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ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED SHANCLOON WIND FARM, CO. GALWAY

VOLUME 2 – MAIN EIAR

CHAPTER 13 – SHADOW FLICKER

Prepared for:
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RWE

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13. SHADOW FLICKER

13.1 Introduction

This chapter assesses potential shadow flicker effects at nearby buildings associated with the operation of Shancloon Wind Farm. The specific objectives of the chapter are to:

- describe the assessment methodology and relevant guidance;
- describe the potential impacts;
- describe the need for any mitigation measures, if required; and
- assess the residual impacts remaining, following the implementation of any mitigation measures.

The Applicant is committed to minimising the potential for shadow flicker to occur at any dwelling within the study area and the shadow flicker assessment described herein will be used to inform the Shadow Flicker Control Measures that will be designed for each turbine.

This chapter presents the results and findings of the assessment of the potential for shadow flicker effects at sensitive receptors within the study area and quantifies the theoretical maximum number of hours per annum where shadow flicker might occur at a property.

13.2 Statement of Authority

This assessment has been undertaken by Mark Tideswell (BSc, Dip, AMIOA) and reviewed by Jim Singleton (BSc, Dip, MIOA), both of TNEI Group.

Mark Tideswell is a Senior Consultant at TNEI, with over ten years' experience in environmental consultancy. He has undertaken numerous shadow flicker assessments in Ireland and the UK and has worked on shadow flicker studies for both pre-construction (feasibility and planning applications) and complaints investigations. He is skilled in shadow flicker prediction and the specification of appropriate mitigation measures.

Jim Singleton is the Team Manager of TNEI's Environment and Engineering Team. He has 17 years environmental consultancy experience and has worked on wind turbine developments ranging from single turbines to over 300 MW developments, and including feasibility studies, authoring of EIAR chapters, compliance surveys, due diligence and appeals. Jim's experience in energy projects includes renewable energy generation, storage and electrical infrastructure, where his focus is on quality assurance of all noise and acoustic services, as well as planning and consenting services, civils and geotechnical studies, and shadow flicker assessments.

A detailed description of the project to be assessed in this EIAR Chapter is provided in Chapter 2.

13.2.1 Scope of Assessment

13.2.1.1 Conditions required for Shadow Flicker

Under certain combinations of geographical position, wind direction, weather conditions and times of day and year, the sun may pass behind the rotors of a wind turbine and cast a shadow over the windows of nearby buildings. When the blades rotate and the shadow passes a window, to a person within that room the shadow appears to 'flick' on and off; this effect is known as 'shadow flicker'. The phenomenon occurs only within buildings where shadows are cast across a window aperture, and best practice is to assess potential shadow flicker effects within an area up to a maximum distance of 10 times the rotor diameter from each wind turbine.

The 10 times rotor diameter criterion, which effectively sets the size of the study area, is advised in several international publications including the German '*Guideline for Identification and Evaluation of the Optical Emissions of Wind Turbines*' (2002), the UK's '*Update of UK Shadow Flicker Evidence Base*' (Parsons Brinkerhoff for DECC, 2011) , the Irish Government 'Wind Energy Development Guidelines' (WEDG 2006), and the Irish Wind Energy Association guidelines (IWEA, 2012).

Specifically, the WEDG 2006 state that:

> *"At distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low".*

And the IWEA 2012 guidelines state that:

> *"The assessment of potentially sensitive locations or receptors within a distance of ten rotor diameters from proposed turbine locations will normally be suitable for EIA purposes"*

13.2.1.2 Study Area

A study area of 1,550 m from each of the 11 wind turbines was selected for this assessment. This is based upon ten times the maximum rotor diameter (155 m) that would be used within the proposed development as per the design flexibility opinion of An Bord Pleanála.

The assessment considers all potential shadow flicker sensitive receptors identified within the study area, which includes habitable residential buildings and buildings that are mixed residential and commercial. The receptor locations are detailed on Figure 13-1 and presented in tabulated format in Appendix 13-1.

The suns path in the sky starts in the morning from the eastern horizon, continues to increase in elevation until it is at its highest in the sky in the afternoon, and then decreases in elevation and sets in the western horizon in the evening. This path differs depending on the time of the year and the suns angle (or azimuth) and elevation are higher during the summer months and lower in the winter months. The general path of the sun across the sky will not change however, and due to the latitude of the site, the suns azimuth relative to the turbines and receptors is such that the conditions required for shadow flicker in some of the southern areas of the study area will never have the potential to occur at any point throughout the year. As such, whilst all residential receptors within the study area have been included in the assessment, shadow flicker effects may not have the potential to occur at every receptor. The calculated area over which shadows from the turbine rotors may be cast is detailed in Figure 13-1.

13.2.1.3 Effects to be Assessed

This chapter presents the results and findings of the potential shadow flicker effects at all of the identified receptors and quantifies the theoretical maximum number of hours per annum where shadow flicker may occur at each identified receptor.

13.3 Methodology

13.3.1 Prediction Method

It is possible to predict the total theoretical number of hours per year that shadow flicker may occur in a building from the relative position of the turbines to the building, the geometry of the wind turbines, the latitude of the wind turbine site and the size & orientation of the windows potentially affected. The predictions can be used to identify the times when curtailment may be required in order to mitigate the effects of shadow flicker. The predictions assume that during daylight hours the sun is shining all day, every day.

The potential for shadow flicker to occur and the intensity and duration of any effects depend upon the following factors:

1. the location and orientation of the window relative to the turbines;
2. whether a window has direct, unobstructed line of sight to the turbine rotor;
3. the distance of the building from the turbines;
4. the turbine geometry;
5. the time of year (which impacts the trajectory of the sun's path across the sky);
6. the frequency of cloudless skies (particularly at low elevations above the horizon); and,
7. the wind direction (which impacts on turbine orientation).

Several specialist software packages are available that can take account of variables 1-5 listed above to determine the maximum theoretical number of shadow flicker hours that could occur at each window under worst-case conditions. Weather conditions (variables 6-7) cannot be predicted with certainty, therefore the software model assumes cloudless skies 100% of the time and that all turbines are face on to all receptors. This cannot happen in reality and the output from the model will therefore be inherently conservative, although estimates of typical weather conditions can be factored into the assessment at a later stage to provide a more realistic estimate of the likely occurrence of shadow flicker.

Where obstructions are present between a window and a turbine due to terrain, this is accounted for within the software model, however the model does not consider other obstructions that may be present (such as walls, buildings, and vegetation).

For this assessment, predictions of shadow flicker effects have been undertaken using industry standard software package ReSoft WindFarm, based on the proposed turbine locations and turbine dimensions described later in Table 13-2.

13.3.2 Assessment Methods

13.3.2.1 Relevant Guidance

'International Legislation and Regulations for Wind Turbine Shadow Flicker Impact ' (Koppen, 2017) presents an overview of the assessment methodologies most commonly used in countries that have their own specific legislation or guidance with regards to shadow flicker effects. The paper states that nearly all countries base their guidance on the German guidelines '*Guideline for Identification and Evaluation of the Optical Emissions of Wind Turbines*' (2002).

The limit values within the German guidelines are 30 minutes per day and 30 days per year. These limits are, however, based on worst case conditions i.e. the total theoretical number of hours per year that shadow flicker may occur, assuming that the sun is always shining during daylight hours. If it is found that mitigation measures are required, then a further limit value of 8 hours per year is set based on the real case shadow flicker i.e. what is actually occurring and not the theoretical maximum that may occur.

Many countries have adopted the German guideline limits, either directly or with some small adjustments. Australia, Belgium (Walloon region), Brazil, Canada, India, Sweden, and USA all have a worst-case limit of 30 hours a year or 30 minutes a day. The UK has no set limit but also typically adopts these guideline levels for assessment purposes.

Belgium (Flanders region) sets a real case limit of 8 hours a year or 30 mins a day, Denmark a real case limit of 10 hours a year and Netherlands a real case limit of 17 days a year where shadow flicker occurs for more than 20 minutes a day.

There is no standard for the assessment of shadow flicker in Ireland, although a maximum of 30 hours per year and 30 mins per day within 500 m of a wind turbine is recommended, as detailed in Wind Energy Development Guidelines (2006).

13.3.2.2 Galway County Development Plan

The Adopted Galway County Development Plan 2022-2028 (Galway County Council, 2022) states the following in relation to shadow flicker:

"When assessing planning applications for wind energy developments the Council will have regard to;

- *the Wind Energy Development Guidelines for Planning Authorities, DoEHLG, (2006) and any amendments to the Guidelines which may be made; and*
- *the Local Authority Renewable Energy Strategy;*

In addition to the above, the following local considerations will be taken into account by the Council in relation to any planning application;

- *Impact on human health in relation to noise disturbance (including consistency with the Word Health Organisations 2018 Environmental Noise Guidelines for the European Region), shadow flicker and air quality"*

13.3.2.3 Mayo County Development Plan 2022-2028

The Adopted Mayo County Development Plan 2022-2028 (Mayo County Council, 2022) prescribes the following development management standard for wind energy: "*Planning applications for wind energy development shall be in compliance with DoEHLG Wind Energy Development Guidelines 2006 (including any new guidelines when issued) and the Renewable Energy Strategy for Mayo"*.

13.3.2.4 Wind Energy Development Guidelines (2006)

Guidance provided by the Department of the Environment, Heritage and Local Government (DoEHLG) states that properties that are within 10 rotor diameters of the turbines are susceptible to the effects of shadow flicker and at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low (DoEHLG, 2006).

There is no standard for the assessment of shadow flicker in Ireland, although the Wind Energy Development Guidelines (WEDG) 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."*

13.3.2.5 Draft Revised Wind Energy Development Guidelines (2019)

The Department of Housing, Planning and Local Government published the Draft Revised Wind Energy Development Guidelines in December 2019. The draft revised guidelines set out a zero shadow flicker policy, encouraging the use of technology for shadow flicker control, to prevent it occurring at sensitive receptors.

The 2019 revised guidelines are currently at draft stage and were subject to consultation and liable to change before the final version is issued. As such, until the revised guidelines are published, the currently adopted WEDG 2006 guidelines will continue to be considered for the assessment of shadow flicker at the proposed development. As such, the assessment herein is based on compliance with the current DoEHLG Guidelines limit

(30 hours per year or 30 minutes per day). However, it should also be noted the Proposed Development is in line with the requirements of the 2019 draft guidelines (which provides for 'zero shadow flicker') through the implementation of the mitigation measures outlined herein.

13.3.2.6 IWEA Best Practice Guidelines

In March 2012, the Irish Wind Energy Association (IWEA) issued a document detailing best practice guidance for wind farms (IWEA, 2012).

The document provides a preferred methodology to predict the worst-case shadow flicker conditions in order to provide the most robust results from the assessment. With regards to shadow flicker, the IWEA guidelines support those given in the WEDG, stating:

> *"The assessment of potentially sensitive locations or receptors within a distance of ten rotor diameters from proposed turbine locations will normally be suitable for EIA purposes. The DoEHLG's Wind Energy Development Guidelines set recommended limits for shadow flicker which are 30 hours per year or 30 minutes per day for receptors within 500 m."*

13.3.2.7 Assessment Criteria

Based on the guidance summarised above, the assessment criteria against which predicted levels will be assessed has been set as a maximum shadow flicker exposure level of 30 minutes per day and 30 hours per year for any residential receptor within 10 rotor diameters of the wind turbines.

13.3.3 Field Assessment

Building location data was supplied by Fehily Timoney & Company, derived from a combination of Eircode data and information from relevant planning applications. The supplied dataset covered an area at least 10 rotor diameters from the turbines. The dataset was refined through the use of aerial imagery to identify any additional buildings, as well as identifying building condition (habitable, derelict etc.), and building dimensions; the building centre-point co-ordinates were also refined where required. The resulting locations are referred to as Shadow Flicker Assessment Locations (SFALs).

One receptor (SFAL004, 357 m from T01) has been identified within the 2006 WEDG 500 m assessment area. SFAL004 is under the control of the Developer and will be taken out of use as a residential property and will not be occupied for the operational period of the development should the Proposed Development be granted planning permission. No other receptors have been identified within 500 m of the proposed wind turbines.

In total, 130 receptors have been identified within the 1,550 m shadow flicker study area, as shown on Figure 13-1. The closest receptor to a wind turbine (other than SFAL004) is SFAL118, at 720 m from T01.

Appendix 13-1 contains the model input data for all of the receptors and their windows. Modelling parameters and assumptions are described in 13.2.5.

13.3.4 Extent of Shadow Flicker Assessment

The shadow flicker model calculates the total theoretical occurrence of shadow flicker at all receptors per year based on a theoretical worst-case scenario that 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 and the turbines (except where this is prevented due to topography). In reality the turbines will not always be orientated as described, clouds will obscure the sun and line of sight may be obscured by structures or vegetation. The theoretical worst-case scenario allows predictions of all possible shadow flicker occurrences, however in reality actual shadow flicker effects will only be possible for some of this time.

To inform the model of potential shadow flicker effects, historical weather data can be used to apply a correction factor, which considers the frequency of clear skies when shadows may be cast. Data compiled by Met Éireann from the nearest long-term weather station to Shancloon Wind Farm (Shannon Airport) has been used to determine the average sunshine hours; this data is presented in Table 13-1.

Table 13-1: Average Monthly Sunshine Hours at Shannon Airport (1991-2020)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Sunshine Hours: Mean Daily Duration[i]	1.7	2.4	3.6	5.4	5.9	5.5	4.4	4.6	3.9	3	2.1	1.5	3.7
Daylight Hours[ii]	7.8	9.6	11.9	14.2	16.2	17.3	16.7	14.9	12.6	10.4	8.3	7.1	12.3
% Sunshine	22%	25%	30%	38%	36%	32%	26%	31%	31%	29%	25%	21%	30%

i Based on meteorological data from Shannon Airport 1991-2020 (https://www.met.ie/cms/assets/uploads/2023/09/www_met_ie_shannon_airport_9120.htm)
ii Based on sunrise and sunset times for Tuam 2024 (https://www.sunrise-and-sunset.com/en/sun/ireland/tuam/2024)

The annual average percentage of sunshine hours is 30%, therefore a correction factor of 30% can be applied to the annual total theoretical predicted levels of shadow flicker to account for the amount of time when the correct meteorological conditions are present for shadows to be cast. It is worth noting that this correction does not account for additional reductions that would occur as a result of variations in wind speed, wind direction, or by determining whether there is line of sight between a turbine and receiver. These predicted levels of shadow flicker are, therefore, still considered to be a conservative estimate.

13.3.5 Modelling Parameters

The levels of shadow flicker at each receptor have been calculated based on a 'greenhouse' modelling approach, where the entire length of each façade of a building is modelled as a window (and is therefore sensitive to shadow flicker). Each modelled window is assumed to have a height of 5 m. This approach has been taken in order to present a conservative estimate of shadow flicker in the absence of any detailed window location data. In reality, only the glazed area of each façade would be sensitive to shadow flicker effects, therefore modelling the full façade will result in higher predicted levels than is actually possible.

Three distinct scenarios were included in the assessment along with the assessment of the potential for the cumulative impacts of wind farms in order to fully assess the range of turbine parameters, as per the design flexibility opinion of an Bord Pleanála, which are considered for the Proposed Development as presented further in Chapter 2: Development Description. The dimensions of the candidate wind turbines that have been considered in the shadow flicker assessment are detailed in Table 13-2.

Table 13-2: Candidate Turbine Dimensions

Candidate Turbine	Hub Height (m)	Rotor Diameter	Tip Height (m)
Siemens-Gamesa SG 6.6-155	**102.5**	**155**	**180**
Vestas V150 5.6 MW	**105**	**150**	**180**
Nordex N149 5.7 MW	**104.7**	**149.1**	**179.25**

13.4 Existing Environment

In total, 130 properties have been identified within 10 rotor diameters (1,550m) of the turbines; all have been identified as dwellings, and are therefore considered potential shadow flicker receptors. One receptor, SFAL004, is located within 500 m of the turbines, however as noted in Section 13.2.2.6 the property is under the control of the Developer and will be removed from residential use should the Proposed Development receive planning permission.

There are no existing wind turbines located within 10 rotor diameters of the 130 properties considered in this assessment. As such, the existing environment contains no prospect for shadow flicker effects to occur.

Figure 13-1 of Volume IV shows the Shadow Flicker Study Area and Receptors.

13.5 Potential Impacts

The output of the shadow flicker model (see Volume III of this EIAR, Appendices 13.1 to 13.3) indicates that there is the potential for shadow flicker to occur at 103 of the 130 receptors considered within the study area, when considering a 155 m turbine rotor diameter. When considering the 150 m rotor diameter, the number of receptors at which shadow flicker could occur is reduced to 96, and when considering a 149.1 m rotor diameter this number reduces to 94. At the remaining receptors, there is no potential for shadow flicker effects to occur because the suns angle relative to the turbines and receptors never reaches the required position. The calculated area over which shadows from the turbines may be cast (resulting in the potential for shadow flicker to occur) is shown for each candidate turbine on Figure 13-1, Volume IV.

A full listing of the worst-case total theoretical instances of shadow flicker by receptor can be found in Appendix 13-3, Volume III.

13.5.1 Annual Impacts

The shadow flicker model for annual impacts sets out the total theoretical hours per year that each receptor can potentially receive shadow flicker. Total theoretical levels of shadow flicker exceed 30 hours per year at 61 receptors when considering a 155 m rotor diameter, and at 58 receptors when considering a 150 m or 149.1 m rotor diameter.

To consider a more realistic scenario, the annual average sunshine hours for the region have also been taken into account. Predicted levels of shadow flicker considering typical sunshine hours, exceeds 30 hours per year at 17 receptors for a 155 m rotor diameter, at 15 receptors for a 150 m rotor diameter, and at 14 receptors for a 149.1 m rotor diameter.

The total theoretical and predicted levels of shadow flicker have been compared against the assessment criteria for each receptor, as detailed in Table 13-3.

13.5.2 Daily Impacts

It is not appropriate to apply the annual average sunshine hours correction to the predicted daily totals as the data is based upon monthly averages, which cannot be applied to daily levels with sufficient accuracy. Furthermore, the infrequency of clear skies is more likely to reduce the overall number of instances of shadow flicker over the year, rather than reduce the length of each individual instance. As such, the assessment of daily impacts considers the maximum theoretical amount of shadow flicker only and is inherently conservative.

The predicted maximum theoretical hours per day of shadow flicker exceeds 30 minutes at 80 receptors when considering a 155 m rotor diameter, at 77 receptors when considering a 150 m rotor diameter, and at 76 receptors when considering a 149.1 m rotor diameter.

Table 13-3 (overleaf) presents a list of the predicted levels of shadow flicker, and highlights calculated/predicted levels which exceed the assessment criteria (shown in blue for minutes/day and purple for hours/year).

Further details, including the duration of individual shadow flicker events occurring at each receptor, are included in Appendix 13-3, Volume III.

Table 13-3: Shadow Flicker Predicted Levels by Receptor

SFAL	Coordinates (ITM)		Theoretical Maximum Days Per Year Where Shadow Flicker May Occur			Theoretical Maximum Level Per Day (Hours:Minutes)			Theoretical Maximum Level Per Year (Hours:Minutes)			Predicted Level Per Year (Hours:Minutes)		
	X	Y	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m
1	530676	755149	109	109	109	0:52	0:49	0:48	69:12	65:36	65:06	20:45	19:40	19:31
2	532377	755688	222	167	165	0:52	0:51	0:50	114:36	89:54	88:48	34:22	26:58	26:38
3	532236	755371	255	218	218	0:42	0:41	0:40	129:24	112:12	111:12	38:49	33:39	33:21
4	532074	753726	280	279	279	1:43	1:40	1:39	362:30	345:48	343:00	108:45	103:44	102:54
5	532906	753403	143	135	135	0:39	0:39	0:38	61:36	55:48	55:12	18:28	16:44	16:33
6	534074	752911	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
7	535161	756089	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
8	535027	756099	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
9	530481	752816	50	0	0	0:29	0:00	0:00	18:54	0:00	0:00	5:40	0:00	0:00
10	533895	752877	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
11	534019	752844	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
12	532922	756866	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
13	532494	756770	65	65	65	0:42	0:36	0:35	39:12	35:06	34:42	11:45	10:31	10:24
14	532166	756530	55	53	52	0:36	0:34	0:34	25:42	24:06	23:54	7:42	7:13	7:10
15	532099	756013	81	79	79	0:37	0:36	0:36	38:24	36:06	35:42	11:31	10:49	10:42
16	532797	754957	220	193	193	1:36	1:19	1:19	174:00	145:12	143:36	52:12	43:33	43:04
17	532715	755022	240	218	216	1:30	1:07	1:07	165:24	125:30	123:54	49:37	37:39	37:10
18	532563	755014	270	264	263	1:20	1:16	1:16	175:48	167:24	165:36	52:44	50:13	49:40

SFAL	Coordinates (ITM)		Theoretical Maximum Days Per Year Where Shadow Flicker May Occur			Theoretical Maximum Level Per Day (Hours:Minutes)			Theoretical Maximum Level Per Year (Hours:Minutes)			Predicted Level Per Year (Hours:Minutes)		
	X	Y	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m
19	532990	753322	135	78	78	0:36	0:35	0:34	53:18	30:24	30:06	15:59	9:07	9:01
20	533041	753283	82	77	77	0:34	0:33	0:33	32:30	28:54	28:30	9:45	8:40	8:33
21	533105	752585	78	77	77	0:31	0:30	0:30	35:54	34:24	34:06	10:46	10:19	10:13
22	535987	755165	50	49	49	0:39	0:37	0:37	25:24	24:00	23:48	7:37	7:12	7:08
23	536320	755069	39	38	38	0:29	0:28	0:28	14:48	14:00	13:48	4:26	4:12	4:08
24	536487	755008	35	0	0	0:26	0:00	0:00	12:06	0:00	0:00	3:37	0:00	0:00
25	532078	755989	81	78	78	0:37	0:36	0:36	37:12	35:00	34:36	11:09	10:30	10:22
26	533102	752459	59	0	0	0:30	0:00	0:00	24:42	0:00	0:00	7:24	0:00	0:00
27	530568	753706	99	98	97	0:39	0:38	0:38	45:48	43:24	42:48	13:44	13:01	12:50
28	530833	753340	138	136	136	0:39	0:38	0:37	68:06	62:06	61:24	20:25	18:37	18:25
29	532847	757365	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
30	532160	756349	72	70	70	0:44	0:43	0:43	38:00	36:00	35:48	11:24	10:48	10:44
31	530514	752870	49	48	48	0:30	0:29	0:29	19:06	18:12	18:00	5:43	5:27	5:24
32	530559	752861	54	54	54	0:32	0:31	0:31	22:30	21:30	21:18	6:45	6:27	6:23
33	531603	756028	34	0	0	0:27	0:00	0:00	12:00	0:00	0:00	3:36	0:00	0:00
34	530398	755166	55	54	54	0:36	0:35	0:35	25:54	24:24	24:06	7:46	7:19	7:13
35	530364	753933	134	131	131	0:37	0:36	0:36	67:54	64:48	64:18	20:22	19:26	19:17
36	530520	753983	173	169	169	0:45	0:43	0:43	95:06	90:06	89:24	28:31	27:01	26:49
37	532775	757105	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00

SFAL	Coordinates (ITM)		Theoretical Maximum Days Per Year Where Shadow Flicker May Occur			Theoretical Maximum Level Per Day (Hours:Minutes)			Theoretical Maximum Level Per Year (Hours:Minutes)			Predicted Level Per Year (Hours:Minutes)		
	X	Y	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m
38	534001	752908	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
39	535114	756114	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
40	532873	754946	211	195	193	1:17	1:15	1:14	157:36	139:12	137:30	47:16	41:45	41:15
41	532232	755851	101	100	99	0:46	0:45	0:44	55:00	52:00	51:30	16:30	15:36	15:27
42	532636	756945	4	3	0	0:03	0:01	0:00	0:12	0:06	0:00	0:03	0:01	0:00
43	534029	752974	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
44	532885	757080	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
45	534979	756036	48	46	46	0:29	0:28	0:28	18:18	17:12	17:00	5:29	5:09	5:06
46	530676	753404	122	118	118	0:42	0:40	0:40	66:36	62:54	62:24	19:58	18:52	18:43
47	536424	754875	39	38	38	0:28	0:27	0:27	14:12	13:30	13:24	4:15	4:03	4:01
48	532426	756735	77	77	77	0:40	0:39	0:39	47:00	44:42	44:18	14:06	13:24	13:17
49	530587	755216	82	77	77	0:40	0:39	0:39	40:12	37:24	37:00	12:03	11:13	11:06
50	530575	755177	72	69	69	0:40	0:39	0:39	37:00	34:24	34:00	11:06	10:19	10:12
51	532642	756871	31	31	31	0:30	0:24	0:23	10:36	9:48	9:24	3:10	2:56	2:49
52	533012	754921	259	255	255	1:09	1:08	1:07	194:00	186:42	184:54	58:12	56:00	55:28
53	532607	756899	31	30	29	0:28	0:22	0:22	9:42	9:00	8:36	2:54	2:42	2:34
54	532868	756839	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
55	532877	756809	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
56	533326	756739	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00

SFAL	Coordinates (ITM)		Theoretical Maximum Days Per Year Where Shadow Flicker May Occur			Theoretical Maximum Level Per Day (Hours:Minutes)			Theoretical Maximum Level Per Year (Hours:Minutes)			Predicted Level Per Year (Hours:Minutes)		
	X	Y	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m
57	530528	752936	46	45	45	0:30	0:28	0:28	17:54	17:00	16:48	5:22	5:06	5:02
58	530533	752974	45	44	44	0:30	0:29	0:29	18:00	17:06	17:00	5:24	5:07	5:06
59	530733	753390	147	109	109	0:45	0:40	0:40	81:30	55:48	55:24	24:27	16:44	16:37
60	536453	755016	36	0	0	0:27	0:00	0:00	12:54	0:00	0:00	3:52	0:00	0:00
61	532614	755018	258	254	254	1:30	1:27	1:27	179:42	172:18	170:30	53:54	51:41	51:09
62	536349	755064	39	37	37	0:28	0:28	0:28	14:18	13:30	13:24	4:17	4:03	4:01
63	531728	756078	37	35	35	0:28	0:28	0:28	13:42	13:00	12:48	4:06	3:54	3:50
64	535950	755114	53	52	51	0:40	0:39	0:39	27:30	25:54	25:36	8:15	7:46	7:40
65	532165	755049	179	168	166	1:11	1:09	1:09	94:12	86:24	85:06	28:15	25:55	25:31
66	532203	755286	251	214	214	0:40	0:39	0:39	123:36	106:24	105:30	37:04	31:55	31:39
67	533075	753095	50	49	49	0:34	0:33	0:33	22:06	20:54	20:42	6:37	6:16	6:12
68	533059	752937	58	56	56	0:34	0:33	0:33	25:30	24:18	24:00	7:39	7:17	7:12
69	532214	752653	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
70	532753	753672	193	188	187	1:23	1:12	1:10	137:24	121:00	119:54	41:13	36:18	35:58
71	532965	756743	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
72	534017	753643	68	65	65	0:47	0:45	0:45	44:12	40:24	40:06	13:15	12:07	12:01
73	534061	753634	74	71	71	0:47	0:45	0:45	48:36	45:06	44:54	14:34	13:31	13:28
74	534218	753767	88	86	86	0:42	0:41	0:41	47:00	44:42	44:06	14:06	13:24	13:13
75	534292	753778	70	68	67	0:39	0:38	0:38	35:30	33:36	33:12	10:39	10:04	9:57

SFAL	Coordinates (ITM)		Theoretical Maximum Days Per Year Where Shadow Flicker May Occur			Theoretical Maximum Level Per Day (Hours:Minutes)			Theoretical Maximum Level Per Year (Hours:Minutes)			Predicted Level Per Year (Hours:Minutes)		
	X	Y	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m
76	532162	756487	72	54	54	0:40	0:36	0:36	36:00	25:24	25:06	10:48	7:37	7:31
77	532583	756872	40	39	39	0:40	0:29	0:29	19:30	15:24	15:06	5:51	4:37	4:31
78	533106	756763	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
79	532536	755297	253	215	214	0:46	0:45	0:45	119:48	100:42	99:24	35:56	30:12	29:49
80	532630	755107	265	252	251	1:01	0:46	0:46	166:24	133:30	132:30	49:55	40:03	39:45
81	532272	755414	256	252	252	0:43	0:42	0:42	132:06	126:06	125:06	39:37	37:49	37:31
82	532061	755041	186	176	176	1:16	0:46	0:46	107:00	83:18	82:48	32:06	24:59	24:50
83	533486	756556	71	71	71	0:49	0:48	0:48	49:00	47:48	47:12	14:42	14:20	14:09
84	533067	752798	73	71	70	0:33	0:32	0:32	30:30	29:00	28:36	9:09	8:42	8:34
85	532829	753524	165	160	159	0:43	0:42	0:41	86:00	79:24	78:42	25:48	23:49	23:36
86	530532	753029	44	44	44	0:31	0:30	0:30	18:18	17:24	17:18	5:29	5:13	5:11
87	530535	753057	61	49	48	0:31	0:30	0:30	20:30	17:36	17:18	6:09	5:16	5:11
88	530528	753004	46	44	44	0:31	0:30	0:30	18:30	17:36	17:24	5:33	5:16	5:13
89	530589	753018	46	46	46	0:32	0:31	0:31	19:42	18:48	18:36	5:54	5:38	5:34
90	529920	754770	35	33	0	0:28	0:27	0:00	12:42	11:54	0:00	3:48	3:34	0:00
91	529932	754814	36	35	34	0:28	0:27	0:27	13:00	12:18	12:12	3:54	3:41	3:39
92	530631	753549	151	150	150	0:42	0:41	0:41	75:18	71:54	71:00	22:35	21:34	21:18
93	529995	754915	36	36	36	0:29	0:28	0:28	14:06	13:24	13:18	4:13	4:01	3:59
94	532849	753491	162	154	153	0:43	0:42	0:41	79:36	73:06	72:24	23:52	21:55	21:43

SFAL	Coordinates (ITM)		Theoretical Maximum Days Per Year Where Shadow Flicker May Occur			Theoretical Maximum Level Per Day (Hours:Minutes)			Theoretical Maximum Level Per Year (Hours:Minutes)			Predicted Level Per Year (Hours:Minutes)		
	X	Y	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m
95	533984	753386	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
96	533881	753487	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
97	530461	753762	133	126	126	0:36	0:36	0:35	55:18	50:42	50:12	16:35	15:12	15:03
98	530453	753944	169	130	129	0:42	0:40	0:40	88:30	71:24	70:48	26:33	21:25	21:14
99	533542	756521	83	83	82	0:53	0:51	0:51	62:36	61:00	60:18	18:46	18:18	18:05
100	532790	757201	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
101	535653	754940	135	131	130	0:55	0:54	0:54	83:36	79:06	78:06	25:04	23:43	23:25
102	532128	755995	84	83	83	0:40	0:39	0:39	42:42	40:24	39:54	12:48	12:07	11:58
103	532194	752678	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
104	530524	752657	79	0	0	0:29	0:00	0:00	28:06	0:00	0:00	8:25	0:00	0:00
105	532347	755746	159	155	154	0:52	0:50	0:50	87:24	82:36	81:48	26:13	24:46	24:32
106	532630	755193	267	261	259	0:49	0:48	0:48	149:18	142:30	141:12	44:47	42:45	42:21
107	530632	753498	140	138	137	0:40	0:39	0:39	74:06	70:42	70:06	22:13	21:12	21:01
108	532648	756966	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
109	530810	755047	121	121	121	1:01	1:00	0:59	98:30	90:30	89:30	29:33	27:09	26:51
110	533239	756682	17	17	15	0:15	0:15	0:13	3:42	3:30	2:48	1:06	1:03	0:50
111	531809	756061	37	37	37	0:30	0:29	0:29	15:00	14:12	14:06	4:30	4:15	4:13
112	533012	753052	55	53	52	0:35	0:34	0:34	25:12	23:48	23:30	7:33	7:08	7:03
113	534190	753712	106	106	105	0:43	0:42	0:42	63:12	60:30	60:00	18:57	18:09	18:00

SFAL	Coordinates (ITM)		Theoretical Maximum Days Per Year Where Shadow Flicker May Occur			Theoretical Maximum Level Per Day (Hours:Minutes)			Theoretical Maximum Level Per Year (Hours:Minutes)			Predicted Level Per Year (Hours:Minutes)		
	X	Y	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m
114	533962	753609	46	42	42	0:37	0:33	0:33	22:30	18:24	18:06	6:45	5:31	5:25
115	532165	756019	84	82	82	0:41	0:40	0:39	44:06	41:36	41:12	13:13	12:28	12:21
116	532939	756808	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
117	536226	754839	46	45	45	0:32	0:31	0:31	19:30	18:30	18:18	5:51	5:33	5:29
118	532659	753587	148	130	128	0:48	0:47	0:46	79:24	66:48	65:48	23:49	20:02	19:44
119	532173	755960	89	89	88	0:43	0:42	0:42	47:30	45:00	44:30	14:15	13:30	13:21
120	532785	757237	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
121	532871	757198	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
122	536323	754765	44	42	42	0:30	0:29	0:28	16:54	16:06	15:54	5:04	4:49	4:46
123	532929	753509	171	166	166	0:45	0:43	0:43	89:48	84:18	83:36	26:56	25:17	25:04
124	530590	752953	50	50	50	0:32	0:31	0:31	21:18	20:18	20:06	6:23	6:05	6:01
125	536266	754847	46	44	43	0:32	0:31	0:31	18:54	17:48	17:42	5:40	5:20	5:18
126	536331	754765	43	42	42	0:30	0:29	0:28	16:48	15:54	15:48	5:02	4:46	4:44
127	532272	752403	0	0	0	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
128	530451	753792	143	136	136	0:37	0:36	0:36	63:24	58:54	58:24	19:01	17:40	17:31
129	532701	755030	246	226	225	1:32	1:07	1:07	172:42	131:24	129:48	51:48	39:25	38:56
130	533033	752389	33	0	0	0:20	0:00	0:00	9:00	0:00	0:00	2:42	0:00	0:00

SFAL	Coordinates (ITM)		Theoretical Maximum Days Per Year Where Shadow Flicker May Occur			Theoretical Maximum Level Per Day (Hours:Minutes)			Theoretical Maximum Level Per Year (Hours:Minutes)			Predicted Level Per Year (Hours:Minutes)		
	X	Y	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m	155 m	150 m	149.1 m
TOTALS			Number of Receptors that may Experience:											
			Any Shadow Flicker			> 30 Mins/Day (Theoretical Max Levels)			> 30 Hours/Year (Theoretical Max Levels)			> 30 Hours/Year (Predicted Levels)		
			103	96	94	80	77	76	61	58	58	17	15	14

13.5.3 Potential Cumulative Impacts

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. The proposed and operational/permitted wind farms in the area are set out hereunder, all of which are beyond 2km of the Proposed Development. As such, a cumulative assessment is not required.

Operational/Permitted Wind Energy Developments

The Cloonlusk wind energy development comprises 2 No. 2 megawatt wind turbines on 75m towers (V52-850 models) and is located 15.16 km south-east of the Proposed development. These turbines were constructed in 2017 under planning consent from Galway County Council (ref 082407 and 14518).

Proposed Wind Energy Developments

The proposed Laurclavagh Renewable Energy development, located approximately 8km southwest of Tuam, is currently lodged as a strategic infrastructure development application to An Bord Pleanála (ref: PA07.319307). The proposed development will comprise 8 no. wind turbines with an overall turbine tip height of 185 metres; a rotor blade diameter of 163 metres; and hub height of 103.5 metres.

The proposed Clonberne Wind Farm is an 11 turbine wind farm located approximately 10.5 km east of Tuam (and approximately 18 km east of the Proposed Development). The development is currently lodged as a strategic infrastructure development application to An Bord Pleanála (ref: PA07.320089).The proposed turbines will have a an overall turbine tip height of 180 metres; a rotor blade diameter of 162 metres; and hub height of 99 metres.

A single turbine development by Sharedturbine Ltd. in the townland of Cloonascragh , Tuam , Co. Galway was granted planning permission in 2023 (Ref Galway County Council 221175). The development is for a turbine with a hub height of 97m, and blade rotor diameter of 136m, and is located c. 12.2km from Shancloon Wind Farm.

13.6 Mitigation Measures

The Developer will install a shadow flicker impact control system at turbines which have the potential to cause shadow flicker on nearby properties. This system will be installed prior to operation of turbines.

This shadow flicker control system, consisting of light sensors and specialised software, will be installed on the turbines to ensure that mitigation is implemented when shadow flicker exceeds the thresholds as set out in the assessment criteria. The calculated shadow flicker periods can be input into the turbine control software and when the correct conditions are met (i.e. the light intensity is sufficient) during a potential period of shadow flicker, individual turbines will cease operation as required until the conditions for shadow flicker are no longer present. This method of mitigation will be used to ensure that mitigation will be implemented for all instances where shadow flicker effects may occur at a residential dwelling within 10 rotor diameters of the turbines.

It should be noted that under certain circumstances, there may be brief periods between the conditions for shadow flicker becoming present (i.e. cloud cover disappearing, resulting in bright sunshine) and mitigation being fully implemented, due to the time required for the turbine blades to slow to a stop.

Appendix 13-2 contains a list of times when each turbine could theoretically cause shadow flicker, which may be used to inform a shadow flicker mitigation system., noting that this mitigation will not be applied to SFAL004, and instead an agreement is in place with the owner of the property to ensure it is not occupied during the operational period.

It is noted that, as might be required by potential adoption of the 2019 draft wind energy guidelines, shadow flicker control modules can be used to ensure that a near zero level of shadow flicker is achieved, allowing for the reaction time of the shadow flicker control modules and also allowing for a short period of time for the turbine blades to slow down to a stop.

During operation of the Proposed Development, any complaints relating to shadow flicker will be fully investigated by the Developer and the shadow flicker control system updated accordingly.

13.7 Residual Impacts

The results of the shadow flicker assessment predict that Shancloon Wind Farm has the potential to introduce shadow flicker at up to 103 receptors surrounding the site. The implementation of a scheme of mitigation to cease operation of the turbines during periods of potential shadow flicker events will ensure that the potential for shadow flicker effects to occur is effectively eliminated for all residential dwellings within 10 rotor diameters of a turbine.

It is therefore considered that Shancloon Wind Farm complies with the shadow flicker policy as set out in the Wind Energy Development Guidelines 2006.

13.8 Do-Nothing Scenario

In the 'Do-Nothing' Scenario, Shancloon Wind Farm would not be constructed and the potential impacts from shadow flicker on local receptors would not occur. No mitigation measures would be required.

13.9 Conclusion

A shadow flicker assessment has been undertaken on 130 receptors within 10 rotor diameters (based on the range of turbine parameters considered for the Proposed Development) of the proposed Shancloon Wind Farm.

Of these 130 receptors, there is the potential for shadow flicker effects to occur at 103 receptors when considering a 155 m rotor diameter, and at 95 receptors when considering a 150 m rotor diameter, and when considering a 149.1 m rotor diameter this number reduces to 94

Based on the Wind Energy Development Guidelines 2006 (WEDG 2006) thresholds, the predicted 'Maximum Theoretical Hours Per Day' of shadow flicker exceeds 30 minutes at 80 receptors when considering a 155 m rotor diameter, and at 77 receptors when considering a 150 m rotor diameter, and at 76 receptors when considering a 149.1 m rotor diameter.

When considering the 'Total Theoretical Hours Per Year', shadow flicker levels may exceed the WEDG 2006 threshold of more than 30 hours per year at 61 receptors when considering a 155 m rotor diameter, and at 58 receptors when considering a 150 m rotor diameter or the 149.1m rotor diameter. However, when accounting for a more 'likely' scenario, where the average annual sunshine hours are taken into account, the number of receptors exceeding 30 hours per year is reduced to 17 when considering a 155 m rotor diameter, and at 15 when considering a 150 m rotor diameter, and at 14 receptors for a 149.1 m rotor diameter.

Under the above circumstances a scheme of mitigation will be implemented into the turbine control software to cease turbine operation during periods when the conditions required for shadow flicker to occur are present.

As a result of the adoption of this mitigation strategy, controlled shadow flicker (allowing for a short time for the rotor to come to a stop) will occur within 10 rotor diameters of a turbine, regardless of which turbine within the design flexibility range will be installed. This mitigation is not required for SFAL004 (as it is not a receptor - see above), and instead an agreement is in place with the owner of the property to ensure it is not occupied during the operational period.

No cumulative impacts with other proposed or operational wind farms in the area are predicted to occur on any receptors in the study area.

13.10 References

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