0.39	**03.41**	1.46	1.02
IE	616510	778155	19.44	0.39	**03.15**	1.49	1.06
IM	616489	778315	22.21	0.45	**03.29**	1.51	1.08
IP	616426	778332	26.11	0.49	**04.03**	1.45	1.03
IR	616630	778391	16.46	0.39	**02.35**	1.67	1.24
IS	616686	778399	14.58	0.37	**02.19**	1.72	1.29
IT	616432	778425	26.28	0.49	**04.01**	1.49	1.07
IW	616350	778483	**32.39**	0.53	**04.48**	1.44	1.03
JD	616140	778599	**57.35**	0.54	**07.22**	1.31	0.93
JJ	614071	778670	28.03	0.34	**03.25**	1.23	1.57
JN	614114	778689	30.45	0.35	**03.40**	1.21	1.54
JO	615180	778698	**54.19**	1.23	**04.55**	0.81	0.80
JS	614009	778728	23.43	0.32	**02.52**	1.32	1.65
JT	613977	778728	21.56	0.31	**02.40**	1.34	1.68
JU	616156	778732	**57.38**	0.43	**06.46**	1.39	1.04
JW	615047	778734	**41.04**	0.57	**03.47**	0.83	0.89
JX	614164	778735	**35.34**	0.36	**04.01**	1.21	1.52
KH	614226	778833	**45.02**	0.35	**04.31**	1.24	1.52
KI	614635	778838	**44.03**	0.50	**04.09**	1.02	1.22
KL	614911	778855	28.32	0.39	**02.33**	0.96	1.06
KQ	614692	778892	**35.14**	0.36	**03.17**	1.05	1.22
KY	614697	778970	27.48	0.34	**02.30**	1.12	1.28
KZ	614788	778981	20.22	0.32	**01.46**	1.11	1.23
LB	614733	778989	23.15	0.33	**02.02**	1.13	1.27

It should be made clear, that these dwellings are located greater than 500m from the proposed development and the expected level of shadow flicker will not exceed the limits set out in the 2006 Guidelines.

Natural Forces is committed to a curtailment strategy for any turbine that causes an exceedance in the existing daily and annual shadow flicker thresholds at a distance of up to 10 rotor diameters from the proposed development. This is standard best practice on windfarm sites. See Appendix B which details how Shadow Flicker Shutdown will be implemented

7. CUMULATIVE IMPACTS

With no operational or planned wind turbines in close proximity to the proposed site, there are no anticipated cumulative impacts. The nearest wind farm is Sliabh Bawn which is located approximately 20km away. Considering that shadow flicker generally occurs over short distances, this distance is deemed too far to result in cumulative shadow flicker impacts on receptors.

8. MITIGATION AND MONITORING MEASURES

Although the shadow flicker assessment indicates no expected shadow flicker exceedances at houses within 500 metres of the site, a shadow flicker shutdown system will be installed within the turbine to address any potential future shadow-related requirements. Please see Appendix B for the turbine supplier’s technical description on shadow shutdown system.

A shadow flicker control system is an optional wind turbine sub-system, integrated with the control system of the turbine, which stops the turbine at appropriate times in order to avoid shadow flicker at sensitive receptors. Such technology has been available for a number of years and is now mature, proven and widely available.

9. RESIDUAL EFFECTS

The outlined mitigation measures will prevent residual effects from being significant. The shadow shutdown system effectively eliminates significant impacts from shadow flicker. The proposed measures will ensure shadow flicker levels at receptors stay below prescribed limits in the 2006 Guidelines. Furthermore, the operation and performance of the shadow flicker control measures will be monitored to confirm their effectiveness.

10. CONCLUSIONS

The assessment of potential shadow flicker impact at sensitive receptors near the Cloonanny Wind Farm was conducted according to relevant guidance, using industry-standard methods and tools. The detailed results of the shadow calculation and the map are attached in Appendix A which suggests that 26 dwellings could experience an exceedance of 30 hours of shadow flicker per year and/or 30 minutes in a day. It should be noted that this assessment remains in compliance with the 2006 Guidelines, as all affected properties are situated more than 500 metres away from the proposed turbines. Furthermore, the analysis was based on a worst-case scenario and did not take into account weather conditions (i.e. when there is total or partial cloud cover), local visual obstructions (such as trees, hedges, or other structures), turbine orientation and turbine operation. In reality, the amount of time when shadow flicker occurs will be less than that predicted. To ensure shadow flicker is adequately addressed, Natural Forces will equip both wind turbines with shadow flicker shutdown systems.

Appendix A: ENERCON Results of the Shadow Calculation and Shadow Map

Wind & Site Engineering Short Report

Shadow Flicker Assessment for

2x ENERCON E-175 EP5 E2 (7.00 MW)
with 111.6 m hub height

Commercial in Confidence

Site: Cloonanny (Ireland)

Report No.: O-16297_A02_WSE_Shadow_SR_a

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Company: WRD GmbH
Department: Wind & Site Engineering
Team: Noise Compatibility (NC)

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Publisher

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O-16297_A01_WSE_Shadow_SR_a	2024-05-23	Shadow Flicker Assessment	Initial Report
O-16297_A01_WSE_Shadow_SR_b	2024-06-06	Shadow Flicker Assessment	Other turbine type
O-16297_A02_WSE_Shadow_SR_a	2024-07-17	Shadow Flicker Assessment	New coordinates

Report Information

Date	Comment	Editor
2024-07-17	Edited by	Dipl.-Phys. Henriette Labsch
2024-07-19	Approved by	Christian Wiedenhöft M. Sc.

Cloonanny

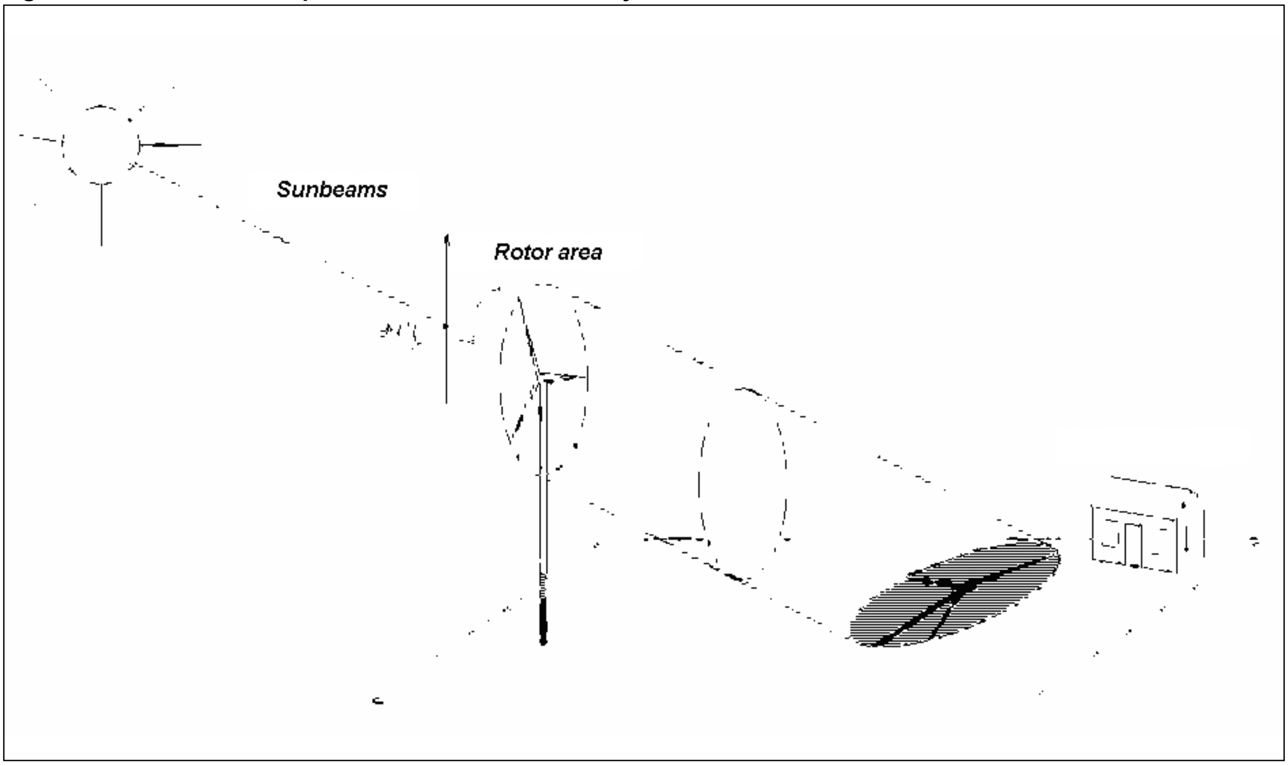
2x ENERCON E-175 EP5 E2 with 7.00 MW rated power

Introduction

Like any solid or opaque objects, wind energy turbine cast shadows on the surrounding areas. The rotation of the blades generates an effect called shadow flicker by repeatedly cutting of the sun rays.

The effect of shadow flicker on certain areas surrounding the turbine depends on the position and intensity of the sun, the direction of the wind (i.e. position of nacelle) and the position of the turbine. Furthermore, shadow flicker can only be observed when the blades rotate.

Fig. 1: Presentation of the periodical shadow caused by rotor blades of a turbine



At present Germany is the only country with detailed recommendations on limits and conditions for calculating shadow impact. These documents result from a pilot study about the effects of shadow flicker on human beings.

Shadow Flicker Basics

The following basics for the shadow calculation are taken into account:

- For the shadow calculation the program WindPRO (Version 3.6.361), in particular the module “Shadow” from the company EMD International A/S, Denmark is used.
- The minimum affecting angle is 3° above horizon.
- The maximum distance for shadow flicker are listed in Tab. 2: Summary of turbine parameters. This value equals the distance to the turbine in which 20 % of the surface area of the sun is covered by the rotor blade. In greater distance to the turbine the shadow is too diffuse to cast a disturbing shadow.
- The coordinates of the nearby shadow receptors (SR) are provided by the customer and concidered in the calculation. In the written part of the report are only shown the receptors with exceeding limits.
- The contour height (z-level) of the terrain is considered.
- Further obstacles like forests or buildings remain unconsidered in the calculations. Therefore, a sight survey has to be done.
- The calculation was performed as “worst case” with following assumptions:
    - The sun shines always
    - The turbines operate perpendicular to the sun at all times.
- In addition, the “real case” was calculated with the following assumptions:
    - The average daily sunshine hours based on data of the meteorological Station CLONES.
    - The angle and operational times of the rotor plane are taken from customers calculations.

Emission Sources

The following table shows the coordinates of the two planned turbines.

Tab. 1: Coordinates of the planned turbines

No.	Type	Hub height [m]	Irish ITM-IRENET95 (IE), geocentric, GRS80		Altitude [m agl]
			Easting	Northing	
WEC1	ENERCON E-175 EP5 E2 7000 kW	111.6	615 036	777 906	47
WEC2	ENERCON E-175 EP5 E2 7000 kW	111.6	615 470	777 952	45

Tab. 2: Summary of turbine parameters

Type	Hub height [m]	Rotor diameter [m]	Distance of influence [m]
ENERCON E-175 EP5 E2 7000 kW	111.6	175.0	1 741

Shadow Receptors

The shadow receptors (SR) are defined as follows:

Tab. 3: Shadow receptor - input

Direction mode	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]
Green house mode	0.1	0.1	2.0	-	0

Results of the shadow calculation

The shadow demands for a worst case 30 hours/year or 30 minutes/day are exceeded at the 26 shadow receptors in the following table. A shadow shut off system has to be installed in the planned turbines, in order to meet the shadow requirements.

Tab. 4: Results of the shadow calculation – worst case (yearly and daily) and real case [hh:mm]

SR	Worst Case Demand (hours / year)	Worst Case Total Shadow Flickering (hours / year)	Worst Case Demand (hours / day)	Worst Case Total Shadow Flickering (hours / day)	Real Case Total Shadow Flickering (hours / year)
CW	30:00	22:38	00:30	**0:31**	03:47
CZ	30:00	**33:03**	00:30	**0:33**	05:54
HX	30:00	21:28	00:30	**0:39**	03:41
IE	30:00	19:44	00:30	**0:39**	03:15
IM	30:00	22:21	00:30	**0:45**	03:29
IP	30:00	26:11	00:30	**0:49**	04:03
IR	30:00	16:46	00:30	**0:39**	02:35
IS	30:00	14:58	00:30	**0:37**	02:19
IT	30:00	26:28	00:30	**0:49**	04:01
IW	30:00	**32:39**	00:30	**0:53**	04:48
JD	30:00	**57:35**	00:30	**0:54**	07:22
JJ	30:00	28:03	00:30	**0:34**	03:25
JN	30:00	**30:45**	00:30	**0:35**	03:40
JO	30:00	**54:19**	00:30	**1:23**	04:55
JS	30:00	23:43	00:30	**0:32**	02:52
JT	30:00	21:56	00:30	**0:31**	02:40
JU	30:00	**57:38**	00:30	**0:43**	06:46
JW	30:00	**41:04**	00:30	**0:57**	03:47
JX	30:00	**35:34**	00:30	**0:36**	04:01
KH	30:00	**45:02**	00:30	**0:35**	04:31
KI	30:00	**44:03**	00:30	**0:40**	04:09
KL	30:00	28:32	00:30	**0:39**	02:33
KQ	30:00	**35:14**	00:30	**0:36**	03:17
KY	30:00	27:48	00:30	**0:34**	02:30
KZ	30:00	20:22	00:30	**0:32**	01:46
LB	30:00	23:15	00:30	**0:33**	02:02

The detailed results of the shadow calculation are attached in Appendix A. Appendix B shows the map rendering the shadow iso-lines of the worst case calculated.

The static shadow of the tower and nacelle is not considered in this report. The calculated results are only a prediction. They are made to the best of our knowledge.

If the locations or the hub heights of the planned turbines change, the calculation is no longer valid and has to be recalculated.

The technical description of the ENERCON Shadow Shutdown is attached in Appendix C.

Appendix A

Results of the Shadow Calculation
Real case / Worst Case
Additional / Total Shadow Flicker

Project:
Cloonanny
O-16297
NC-SR
Natural Forces

Description:
This calculation was performed without visiting the site and is based solely on information provided by the developer or third party. ENERCON shall not be responsible and takes therefore no liability for the accuracy and sufficiency of any such data. In case of discrepancies of site coordinates or other relevant data, ENERCON does not take any responsibility for calculated shadow flicker at considered shadow receptors (SR). The calculation does include an elevation model.
If other wind farms are included like an existing wind farm, the real case calculation is based on the average operational hours of all turbines.
The calculated results are provided as a basis for information purposes only.

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Calculated:
2024-07-21 07:56/3.6.361

SHADOW - Main Result

Calculation: Additional / Total Shadow Impact: A02a

Assumptions for shadow calculations

Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

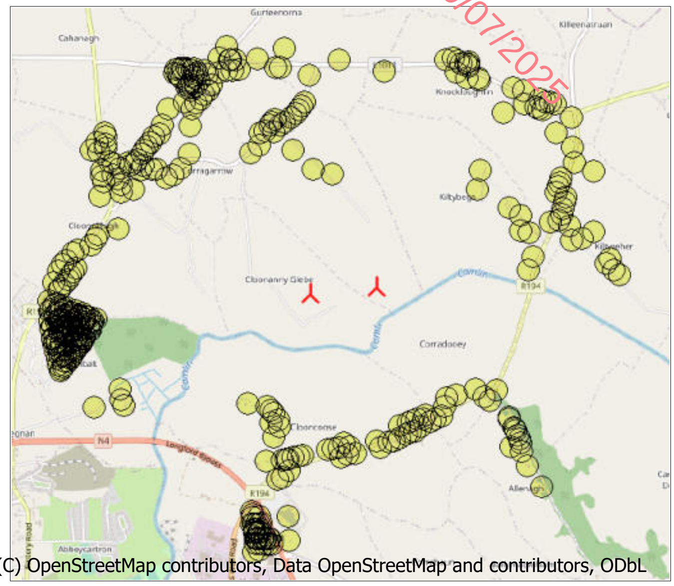
Sunshine probability S (Average daily sunshine hours) [CLONES]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.45	1.93	2.72	4.31	5.45	4.41	4.74	3.96	3.48	2.54	1.71	1.01

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
350	263	526	788	613	788	876	964	1 489	876	657	570	8 760

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Höhenlinien: CONTOURLINE_Cloonanny_0.wpo (1)
Receptor grid resolution: 1.0 m



Scale 1:50 000
New WTG   Shadow receptor

All coordinates are in
Irish ITM-IRENET95 (IE), geocentric, GRS80

WTGs

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
WEC1	615 036	777 906	47.0	ENERCON GmbH E-17...	Yes	ENERCON GmbH	E-175 EP5 E2-7 000	7 000	175.0	111.6	1 741	0.0
WEC2	615 470	777 952	45.0	ENERCON GmbH E-17...	Yes	ENERCON GmbH	E-175 EP5 E2-7 000	7 000	175.0	111.6	1 741	0.0

Shadow receptor-Input

No.	Easting	Northing	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
			[m]	[m]	[m]	[m]	[°]		[m]
A	614 660	776 193	52.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
B	614 701	776 202	52.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
C	614 756	776 243	54.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
D	614 778	776 244	54.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
E	614 729	776 244	53.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
F	614 699	776 247	53.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
G	614 674	776 248	52.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
H	614 898	776 266	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
I	614 768	776 274	54.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
J	614 760	776 274	54.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
K	614 723	776 277	53.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
L	614 715	776 277	53.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
M	614 737	776 277	53.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
N	614 746	776 277	53.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
O	614 700	776 278	53.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
P	614 691	776 278	53.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
Q	614 678	776 282	52.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
R	614 669	776 283	52.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
S	614 668	776 317	52.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
T	614 702	776 317	52.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
U	614 701	776 323	52.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
V	614 668	776 323	52.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
W	614 665	776 338	51.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
X	614 698	776 341	52.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
Y	614 664	776 343	51.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
Z	614 697	776 346	52.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AA	614 651	776 374	50.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AB	614 660	776 375	51.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AC	614 676	776 377	51.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0

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SHADOW - Main Result

Calculation: Additional / Total Shadow Impact: A02a

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No.	Easting	Northing	Z [m]	Width [m]	Height [m]	Elevation a.g.l. [m]	Slope of window [°]	Direction mode	Eye height (ZVI) a.g.l. [m]
AD	614 685	776 378	51.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AE	614 698	776 380	51.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AF	614 708	776 381	51.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AG	614 655	776 417	50.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AH	614 698	776 420	50.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AI	614 890	776 425	50.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AJ	614 652	776 440	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AK	614 649	776 457	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AL	616 574	776 625	65.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AM	614 815	776 673	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AN	614 849	776 686	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AO	614 897	776 731	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AP	616 478	776 768	59.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AQ	614 741	776 793	51.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AR	614 851	776 804	52.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AS	614 873	776 807	52.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AT	614 891	776 810	52.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AU	615 240	776 818	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AV	614 921	776 821	51.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AW	614 958	776 827	50.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AX	614 986	776 836	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AY	615 287	776 840	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
AZ	615 337	776 848	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BA	616 442	776 861	60.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BB	615 153	776 869	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BC	615 192	776 878	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BD	615 230	776 885	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BE	615 504	776 886	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BF	615 297	776 892	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BG	616 370	776 899	60.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BH	615 257	776 918	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BI	616 435	776 919	64.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BJ	615 561	776 920	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BK	615 475	776 926	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BL	615 591	776 930	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BM	616 422	776 947	65.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BN	615 624	776 950	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BO	614 795	776 953	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BP	616 412	776 973	64.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BQ	615 669	776 976	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BR	615 700	776 992	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BS	615 731	776 995	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BT	616 401	777 002	64.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BU	616 396	777 014	64.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BV	616 389	777 022	64.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BW	615 770	777 022	50.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BX	614 828	777 029	57.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BY	615 629	777 036	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
BZ	614 773	777 048	57.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CA	615 687	777 050	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CB	615 830	777 059	52.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CC	615 713	777 062	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CD	614 819	777 068	57.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CE	615 864	777 078	53.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CF	615 747	777 080	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CG	616 358	777 081	65.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CH	615 789	777 084	51.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CI	616 355	777 093	65.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CJ	615 910	777 100	54.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CK	615 802	777 106	51.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CL	614 796	777 113	58.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CM	614 773	777 137	59.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CN	613 601	777 146	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CO	614 750	777 155	59.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0

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SHADOW - Main Result

Calculation: Additional / Total Shadow Impact: A02a

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No.	Easting	Northing	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
			[m]	[m]	[m]	[m]	[°]		[m]
CP	615 928	777 160	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CQ	613 798	777 162	47.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CR	614 615	777 182	59.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CS	613 774	777 198	47.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CT	616 224	777 203	65.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CU	615 944	777 219	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CV	616 190	777 222	65.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CW	616 006	777 242	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CX	613 768	777 265	46.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CY	616 273	777 268	65.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
CZ	616 136	777 274	65.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DA	613 374	777 389	50.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DB	613 383	777 402	51.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DC	613 392	777 415	52.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DD	613 402	777 427	52.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DE	613 361	777 431	52.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DF	613 400	777 451	52.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DG	613 425	777 452	51.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DH	613 437	777 468	50.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DI	613 355	777 476	54.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DJ	613 444	777 479	50.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DK	613 371	777 485	53.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DL	613 390	777 491	52.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DM	613 452	777 492	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DN	613 407	777 493	51.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DO	613 460	777 507	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DP	613 422	777 507	51.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DQ	613 345	777 513	55.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DR	613 468	777 520	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DS	613 357	777 522	54.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DT	613 434	777 527	50.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DU	613 373	777 528	53.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DV	613 474	777 532	49.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DW	613 480	777 541	49.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DX	613 489	777 551	49.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DY	613 408	777 560	50.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
DZ	613 500	777 562	48.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EA	613 334	777 564	55.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EB	613 506	777 569	48.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EC	613 383	777 570	51.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
ED	613 342	777 575	54.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EE	613 511	777 579	48.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EF	613 436	777 579	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EG	613 351	777 581	53.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EH	613 518	777 588	47.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EI	613 450	777 589	49.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EJ	613 465	777 596	49.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EK	613 524	777 597	47.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EL	613 474	777 600	48.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EM	613 320	777 601	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EN	613 416	777 601	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EO	613 495	777 601	48.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EP	613 530	777 606	47.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EQ	613 328	777 607	54.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
ER	613 335	777 613	54.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
ES	613 537	777 614	47.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
ET	613 491	777 618	48.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EU	613 488	777 628	48.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EV	613 390	777 630	51.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EW	613 404	777 634	50.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EX	613 415	777 634	49.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EY	613 424	777 646	49.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
EZ	613 364	777 652	51.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FA	613 437	777 655	49.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0

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SHADOW - Main Result

Calculation: Additional / Total Shadow Impact: A02a

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No.	Easting	Northing	Z [m]	Width [m]	Height [m]	Elevation a.g.l. [m]	Slope of window [°]	Direction mode	Eye height (ZVI) a.g.l. [m]
FB	613 572	777 658	47.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FC	613 372	777 658	51.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FD	613 444	777 660	49.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FE	613 499	777 661	48.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FF	613 458	777 663	49.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FG	613 380	777 665	50.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FH	613 308	777 667	53.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FI	613 568	777 668	47.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FJ	613 493	777 669	48.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FK	613 389	777 672	50.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FL	613 555	777 678	47.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FM	613 485	777 678	48.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FN	613 400	777 680	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FO	613 320	777 681	52.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FP	613 407	777 687	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FQ	613 476	777 692	49.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FR	613 578	777 692	47.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FS	613 415	777 693	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FT	613 519	777 693	48.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FU	613 581	777 699	47.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FV	613 470	777 699	49.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FW	613 423	777 701	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FX	613 529	777 706	48.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FY	613 462	777 708	49.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
FZ	613 349	777 711	50.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GA	613 588	777 712	47.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GB	613 537	777 713	48.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GC	613 357	777 717	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GD	613 503	777 719	49.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GE	613 593	777 720	47.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GF	613 365	777 722	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GG	613 447	777 723	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GH	613 301	777 723	50.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GI	613 372	777 729	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GJ	613 606	777 736	47.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GK	613 383	777 737	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GL	613 482	777 737	49.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GM	613 523	777 737	49.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GN	613 490	777 744	49.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GO	613 560	777 744	48.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GP	613 396	777 746	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GQ	613 551	777 748	48.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GR	613 335	777 751	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GS	613 498	777 752	49.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GT	613 535	777 753	48.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GU	613 411	777 758	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GV	613 503	777 758	49.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GW	613 343	777 764	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GX	613 374	777 767	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GY	613 517	777 767	49.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
GZ	613 423	777 768	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HA	613 431	777 775	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HB	613 354	777 781	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HC	613 442	777 782	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HD	613 301	777 787	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HE	613 465	777 789	49.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HF	613 403	777 791	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HG	613 366	777 793	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HH	613 310	777 799	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HI	613 410	777 808	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HJ	613 380	777 812	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HK	613 329	777 820	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HL	613 377	777 824	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HM	613 340	777 834	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0

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SHADOW - Main Result

Calculation: Additional / Total Shadow Impact: A02a

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No.	Easting	Northing	Z [m]	Width [m]	Height [m]	Elevation a.g.l. [m]	Slope of window [°]	Direction mode	Eye height (ZVI) a.g.l. [m]
HN	613 297	777 854	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HO	613 361	777 919	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HP	613 378	777 940	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HQ	613 400	777 970	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HR	613 332	777 980	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HS	613 418	777 996	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HT	613 435	778 018	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HU	617 091	778 042	53.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HV	613 456	778 048	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HW	613 358	778 051	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HX	616 485	778 067	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HY	617 047	778 068	52.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
HZ	613 477	778 072	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IA	613 384	778 094	50.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IB	616 996	778 115	51.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IC	613 411	778 126	51.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
ID	617 022	778 147	53.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IE	616 510	778 155	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IF	613 455	778 178	52.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IG	613 490	778 190	52.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IH	613 576	778 229	52.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
II	616 765	778 267	49.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IJ	613 605	778 269	52.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IK	616 840	778 278	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IL	613 625	778 292	53.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IM	616 489	778 315	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IN	616 911	778 320	51.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IO	613 751	778 332	53.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IP	616 426	778 332	50.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IQ	616 751	778 361	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IR	616 630	778 391	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IS	616 686	778 399	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IT	616 432	778 425	52.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IU	616 701	778 439	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IV	616 708	778 473	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IW	616 350	778 483	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IX	616 718	778 519	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IY	613 636	778 547	58.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
IZ	616 723	778 551	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JA	613 767	778 578	58.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JB	616 661	778 589	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JC	613 857	778 593	57.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JD	616 140	778 599	57.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JE	616 677	778 623	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JF	613 771	778 623	59.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JG	613 654	778 647	59.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JH	616 692	778 651	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JI	613 751	778 660	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JJ	614 071	778 670	51.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JK	616 697	778 676	50.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JL	613 647	778 687	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JM	613 719	778 688	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JN	614 114	778 689	52.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JO	615 180	778 698	51.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JP	616 908	778 724	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JQ	613 644	778 725	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JR	613 902	778 726	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JS	614 009	778 728	54.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JT	613 977	778 728	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JU	616 156	778 732	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JV	613 763	778 734	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JW	615 047	778 734	54.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JX	614 164	778 735	53.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
JY	613 923	778 750	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0

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SHADOW - Main Result

Calculation: Additional / Total Shadow Impact: A02a

...continued from previous page

No.	Easting	Northing	Z [m]	Width [m]	Height [m]	Elevation a.g.l. [m]	Slope of window [°]	Direction mode	Eye height (ZVI) a.g.l. [m]
JZ	613 840	778 752	57.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KA	613 718	778 765	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KB	613 818	778 767	58.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KC	613 868	778 773	56.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KD	616 784	778 777	50.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KE	613 696	778 780	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KF	613 884	778 794	55.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KG	613 908	778 832	55.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KH	614 226	778 833	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KI	614 635	778 838	52.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KJ	613 629	778 842	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KK	613 576	778 854	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KL	614 911	778 855	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KM	613 927	778 857	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KN	613 675	778 865	59.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KO	616 771	778 878	51.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KP	613 943	778 882	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KQ	614 692	778 892	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KR	613 672	778 895	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KS	613 965	778 906	56.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KT	613 611	778 907	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KU	613 666	778 943	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KV	613 987	778 943	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KW	614 031	778 961	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KX	613 663	778 967	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KY	614 697	778 970	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
KZ	614 788	778 981	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LA	616 660	778 982	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LB	614 733	778 989	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LC	614 235	779 013	58.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LD	614 235	779 013	58.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LE	614 759	779 018	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LF	614 834	779 021	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LG	614 047	779 025	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LH	614 776	779 042	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LI	614 856	779 044	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LJ	614 795	779 063	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LK	614 898	779 073	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LL	616 761	779 077	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LM	616 761	779 077	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LN	616 761	779 077	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LO	614 932	779 103	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LP	616 312	779 111	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LQ	614 950	779 126	54.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LR	616 574	779 129	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LS	614 085	779 133	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LT	614 241	779 133	57.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LU	616 547	779 141	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LV	616 522	779 150	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LW	614 972	779 151	54.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LX	614 274	779 167	56.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LY	616 653	779 169	54.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
LZ	616 453	779 170	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MA	614 992	779 177	53.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MB	614 190	779 179	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MC	616 622	779 181	54.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MD	616 591	779 187	54.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
ME	614 298	779 195	55.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MF	616 551	779 204	54.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MG	614 325	779 226	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MH	614 239	779 250	56.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MI	614 351	779 253	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MJ	616 444	779 258	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MK	614 250	779 267	56.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0

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SHADOW - Main Result

Calculation: Additional / Total Shadow Impact: A02a

...continued from previous page

No.	Easting	Northing	Z [m]	Width [m]	Height [m]	Elevation a.g.l. [m]	Slope of window [°]	Direction mode	Eye height (ZVI) a.g.l. [m]
ML	614 212	779 267	57.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MM	616 377	779 274	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MN	614 222	779 282	56.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MO	614 266	779 283	55.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MP	614 373	779 290	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MQ	614 230	779 293	56.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MR	614 288	779 311	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MS	614 243	779 311	55.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MT	616 150	779 327	58.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MU	614 259	779 334	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MV	614 174	779 336	56.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MW	616 142	779 343	58.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MX	614 159	779 344	56.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MY	616 067	779 344	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
MZ	614 247	779 345	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NA	614 145	779 355	56.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NB	615 016	779 355	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NC	614 264	779 358	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
ND	614 347	779 361	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NE	614 130	779 362	57.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NF	614 279	779 368	55.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NG	614 418	779 375	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NH	615 995	779 375	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NI	614 325	779 385	55.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NJ	615 515	779 385	53.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NK	614 243	779 385	55.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NL	614 472	779 388	55.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NM	614 506	779 388	56.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NN	614 552	779 391	56.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NO	614 136	779 393	57.2	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NP	614 225	779 394	55.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NQ	614 254	779 395	55.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NR	614 206	779 395	55.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NS	614 186	779 396	55.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NT	614 170	779 396	56.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NU	614 151	779 398	56.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NV	614 795	779 403	55.7	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NW	614 832	779 405	55.6	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NX	616 080	779 415	59.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NY	616 084	779 432	58.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
NZ	616 032	779 439	59.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
OA	616 058	779 441	59.3	0.1	0.1	2.0	0.0	"Green house mode"	2.0
OB	616 083	779 446	58.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
OC	614 500	779 453	55.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
OD	614 533	779 454	56.8	0.1	0.1	2.0	0.0	"Green house mode"	2.0
OE	616 009	779 455	59.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
OF	614 489	779 456	55.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
OG	615 219	779 456	53.5	0.1	0.1	2.0	0.0	"Green house mode"	2.0
OH	614 676	779 459	57.1	0.1	0.1	2.0	0.0	"Green house mode"	2.0
OI	615 927	779 461	60.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
OJ	614 417	779 463	56.0	0.1	0.1	2.0	0.0	"Green house mode"	2.0
OK	615 978	779 472	57.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
OL	614 856	779 533	58.9	0.1	0.1	2.0	0.0	"Green house mode"	2.0
OM	614 476	779 545	55.4	0.1	0.1	2.0	0.0	"Green house mode"	2.0

Calculation Results

Shadow receptor

	Shadow, worst case			Shadow, expected values
No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
A	0:00	0	0:00	0:00
B	0:00	0	0:00	0:00

To be continued on next page...

Description:
This calculation was performed without visiting the site and is based solely on information provided by the developer or third party. ENERCON shall not be responsible and takes therefore no liability for the accuracy and sufficiency of any such data. In case of discrepancies of site coordinates or other relevant data, ENERCON does not take any responsibility for calculated shadow flicker at considered shadow receptors (SR). The calculation does include an elevation model.
If other wind farms are included like an existing wind farm, the real case calculation is based on the average operational hours of all turbines.
The calculated results are provided as a basis for information purposes only.

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Calculated:
2024-07-21 07:56/3.6.361

SHADOW - Main Result

Calculation: Additional / Total Shadow Impact: A02a

...continued from previous page

	Shadow, worst case			Shadow, expected values
No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
C	0:00	0	0:00	0:00
D	0:00	0	0:00	0:00
E	0:00	0	0:00	0:00
F	0:00	0	0:00	0:00
G	0:00	0	0:00	0:00
H	0:00	0	0:00	0:00
I	0:00	0	0:00	0:00
J	0:00	0	0:00	0:00
K	0:00	0	0:00	0:00
L	0:00	0	0:00	0:00
M	0:00	0	0:00	0:00
N	0:00	0	0:00	0:00
O	0:00	0	0:00	0:00
P	0:00	0	0:00	0:00
Q	0:00	0	0:00	0:00
R	0:00	0	0:00	0:00
S	0:00	0	0:00	0:00
T	0:00	0	0:00	0:00
U	0:00	0	0:00	0:00
V	0:00	0	0:00	0:00
W	0:00	0	0:00	0:00
X	0:00	0	0:00	0:00
Y	0:00	0	0:00	0:00
Z	0:00	0	0:00	0:00
AA	0:00	0	0:00	0:00
AB	0:00	0	0:00	0:00
AC	0:00	0	0:00	0:00
AD	0:00	0	0:00	0:00
AE	0:00	0	0:00	0:00
AF	0:00	0	0:00	0:00
AG	0:00	0	0:00	0:00
AH	0:00	0	0:00	0:00
AI	0:00	0	0:00	0:00
AJ	0:00	0	0:00	0:00
AK	0:00	0	0:00	0:00
AL	0:00	0	0:00	0:00
AM	0:00	0	0:00	0:00
AN	0:00	0	0:00	0:00
AO	0:00	0	0:00	0:00
AP	0:00	0	0:00	0:00
AQ	0:00	0	0:00	0:00
AR	0:00	0	0:00	0:00
AS	0:00	0	0:00	0:00
AT	0:00	0	0:00	0:00
AU	0:00	0	0:00	0:00
AV	0:00	0	0:00	0:00
AW	0:00	0	0:00	0:00
AX	0:00	0	0:00	0:00
AY	0:00	0	0:00	0:00
AZ	0:00	0	0:00	0:00
BA	0:00	0	0:00	0:00
BB	0:00	0	0:00	0:00
BC	0:00	0	0:00	0:00
BD	0:00	0	0:00	0:00
BE	0:00	0	0:00	0:00
BF	0:00	0	0:00	0:00
BG	5:43	40	0:13	0:54
BH	0:00	0	0:00	0:00
BI	10:53	52	0:18	1:46
BJ	0:00	0	0:00	0:00
BK	0:00	0	0:00	0:00
BL	0:00	0	0:00	0:00
BM	12:53	56	0:20	2:07

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SHADOW - Main Result

Calculation: Additional / Total Shadow Impact: A02a

...continued from previous page

	Shadow, worst case			**Shadow, expected values**
No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
BN	0:00	0	0:00	0:00
BO	0:00	0	0:00	0:00
BP	15:02	59	0:22	2:30
BQ	0:00	0	0:00	0:00
BR	0:00	0	0:00	0:00
BS	0:00	0	0:00	0:00
BT	17:27	63	0:24	2:56
BU	18:19	64	0:24	3:05
BV	18:39	65	0:24	3:09
BW	0:00	0	0:00	0:00
BX	0:00	0	0:00	0:00
BY	0:00	0	0:00	0:00
BZ	0:00	0	0:00	0:00
CA	0:00	0	0:00	0:00
CB	0:00	0	0:00	0:00
CC	0:00	0	0:00	0:00
CD	0:00	0	0:00	0:00
CE	0:00	0	0:00	0:00
CF	0:00	0	0:00	0:00
CG	21:21	71	0:25	3:42
CH	0:00	0	0:00	0:00
CI	21:49	72	0:25	3:48
CJ	0:00	0	0:00	0:00
CK	0:00	0	0:00	0:00
CL	0:00	0	0:00	0:00
CM	0:00	0	0:00	0:00
CN	13:43	52	0:25	2:55
CO	0:00	0	0:00	0:00
CP	1:02	19	0:05	0:09
CQ	28:44	78	0:29	5:36
CR	0:00	0	0:00	0:00
CS	27:35	85	0:29	5:31
CT	27:51	79	0:29	4:55
CU	11:00	46	0:21	1:45
CV	29:19	79	0:30	5:10
CW	22:38	63	0:31	3:47
CX	20:34	65	0:30	4:21
CY	19:22	81	0:28	3:42
CZ	33:03	84	0:33	5:54
DA	6:51	30	0:21	1:19
DB	6:49	30	0:21	1:19
DC	6:54	30	0:22	1:19
DD	6:56	30	0:21	1:20
DE	6:26	30	0:21	1:14
DF	6:55	30	0:22	1:19
DG	7:20	31	0:22	1:24
DH	7:35	32	0:23	1:27
DI	6:12	28	0:21	1:10
DJ	7:43	31	0:23	1:28
DK	6:22	28	0:21	1:12
DL	6:43	30	0:21	1:16
DM	7:52	32	0:23	1:30
DN	6:58	29	0:22	1:19
DO	7:54	32	0:24	1:30
DP	7:09	30	0:22	1:21
DQ	5:57	28	0:20	1:08
DR	8:03	32	0:23	1:31
DS	6:10	29	0:21	1:10
DT	7:21	30	0:23	1:24
DU	6:21	29	0:21	1:12
DV	8:04	32	0:23	1:32
DW	8:15	32	0:24	1:34
DX	8:23	33	0:24	1:36

To be continued on next page...

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SHADOW - Main Result

Calculation: Additional / Total Shadow Impact: A02a

...continued from previous page

	Shadow, worst case			**Shadow, expected values**
No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
DY	7:09	30	0:23	1:22
DZ	8:36	32	0:24	1:38
EA	5:43	27	0:20	1:05
EB	8:43	34	0:25	1:40
EC	6:39	30	0:22	1:16
ED	5:53	26	0:20	1:07
EE	8:47	33	0:24	1:40
EF	7:21	30	0:23	1:24
EG	6:03	28	0:21	1:09
EH	8:56	34	0:25	1:42
EI	7:41	30	0:24	1:28
EJ	7:52	32	0:23	1:30
EK	9:00	34	0:25	1:43
EL	8:09	32	0:24	1:33
EM	0:00	0	0:00	0:00
EN	7:08	30	0:22	1:22
EO	8:26	34	0:25	1:37
EP	9:06	32	0:25	1:44
EQ	5:42	26	0:20	1:05
ER	5:54	27	0:21	1:08
ES	9:16	34	0:25	1:46
ET	8:20	33	0:24	1:36
EU	8:19	32	0:24	1:36
EV	6:39	28	0:22	1:16
EW	6:53	29	0:22	1:19
EX	7:11	30	0:23	1:23
EY	7:11	30	0:23	1:23
EZ	6:14	28	0:21	1:12
FA	7:26	30	0:23	1:26
FB	9:46	34	0:26	1:52
FC	6:22	28	0:22	1:13
FD	7:32	30	0:23	1:27
FE	8:30	32	0:24	1:38
FF	7:39	30	0:23	1:28
FG	6:28	28	0:21	1:15
FH	0:00	0	0:00	0:00
FI	9:38	34	0:26	1:51
FJ	8:11	30	0:24	1:34
FK	6:42	28	0:22	1:17
FL	9:26	33	0:26	1:49
FM	8:14	32	0:24	1:35
FN	6:53	30	0:22	1:20
FO	5:41	26	0:20	1:06
FP	6:55	29	0:23	1:20
FQ	7:53	32	0:24	1:31
FR	9:50	34	0:26	1:54
FS	6:57	28	0:22	1:20
FT	8:34	33	0:25	1:39
FU	9:47	35	0:27	1:53
FV	7:52	30	0:23	1:31
FW	7:05	30	0:23	1:22
FX	8:50	32	0:26	1:42
FY	7:38	30	0:24	1:28
FZ	6:10	27	0:22	1:11
GA	9:59	34	0:27	1:56
GB	8:58	34	0:25	1:44
GC	6:17	28	0:21	1:13
GD	8:17	31	0:25	1:36
GE	9:58	34	0:26	1:55
GF	6:28	28	0:22	1:15
GG	7:30	30	0:23	1:27
GH	0:00	0	0:00	0:00
GI	6:27	28	0:22	1:15

To be continued on next page...

SHADOW - Main Result

Calculation: Additional / Total Shadow Impact: A02a

...continued from previous page

	Shadow, worst case			**Shadow, expected values**
No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
GJ	10:15	36	0:27	1:59
GK	6:36	28	0:22	1:17
GL	7:56	30	0:24	1:32
GM	8:39	32	0:25	1:40
GN	8:01	32	0:24	1:33
GO	9:16	32	0:26	1:48
GP	6:44	28	0:22	1:18
GQ	9:07	34	0:26	1:46
GR	6:05	28	0:21	1:10
GS	8:03	30	0:25	1:33
GT	8:52	32	0:25	1:43
GU	6:55	30	0:23	1:20
GV	8:14	31	0:24	1:35
GW	6:04	26	0:21	1:10
GX	6:25	27	0:22	1:14
GY	8:33	32	0:25	1:39
GZ	7:04	28	0:23	1:22
HA	7:08	30	0:23	1:22
HB	6:08	26	0:21	1:10
HC	7:21	30	0:23	1:25
HD	5:32	25	0:20	1:03
HE	7:33	30	0:24	1:27
HF	6:46	29	0:23	1:18
HG	6:18	28	0:21	1:12
HH	5:42	26	0:21	1:05
HI	6:54	29	0:23	1:18
HJ	6:27	28	0:22	1:13
HK	5:55	26	0:21	1:07
HL	6:22	26	0:22	1:12
HM	5:54	26	0:21	1:06
HN	5:36	26	0:20	1:01
HO	6:09	26	0:22	1:04
HP	6:18	27	0:22	1:04
HQ	6:29	28	0:22	1:05
HR	5:49	26	0:21	0:58
HS	6:39	27	0:23	1:06
HT	6:49	28	0:23	1:08
HU	6:05	27	0:22	1:01
HV	7:10	29	0:24	1:11
HW	5:59	26	0:22	0:59
HX	21:28	49	0:39	3:41
HY	6:40	28	0:23	1:07
HZ	7:18	29	0:24	1:12
IA	6:11	27	0:22	1:01
IB	7:19	29	0:24	1:14
IC	6:18	26	0:22	1:02
ID	6:51	28	0:23	1:09
IE	19:44	46	0:39	3:15
IF	6:42	28	0:23	1:04
IG	7:08	29	0:24	1:08
IH	8:14	30	0:25	1:16
II	11:06	35	0:29	1:46
IJ	8:30	31	0:26	1:16
IK	9:37	33	0:27	1:32
IL	8:44	32	0:26	1:17
IM	22:21	46	0:45	3:29
IN	8:10	31	0:25	1:17
IO	10:57	36	0:29	1:35
IP	26:11	50	0:49	4:03
IQ	11:03	36	0:29	1:43
IR	16:46	41	0:39	2:35
IS	14:58	39	0:37	2:19
IT	26:28	52	0:49	4:01

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SHADOW - Main Result

Calculation: Additional / Total Shadow Impact: A02a

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	Shadow, worst case			Shadow, expected values
No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
IU	11:48	37	0:30	1:48
IV	11:32	37	0:29	1:45
IW	32:39	62	0:53	4:48
IX	11:10	36	0:29	1:40
IY	7:46	31	0:24	1:04
IZ	10:58	36	0:29	1:38
JA	9:59	36	0:27	1:21
JB	12:13	39	0:30	1:49
JC	17:15	56	0:29	2:19
JD	57:35	116	0:54	7:22
JE	11:42	38	0:29	1:43
JF	9:45	34	0:27	1:18
JG	7:45	32	0:24	1:02
JH	11:13	38	0:28	1:39
JI	9:09	35	0:26	1:12
JJ	28:03	76	0:34	3:25
JK	11:00	37	0:28	1:36
JL	7:29	32	0:24	0:59
JM	8:34	33	0:25	1:07
JN	30:45	82	0:35	3:40
JO	54:19	58	1:23	4:55
JP	6:55	30	0:23	1:01
JQ	7:24	31	0:23	0:58
JR	13:04	42	0:29	1:34
JS	23:43	73	0:32	2:52
JT	21:56	70	0:31	2:40
JU	57:38	106	0:43	6:46
JV	9:16	34	0:25	1:09
JW	41:04	62	0:57	3:47
JX	35:34	100	0:36	4:01
JY	19:23	66	0:29	2:22
JZ	11:12	40	0:27	1:21
KA	8:25	33	0:25	1:03
KB	10:27	38	0:26	1:15
KC	11:56	42	0:28	1:24
KD	8:56	34	0:25	1:16
KE	8:03	32	0:24	1:00
KF	12:19	43	0:28	1:25
KG	13:11	46	0:28	1:30
KH	45:02	106	0:35	4:31
KI	44:03	82	0:40	4:09
KJ	6:51	30	0:22	0:50
KK	6:14	30	0:21	0:46
KL	28:32	54	0:39	2:33
KM	14:00	48	0:28	1:34
KN	7:30	32	0:23	0:53
KO	9:00	36	0:25	1:12
KP	14:41	51	0:28	1:37
KQ	35:14	70	0:36	3:17
KR	7:31	34	0:23	0:53
KS	15:48	56	0:28	1:42
KT	6:32	32	0:21	0:46
KU	7:19	34	0:21	0:51
KV	17:16	70	0:28	1:46
KW	21:31	72	0:28	2:04
KX	7:11	33	0:21	0:49
KY	27:48	58	0:34	2:30
KZ	20:22	48	0:32	1:46
LA	10:56	42	0:25	1:23
LB	23:15	52	0:33	2:02
LC	29:10	86	0:30	2:46
LD	29:10	86	0:30	2:46
LE	17:53	44	0:30	1:32

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SHADOW - Main Result

Calculation: Additional / Total Shadow Impact: A02a

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No.	Shadow, worst case Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow, expected values Shadow hours per year [h/year]
LF	11:14	34	0:25	0:56
LG	22:28	62	0:28	2:04
LH	13:27	38	0:26	1:08
LI	6:17	24	0:19	0:30
LJ	9:16	32	0:23	0:46
LK	0:00	0	0:00	0:00
LL	8:40	38	0:22	1:05
LM	8:40	38	0:22	1:05
LN	8:40	38	0:22	1:05
LO	0:00	0	0:00	0:00
LP	17:50	46	0:28	1:44
LQ	0:00	0	0:00	0:00
LR	17:19	68	0:26	1:56
LS	16:10	46	0:26	1:22
LT	16:49	74	0:23	1:37
LU	18:56	64	0:26	2:03
LV	19:51	60	0:26	2:06
LW	0:00	0	0:00	0:00
LX	13:31	68	0:24	1:20
LY	13:24	68	0:24	1:33
LZ	19:48	52	0:27	1:59
MA	0:00	0	0:00	0:00
MB	4:42	22	0:16	0:22
MC	15:41	66	0:24	1:44
MD	17:22	62	0:25	1:52
ME	15:29	64	0:23	1:27
MF	18:27	57	0:25	1:55
MG	16:46	58	0:23	1:31
MH	0:00	0	0:00	0:00
MI	16:55	52	0:24	1:29
MJ	12:20	40	0:24	1:10
MK	0:00	0	0:00	0:00
ML	0:00	0	0:00	0:00
MM	6:27	28	0:18	0:35
MN	0:00	0	0:00	0:00
MO	0:00	0	0:00	0:00
MP	15:16	46	0:24	1:17
MQ	0:00	0	0:00	0:00
MR	0:00	0	0:00	0:00
MS	0:00	0	0:00	0:00
MT	0:00	0	0:00	0:00
MU	0:00	0	0:00	0:00
MV	0:00	0	0:00	0:00
MW	0:00	0	0:00	0:00
MX	0:00	0	0:00	0:00
MY	0:00	0	0:00	0:00
MZ	0:00	0	0:00	0:00
NA	0:00	0	0:00	0:00
NB	0:00	0	0:00	0:00
NC	0:00	0	0:00	0:00
ND	0:00	0	0:00	0:00
NE	0:00	0	0:00	0:00
NF	0:00	0	0:00	0:00
NG	0:00	0	0:00	0:00
NH	0:00	0	0:00	0:00
NI	0:00	0	0:00	0:00
NJ	0:00	0	0:00	0:00
NK	0:00	0	0:00	0:00
NL	0:00	0	0:00	0:00
NM	0:00	0	0:00	0:00
NN	0:00	0	0:00	0:00
NO	0:00	0	0:00	0:00
NP	0:00	0	0:00	0:00

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SHADOW - Main Result

Calculation: Additional / Total Shadow Impact: A02a

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No.	Shadow, worst case Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow, expected values Shadow hours per year [h/year]
NQ	0:00	0	0:00	0:00
NR	0:00	0	0:00	0:00
NS	0:00	0	0:00	0:00
NT	0:00	0	0:00	0:00
NU	0:00	0	0:00	0:00
NV	0:00	0	0:00	0:00
NW	0:00	0	0:00	0:00
NX	0:00	0	0:00	0:00
NY	0:00	0	0:00	0:00
NZ	0:00	0	0:00	0:00
OA	0:00	0	0:00	0:00
OB	0:00	0	0:00	0:00
OC	0:00	0	0:00	0:00
OD	0:00	0	0:00	0:00
OE	0:00	0	0:00	0:00
OF	0:00	0	0:00	0:00
OG	0:00	0	0:00	0:00
OH	0:00	0	0:00	0:00
OI	0:00	0	0:00	0:00
OJ	0:00	0	0:00	0:00
OK	0:00	0	0:00	0:00
OL	0:00	0	0:00	0:00
OM	0:00	0	0:00	0:00

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
WEC1	ENERCON GmbH E-175 EP5 E2 7000 175.0 !O! NH: 111.6 m (Ges:199.1 m) (7)	334:56	49:13
WEC2	ENERCON GmbH E-175 EP5 E2 7000 175.0 !O! NH: 111.6 m (Ges:199.1 m) (8)	326:10	38:57

Total times in Receptor wise and WTG wise tables can differ, as a WTG can lead to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more WTGs simultaneously.

The calculation of the total expected values for a given receptor assumes a weighted average directional reduction for all WTGs contributing to shadow flicker within the same day. In the case where shadow flicker from different WTGs is not concurrent within the day, the total expected time at a given receptor may deviate marginally from the individual flicker time caused by each turbine separately.

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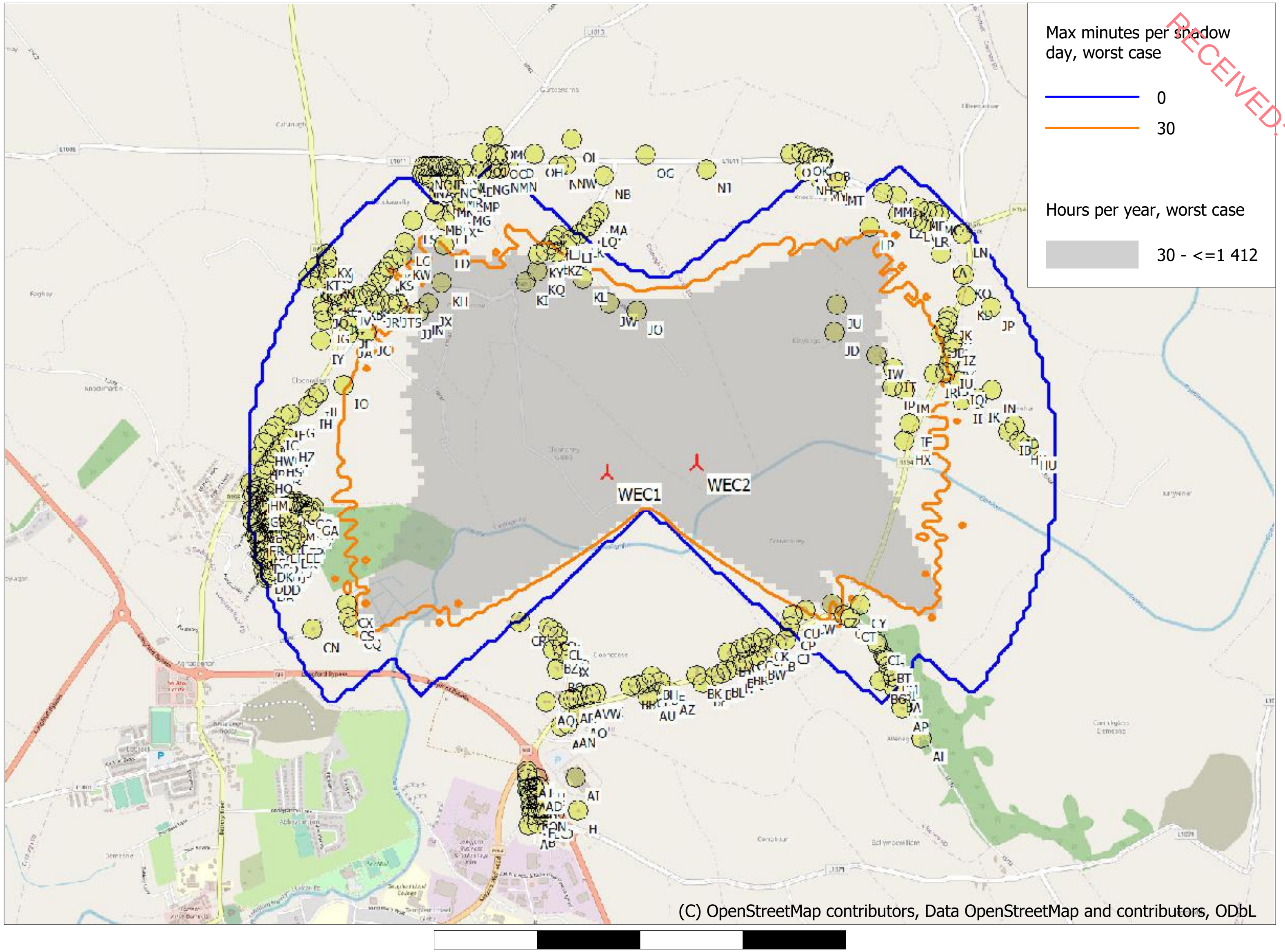
Appendix B

Shadow Map – Worst Case
Additional / Total Shadow Flicker



Map: EMD OpenStreetMap , Print scale 1:30 000, Map center Irish ITM-IRENET95 (IE), geocentric, GRS80 East: 615 150 North: 777 900

New WTG   Shadow receptor

Flicker map level: Höhenlinien: CONTOURLINE_Cloonanny_0.wpo (1)

Time step: 4 minutes, Day step: 14 days, Map resolution: 30 m, Visibility resolution: 15 m, Eye height: 2.0 m

Project:

Cloonanny
O-16297
NC-SR
Natural Forces

Description:

This calculation was performed without visiting the site and is based solely on information provided by the developer or third party. ENERCON shall not be responsible and takes therefore no liability for the accuracy and sufficiency of any such data. In case of discrepancies of site coordinates or other relevant data, ENERCON does not take any responsibility for calculated shadow flicker at considered shadow receptors (SR). The calculation does include an elevation model. If other wind farms are included like an existing wind farm, the real case calculation is based on the average operational hours of all turbines. The calculated results are provided as a basis for information purposes only.

SHADOW - Map

Calculation:

Additional / Total Shadow Impact: A02a

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Appendix B: Shadow Flicker Shutdown

Technical description

Shadow shutdown

ENERCON Platform Independent Control System (PI-CS)

Released: 2023-06-22 06:51

Publisher

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Table of contents

1 General information

Periodic shadow flickering is the recurrent shading of direct sunlight by the movement of the wind energy converter's rotor blades. The occurrence of this effect depends on current local weather conditions, alignment of the nacelle according to the wind direction, the position of the sun and the wind energy converter operating times.

2 Operating principle

Shadow shutdown for wind energy converters with control system type PI-CS is effected via the ENERCON SCADA Edge Server.

The number and installation location of the sensors required for the respective project is determined and defined on a project-specific basis.

2.1 Determining potential shadow casting time

The shadow shutdown feature is based on a calendric system. The start and finish times of the maximum astronomical shadow casting at affected immission sites are computed considering site-specific parameters such as hub height, rotor diameter, wind energy converter coordinates, location of the immission site, and its topography.

The shutdown times determined on this basis are programmed in the ENERCON SCADA Edge Server.

Fine-tuning of these shutdown times is possible at any time for each immission site and time period.

2.2 Measuring illuminance

Periodic shadow flickering is dependent on sunlight. According to the Joint Working Group of the German Federal Government/Federal States on Immission Control (Bund/Länder-Arbeitsgemeinschaft für Immissionsschutz (LAI)), shadow flickering is likely when the sunlight is greater than 120 W/m^2 at the level vertical to the incidence direction.

The level of illuminance on a horizontal measuring surface is influenced by the position of the sun and the photometric equivalent. The latter is determined by refraction and atmospheric opacity; it also depends on the position of the sun. The illuminance depending on the sun's position can therefore only be approximated.

In order to measure the illuminance, the sensors are arranged such that at least one sensor is on the sunny side and one on the shadow side of the tower.

The highest and lowest illuminances, i.e. the light and shadow intensity, are determined from the measured values from the sensors.

Instead of using an inherently inaccurate measurement of illuminance to determine whether shadow flickering is likely to occur, the ratio of light intensity to shadow intensity and the shutdown intensity derived from this are used.

With an illuminance of 120 W/m^2, the determined shutdown intensity is 36 %. This value is independent of the position of the sun. Once the ratio of light intensity to shadow intensity drops below 36 %, illuminance is greater than 120 W/m^2. Shadow flickering occurs.

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2.3 Automatic shutdown

Shadow shutdown is activated as soon as the shutdown intensity falls below the set value within the programmed timeframe. The measured illuminance is not averaged. Automatic shutdown also reacts when the shutdown intensity falls below the defined shutdown intensity even briefly. Filtering times can be used to define a delay in the response of the shadow shutdown feature. A parameter specifies for how long, on average, the ratio of light intensity to shadow intensity must be below the defined shutdown intensity in order for shadow shutdown to be activated.

If the light conditions change such that shadow flickering is no longer possible, shadow shutdown initially remains active. Shadow shutdown is deactivated and the wind energy converter restarts when the programmed timeframe has expired or when the value of the shutdown intensity is constantly exceeded during a specified time period. A parameter specifies for how long, on average, the ratio of light intensity to shadow intensity must be above the defined shutdown intensity in order for shadow shutdown to be deactivated.

2.4 Advanced functions

Shadow shutdown can also take place without taking the illuminance into account. In this case, shutdown of the wind energy converter is time-controlled according to the time windows programmed in the ENERCON SCADA Edge Server. This means the wind energy converter is also stopped if there is cloud cover.

A weekday function is available, allowing the shutdown to be limited to selected days of the week. This function is useful for wind energy converters near commercial areas or industrial estates, for example, where no work in spaces requiring protection is carried out at weekends.

Advanced functions can be implemented in targeted fashion for selected immission sites.

3 Safety

The function of the light sensors is automatically and continuously checked for plausibility during operation. If the measured values are not plausible, a message is generated.

Failure of a sensor, e.g. due to a broken cable or short-circuiting, results in the ratio of shadow to light intensity falling below the shutdown intensity value. The wind energy converter stops within the programmed timeframe and a message is generated.

4 Logging

Activation of the shadow shutdown system is recorded by the ENERCON SCADA Edge Server as a status message with the date, time and duration and is stored for several years.

If required, measured data from the light sensors is logged. The ratio of shadow to light intensity is recorded as an average per minute; the minimum and maximum values at one-minute intervals and the defined shutdown intensity are also recorded.

Appendix C: General Principal of Shadow Flicker

The principle of periodic shadow flickering, is the recurrent shading of direct sunlight by the movement of a wind turbines rotor blades. The occurrence of this effect depends on current local weather conditions, alignment of the nacelle according to the wind direction, the position of the sun and the wind energy converter operating times.

Technological Mitigation

The proposed turbine manufacturer has developed an advanced anti-shadow flicker function within the wind turbine control system, which described as a "Shadow Shutdown" function.

The principle of the function is to avoid periodic shadow flickering on dwellings or sensitive receptors. Shadow flicker as a concept, is the recurrent shading of direct sunlight by the movement of the wind turbine's rotor blades. The occurrence of this effect depends on current local weather conditions, alignment of the nacelle according to the wind direction, the position of the sun and the wind energy converter operating.

The shadow shutdown is a function that is integrated into the control system of the turbine and specifically activated in the turbine where shadow shutdown is necessary i.e. an exceedance of shadow flicker limits

In order to establish when the wind turbine is to be shut down to avoid shadow flicker on a dwelling or sensitive receptor, a computerised model is developed mapping out the turbine location and the location of the relevant dwellings or sensitive receptors. The model then calculates the impact based on a calendric system. The start and finish times of the maximum astronomical shadow casting at affected dwellings or sensitive receptors are computed considering site-specific parameters such as hub height, rotor diameter, turbine coordinates, location of the dwellings or sensitive receptors, and its topography. The shutdown times determined are then programmed into the turbine control system.

Determination of Impacted Receptors

Annex A provide further details for the industry standard software package windPRO EDM International A/S, where a map illustrates the potentially impacted dwellings or sensitive receptors within the 30 minutes per day or 30 hours per year standard.

The exact dates and times of the shadow flicker events at each of the shadow flicker receptors listed above will not be possible based on the assumptions used to run the shadow flicker assessment.

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

Based on sun/shadow angles through-out the year it is expected that the shadow receptors may experience shadow flicker events during the months of May, June, July and August, these months are the time of year in which duration of sunlight is longest due to a combination of the tilt of axis and rotation of the earth.