

Ballyfeeny Green Energy Project



Environmental Impact Assessment Report Volume II

Chapter 15 – Shadow Flicker

September 2025

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Acronyms

Term	Meaning
GCR	Grid Connection Route
TDR	Turbine Delivery Route
EIAR	Environmental Impact Assessment Report
LA	Local Authority
GSI	Geological Survey Ireland
LVIA	Landscape Visual Impact Assessment
WEDG 2006	Wind Energy Development Guidelines 2006
DRAFT WEDG 2019	Draft Wind Energy Development Guidelines 2019
OSI	Ordinance Survey Ireland
Hz	Hertz
DoHPLG	Department of Housing Planning and Local Government
CDP	County Development Plan
EPA	Environmental Protection Agency
SEAI	Sustainable Energy Authority of Ireland
EU	European Union
RCDP	Roscommon County Development Plan
EIA	Environmental Impact Assessment
COMAH	Control of Major Accident Hazard
T01	Turbine 1
T02	Turbine 2
T03	Turbine 3
T04	Turbine 4
T05	Turbine 5
T06	Turbine 6

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15. Shadow Flicker

15.1 Introduction

This Chapter assesses the likely significant direct and indirect effects of shadow flicker occurrence at nearby residences as a result of the proposed Project, during the construction, operation and decommissioning phases.

The proposed Project includes six no. turbines and all associated infrastructure including Turbine Foundations, Turbine Hardstands, Site Access Tracks, Wind Farm Internal Cabling, Grid Connection Route (GCR), Relay Tower, Onsite Substation and works required along the public road network for the two Turbine Delivery Route (TDR) options to facilitate the delivery of turbine components. A full description of the proposed Project is provided in **Chapter 2 – Project Description**.

The Applicant is in receipt of a notification of opinion by the Local Authority on design flexibility. The notification is provided in **Appendix 1.5 – DFR-25-1 Notification of Opinion by Local Authority**. This opinion from the Local Authority confirmed that it was *‘appropriate that the proposed application be made and decided before the prospective applicant has confirmed certain details of the application’*.

Chapter 1 – Introduction, Section 1.6 Approach to Design Flexibility, outlines with respect to the notification of opinion by the Local Authority, the Applicant in this EIAR, proposes to assess three distinct Technology Options within the range outlined by the Local Authority and in accordance with the design flexibility parameters sought. **Chapter 1 – Introduction Table 1-3**, outlines the options and associated parameters that are used in the EIAR, comprising three potential turbines classified as Technology Option 1, 2 and 3. Further details on the assessment of the Technology Options in this Chapter is provided in **Section 15.3.3**.

This Chapter is supported by the following:

- **Volume 4: EIAR Figures.**

The assessment should be read in conjunction with:

- **Appendix 15.1 – List of Sensitive Receptors Assessed;**
- **Appendix 15.2 – Shadow Flicker Assessment;** and
- **Chapter 5 – Population and Human Health.**

15.1.1 Statement of Authority

This technical assessment was undertaken by Peter Connell, GIS and LVIA Consultant (BA, MPhil, MSc) of Macro Works Ltd., a specialist landscape and visual assessment company with over 20 years' experience in the appraisal of visual effects from a variety of energy, infrastructure and commercial developments, including landscape and visual impact assessments, and glint and glare assessments. Peter has previously prepared shadow flicker impact models and assessments for inclusion in Environmental Impact Assessment Reports.

Dr James Massey has reviewed this Chapter. James is a senior environmental consultant and ecologist with over 25 years' experience, specifically on environment assessment of renewable projects, onshore and offshore in Ireland and worldwide. James is a Fellow of the Institute of Environmental Sciences and a member of several professional organisations. James is a Chartered Environmentalist and Chartered Scientist and holds a PhD, DSc, BSc in Applied Marine Biology and a number of professional and industry qualifications.

15.1.2 Scope of Assessment

Shadow flicker is defined as the alternating light intensity produced by a wind turbine as the rotating blade casts shadows on the ground and stationary objects, such as the window of a residence, which may have the potential to cause disturbance or annoyance. This chapter considers the potential impact to human beings from shadow flicker generated by the proposed Project during the operational stage only, as the potential impact can only occur when the turbines are in operation.

The 2019 Draft (hereafter referred to as Draft WEDG 2019) Revision of the 2006 Wind Energy Development Guidelines (hereafter referred to as WEDG 2006) reiterate that:

“Shadow Flicker occurs when the sun is low in the sky and the rotating blades of a wind turbine casts a moving shadow which, if it passes over a window in a nearby house or other property results in a rapid change or flicker in the incoming sunlight. The time period in which a neighbouring property may be affected by shadow flicker is completely predictable.”

“This effect lasts only for a short period and happens only in certain specific combined circumstances. The circumstances require that:

- *the sun is shining;*
- *the turbine is directly between the sun and the affected property; and*
- *there is enough wind energy to ensure that the turbine blades are moving.”*

According to the WEDG 2006 guidelines, if any one of the conditions outlined above is absent, shadow flicker cannot occur. The recently published Draft WEDG 2019 added that another condition required for shadow flicker to occur is that;

“There is sufficient direct sunlight to cause shadows (cloud, mist, fog or air pollution could limit solar energy levels)”.

and notes that:

“Generally only properties within 130 degrees either side of north, relative to the turbines, can be affected at these latitudes in the UK and Ireland – turbines do not cast long shadows on their southern side”.

The path of the sun varies over the seasons resulting in a changing potential for a shadow to be cast throughout the year. Similarly, the sun's position in the sky over the course of a day changes such that the shadow cast by a turbine is constantly changing. Notwithstanding, shadow flicker is more likely to occur on sunny winter days when the sun is lower in the sky and shadows are cast a greater distance from the turbine. Furthermore, shadow flicker is more likely to occur where turbines are sited to the east, south-east, west or south-west of nearby receptors. On balance, careful site selection, design and planning, and good use of relevant software to control the turbine operation can reduce the possibility of shadow flicker.

The distance and direction between the turbine and surrounding receptors is of significance because:

- The duration of the shadow will be shorter the greater the distance (i.e. it will pass by quicker); and
- The shadow flicker cast will be reduced, the further a receptor is from an operating turbine.

It should be noted that, modern wind turbines are fitted with an automated shadow detection system which stops the blades rotating during conditions where shadow flicker is likely to occur. Where likely significant effects are predicted, this chapter identifies appropriate mitigation strategies.

Human Health

In regards to the potential for health impacts resulting from shadow flicker, persons with photosensitive epilepsy tend to be sensitive to flickering light between 3 and 60 flashes per second (Hertz (Hz))(Epilepsy Action, 2012) with sensitivity under 3Hz deemed uncommon. (Epilepsy Society, 2025). This is supported by research asserting that flicker from turbines

must interrupt or reflect sunlight at frequencies greater than 3Hz to pose a potential risk of inducing photosensitive seizures (Smedley, Webb and Wilkins, 2010) The frequencies of flicker caused by modern commercial wind turbines are typically less than 1Hz (Harding et al., 2008). At between 0.3 and 1Hz, shadow flicker falls well below the frequencies known to trigger effects in these individuals. Therefore, any potential shadow flicker effect from the proposed Project is considered an effect on residential amenity, rather than having the potential to affect the health of residents.

15.2 Legislation, Guidance and Policy

The relevant Irish guidance for shadow flicker is derived from the 'Wind Energy Development Guidelines for Planning Authorities' (Department of the Environment, Heritage and Local Government (WEDG 2006) and the 'Best Practice Guidelines for the Irish Wind Energy Industry' (Irish Wind Energy Association, 2012).

The Department of Environment, Community and Local Government in its 2006 Wind Energy Development Guidelines (hereafter referred to as WEDG 2006) considers that:

"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".

The WEDG 2006 Guidelines also state that:

"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".

Although the WEDG 2006 thresholds apply to sensitive receptors located within 500 metres of a proposed turbine location, for the purposes of this assessment, the guideline thresholds of 30 hours per year or 30 minutes per day have been applied to all sensitive receptors located within ten rotor diameters (See **Section 15.4.1** for details on receptor identification). This is a radius of 1,380m, as 138m is the widest potential rotor diameter for the proposed Project (refer to **Chapter 1 – Introduction, Table 1-3**). For completeness, the radius has been extended to 2km from the proposed turbines for this assessment. The WEDG 2006 state that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

The adopted WEDG 2006 are currently under review. The DoHPLG released the 'Draft Revised Wind Energy Development Guidelines' in December 2019. The revised draft of Wind

Energy Development Guidelines 2019 (hereafter referred to as Draft WEDG 2019) advises developers or operators to eliminate shadow flicker at sensitive receptors:

“A condition should be attached to all planning permissions for wind energy development to ensure that there will be no shadow flicker at any existing nearby dwelling or other relevant existing affected sensitive property and that the necessary measures outlined in the shadow flicker assessment submitted with the application, such as turbine shut down during the associated time periods, should be taken by the wind energy developer or operator to eliminate the shadow flicker”.

The Draft WEDG 2019 are based on the recommendations set out in the ‘Proposed Revisions to WEDG 2006 – Targeted Review’ (December 2013) and the ‘Review of the Wind Energy Development Guidelines 2006 – Preferred Draft Approach’ (June 2017).

Geographically, the Site is located within County Roscommon and consequently, the Roscommon County Development Plan (CDP) 2022-2028 has also been consulted as part of the assessment process.

15.2.1 Policy

The overarching planning policy relevant to the proposed Project is detailed in **Chapter 4 – Planning and Policy**. A **Planning Statement** has been provided with the planning application documents. There is no specific policy or objectives with regards shadow flicker in the Roscommon CDP 2022 – 2028.

15.2.2 Adoption of Relevant Policy

The proposed Project aims to adhere to the Shadow Flicker policies set out in the WEDG 2006 and with due regard to the Draft WEDG 2019. As the current adopted policy, all elements of the WEDG 2006 have been complied with in relation to shadow flicker. The WEDG 2006 guidance that no receptor within 500m should experience shadow flicker for periods exceeding 30 minutes a day or 30 hours a year has been applied to all identified receptors within the study area (**Section 15.2.3**) as a matter of professional judgement. With respect to the Draft WEDG 2019, all considerations in the ‘Shadow Flicker Control’ (5.8.2) section of the document have been considered. Site design has incorporated measures to minimise shadow flicker effects (**Section 15.5**) and the developer has made a commitment to implement turbine shutdown protocols, where necessary, to eliminate adverse shadow flicker effects, allowing for a short period of time for the rotor to come to a stop (**Section 15.7**).

Accordingly, the proposed Project is in full compliance with the requirements of WEDG 2006. Furthermore, by also applying professional judgement and recognised best practice in the management of shadow flicker the proposed Project has due regard to the Draft WEDG 2019.

15.2.3 Definition of Study Area

As outlined in **Section 15.2.2**, the WEDG 2006 state that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low, thus it is considered that the minimum study area for shadow flicker is 10 times the rotor diameter of the proposed turbines ($10 \times 138\text{m} = 1,380\text{m}$). This figure refers to Technology Option 3 which has the largest rotor diameter of the proposed turbine options. In the interest of compiling a robust and complete assessment, a study area of 2km radius is used in this instance.

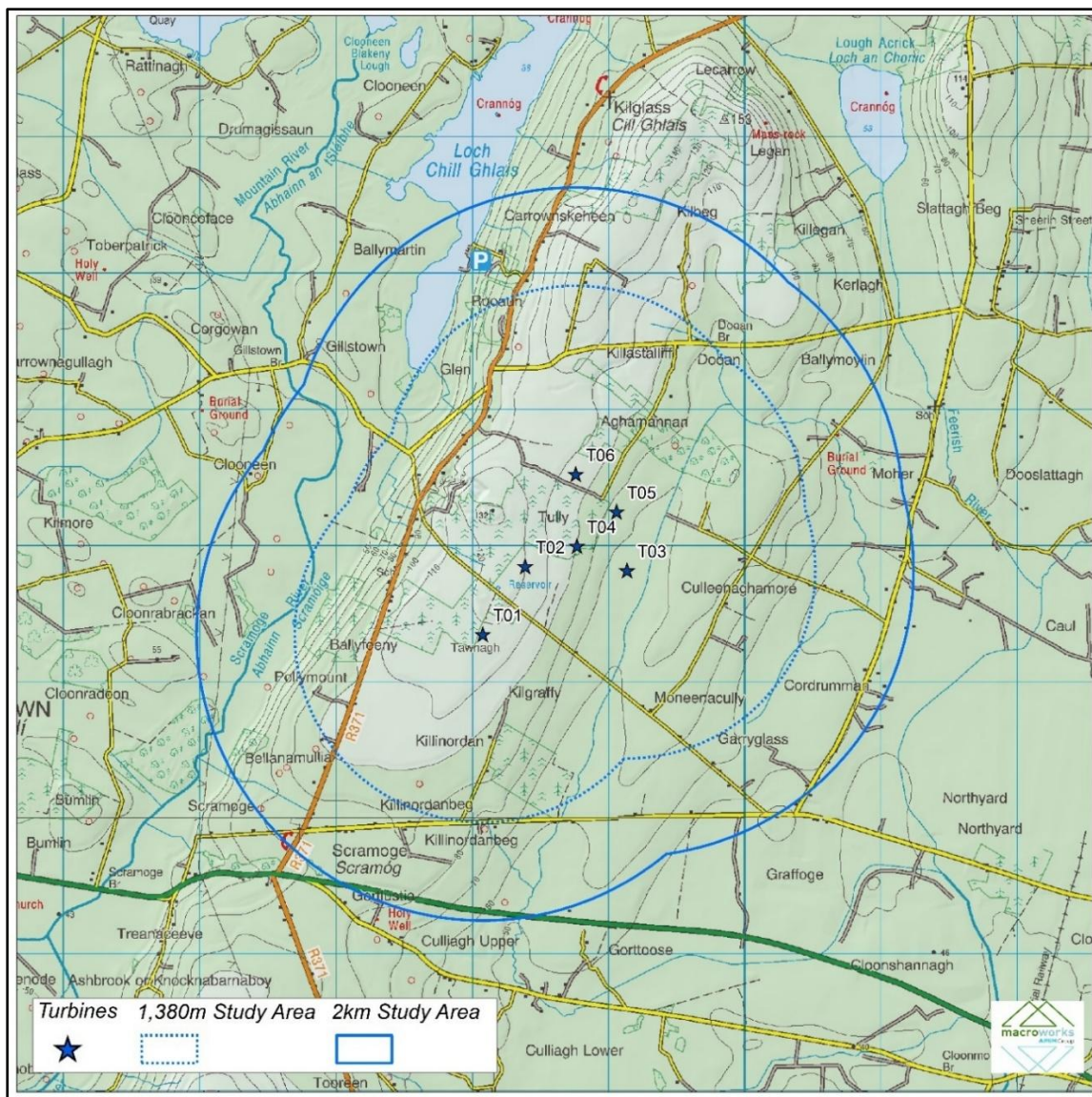


Figure 15-1: Shadow Flicker Assessment Study Area

15.3 Methodology

An industry standard wind farm assessment software package, WindPRO Version 4.0 from EMD International was used to prepare a model of the proposed Project. The programme facilitates the analysis of a wind farm for possible shadow flicker occurrence at nearby sensitive receptors. WindPRO produces a set of predicted shadow flicker results and mapping outputs. The data output from the programme have been analysed and the receptors potentially vulnerable to shadow flicker were identified. The significance of shadow flicker effects was then assessed.

Three turbine types of similar dimensions were assessed as part of this study (Refer to **Chapter 1 – Introduction, Table 1-3**). Each of these Technology Options were assessed individually in the shadow flicker model, with the results of each assessed collectively in Section 15.5

- Technology Option 1 – Rotor Diameter 136m – Hub Height 92m – Tip height 160m (maximum);
- Technology Option 2 – Rotor Diameter 133.2m – Hub Height 90m – Tip height 156m; and
- Technology Option 3 – Rotor Diameter 138.25m – Hub Height 90m – Tip height 159m.

In the absence of specific information on windows at receptors within the assessment study area, in accordance with best practice, each receptor was assumed to have a North, South, East and West facing window, of 2m width, 2m height and 0.5m from bottom line above ground. The model assumes the receptor will not face any particular direction but instead will face all directions. These windows represent an approximation of the existing windows on the houses facing north, south, east and west and provide an estimate of potential shadow flicker to a window on each side of the house.

The software determines the times of day/year when the sun will be in line with the rotational components of the turbine and the house/receptor, thereby having the potential to cause shadow flicker. The software outputs details of potential shadow flicker, in this case by mean and maximum duration of the shadow flicker events, days per year and times of occurrence and maximum hours per year and maximum minutes per day of shadow flicker.

The following data inputs were required and used to produce an estimate of the effect of shadow flicker from the proposed wind farm:

- Ordnance Survey Ireland Raster base map;

- Digital Elevation Model of the proposed Project and areas around all receptors within the model (10m resolution – OSi X, Y, and Z data points);
- Turbine locations;
- Dimensions for each turbine option (rotor diameter and hub height);
- Receptor locations (i.e. property locations);
- Bottom line height above ground ‘window’ (0.5m above ground level) applied to each side of dwellings i.e. ‘greenhouse mode’; and
- Wind speed and direction for the site to determine the period that the wind turbines will be in operation from the different wind directions during the year.

The software creates a mathematical model of the proposed Project and its surroundings and uses this information to calculate specific theoretical times and durations of flicker effects for the identified receptors. The following ‘worst-case’ assumptions were initially incorporated into the shadow flicker modelling:

- There are no clouds and sunlight is always bright and direct;
- The turbines are always rotating, whereas this might not be the case due to curtailment, maintenance works or break downs;
- Dwelling receptors have windows on all sides;
- There is no intervening structures or vegetation (other than topography) that may restrict the visibility of a turbine, preventing or reducing the effect i.e. bare-earth scenario; and
- A limit to human perception of shadow flicker is not considered by the model.

The model operates by simulating the path of the sun during the year. The results of the model provide a calculation of theoretical specific times and durations of flicker effects for the identified receptors. As previously stated, given the assumptions incorporated into the model, the calculations overestimate the duration of effects. The worst-case assumption is considered to be sufficient for the purposes of this assessment as it assumes the sky is always clear, the turbines are always aligned face-on to each window and that there is a clear and undisturbed line of sight between the windows of the receptors and the turbines (except where this is prevented due to topography).

In reality, this will not occur; the turbines will not always be orientated as described, clouds will obscure the sun and line of sight may also be obscured (for example, from leaves on trees). The shadow flicker effects will be substantially less than this and will not meet the results of the worst-case assumption.

The model also outputs a more realistic scenario, or “expected values” (real-case scenario). In this scenario, the only change in assumptions is that the statistically likely monthly sunshine frequency and wind direction frequency data are assessed. This assessment only changes the annual hours per year metric and is not applied to the daily data. This is because it could be sunny, with the wind coming from the relevant direction, on any individual day. The data used in the model were:

- Long-term sunshine data from the Met Éireann synoptic station in Clones (c.66km northeast of the proposed Project); (Met Eireann, 2025) and
- Wind directional data from the Met Éireann synoptic station at Mount Dillon (c. 7km southeast of the proposed Project) (Met Eireann, 2025).

The significance of effects is determined in respect of the EPA Guidelines which outlines the information to be contained in Environmental Impact Assessment Reports. The magnitude of change in relation to the sensitivity of the receiving environment determines the significance of effects. In reference to the WEDG 2006, any receptor which exceeds the shadow flicker threshold of 30 hours per year or 30 minutes per day is considered to have a significant and adverse effect. Given the nature of the proposed Project, any effects are considered to be long-term.

15.3.1 Determining the Significance of Effects

The effects on Shadow Flicker are described as outlined in **Chapter 1 – Introduction**. The significance of an effect was determined by considering the magnitude of the impact and the sensitivity of the receptor, with the classifications assigned in accordance with the EPA Guidelines, including **Imperceptible, Not Significant, Slight, Moderate, Significant, Very Significant** and **Profound**.

In considering the effects, criteria such as quality, duration, probability and type were also considered. These criteria are detailed in Table 3.4 of the EPA Guidelines, which are also noted in **Table 1-6 of Chapter 1 – Introduction**. As per the guidelines, all categories of these terms do not need to be used for every effect.

For the purpose of this assessment, effects rates as ‘**Significant**’ or above are considered to be Significant in EIA terms. Effects identified as ‘**Moderate**’ significance or below are considered **Not Significant** in EIA terms.

In the context of this assessment, receptors which exceed the WEDG 2006 thresholds of 30 hours of shadow flicker per year or 30 minutes of shadow flicker a day are considered to experience **Significant** adverse effects.

In order to determine the significance of effect, the EPA Guidelines has provided a matrix which compares the character (magnitude) of the potential impact to the sensitivity of the receiving environment, see **Figure 15.2**.

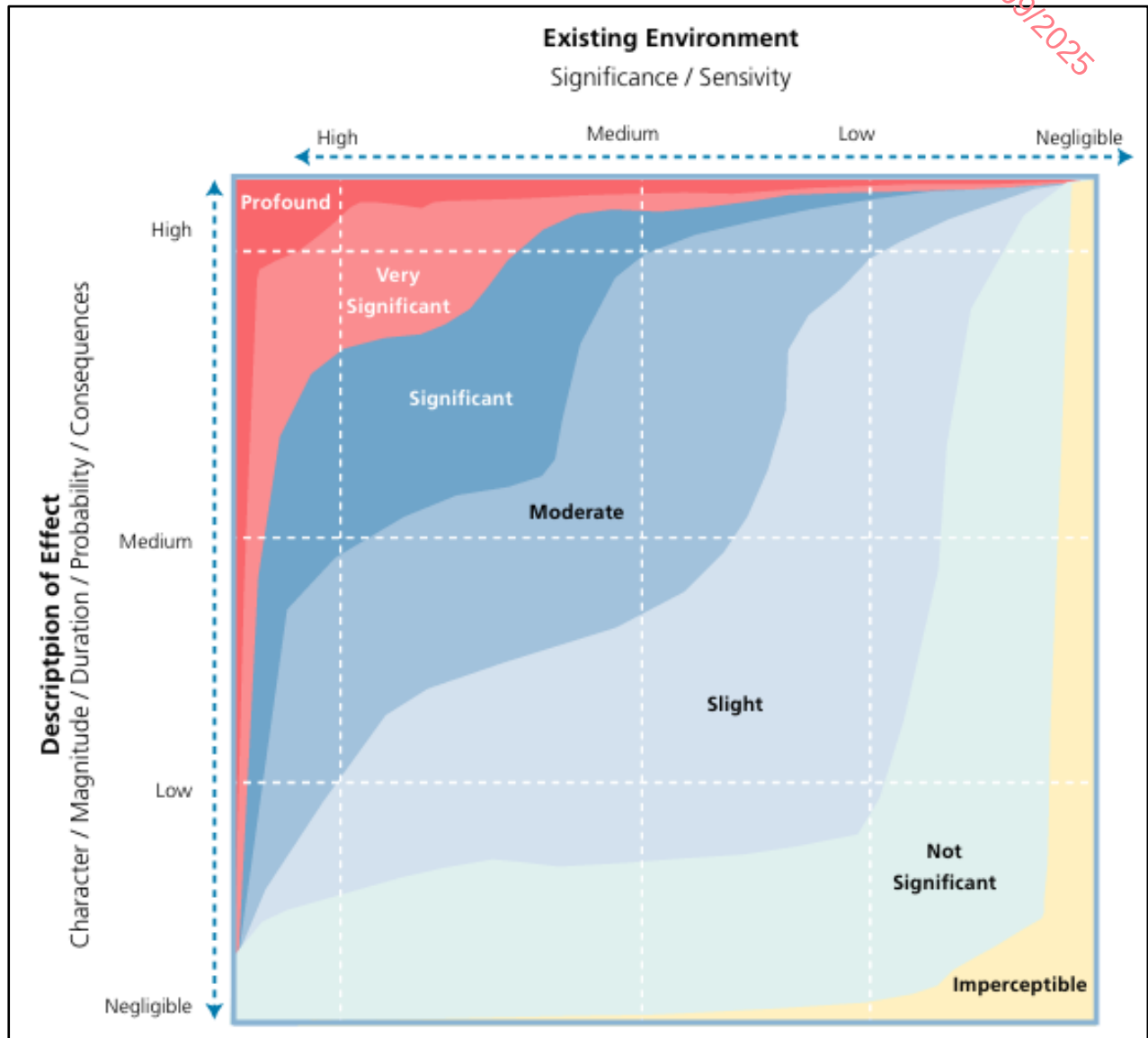


Figure 15-2: Typical Classification of the Significance of Effects (EPA, 2022).

15.3.2 Consultation

Scoping and consultation have been carried out in support of the proposed Project and in line with the EIA Directive, together with the EPA Guidelines (2022) and with due regard to the *Environmental Impact Assessment of Projects: Guidance on Scoping* (European Commission, 2017).

All scoping consultation responses are provided in **Appendix 1.3 – Scoping Consultation Responses**.

During community consultation concerns regarding shadow flicker were raised by a number of consultees at the Door-to-Door visits, Community Clinic and also via email correspondence. Understanding these concerns and having due regard to the Draft WEDG 2019, Ballyfeeny Green Energy has committed to eliminate adverse shadow flicker at dwellings or other potentially affected properties. Please refer to **Appendix 5.1 – Community Report** for further information regarding the community consultation process.

15.3.3 Approach to Project Design

As set out in **Chapter 1 – Introduction**, under Section 32I of the Planning and Development Act 2000 (as amended), the Applicant is in receipt of an opinion on flexibility, relating to 3 no. options of Turbines. This opinion from the Local Authority confirmed that it was ‘appropriate that the proposed application be made and decided before the prospective applicant has confirmed certain details of the application’.

The differences in the three Technology Options are listed in **Chapter 1 – Introduction, Table 1-3**. This Chapter assesses the potential effects of Shadow Flicker on sensitive receptors for each of the three Technology Options, together with a conclusion of the significance of effect for each option.

15.4 Baseline Environment

15.4.1 Study Area

Taking the above into consideration, maps were examined to identify sensitive receptors within a study area, a distance ten times the maximum proposed rotor diameter of the proposed turbines ($10 \times 138\text{m} = 1,380\text{m}$). A rotor diameter of 138m, which is the maximum of the proposed Technology Options, was used to calculate this distance which was then rounded up to 2km to allow for a robust assessment. The receptors within the shadow flicker study area were identified using a combination of Ordnance Survey of Ireland (OSI) Maps, Geographic Information System (GIS) mapping including open source internet mapping resources including Eircode Finder, Google Street View, Google Earth, Bing Maps, a planning permission search using the Local Authority web resource and a visit to the Study Area to complete an on the ground true-up of the desktop mapping. There are 219 sensitive receptors within the 2km shadow flicker study area. The coordinates of each receptor and its distance to the closest proposed turbine are listed in **Appendix 15.1 – List of Sensitive Receptors Assessed** and are shown in **Figure 15-3**.

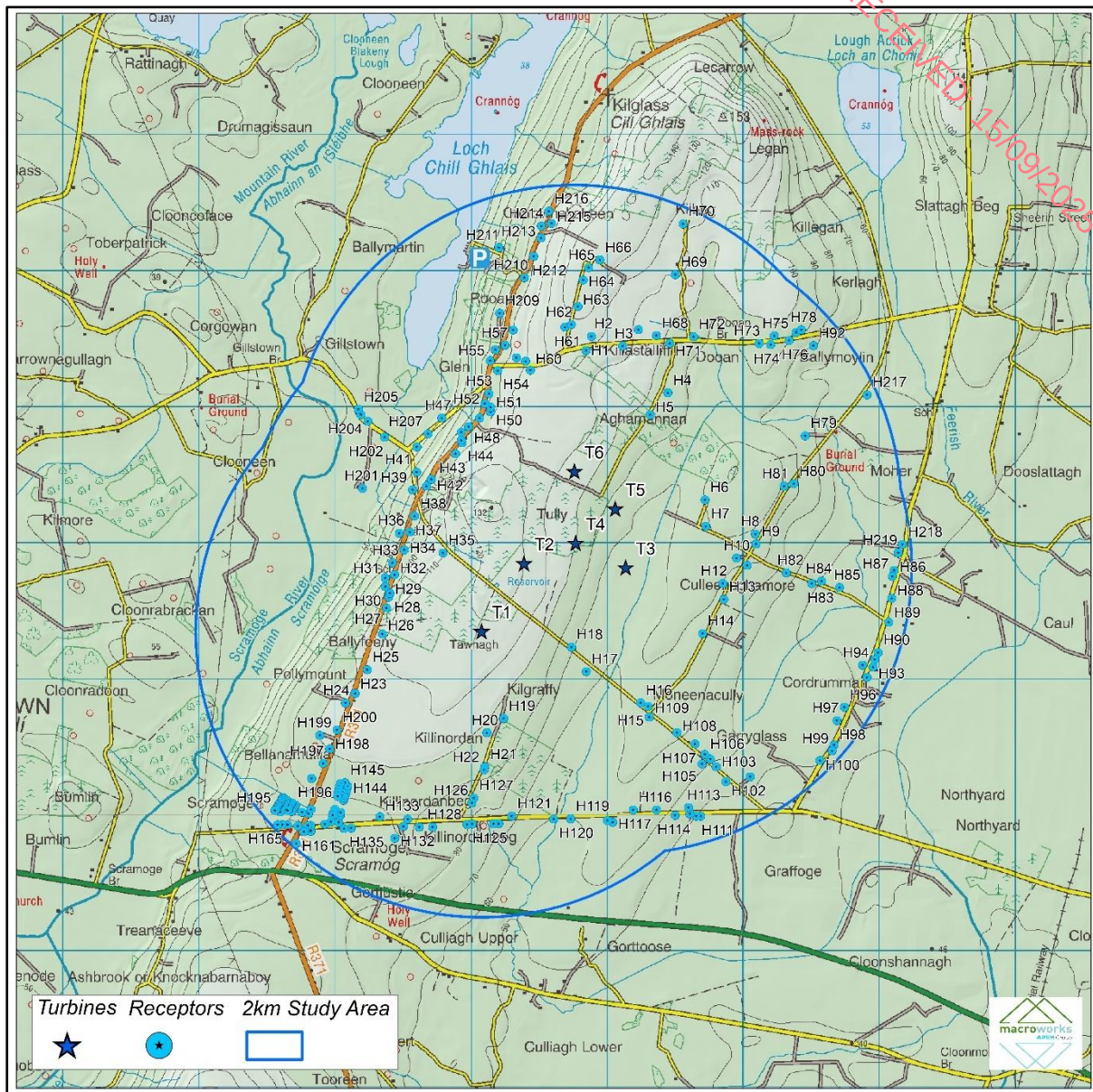


Figure 15-3: Map indicating locations of Receptors relation to the Proposed Turbines (Ref: EIAR Figure 15-3 (Volume 4))

15.5 Embedded Mitigation

Through the development of the proposed Project, measures have been adopted as part of the evolution of the design to avoid or reduce adverse effects on the environment. These measures are referred to as 'embedded mitigation' and are effectively built into the impact assessment. Embedded mitigation relevant to Shadow Flicker is set out below. Where additional mitigation measures are proposed, these are detailed after the assessment of effects (Section 15.6).

The process of site selection and the consideration of alternatives (**Chapter 3 - Consideration of Reasonable Alternatives**) has considered alternative locations, designs and processes for the proposed Project.

The process included a multi staged assessment which was guided by the 'Methodology for Local Authority Renewable Energy Strategies' Report from the SEAI (SEAI, 2013) and which included the consideration of environmental effects.

During the turbine layout optimisation key consideration was given to the layout of the turbines in order to minimise the potential for shadow flicker. However, this on its own cannot eliminate shadow flicker and as such further mitigation measures are needed in order to eliminate shadow flicker at dwellings or other potentially affected properties.

Overall, the site selection process for the proposed wind farm Site was therefore considered a key driver for mitigation by avoidance.

15.6 Assessment of Effects

15.6.1 Do Nothing Scenario

In the do-nothing scenario, the proposed Project would not be constructed. Therefore, no shadow flicker effects would occur.

If the proposed Project were not to proceed, the opportunity to capture part of Roscommon's valuable renewable energy resource would be lost, as would the opportunity to contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions". The RCDP 2022-2028, supports the concept of generating renewable energy at 'local' level and the significant contribution that wind energy can make as a clean sustainable solution to energy requirements.

15.6.2 Construction Phase

As outlined in **Section 15.1.2**, the effects from shadow flicker can only occur under certain specific combined circumstances, such as when;

- the sun is shining;
- the turbine is directly between the sun and the affected property; and
- there is enough wind energy to ensure that the turbine blades are moving.

If any of the above circumstances are not present shadow flicker cannot occur.

During the construction phase the turbine blades will not be moving. As such the shadow flicker effect is only linked to the operational phase of the proposed wind farm and has been excluded from the construction phase. Thus, there will be no shadow flicker effects during the construction phase of the proposed Project.

15.6.3 Operational Phase

The below sections outline the results of the shadow flicker analyses for each of the proposed Technology Options, discussing the results of both the worst-case and expected scenarios for each. The results of these analyses are outlined in full in **Appendix 15.2 – Shadow Flicker Assessment**, which includes a predicted shadow flicker contour map for both the worst-case and expected scenarios.

This assessment considers the potential shadow flicker impact of the proposed Project on all surrounding receptors in terms of:

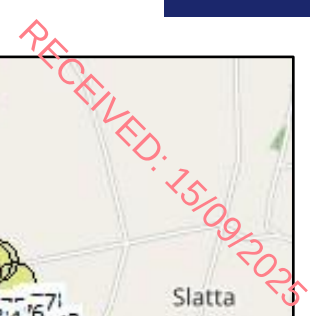
- Predicting and assessing the extent of shadow flicker experienced by all receptors within the shadow flicker study area; and
- Specifying mitigation measures, where deemed necessary.

Worst-case Scenario

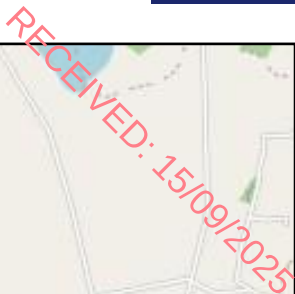
The calculated worst-case shadow flicker occurrences as outlined in **Appendix 15.2 – Shadow Flicker Assessment** assumes that the sun is always shining, there is never any cloud cover, and the dwelling is always occupied. **Figure 15-2** displays the potential shadow flicker coverage for Technology Option 3 (largest rotor diameter option). This provides a visual representation of the worst-case predicted shadow impacts. This indicates that receptors to the east and west of the site are more likely to be affected than those to the north and south. As previously stated, this calculation is based on topography alone and excludes features on the earth's surface such as vegetation, buildings and other man-made structures. In reality, considering the mature forestry and site topography, there is likely to be considerable screening afforded by these features, acting as a buffer between the turbines and receptors. Additionally, the worse-case scenario does not account for durations throughout the year when the turbine blades will not be rotating, due to weather conditions or maintenance works, or when the rotor is facing away from the receptor. As such, the worst-case scenario figures are often considerably higher than the real-world outcomes and, thus, should be considered as theoretical. The worst-case scenario models the information without considering embedded mitigations, such as automatic shadow detection systems.

The results in **Appendix 15.2 – Shadow Flicker Assessment** indicate that there was no considerable difference between the three technology options assessed in terms of potential shadow flicker in the worst-case scenario. Of the 219 receptors assessed, 78 could potentially experience an impact from shadow flicker as a result of the proposed Project, if Technology Option 1 or Technology Option 2 are chosen. Technology Option 3 saw a marginally lower number of potentially effected receptors at 77. Of those 78 receptors potentially effected by Technology Option 1 and Technology Option 2, 49 have the potential to exceed the WEDG 2006 of 30 hours per year or 30 minutes per day. Technology Option 3 saw 51 receptors which could potentially exceed these figures. Receptor 35 saw the greatest potential for theoretical shadow flicker exposure at a maximum of 154:16 hours throughout the year and a maximum of 1:14 hours a day (Technology Option 3). As previously stated, receptor 35 pertains to a landowner involved in the proposed Project. While there are subtle differences in the output figures for the three Technology Options, there is no tangible difference between the significance of effect experienced at the sensitive receptors assessed. It is considered that, in the worst-case scenario for each of the three Technology Options, the shadow flicker effects at each receptor which exceeds the WEDG 2006 (a maximum of 51) is considered of short duration on any exposure but of **Long Term**, **Adverse** and **Significant**. This is considered **Significant** in EIA terms.

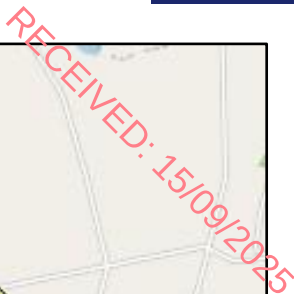
For the receptors that showed potential to experience shadow flicker and did not exceed the WEDG 2006 (a maximum of 26), the effects are considered **Long Term**, **Adverse** and **Not Significant**. This is considered **Not Significant** in EIA terms.



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Real-case Scenario

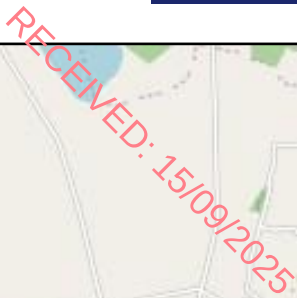
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occurrence and, thus, allow the determination of 'projected' values for shadow flicker occurrence.

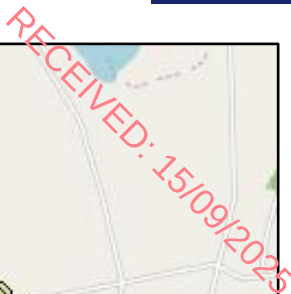
The worst-case predicted hours for shadow flicker are reduced by the average time the weather is cloudy annually. To estimate the impact of sunshine occurrence, historical meteorological data are utilised to consider the likelihood of sunshine (the sunshine probability) at different times of the year. This allows the determination of 'expected' values for shadow flicker occurrence. This is achieved by applying a reductive factor to the worst-case total hours per year of shadow flicker. **Figure 15-7** provides a visual representation of the expected or 'real-case' predicted shadow impacts using Technology Option 3 (largest rotor diameter). This indicates that receptors to the east and west of the proposed Project are most likely to be affected by shadow flicker.

The results in **Appendix 15.2** indicate that there was no considerable difference between the three Technology Options assessed in terms of potential shadow flicker in the real-case scenario. As is the case with the worst-case scenario, 78 receptors can potentially experience an impact from shadow flicker with Technology Option 1 and Technology Option 2, whereas 77 receptors can be impacted with Technology Option 3.

None of the identified receptors had potential to exceed the WEDG 2006 guidelines. Receptor 35 saw a maximum of 22:46 hours of shadow flicker throughout the year (Technology Option 3). While there are subtle differences in the output figures for the three Technology Options, there is no tangible difference between the significance of effect experienced at the sensitive receptors assessed. It is considered that, in the real-case scenario for each of the three Technology Options, the shadow flicker effects at each receptor is considered **Long Term**, **Adverse** but are below the exposure threshold acceptable under the WEDG 2006 guidelines for all receptors and therefore **Not Significant**. This is considered **Not Significant** in EIA terms.



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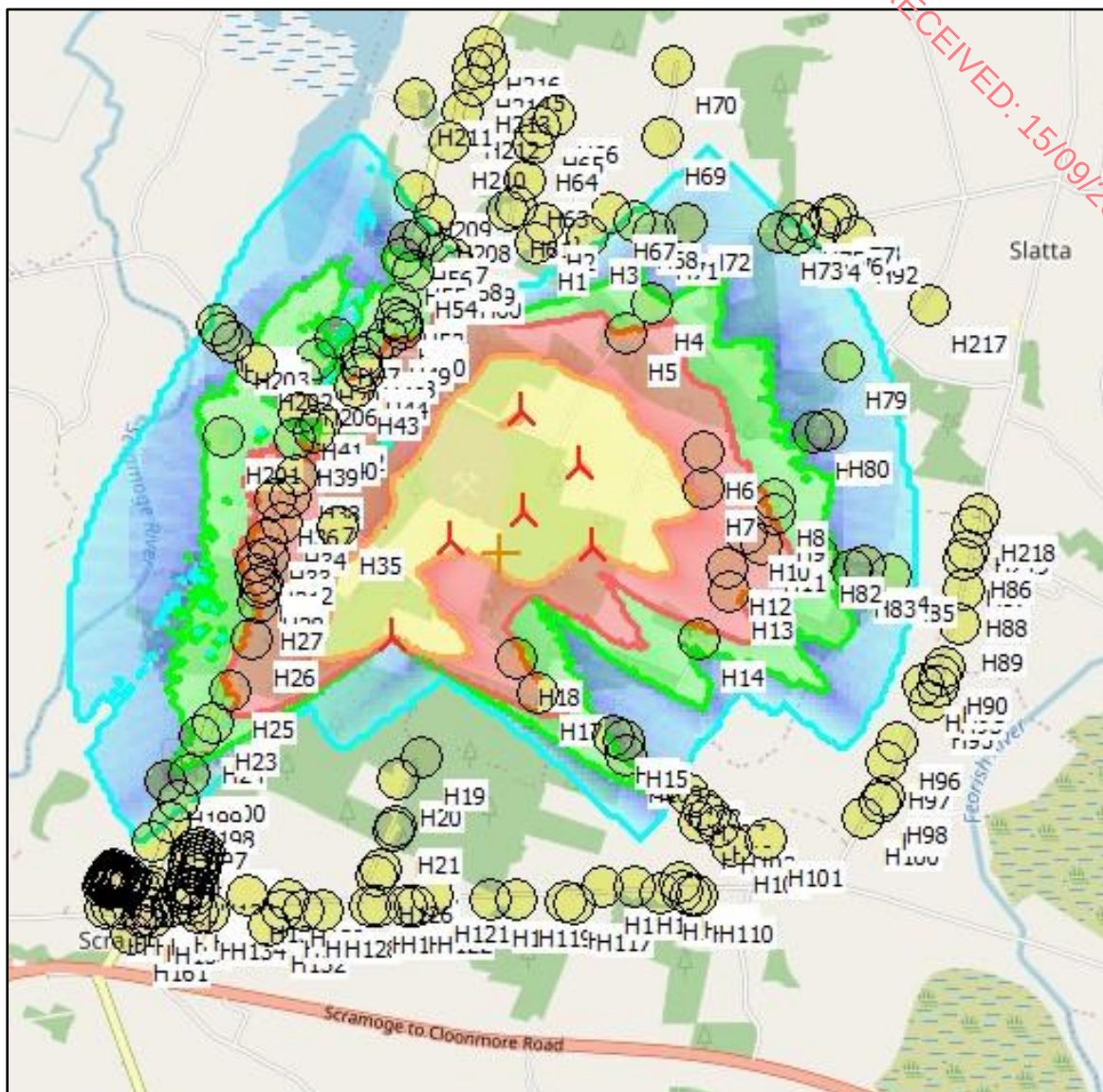


Figure 15-9: Extract from Appendix 15.2 outlining shadow flicker potential in the expected-shadow scenario (Technology Option 3).

15.6.4 Decommissioning Phase

As outlined in **Section 15.1.2**, the effects from shadow flicker can only occur under certain specific combined circumstances, such as when;

- the sun is shining;
- the turbine is directly between the sun and the affected property; and
- there is enough wind energy to ensure that the turbine blades are moving.

If any of the above circumstances are not present shadow flicker cannot occur.

During the decommissioning phase the turbine blades will not be moving. As such the shadow flicker effect is only linked to the operational phase of the proposed wind farm and has been excluded from the decommissioning phase. Thus, there will be no shadow flicker effects during the decommissioning phase of the proposed Project.

15.7 Mitigation Measures

As outlined in **Section 15.3**, unless otherwise required by a condition planning, the Applicant, having due regard to the Draft WEDG 2019 and in accordance with best industry practice, has committed to eliminate adverse shadow flicker at dwellings or other potentially affected properties. As outlined in **Section 15.2**, it is proposed that, for each of the three Technology Options, each turbine is fitted with an automatic shadow detection system during turbine manufacturing. This is an embedded mitigation measure that will see that the turbines shut down during periods where shadow flicker is predicted at any of the identified receptors, until the potential for shadow flicker ceases. Such systems are common in many wind farm developments, and the technology has been well established. A case study in Scotland found that the use of turbine shut-down control modules for turbines which were causing shadow flicker at nearby offices was successful (Brinckerhoff, 2022). These mitigation measures have been proposed with due regard to the Draft WEDG 2019 in accordance with best industry practice.

The control system will calculate, in real-time:

- Whether shadow flicker has the potential to effect nearby receptors, based on pre-programmed co-ordinates for the receptors and turbines;
- Wind speed, which can affect how fast the turbine will turn and how quickly the flicker will occur;
- Wind direction; and
- The intensity of the sunlight.

When the control system detects that the sunlight is strong enough to cast a shadow, and the shadow falls on a receptor, then the turbine will automatically shut down and will restart when the potential for shadow flicker ceases at the affected receptors. It is recognised that there may be a short period for complete curtailment to occur depending on the rotor speed once the pause criteria are met.

The measures outlined above, subject to a short period once the pause criterion is met and for the turbine (s) to come to a stop, will eliminate the potential for shadow flicker to effect any of the receptors within the study area. In the event that complaints of shadow flicker are

received by the Developer / Site Operator or by the Local Authority, an investigation will take place and the complaints frequency, duration and time of complaints will be considered and specialist modelling software will be used to confirm the occurrence(s). Should the complaint persist, a shadow flicker survey involving the collection of light data will also be carried out at the receptor in which the complaint was made. Further refinement of the blade shadow control system will be conducted to eliminate the shadow flicker occurrence. This may result in the shutting off turbines at specific times of day.

15.8 Residual Effects

As outlined in **Section 15.7**, it is proposed that, for the Technology Option that is selected prior to construction, each turbine will be fitted with an automatic shadow detection system during turbine manufacturing which will then shut down the turbine during periods where shadow flicker is predicted at any of the identified receptors, until the potential for shadow flicker ceases. Upon implementation of the proposed mitigation measures, it is assessed that there would be no significant residual adverse shadow flicker effects as a result of the proposed Project. The proposed Project would align with the Draft WEDG 2019, in accordance with best industry practice and would be well below the WEDG 2006 thresholds. Thus, residual shadow flicker effects are considered to be **Imperceptible** and **Not Significant**. In EIA terms, the effect is considered as **Not Significant**.

15.9 Unplanned Events

This section considers the vulnerability of the proposed Project to major accidents and/or disasters, the risk of those major accidents and/or disasters occurring and the potential for any significant adverse effects arising from shadow flicker.

According to EPA Guidelines, these unplanned events can include ‘spill from traffic accidents, floods or landslides affecting the site, fire, collapse or equipment failure on site’. Additionally, the EIA Directive requires “major accidents, and/or natural disasters (such as flooding, sea level rise or earthquakes)” be addressed.

The *Environmental Impact Assessment of Projects: Guidance on the preparation of the Environmental Impact Assessment Report* (European Commission, 2017) requires the consideration of major hazards in the context of the SEVESO III Directive. It is noted that the proposed Project will not come under the Control of Major Accident Hazards (COMAH) Regulations and the closest COMAH establishment is c. 37km west of the development.

There are no unplanned events associated with the construction, operation or decommissioning of the proposed Project, that would result in significant effects on Shadow Flicker. Therefore, the significance of effects on Shadow Flicker in relation to unplanned events associated with all phases of the Project are deemed to be **Not Significant** in EIA terms.

15.10 Cumulative Effects

Cumulative shadow flicker impacts may arise in instances where sensitive receptors are at risk from potential shadow flicker impacts as a result of more than one wind farm. While separate wind farms are not likely to cause effects simultaneously, they could increase the cumulative total hours where a receptor is has the potential for impacts.

In this Instance, there are no consented nor constructed wind farms within a 2km range of the proposed Project. On the basis of shadow flicker being deemed unlikely at distances over 10 rotor diameters (1,380m for Technology Option 3) from a receptor, it is considered that there is no potential for cumulative shadow flicker effects resulting from the proposed Project. The nearest operational wind farm is Sliabh Bawn Wind Farm, whose nearest turbine is located approximately 4km from the nearest proposed turbine (T01). Therefore, the significance of effects on Shadow Flicker in relation to cumulative effects associated with the proposed Project are deemed to be **Not Significant**. In EIA terms, the effect is considered as **Not Significant**.

15.11 Inter – Related Effects

The topics addressed in this EIAR do not exist separately from one another, and therefore, any effect on a specific element of the environment has the potential to impact another. The interactions between effects on various factors throughout the EIAR, and in further detail within **Chapter 17 – Interrelated Effects**. Where any potential adverse effect has been identified during the assessment of effects, mitigation has been proposed to reduce the impact

Chapter 17 Interrelated Effects addresses any interactions between shadow flicker effects on different environmental aspects. Potential interactions Shadow flicker and Population and Human Health were identified. However, the Chapter concluded that no inter-related effects will be produced as a result of the proposed Project that are of a greater significance to those already identified in the respective Chapters.

15.12 Summary of Effects

This assessment examined the potential for likely significant shadow flicker effects, including for the three Technology Options, for the proposed Project. When the proposed mitigation measures outlined in **Section 15.7**, including the implementation of an automatic shadow detection system, has been implemented, the proposed Project would align with the Draft WEDG 2019 and would be well below the WEDG 2006 thresholds.

There will not be any discernible effects from shadow flicker during the construction or decommissioning phases. The developer has committed to eliminating operational effects by the inclusion of mitigation in due regard for the 2019 Draft WEDG.

Thus, residual shadow flicker effects are considered to be **Imperceptible**. In EIA terms, the effect is considered as **Not Significant**.

15.13 References

- Brinckerhoff, P. (2022). 'Update of UK Shadow Flicker Evidence Base' for Department of Energy and Climate Change, United Kingdom. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/48052/1416-update-uk-shadow-flicker-evidence-base.pdf [Access 12 June 2025]
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