

15 SHADOW FLICKER

15.1 INTRODUCTION

This chapter assesses the likely significant direct and indirect effects of the Project in terms of shadow flicker. The Project refers to all elements of the application for the construction of Derreenacrinnig West Wind Farm as detailed in **Chapter 2: Project Description**. Where negative effects are predicted, the chapter identifies appropriate mitigation strategies therein. The assessment considers the potential effects during the Operational phase of the Project.

Shadow flicker will not occur during the construction or Decommissioning phase of the Project. Shadow flicker is an effect caused by the sun shining behind the rotating blades of a turbine relative to a nearby sensitive receptor which causes a momentary shadow on a window of that sensitive receptor. This shadow can appear as a flickering of sun light due to the rotating blades. Therefore, shadow flicker will only occur during the operational phase of the Project.

Common acronyms used throughout this EIAR can be found in **Appendix 1.4**. This chapter of the EIAR is supported by Figures and by the following Appendix documents provided in **Volume III** of this EIAR:

- **Appendix 15.1 Shadow Flicker Analyses**

15.1.1 Statement of Authority

This chapter has been prepared by Ms. Kathlyn Feeney and Ms. Breena Coyle of JOD.

Kathlyn Feeney is an Environmental Scientist, who holds a Bachelor (Hons) Degree in Environmental Science from the Atlantic Technological University, Sligo. She forms part of the Environmental team responsible for preparing the EIAR Chapters. Kathlyn has experience writing EIARs, Feasibility Studies and Shadow Flicker analysis.

Breena Coyle is a Senior Town Planner in Jennings O'Donovan & Partners Limited (JOD). She has a Masters in Environment Planning from Queens University and has over 13 years' experience in Environmental Planning throughout Ireland and the UK. She has a clear understanding of the legislative framework and has experience in the development of windfarms from the pre-planning process through to construction.

This chapter has been reviewed by Mr. David Kiely who is Managing Director of JOD. He holds a BE in Civil Engineering from University College Dublin and MSc in Environmental Protection from IT Sligo. He is a Fellow of Engineers Ireland, a Chartered Member of the Institution of Civil Engineers (UK) and has over 40 years' experience. He has extensive experience in the preparation of EIARs and EISs for environmental projects including Wind Farms, Solar Farms, Wastewater Projects, and various commercial developments. David has also been involved in the construction of over 60 wind farms since 1997.

15.1.2 Assessment Structure

In line with the relevant legislation and guidelines identified in **Chapter 1, Section 1.6** and the topic-specific guidance described below, the structure of this shadow flicker chapter is as follows:

- Assessment methodology and significance criteria
- Description of baseline conditions at the Site including the likely evolution of the Baseline
- Limitations of the assessment
- Identification and assessment of effects of shadow flicker associated with the Proposed Development, during the construction, operational and Decommissioning phases of the Proposed Development
- Mitigation measures to avoid or reduce the effects identified
- Identification and assessment of residual impact of the Proposed Development considering mitigation measures
- Identification and assessment of cumulative effects if and where applicable

The information presented in this chapter and the appendices is considered appropriate to allow CCC to carry out an adequate assessment of the Project.

15.2 SHADOW FLICKER

This chapter comprehensively assesses the potential shadow flicker effects of the operational stage of the Project. No shadow flicker will occur during the construction or Decommissioning phases. The Grid Connection and TDR are not included in this assessment as shadow flicker relates to the turbines only.

15.2.1 Assessment Methodology

This assessment of shadow flicker involved the following:

- Evaluation of potential effects (see **Section 15.2.6**) includes predicting the shadow flicker effects on the sensitive receptors within the Study Area of the two candidate models and comparing them against the 2006 Guidelines.

- Comparison of results against the Draft 2019 Guidelines;
- Evaluation of the significance of effects using the methodology set out in **Chapter 1: Introduction, Section 1.11.3**
- Identification of measures to avoid and mitigate potential effects

The Study Area is defined as 10 times the widest possible potential rotor diameter within the range (10 x 82 m = 820m). It is common practice to use a distance of ten rotor diameters as a maximum limit within which significant shadow flicker effects can occur, this is based on 2006 Guidelines which state: '*At distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low*'. As a precautionary measure, this was increased to 1,500m (1.5km).

A shadow flicker computer model (WindPRO 4.0) was used to calculate the occurrence of shadow flicker at relevant receptors to the Project. The sensitive receptors were identified using a combination of Ordnance Survey of Ireland (OSI) Maps, AutoCAD drawings and from internet mapping resources including Eircode Finder, Google Street View, Google Earth, Bing Maps and a planning permission search using the CCC web resource. A ground truth survey of all online sources was undertaken with a visit to the Study Area. The desktop sensitive receptor search was originally completed in April 2025 with regular rechecks completed to ensure no new receptors are identified within the Study Area. The output from the calculations is analysed to identify and assess potential shadow flicker effects. Wind turbines, like other tall structures, can cast long shadows when the sun is low in the sky. A minimum separation distance of 500m from all occupied sensitive receptors has been incorporated into the Project design, in line with the 2019 Guidelines. There are 21 No. receptors within 1.5km of any proposed wind turbine location. The closest house to a turbine that is to be assessed as part of this EIAR, is H1. This is located 983m from T3.

The 2019 Draft Revised Wind Energy Guidelines confirms 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."

The turbine for this Wind Farm which was assessed in this Chapter is outlined below:

Enercon E82	
Hub Height	78.3 m
Rotor Diameter	82 m
Tip Height	119.3 m

Cumulative effects were also assessed in **Section 15.2.8**.

Where negative effects are predicted, this section identifies appropriate mitigation strategies.

A shadow flicker computer model was used to calculate the occurrence of shadow flicker at relevant receptors to the Project. The output from the calculations is analysed to identify and assess potential shadow flicker effects. This is further detailed in **Appendix 15.1**.

The 2006 Guidelines state that shadow flicker lasts only for a short period and happens only in certain specific combined circumstances. The circumstances required for shadow flicker to occur are:

- the sun is shining and at a low angle in the sky; and
- the turbine is directly between the sun and the affected sensitive receptor; and
- there is enough wind energy to ensure that the turbine blades are moving; and
- the turbine blades are positioned so as to cast a shadow on the receptor.

If any one of these conditions is absent, shadow flicker cannot occur.

15.2.2 Relevant Guidance

The relevant Irish guidance for shadow flicker is derived from the 'WEDG' (Department of the Environment, Heritage and Local Government (DoEHLG), 2006) the '*Best Practice Guidelines for the Irish Wind Energy Industry*' (IWEA, 2012), and the Draft Revised WEDG (Department of Housing, Local Government and Heritage, 2019).

The DoE, Community and Local Government in its WEDG (2006) (the 2006 Guidelines) 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 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”.

The 2006 Guidelines state that shadow flicker lasts only for a short period of time and occurs only during certain specific combined circumstances, as follows:

- the sun is shining and is at a low angle in the sky, i.e., just after dawn and before sunset;
- the turbine is located directly between the sun and the affected sensitive receptor;
- there is enough wind energy to ensure that the turbine blades are moving; and
- the sun and the turbine blades are aligned so as to cast a shadow on the receptor.

Although the DoEHLG thresholds apply to dwellings located within 500 m 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 (i.e., 820 m) of the proposed turbines within the Site (as per IWEA guidelines, 2012¹). This was then increased to 1.5km for completeness. The 2006 Guidelines state that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

The 2006 Guidelines are currently under review. The Department of Housing, Local Government and Heritage released the ‘Draft Revised WEDG’ in December 2019. The Draft Revised WEDG (2019) provides for zero shadow flicker:

“Computational models can be used to accurately predict the strength and duration of potential shadow flicker during daylight hours for every day of the year. A Shadow Flicker Study detailing the outcome of computational modelling for the potential for shadow flicker from the development should accompany all planning applications for wind energy development.

If a suitable shadow flicker prediction model indicates that there is potential for shadow flicker to occur at any particular dwelling or other potentially affected property, then a review of site design involving the possible relocation of one or more turbines to explore the possibility of eliminating the occurrence of potential flicker is required. Following such a review, if shadow flicker is not eliminated for any dwelling or other potentially affected

¹ IWEA, 2012. *Best Practice Guidelines for the Irish Wind Energy Industry*, Cork: Wind Skillnet. [Available online: <https://windenergyireland.com/images/files/9660bdfb5a4f1d276f41ae9ab54e991bb600b7.pdf>]

property then clearly specified measures which provide for automated turbine shut down to eliminate shadow flicker should be required as a condition of a grant of permission.”

The Draft 2019 Guidelines are based on the recommendations set out in the ‘Proposed Revisions to WEDG 2006 – Targeted Review in relation to Noise, Proximity and Shadow Flicker’ (December 2013) and the ‘Review of the WEDG 2006 – Preferred Draft Approach’ (June 2017).

The 2019 Draft Revised WEDG confirms 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.”

The 2019 Draft Revised WEDG ² also added the circumstance where:

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

Shadow flicker may have the potential to cause disturbance and annoyance to residents if it affects occupied rooms of a house. Persons with photosensitive epilepsy can be sensitive to flickering light between 3 and 60 Hz. This is supported by research in recent years asserting that flicker from turbines must interrupt or reflect sunlight at frequencies greater than 3 Hz to pose a potential risk of inducing photosensitive seizures³. The frequencies of flicker caused by modern wind turbines are less than 1 Hz and are well below the frequencies known to trigger effects in these individuals. Therefore, any potential shadow flicker effect from the Project is considered an effect on residential amenity, rather than having the potential to affect the health of residents.

Careful site selection, design and planning, and good use of relevant software to control the turbine operation can help reduce the possibility of shadow flicker. Modern wind turbines

² DHPLG, 2019. *Draft Revised WEDG*, Dublin. Government of Ireland. [Available Online: <https://assets.gov.ie/46097/6e68ea81b8084ac5b7f9343d04f0b0ef.pdf>]

³ Harding, Graham & Harding, Pamela & Wilkins, Arnold. (2008). Wind turbines, flicker, and photosensitive epilepsy: Characterizing the flashing that may precipitate seizures and optimizing guidelines to prevent them. *Epilepsia*. 49. 1095-8. 10.1111/j.1528-1167.2008.01563.x.

have the facility to measure sunlight levels and to reduce or stop turbine rotation if the conditions exist that would lead to any shadow flicker at neighbouring sensitive receptors.

The distance and direction between the turbine and sensitive receptor is of significance because:

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

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 is changing such that the shadow cast by a turbine is constantly changing. Shadow flicker is more likely to occur on sunny winter days when the sun is lower in the sky and shadows cast a greater distance from the turbine. Shadow flicker is more likely to occur to the east or west of the Site. This can be seen in **Appendix 15.1**.

The assessment herein is based on compliance with the current 2006 Guidelines limit (30 hours per year or 30 minutes per day). However, it should also be noted the Proposed Development can be brought in line with the requirements of the 2019 draft guidelines, should they be adopted while this application is in the planning system, through the implementation of the mitigation measures outlined in **Section 15.2.9**, which allows for elimination of shadow flicker to affect an existing sensitive receptor.

15.2.3 Shadow Flicker Modelling

An industry standard wind farm assessment software package, WindPRO from EMD International Version 4.0 was used to prepare a model of the Project. The programme facilitates the analysis of a wind farm for possible shadow flicker occurrence at nearby houses. It allows for the production of maps, and shadow flicker prediction. The data output from the programme has been analysed and the receptors potentially vulnerable to shadow flicker were identified. The significance of shadow flicker effects was assessed.

Generic windows of 2 m width, 2 m height and 0.5 m from bottom line above ground are applied in the model to each side of the house. 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 Wind Farm:

- Digital elevation model of the Proposed Development and areas around all sensitive receptors within the model (10m resolution – OS X, Y, and Z data points)
- Turbine locations
- Turbine dimensions (rotor diameter and hub height)
- Receptor locations
- Bottom line height above ground 'window' (0.5m AGL)
- 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 Project and its surroundings and uses this information to calculate specific theoretical times and durations of flicker effects for the identified sensitive 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 maintenance works, break downs, wind speeds below the turbine threshold or curtailment
- there is no intervening structures or vegetation (other than topography) that may restrict the visibility of a turbine, preventing or reducing the effect
- 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 sensitive 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 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”. In this scenario, the only change in assumptions is that the statistically likely monthly sunshine frequency and wind direction frequency data is 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 was the:

- Long-term sunshine probability data from the Met Éireann synoptic station in Valentia, Co. Cork; and
- Long-term wind rose data from the SEAI Wind Mapping System (ITM co-ordinates 514000E, 56000N)

15.2.4 Baseline Description & Likely Evolution of the Baseline

The Site is located in a rural setting within an agricultural and forested landscape. Housing density in the area is low to medium. Should the Proposed Development not proceed, the surrounding areas will remain the same and receptors will not experience any shadow flicker effects associated with the Project. Shadow flicker is directly associated with the operation of turbines.

Taking the above into consideration, JOD examined maps to identify sensitive receptors in the local area within a Study Area, a distance ten times the proposed rotor diameter of the proposed turbines (10 x 82 m = 820 m), which was increased to 1.5km for completeness. There are 21 receptors within the shadow flicker Study Area radius. The coordinates of each sensitive receptor and its distance to the closest proposed turbine are listed in **Table 15.1**.

Table 15.1: Sensitive receptors within the shadow flicker study area

House ID	Easting ITM	Northing ITM	Closest Turbine	Closest Distance to Turbine (m)
H1	511995	553023	T3	983
H2	510767	550866	T1	994
H3	511608	553060	T3	1039
H4	510962	550767	T1	1083
H5	510807	550763	T1	1091
H6	511001	550749	T1	1103

House ID	Easting ITM	Northing ITM	Closest Turbine	Closest Distance to Turbine (m)
H7	510756	550731	T1	1129
H8	510943	550719	T1	1130
H9	511031	553032	T2	1164
H10	511293	550692	T1	1217
H11	510707	553049	T1	1218
H12	511892	553350	T3	1301
H13	509928	552697	T1	1301
H14	510958	553161	T2	1310
H15	509876	552698	T1	1342
H16	509742	552619	T1	1403
H17	509670	552559	T1	1433
H18	509695	552618	T1	1442
H19	512328	550677	T3	1453
H20	511801	553526	T3	1477
H21	512392	550659	T3	1492

15.2.5 Limitations of the Assessment

As previously stated, this calculation is based on topography alone and excludes vegetation, buildings and other man-made structures. These factors cannot be accurately predicted due to the changeable nature of these variables.

15.2.6 Assessment of Potential Effects

This assessment considers the potential shadow flicker effect of the Proposed Development on the surrounding sensitive receptors in terms of:

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

The maximum expected daily shadow flicker for each receptor is outlined in the table below. This is the highest amount expected across the whole year on any given day. All other days will experience no more than this amount of shadow flicker, pre-mitigation.

There are no wind farms within 2 km of the Project to be considered with the Project for cumulative effects. The IWEA Guidelines recommend that all existing and / or permitted

wind farm developments within 2 km of a proposed development should be considered in a cumulative shadow flicker assessment.

Table 15.2: Summary of Potential Shadow Flicker Listing for All Sensitive Receptors

Receptor ID	Enercon E82		
	Worst Case Shadow [h/year]	Expected Shadow [h/year]	Max. Expected Shadow [h/day]
H1	21:41	02:15	00:27
H2	00:00	00:00	00:00
H3	30:51:00	02:53	00:52
H4	00:00	00:00	00:00
H5	00:00	00:00	00:00
H6	00:00	00:00	00:00
H7	00:00	00:00	00:00
H8	00:00	00:00	00:00
H9	00:00	00:00	00:00
H10	00:00	00:00	00:00
H11	12:51	01:08	00:16
H12	02:05	00:11	00:09
H13	04:00	00:27	00:15
H14	11:43	01:00	00:16
H15	03:48	00:26	00:15
H16	03:18	00:22	00:14
H17	03:04	00:22	00:13
H18	02:58	00:20	00:13

Receptor ID	Enercon E82		
	Worst Case Shadow [h/year]	Expected Shadow [h/year]	Max. Expected Shadow [h/day]
H19	00:00	00:00	00:00
H20	00:00	00:00	00:00
H21	00:00	00:00	00:00

It can be demonstrated from **Table 15.2**, there will be 10 receptors out of 21 that will experience some degree of shadow flicker and 11 receptors that will experience no shadow flicker. H3 is expected to experience 2 hours 53 minutes of shadow flicker in a year, which is the worst affected occupied receptor. One sensitive receptor, H3, exceeded the 2006 Guidelines of a maximum 30 minutes of shadow flicker per day. The closest receptor, H1, is within 983m of the closest turbine (T3). This receptor has 2 hours 15 minutes of expected shadow flicker per year, and a maximum of 27 minutes of shadow flicker per day.

None of the receptors are expected to exceed the 2006 Wind Energy Guidelines recommended threshold of 30 hours or more of shadow flicker per year.

The calculated worst-case shadow flicker occurrences in the **Table 15.2** assumes the sun is always shining, that there is no cloud cover, the turbines are rotating and the sensitive receptor is always occupied. As previously stated, this calculation is based on topography alone and excludes vegetation, buildings and other man-made structures. As can be seen in the shadow flicker assessment attached as **Appendix 15.1** all of the proposed turbines give rise to some degree of cumulative shadow flicker, if unmitigated.

15.2.7 Assessment of Expected Shadow Flicker Impact

In order to calculate more realistic and '*real world*' occurrences of shadow flicker for the receptors that are identified as potentially vulnerable to shadow flicker (**Table 15.2**), it is necessary to identify the likely met conditions which are expected to be experienced at the Site. To estimate the likely duration of sunshine occurrence at the Site, historical met data from Met Éireann is automatically uploaded by the software. Data from Valentia Weather Station was used as this Met Éireann observatory is the closest to the Site and also measures multiple environmental parameters (**Table 15.3**). This gives a good representation of data for the Project. This data was utilised to consider the probability of sunshine occurrence, and thus allow the determination of '*projected*' values for shadow flicker occurrence.

Table 15.3. Average daily sunshine hours from Valentia Weather Station

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.30	2.04	2.89	4.92	5.79	4.99	4.32	4.35	3.60	2.54	1.64	1.06

The worst-case predicted hours for shadow flicker are reduced by the average time the weather is cloudy annually. As discussed above; to estimate the impact of sunshine occurrence, historical met data is 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. 'Long term average sunshine hours' refers to data collected by Met Éireann.

Table 15.2 shows the potential and the expected shadow flicker values per year which are likely to be experienced by each receptor. '*Potential sunshine hours*' refers to the intervening time period between modelled sunrise and sunset. Although the projected duration of shadow flicker is reduced substantially for each sensitive receptor, they are not eliminated entirely for all of the 21 receptors within the shadow flicker Study Area of the Project.

The expected daily shadow flicker cannot be predicted as this depends on multiple variable factors such as wind direction, wind speed, cloud cover and sunshine. These factors cannot be accurately predicted to give an expected minutes of shadow flicker per day. The maximum scenario in this assessment is based on the average sunshine and average wind direction for the Site.

The Draft Revised WEDG, December 2019, recommend that shadow flicker should not affect any sensitive receptor, therefore the relevant turbine (or turbines) must be shut down on a temporary basis until the potential for shadow flicker ceases. The mitigation measures to avoid exceedance of the 2019 Guideline's thresholds is outlined in **Section 15.2.9**.

15.2.8 Cumulative Effects

The IWEA Guidelines recommend that all existing and / or permitted wind farm developments within 2km of a proposed development should be considered in a cumulative shadow flicker assessment, however, the key factor to determine whether cumulative effects may occur is whether receptors are located within the Shadow Flicker Study Area of 10 times the rotor diameter for the Proposed Wind Farm.

Cumulative shadow flicker effects could arise if sensitive receptors are at risk from potential shadow flicker effects 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 affected. In this instance, there are no proposed or operational wind farms within a 2km range of the turbines that may cause cumulative effects.

15.2.9 Mitigation Measures & Residual Effects

15.2.9.1 *Likely Evolution of the Baseline*

The shadow flicker effect is related to the operational phase of a wind farm. If the Project were not to proceed, the effects described in this chapter will not occur.

15.2.9.2 *Construction Phase*

As previously stated, the shadow flicker effect is associated with the operational phase of the wind farm and has been scoped out for the construction phase. During construction there will be no shadow flicker effect and therefore no mitigation is required.

15.2.9.3 *Operational Phase*

Shadow flicker control systems, consisting of light sensors and specialised software, will be installed on each of the wind turbines. The control system will calculate, in real-time:

- Whether shadow flicker has the potential to effect nearby sensitive receptors, based on pre-programmed co-ordinates for the sensitive receptors and turbines;
- Wind speed (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 sensitive receptor or receptors, then the turbine will automatically shut down; and will restart when the potential for shadow flicker ceases at the effected receptors. 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 successful⁴.

The proposed method of mitigation will be used to eliminate all shadow flicker effects resulting in zero shadow flicker, allowing for approximately 60 seconds for the rotor to come to a stop. This will eliminate the potential for shadow flicker to affect any of the sensitive receptors within the Study Area. **Appendix 15.1** contains all calculated potential shadow flicker periods for each turbine. The relevant data will be input into the turbine control software. In the event that complaints of shadow flicker are received by the Developer / site operator or by CCC, the Developer will conduct an investigation and the complaints

⁴ ClimateXChange, 2017. 'Review of Light and Shadow Effects from Wind Turbines in Scotland' [Available at: chrome-extension://efaidnbnmnibpcjpcglclefindmkaj/https://www.climateexchange.org.uk/wp-content/uploads/2023/09/light_and_shadow_effects_from_wind_turbines_in_scotland_stages_1_and_2.pdf]

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 could result in the shutting off turbines at specific times of day.

15.2.9.4 Decommissioning Phase

As previously stated, the shadow flicker effect is associated with the operational phase of the Wind Farm and has been scoped out for the Decommissioning phase. During Decommissioning there will be no shadow flicker effect and therefore no mitigation is required.

15.2.9.5 Residual Effects

The results of the shadow flicker assessment predict that Derreenacrinnig West Wind Farm has the potential to result in shadow flicker at a maximum of 10 receptors surrounding the Wind Farm. The implementation of mitigation to cease operation of the turbines during periods of potential shadow flicker will ensure that no shadow flicker effects are experienced at any sensitive receptor within the Study Area. It is therefore considered that Derreenacrinnig Wind Farm will comply with the recommended limits of 30 hours per year and 30 minutes per day detailed within the WEDG (2006) and has due regard for the zero shadow flicker policy as set out in the Draft Revised WEDG (2019).

Following implementation of mitigation measures described in **Section 15.2.9.3**, the residual impact as a result of shadow flicker will be a neutral, imperceptible, long-term effect. Accordingly, it is considered that there will be no residual impact as a result of shadow flicker.

15.3 SUMMARY OF SIGNIFICANT EFFECTS

This chapter has assessed the significance of potential effects of the Project on shadow flicker.

This assessment has identified the potential for shadow flicker to affect 10 no. out of 21 no. receptors within the shadow flicker Study Area. It is proposed that a shadow control system be installed to eliminate the potential for shadow flicker from the Project. This assessment has identified that by installing a blade shadow control system on the proposed turbines, there will be no significant direct or indirect effects. Given that only effects of significant

impact or greater are considered “significant” in terms of the EIA Directive the potential effects of the Project as a result of shadow flicker, when mitigated, are considered to be not significant. The Project has been assessed as having the potential to result in **negative, imperceptible, long-term effects** overall with regards to shadow flicker. There are no predicted cumulative effects.

15.4 REFERENCES

DHPLG, *Draft Revised WEDG* (2019)

Department of the Environment, Heritage and Local Government, *WEDG* (2006)

IWEA & Wind Skillnet, *Best Practice Guidelines for the Irish Wind Energy Industry* (2012)