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Acronyms and Abbreviations

SLR	SLR Consulting Limited
EIAR	Environmental Impact Assessment Report
WEDGs	Wind Energy Development Guidelines
DTM	Digital Terrain Model
OS	Ordnance Survey
WEG	Wind Energy Guidelines

Introduction

11.1 This chapter considers the potential impact on receptors from shadow flicker generated by the Proposed Development during the operational phase of the project.

11.2 The specific objectives of the chapter are to:

- Describe the existing baseline.
- 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.

Background

11.3 Under certain combinations of geographical position and time of day, when the sun passes behind the rotors of a wind turbine and casts a shadow over neighbouring properties, as the blades rotate, the shadow may appear to flick on and off, when viewed through a narrow aperture such as a window. The phenomenon occurs only within buildings where shadows are cast across a window aperture, and the effects are considered to occur up to a maximum distance of 10 times the rotor diameter from each wind turbine[1]. This effect is known as shadow flicker.

11.4 The likelihood and duration of the effect depends upon:

- Direction and aspect of the property relative to the turbine(s): in Ireland, only properties within 130 degrees either side of north, relative to the turbines, can be affected, as turbines do not cast long shadows on their southern side[2];
- Distance from turbine(s): the further the building is from the turbine, the less potential there is for the effect to arise, given the shadow flicker effect fades with distance due to light refraction.
- Turbine height and rotor diameter.
- Topography between the turbine and the receptor.
- Time of year and day.
- Wind direction and orientation of the turbine blades in relation to the receptor; and
- Weather conditions (i.e. cloudy days reduce the likelihood of effects occurring).

11.5 If significant effects due to shadow flicker cannot be avoided through embedded mitigation, then technical mitigation solutions are available, such as shutting down those turbine(s) which cause the effect when certain conditions prevail.

[1] IWEA Best Practice Guidelines for Wind Farms. Available at: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://windenergyireland.com/images/files/best-practice-guidelines-for-windfarm-electrical-operation1.pdf Date Accessed 23/6/2023

[2] As described in the Draft Wind Energy Guidelines, 2019.

11.6 Shadow flicker effects are only considered during the operational phase of a wind farm development, and do not occur if the turbines are not rotating or if the sun is not shining.

Statement of Authority

11.7 This technical assessment was undertaken by Tim Doggett (BSc(hons), MSc, WASP) and Anne Altringham (BSc(hons), MSc) of SLR Consulting Ltd.

- Tim is a Principal EIA Consultant who has over 15 years of experience in undertaking wind farm design and shadow flicker impact assessments for EIA and ES in the UK and Ireland.
- Anne is a Senior GIS Analyst in SLR who assists the Environmental & Social Impact Assessment team. She has several years' experience of inputting into wind farm EIAs, including preparing shadow flicker models and assessments.

Methodology and Guidance

Relevant Guidance

11.8 There are various sources of guidance with regards to the assessment and management of shadow flicker impacts caused by wind turbines. Irish guidance relevant to the Proposed Development is summarised below.

IWEA Best Practice Guidelines

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

11.10 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.'

Westmeath County Council Development Plan (2021 – 2027)

11.11 Section 10.23 of the Westmeath Development Plan references wind energy. In relation to shadow flicker, CPO 10.146 states:

'Ensure that proposals for energy development demonstrate that human health has been considered, including those relating to the topics of:

…

Shadow Flicker (for wind turbine developments, including detailed Shadow Flicker Study)'

…"

Meath County Council Development Plan (2021 – 2027)

11.12 No specific mention of shadow flicker assessment is contained within this development plan, but reference is made to wind energy being supported, subject to assessments being undertaken in line with the 2006 Wind Energy Development Guidelines, or any revisions thereof.

Wind Energy Development Guidelines (2006)

11.13 The 2006 Guidelines state that:

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

11.14 The Guidelines also state 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.'

11.15 The shadow flicker modelling approach in this assessment is consistent with this recommendation.

Draft Revised Wind Energy Development Guidelines (2019)

11.16 Draft WEDGs were published in December 2019 and are subject to a consultation process. It is noted that at the time of writing (August 2023) the Draft 2019 WEDGs have not yet been adopted and the 2006 Guidelines referred to above remain in place. Nonetheless, this EIAR is cognisant of the content and adheres to the proposed measures set out in the Draft 2019 WEDGs. The Draft 2019 WEDGs 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.'

11.17 The Draft 2019 WEDGs also outline that the time period in which a neighbouring property may be affected by shadow flicker is completely predictable from the relative locations of the wind turbine(s) and the property. To support this,

'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.'

11.18 The Draft 2019 WEDGs advise that if shadow flicker prediction modelling indicates that there is potential for shadow flicker to occur at any potentially affected property, that a design review should be carried out to consider if turbine(s) can be relocated to eliminate shadow flicker. If this cannot be accommodated, then measures which provide for automated turbine shutdown to eliminate shadow flicker would be required, subject to operational phase assessments to confirm such impacts. The Draft 2019 WEDGs also state that:

'The planning authority or An Bord Pleanála should impose condition(s) to ensure that no existing dwelling or other affected property will experience shadow flicker as a result of the wind energy development subject of the planning application.'

11.19 This approach in the current draft of the Guidelines provides for the prevention of shadow flicker by automatic shutdown of the turbines. This means that turbines will need be programmed to shut down when shadow flicker effects occur, i.e. no amount of shadow flicker per day or per year would be acceptable.

Note on Guidance

11.20 It is acknowledged that the 2006 Wind Energy Development Guidelines are currently being revised. A draft version of the replacement Wind Energy Development Guidelines (WEDGs) was published in December 2019. The consultation period has now closed, and the final version is awaiting publication.

11.21 If the 2019 document is published in final form within the determination period of the Proposed Development, the Board will apply the new guidelines to their assessment. However, the 2019 draft Guidelines have not been formally adopted at the time of the preparation of this chapter. This assessment covers both requirements nonetheless.

11.22 The make or model of turbine which is eventually selected for installation within the ranges assessed, will adhere to the limits set out in the relevant chapters and the developer commits that the impacts from the selected machine will be no greater than what is assessed and committed to within in this EIAR.

11.23 Post-construction monitoring will be carried out to confirm the impacts from shadow flicker to sensitive receptors and ensure these are no more significant than what is allowable. Any significant impacts above allowable limits will be mitigated for as set out in this EIAR.

Field Assessment

11.24 Building location data was obtained from the Geodirectory – Residential Addresses dataset in 2022 and via housing survey data provided by the Applicant in 2022. The supplied dataset covered an area 10 rotor diameters from the turbines. The dataset was then further refined through the use of aerial imagery in 2022/23 to identify any additional buildings omitted from the dataset, as well as identifying building condition (habitable, derelict etc.), and building dimensions; the building centre-point co-ordinates were also refined where required.

11.25 The following sources of information outlined in **Table 11-1** were used to inform this assessment.

Table 11-1 Sources of Information

Topic	Source of Information
Residential properties Location in relation to Proposed Development and identification of windows.	GeoDirectory - Residential Addresses Ordnance Survey (OS) Ireland 1:25,000 Mapping Google Earth Street View
Topography Height data	Copernicus 25m DTM data

11.26 Any building that was clearly identified as uninhabitable (such as a farm outbuilding) or derelict was removed, however where this was not possible to confirm, the building was considered as part of the assessment.

11.27 Two turbine models have been considered for this assessment: one with a 155m rotor diameter (Scenario 1), and one with a 162m rotor diameter (Scenario 2). As the shadow

flicker study area is defined by the diameter of the rotor, two modelling scenarios have been used as follows. As the rotor diameters represent both ends of the range of effects, all permutations within the range which the planning application is seeking permission for will be within the identified effects.

11.28 No receptors have been identified within the 2006 WEDG 500 m assessment area, and in total up to 211 receptors have been identified within the 1,550 and 1,620 m shadow flicker study areas, as shown on **Figure 11-1**.

11.29 The closest receptor (a property where the occupier has a financial involvement in the wind farm development) is 705 m from the nearest proposed wind turbine. **Appendix 11-1** contains the model input data for all of the receptors and their windows. Modelling parameters and assumptions are described in Section 11.27.

Extent of Shadow Flicker Assessment

11.30 For a receptor to be sensitive to shadow flicker, there must be windows with line of sight to the turbine rotor and the room where the window is located must have the potential to be occupied, e.g. a living or workspace. The study area and receptor locations are shown on **Figure 11-1 and Figure 11-2** and presented in tabulated format in **Appendix 11-1**.

Scenario 1

11.31 A study area of 1,550 m from each of the wind turbines has been used for this assessment. This is based upon ten times the maximum rotor diameter (155 m) that would be used within the Proposed Development in accordance with current guidelines if this turbine were procured post consent.

11.32 The assessment considers all identified potential shadow flicker sensitive receptors within the study area. For this assessment, inhabited residential buildings have been considered sensitive receptors (no other property types were identified within the study area), in line with the guidance in the Wind Energy Development Guidelines (2006).

Scenario 2

11.33 A study area of 1,620 m from each of the wind turbines has been used for this assessment. This is based upon ten times the maximum rotor diameter (162 m) that would be used within the Proposed Development in accordance with current guidelines if this turbine were procured post consent.

11.34 The assessment considers all identified potential shadow flicker sensitive receptors within the study area. For this assessment, inhabited residential buildings have been considered sensitive receptors (no other property types were identified within the study area), in line with the guidance in the Wind Energy Development Guidelines (2006).

Modelling Parameters

11.35 The shadow flicker assessment comprises numerical modelling of the proposed turbines and receptors within the defined study area. SLR Consulting use one of the industry standard software packages, ReSoft Wind Farm software (version 5.1.2.1).

11.36 The calculations from this assessment process assume a worst-case scenario based on the sun shining during all daylight hours over the course of a year, no obscuring features

(such as trees, hedges, other buildings) being present, the face of the rotor always being aligned towards the dwelling, and that the rotor is always turning (i.e. the wind is always blowing between 4m/s and 25m/s, and no account is taken of shut down periods for maintenance). This methodology yields a theoretical maximum indication of potential shadow flicker incidence, together with the times of day, and dates during the year when potential incidence may occur.

11.37 The levels of shadow flicker at each receptor have been calculated based on a 'greenhouse' modelling approach, where the full 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 2 m. This approach has been taken in order to present a worst-case 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 will actually be likely.

11.38 The software performs calculations to determine the position of the sun throughout the year, and thus during what times of day it will theoretically cast a shadow across the windows of nearby houses within 10 rotor diameters. Data input into the model where shadow flicker assessment is required is as follows:

- The locations of all properties within ten times the rotor diameter and 130 degrees either side of north of any turbine.
- The dimensions and orientations of windows facing the Proposed Development.
- The surrounding topography (Ordnance Survey Digital Terrain Model); and
- The locations and dimensions of the turbines, as defined by the two modelled scenarios detailed in Section 11.27.

11.39 Running the software with the above data inputs is defined as the 'worst case scenario' for the purposes of the shadow flicker model. In addition, this 'worst case scenario' does not take into consideration the screening effect of anything such as vegetation or buildings located between the wind turbines and the property.

11.40 In practice it is likely that shadow flicker effects would occur for considerably less time than the worst-case predictions, for the following reasons:

- In Ireland, sunshine typically occurs for approximately 28.6% of daylight hours (see **Figure 11-3** and **Figure 11-4**). At other times, the wind turbines are unlikely to cast shadows sufficiently pronounced to cause shadow flicker effects to occur;
- The model assumes that the wind is blowing constantly so that the turbine blades are rotating during all daylight hours; and
- At times when the wind turbine rotor is not oriented exactly perpendicular to the property, the duration of shadow flicker effects would be reduced due to the elliptical shape of the shadow cast.

11.41 Only those properties within the relevant study areas of the proposed turbines for each scenarios study area have been included in the calculations. The model has been run using Copernicus 25 DTM data which is the most accurate digital terrain data available for the site.

Average Sunshine Hours

11.42 The closest meteorological station to the Proposed Development with historical measurements compiled by Met Éireann is located at Mullingar, approximately 28 km from

the Proposed Development. This data, found in **Table 11-2**, represents the average sunshine per day as recorded over a 30 year period (1979 – 2008), the actual sunshine (daylight) hours at the Proposed Development site and therefore the average percentage of time shadow flicker could actually occur per year is 29.8%.

Table 11-2 Average Sunshine Hours for period 1979 - 2008

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual Average
Mean Daily Duration[3]	1.8	2.5	3.2	4.9	5.8	5.0	4.6	4.6	3.9	3.2	2.2	1.6	3.6
Daylight hours[4]	8.09	9.56	11.53	14.04	15.57	17.03	16.34	14.52	12.46	10.41	8.43	7.37	12.1
% Sunshine	22.2	26.2	2787	34.9	37.3	29.7	28.2	31.7	31.3	30.7	26.1	21.7	29.8

Existing Environment

Scenario 1

11.43 171 residential properties have been identified which fall within the 1,550m study area. These properties could theoretically be affected by shadow flicker from the Proposed Development (**Figure 11-1**)**.** Summary details of these properties are identified in **Table 11-3**, with additional details of the properties found in **Appendix 11-1**.

Scenario 2

11.44 An additional 40 properties compared to Scenario 1 fall into the larger study area associated with Scenario 2. These properties could theoretically be affected by shadow flicker from the Proposed Development (**Figure 11-2**)**.** Summary details of these properties are identified in **Table 11-4**, with additional details of the properties found in **Appendix 11-1.**

Table 11-3 Identified Receptors Within Scenario 1 Study Area

SLR ID No.	Easting	Northing	Distance from Nearest Proposed Turbine (m)
2	663178	769451	1,340
3	663314	769378	1,275
4	662696	769273	1,253
5	663186	769258	1,147
6	663622	769206	1,185

[3] https://www.met.ie/climate-ireland/1981-2010/mullingar.html

[4] https://www.worlddata.info/europe/ireland/sunset.php

SLR ID No.	Easting	Northing	Distance from Nearest Proposed Turbine (m)
7	663748	769190	1,225
8	663619	769164	1,145
9	663790	769151	1,212
10	663813	769145	1,219
11	663763	769129	1,179
13	663252	769078	970
14	663847	769075	1,179
15	661858	768977	1,455
16	661833	768951	1,488
17	662837	768924	877
18	664269	768845	1,324
22	664483	768817	1,493
24	664548	768800	1,543
25	664557	768798	1,550
31	664502	768771	1,489
32	664515	768768	1,499
33	664540	768764	1,520
34	664539	768757	1,516
35	664573	768756	1,546
37	664534	768748	1,508
38	664531	768743	1,503
40	664526	768735	1,495
41	664523	768730	1,490
44	664517	768719	1,480
45	664551	768715	1,510
47	664511	768714	1,473
48	664546	768710	1,503
49	664591	768708	1,544
51	664541	768701	1,495
52	664536	768696	1,488
53	664589	768696	1,537
55	664532	768687	1,481
57	662193	768682	1,028
58	664583	768682	1,526
59	664526	768681	1,473

SLR ID No.	Easting	Northing	Distance from Nearest Proposed Turbine (m)
61	664565	768675	1,507
62	664521	768673	1,466
63	661508	768672	1,477
65	664515	768667	1,458
67	664557	768663	1,495
68	664509	768660	1,449
69	664506	768652	1,444
70	664553	768649	1,486
71	664614	768645	1,542
73	664543	768639	1,473
78	664539	768625	1,465
80	664542	768610	1,462
81	664599	768607	1,515
82	664611	768602	1,525
83	664624	768600	1,536
84	664636	768596	1,546
88	662416	768566	831
90	662375	768547	828
94	661966	768508	1,023
95	662191	768508	880
96	661880	768496	1,078
97	661618	768490	1,282
98	661946	768391	959
99	662013	768391	908
100	661473	768388	1,356
101	661582	768321	1,228
103	664607	768202	1,442
105	664417	768107	1,250
106	664413	768054	1,247
107	664367	767954	1,200
108	661448	767948	1,248
109	664378	767844	1,190
110	661343	767481	1,374
111	664170	767139	1,110
112	662346	767131	731

SLR ID No.	Easting	Northing	Distance from Nearest Proposed Turbine (m)
113	664139	767108	1,098
114	662352	767045	806
115	662874	767030	724
116	662717	767019	760
117	662622	766994	787
118	664369	766985	1,359
119	662533	766982	811
120	662671	766976	803
121	662624	766894	743
122	663992	766834	1,157
123	661179	766812	1,537
124	662917	766811	705
126	663984	766779	1,192
127	661117	766752	1,543
128	663206	766692	763
129	663859	766681	1,194
130	663815	766643	1,203
131	663774	766621	1,202
132	661021	766593	1,525
133	663632	766582	1,057
134	662006	766575	783
135	663738	766575	1,152
136	661985	766552	789
137	661963	766528	797
138	663549	766490	945
139	661022	766443	1,447
140	661022	766443	1,447
141	661698	766325	825
142	661763	766248	725
143	661719	766228	745
144	663812	766228	1,096
145	661658	766210	783
146	661671	766209	771
147	661126	766115	1,223
148	661511	766112	861

SLR ID No.	Easting	Northing	Distance from Nearest Proposed Turbine (m)
149	661612	766104	767
150	661186	766099	1,161
151	664064	766046	1,278
152	661480	766009	854
153	663946	765990	1,151
154	663931	765957	1,130
155	661115	765936	1,127
156	663749	765858	937
157	661143	765835	1,044
158	663799	765835	985
159	663781	765814	966
160	661166	765774	991
162	663560	765740	744
163	663755	765714	940
164	660662	765704	1,418
165	661169	765687	945
166	663755	765678	943
167	663734	765635	927
168	661163	765591	909
169	663711	765571	916
170	661173	765536	880
171	663685	765517	905
172	661162	765500	879
173	663713	765437	956
174	663714	765429	960
175	661117	765386	897
176	663724	765354	998
177	663727	765305	1,022
178	661182	765243	821
179	663766	765181	1,117
180	660527	765169	1,477
181	661171	765099	844
182	663408	765064	916
183	661179	765061	843
184	661186	765028	844

SLR ID No.	Easting	Northing	Distance from Nearest Proposed Turbine (m)
185	661190	764996	849
186	663503	764757	1,149
187	663573	764688	1,246
188	663573	764688	1,246
189	663717	764675	1,372
190	663740	764659	1,400
191	663549	764655	1,246
192	663549	764655	1,246
193	663495	764598	1,240
194	663472	764552	1,254
195	663472	764552	1,254
196	663324	764525	1,172
197	663440	764510	1,261
198	661264	764369	1,143
199	661239	764346	1,177
200	661200	764304	1,234
201	661128	764267	1,310
202	661128	764267	1,310
203	661110	764253	1,332
204	661110	764253	1,332
205	661084	764237	1,361
206	660917	764228	1,484
207	661062	764225	1,385
208	661031	764215	1,414
209	661004	764201	1,442
210	660975	764171	1,484

Table 11-4 Additional Identified Receptors Within Scenario 2 Study Area

SLR ID No.	Easting	Northing	Distance from Nearest Proposed Turbine (m)
1	662782	769679	1,614
12	661836	769090	1,561
19	664571	768827	1,576
20	664567	768824	1,571
21	664565	768819	1,567
23	664563	768813	1,562

SLR ID No.	Easting	Northing	Distance from Nearest Proposed Turbine (m)
26	664601	768786	1,584
27	664617	768779	1,596
28	664623	768777	1,601
29	664628	768776	1,605
30	664633	768776	1,609
36	664583	768751	1,553
39	664619	768740	1,582
42	664614	768728	1,573
43	664660	768721	1,612
46	664612	768715	1,566
50	664657	768708	1,605
54	664653	768696	1,597
56	664646	768685	1,586
60	664633	768676	1,571
64	664669	768669	1,602
66	664682	768666	1,613
72	664628	768645	1,555
74	664640	768639	1,564
75	664654	768637	1,577
76	664666	768631	1,586
77	664681	768630	1,600
79	664693	768625	1,610

Potential Impacts

11.45 Two turbine models have been considered in this assessment as outlined in Section 11.27. In terms of EIA the turbine with a 162m rotor diameter is considered to be the worst case as it brings more receptors into the assessment area and covers all design permutations that have been set out in **Chapter 2** of this EIAR. Both models of turbine, comprising the 155 m and 162 m diameter rotors. have been assessed and the results presented below.

11.46 The make or model of turbine which is eventually selected for installation within the ranges assessed, will adhere to the limits set out, and the developer commits that the impacts from the selected machine will be no greater than what is assessed and committed to within in this EIAR.

Scenario 1

11.47 **Figure 11-3 and Figure 11-4** show the estimated annual hours of shadow flicker effect across the study area. Based on the predictive modelling technique outlined above, there is predicted to be shadow flicker effects of up to 145 hours per year, with the highest

potential effect found on receptor 142, (shown in **Table 11-5)** assuming the worst-case scenario. Of the 171 receptors in the study area, 29 would not experience any shadow flicker effects arising as a result of the operational phase of the wind farm.

11.48 The theoretical results shown in **Table 11-5** are based on the 'worst-case scenario[5]', which does not make any allowance for average sunshine hours and assumes the sun is shining and the wind is blowing during 100% of daylight hours. The "likely" scenario takes into account the long-term average sunshine hours per year (29.8%) recorded at the nearest Met Éireann Met Station (see Section 11.42).

Table 11-5 Shadow Flicker Effects – Scenario 1

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Max Minutes Per Day	Total Theoretical Hours Per Year	Likely[6] Hours Per Year	Likely[4] Average Minutes per day
2	0	0	0	0	0.0	0.0
3	0	0	0	0	0.0	0.0
4	0	0	0	0	0.0	0.0
5	0	0	0	0	0.0	0.0
6	0	0	0	0	0.0	0.0
7	23	0.31	18.6	5.6	1.7	5.5
8	0	0	0	0	0.0	0.0
9	40	0.48	28.8	15.4	4.6	8.6
10	44	0.51	30.6	18.2	5.4	9.1
11	40	0.49	29.4	15.8	4.7	8.8
13	0	0	0	0	0.0	0.0
14	60	0.55	33	28.2	8.4	9.8
15	0	0	0	0	0.0	0.0
16	19	0.24	14.4	3.5	1.0	4.3
17	24	0.37	22.2	6.8	2.0	6.6
18	49	0.53	31.8	18.1	5.4	9.5
22	40	0.47	28.2	12.9	3.8	8.4
24	38	0.45	27	11.8	3.5	8.0
25	37	0.44	26.4	11.6	3.5	7.9
31	39	0.46	27.6	12.5	3.7	8.2
32	38	0.46	27.6	12.3	3.7	8.2
33	38	0.45	27	11.9	3.5	8.0

[5] See section 11.42

[6] Based on the average sunshine hours for the site of 29.8%.

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Max Minutes Per Day	Total Theoretical Hours Per Year	Likely[6] Hours Per Year	Likely[4] Average Minutes per day
34	38	0.45	27	11.9	3.5	8.0
35	38	0.45	27	11.4	3.4	8.0
37	36	0.46	27.6	11.9	3.5	8.2
38	38	0.46	27.6	12.1	3.6	8.2
40	38	0.46	27.6	12.2	3.6	8.2
41	37	0.46	27.6	12.2	3.6	8.2
44	38	0.46	27.6	12.4	3.7	8.2
45	36	0.45	27	11.7	3.5	8.0
47	38	0.47	28.2	12.5	3.7	8.4
48	38	0.46	27.6	11.9	3.5	8.2
49	35	0.44	26.4	11.1	3.3	7.9
51	37	0.46	27.6	12	3.6	8.2
52	36	0.46	27.6	12	3.6	8.2
53	36	0.45	27	11.3	3.4	8.0
55	38	0.46	27.6	12.2	3.6	8.2
57	124	0.84	50.4	63.6	19.0	15.0
58	36	0.45	27	11.4	3.4	8.0
59	38	0.46	27.6	12.3	3.7	8.2
61	36	0.45	27	11.7	3.5	8.0
62	37	0.47	28.2	12.3	3.7	8.4
63	60	0.5	30	19.4	5.8	8.9
65	38	0.47	28.2	12.5	3.7	8.4
67	37	0.46	27.6	11.7	3.5	8.2
68	38	0.47	28.2	12.6	3.8	8.4
69	39	0.47	28.2	12.7	3.8	8.4
70	36	0.46	27.6	11.9	3.5	8.2
71	35	0.44	26.4	11	3.3	7.9
73	38	0.46	27.6	12.1	3.6	8.2
78	37	0.46	27.6	12.1	3.6	8.2
80	36	0.46	27.6	12.1	3.6	8.2
81	36	0.45	27	11.3	3.4	8.0
82	35	0.45	27	11.1	3.3	8.0
83	36	0.44	26.4	10.9	3.2	7.9
84	34	0.44	26.4	10.8	3.2	7.9

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Max Minutes Per Day	Total Theoretical Hours Per Year	Likely[6] Hours Per Year	Likely[4] Average Minutes per day
88	134	0.97	58.2	84	25.0	17.3
90	140	1.12	67.2	92.3	27.5	20.0
94	144	0.97	58.2	83.6	24.9	17.3
95	145	1.12	67.2	97.2	29.0	20.0
96	147	0.95	57	72.9	21.7	17.0
97	56	0.57	34.2	21.7	6.5	10.2
98	159	1.11	66.6	81.2	24.2	19.8
99	157	1.15	69	95	28.3	20.6
100	44	0.53	31.8	16.1	4.8	9.5
101	48	0.58	34.8	19.8	5.9	10.4
103	74	0.47	28.2	23.9	7.1	8.4
105	83	0.54	32.4	32.4	9.7	9.7
106	85	0.55	33	33.3	9.9	9.8
107	90	0.57	34.2	37	11.0	10.2
108	41	0.55	33	15.8	4.7	9.8
109	93	0.56	33.6	38	11.3	10.0
110	42	0.51	30.6	15.2	4.5	9.1
111	87	0.65	39	48.9	14.6	11.6
112	90	0.73	43.8	55.9	16.7	13.1
113	79	0.66	39.6	43.7	13.0	11.8
114	72	0.7	42	40.4	12.0	12.5
115	0	0	0	0	0.0	0.0
116	0	0	0	0	0.0	0.0
117	0	0	0	0	0.0	0.0
118	80	0.54	32.4	36.3	10.8	9.7
119	0	0	0	0	0.0	0.0
120	0	0	0	0	0.0	0.0
121	35	0.58	34.8	16.4	4.9	10.4
122	39	0.46	27.6	12.8	3.8	8.2
123	72	0.49	29.4	30.5	9.1	8.8
124	68	1.36	81.6	65.3	19.5	24.3
126	94	0.47	28.2	30.9	9.2	8.4
127	84	0.49	29.4	24.8	7.4	8.8
128	117	0.87	52.2	82.1	24.5	15.6

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Max Minutes Per Day	Total Theoretical Hours Per Year	Likely[6] Hours Per Year	Likely[4] Average Minutes per day
129	105	0.52	31.2	37.9	11.3	9.3
130	108	0.54	32.4	40.7	12.1	9.7
131	113	0.56	33.6	44.2	13.2	10.0
132	48	0.48	28.8	16.4	4.9	8.6
133	145	0.63	37.8	63.2	18.8	11.3
134	140	1.03	61.8	107.2	31.9	18.4
135	116	0.58	34.8	46.6	13.9	10.4
136	146	0.97	58.2	111.4	33.2	17.3
137	152	0.99	59.4	114.6	34.2	17.7
138	171	0.7	42	93.8	28.0	12.5
139	84	0.5	30	29.9	8.9	8.9
140	84	0.5	30	29.9	8.9	8.9
141	186	1.04	62.4	123	36.7	18.6
142	198	1.23	73.8	145	43.2	22.0
143	198	1.23	73.8	139.1	41.5	22.0
144	124	0.64	38.4	54.4	16.2	11.4
145	200	1.2	72	128.3	38.2	21.5
146	200	1.22	73.2	131.4	39.2	21.8
147	156	0.58	34.8	68.1	20.3	10.4
148	193	1.21	72.6	114.7	34.2	21.6
149	199	1.33	79.8	128.2	38.2	23.8
150	188	0.59	35.4	85.6	25.5	10.5
151	80	0.52	31.2	28.3	8.4	9.3
152	213	1.11	66.6	129.1	38.5	19.8
153	123	0.58	34.8	46	13.7	10.4
154	126	0.59	35.4	47.7	14.2	10.5
155	155	0.64	38.4	64.7	19.3	11.4
156	155	0.73	43.8	70.1	20.9	13.1
157	183	0.68	40.8	77.2	23.0	12.2
158	147	0.67	40.2	63.5	18.9	12.0
159	154	0.68	40.8	66.6	19.8	12.2
160	183	0.71	42.6	81.2	24.2	12.7
162	229	0.89	53.4	131.7	39.2	15.9
163	175	0.72	43.2	77.6	23.1	12.9

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Max Minutes Per Day	Total Theoretical Hours Per Year	Likely[6] Hours Per Year	Likely[4] Average Minutes per day
164	38	0.5	30	13.9	4.1	8.9
165	140	0.74	44.4	69.1	20.6	13.2
166	184	0.72	43.2	81.4	24.3	12.9
167	212	0.73	43.8	95.6	28.5	13.1
168	134	0.75	45	68.8	20.5	13.4
169	205	0.74	44.4	104.5	31.1	13.2
170	132	0.79	47.4	70.7	21.1	14.1
171	199	0.76	45.6	109.5	32.6	13.6
172	127	0.86	51.6	69.8	20.8	15.4
173	188	0.76	45.6	105.4	31.4	13.6
174	187	0.78	46.8	105.5	31.4	13.9
175	117	1.05	63	66.5	19.8	18.8
176	176	0.88	52.8	107.2	31.9	15.7
177	168	0.88	52.8	98.3	29.3	15.7
178	123	1.12	67.2	78	23.2	20.0
179	124	0.65	39	60.6	18.1	11.6
180	36	0.47	28.2	12.2	3.6	8.4
181	162	0.92	55.2	83.7	24.9	16.4
182	153	1.22	73.2	116.5	34.7	21.8
183	158	0.86	51.6	86	25.6	15.4
184	151	0.82	49.2	86.3	25.7	14.7
185	144	0.82	49.2	85.9	25.6	14.7
186	59	0.6	36	26.7	8.0	10.7
187	53	0.54	32.4	21.3	6.3	9.7
188	53	0.54	32.4	21.3	6.3	9.7
189	69	0.54	32.4	31.2	9.3	9.7
190	69	0.53	31.8	30.4	9.1	9.5
191	41	0.39	23.4	11.6	3.5	7.0
192	41	0.39	23.4	11.6	3.5	7.0
193	0	0	0	0	0.0	0.0
194	0	0	0	0	0.0	0.0
195	0	0	0	0	0.0	0.0
196	87	0.49	29.4	33.2	9.9	8.8
197	0	0	0	0	0.0	0.0

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Max Minutes Per Day	Total Theoretical Hours Per Year	Likely[6] Hours Per Year	Likely[4] Average Minutes per day
198	0	0	0	0	0.0	0.0
199	0	0	0	0	0.0	0.0
200	0	0	0	0	0.0	0.0
201	0	0	0	0	0.0	0.0
202	0	0	0	0	0.0	0.0
203	0	0	0	0	0.0	0.0
204	0	0	0	0	0.0	0.0
205	0	0	0	0	0.0	0.0
206	30	0.21	12.6	4.4	1.3	3.8
207	0	0	0	0	0.0	0.0
208	0	0	0	0	0.0	0.0
209	0	0	0	0	0.0	0.0
210	0	0	0	0	0.0	0.0

Scenario 2

11.49 **Figure 11-2** shows the estimated annual hours of shadow flicker effect across the study area. Based on the predictive modelling technique outlined above, there is predicted to be shadow flicker effects of up to 154.6 hours per year, with the highest potential effect found on receptor 142 (shown in **Table 11-6**) assuming the worst-case scenario. Of the 211 receptors in the study area, 24 would not experience any shadow flicker effects arising as a result of the operational phase of the wind farm.

11.50 The total theoretical hours per year results shown in **Table 11-6** are based on the 'worst-case scenario', which does not make any allowance for average sunshine hours and assumes the sun and shining and the wind is blowing 100% of daylight hours. The "likely" scenario takes into account the long-term average sunshine hours per year (29.8%) recorded at the nearest Met Éireann Met Station (see Section 11.42).

Table 11-6 Shadow Flicker Effects Scenario 2

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Hours Per Day	Total Theoretical Hours Per Year	Likely[7] Hours Per Year	Likely[4] Average Minutes per day
1	0	0	0	0	0.0	0.0
2	0	0	0	0	0.0	0.0

[7] Based on the average sunshine hours for the site of 29.8%.

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Hours Per Day	Total Theoretical Hours Per Year	Likely[7] Hours Per Year	Likely[4] Average Minutes per day
3	0	0	0	0	0.0	0.0
4	0	0	0	0	0.0	0.0
5	0	0	0	0	0.0	0.0
6	0	0	0	0	0.0	0.0
7	28	22.2	0.29	8.1	2.4	6.6
8	0	0	0	0	0.0	0.0
9	42	30.6	0.42	17.7	5.3	9.1
10	47	30.6	0.42	19.8	5.9	9.1
11	43	31.2	0.42	18.1	5.4	9.3
12	0	0	0	0	0.0	0.0
13	0	0	0	0	0.0	0.0
14	62	34.8	0.49	30.6	9.1	10.4
15	48	29.4	0.32	15.3	4.6	8.8
16	70	28.8	0.29	20	6.0	8.6
17	30	28.2	0.37	11.1	3.3	8.4
18	121	33	0.4	49	14.6	9.8
19	38	27.6	0.32	12.2	3.6	8.2
20	38	27.6	0.32	12.3	3.7	8.2
21	39	27.6	0.32	12.4	3.7	8.2
22	40	28.8	0.34	13.7	4.1	8.6
23	38	27.6	0.33	12.4	3.7	8.2
24	38	28.2	0.33	12.6	3.8	8.4
25	39	27.6	0.32	12.5	3.7	8.2
26	38	27	0.31	11.8	3.5	8.0
27	36	27	0.32	11.5	3.4	8.0
28	38	27	0.3	11.4	3.4	8.0
29	37	27	0.31	11.4	3.4	8.0
30	37	27	0.31	11.3	3.4	8.0
31	40	28.8	0.34	13.4	4.0	8.6
32	38	28.8	0.34	13.1	3.9	8.6
33	38	28.2	0.34	12.8	3.8	8.4
34	38	28.2	0.33	12.7	3.8	8.4
35	38	27.6	0.32	12.3	3.7	8.2
36	36	27.6	0.33	12	3.6	8.2

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Hours Per Day	Total Theoretical Hours Per Year	Likely[7] Hours Per Year	Likely[4] Average Minutes per day
37	39	28.2	0.33	12.9	3.8	8.4
38	38	28.8	0.34	12.9	3.8	8.6
39	36	27	0.32	11.4	3.4	8.0
40	38	28.8	0.34	13	3.9	8.6
41	40	28.8	0.33	13.1	3.9	8.6
42	36	27	0.32	11.6	3.5	8.0
43	36	26.4	0.3	11	3.3	7.9
44	38	28.8	0.35	13.2	3.9	8.6
45	38	28.2	0.33	12.7	3.8	8.4
46	37	27.6	0.32	11.7	3.5	8.2
47	38	28.8	0.35	13.3	4.0	8.6
48	38	28.2	0.34	12.8	3.8	8.4
49	38	27.6	0.32	12.1	3.6	8.2
50	36	27	0.31	11	3.3	8.0
51	39	28.8	0.33	12.9	3.8	8.6
52	39	28.8	0.33	13	3.9	8.6
53	37	27.6	0.32	12	3.6	8.2
54	36	27	0.31	11.1	3.3	8.0
55	38	28.8	0.34	13	3.9	8.6
56	36	27	0.31	11.2	3.3	8.0
57	126	55.2	0.56	70.5	21.0	16.4
58	37	28.2	0.33	12.2	3.6	8.4
59	40	28.8	0.33	13.2	3.9	8.6
60	36	27	0.32	11.4	3.4	8.0
61	37	28.2	0.34	12.4	3.7	8.4
62	39	28.8	0.34	13.3	4.0	8.6
63	61	31.2	0.34	20.7	6.2	9.3
64	36	26.4	0.3	10.9	3.2	7.9
65	38	29.4	0.35	13.4	4.0	8.8
66	34	26.4	0.32	10.7	3.2	7.9
67	38	28.2	0.33	12.7	3.8	8.4
68	40	29.4	0.34	13.6	4.1	8.8
69	40	29.4	0.34	13.6	4.1	8.8
70	38	28.8	0.34	12.8	3.8	8.6

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Hours Per Day	Total Theoretical Hours Per Year	Likely[7] Hours Per Year	Likely[4] Average Minutes per day
71	38	27.6	0.31	11.8	3.5	8.2
72	36	27.6	0.32	11.6	3.5	8.2
73	38	28.8	0.34	13	3.9	8.6
74	36	27	0.32	11.4	3.4	8.0
75	34	27	0.33	11.1	3.3	8.0
76	36	27	0.31	11	3.3	8.0
77	35	26.4	0.31	10.8	3.2	7.9
78	38	28.8	0.35	13.1	3.9	8.6
79	34	26.4	0.31	10.6	3.2	7.9
80	38	28.8	0.35	13.1	3.9	8.6
81	37	28.2	0.33	12.1	3.6	8.4
82	36	27.6	0.33	11.9	3.5	8.2
83	36	27.6	0.33	11.7	3.5	8.2
84	36	27.6	0.32	11.5	3.4	8.2
85	36	27	0.32	11.4	3.4	8.0
86	36	27	0.31	11.2	3.3	8.0
87	34	27	0.32	11	3.3	8.0
88	136	66	0.69	94.1	28.0	19.7
89	33	26.4	0.31	10.4	3.1	7.9
90	141	71.4	0.72	101.5	30.2	21.3
91	34	26.4	0.31	10.7	3.2	7.9
92	34	26.4	0.32	10.8	3.2	7.9
93	34	27	0.32	11	3.3	8.0
94	148	61.8	0.6	89.1	26.6	18.4
95	146	71.4	0.72	105.2	31.3	21.3
96	148	60	0.52	77.2	23.0	17.9
97	91	35.4	0.37	33.8	10.1	10.5
98	161	70.2	0.54	86.7	25.8	20.9
99	162	72.6	0.63	101.3	30.2	21.6
100	46	33	0.38	17.3	5.2	9.8
101	84	36	0.38	31.7	9.4	10.7
102	34	27.6	0.32	10.8	3.2	8.2
103	75	29.4	0.34	25.8	7.7	8.8
104	34	27	0.31	10.5	3.1	8.0

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Hours Per Day	Total Theoretical Hours Per Year	Likely[7] Hours Per Year	Likely[4] Average Minutes per day
105	88	33.6	0.4	34.9	10.4	10.0
106	88	34.2	0.41	35.8	10.7	10.2
107	93	35.4	0.43	39.8	11.9	10.5
108	43	34.2	0.4	17	5.1	10.2
109	96	34.8	0.43	40.9	12.2	10.4
110	42	31.8	0.39	16.3	4.9	9.5
111	109	41.4	0.57	62.5	18.6	12.3
112	92	45	0.63	58.4	17.4	13.4
113	103	41.4	0.58	59.9	17.9	12.3
114	81	43.8	0.53	42.7	12.7	13.1
115	10	10.8	0.13	1.3	0.4	3.2
116	0	0	0	0	0.0	0.0
117	0	0	0	0	0.0	0.0
118	81	33.6	0.47	38	11.3	10.0
119	8	9.6	0.13	1	0.3	2.9
120	6	4.8	0.06	0.4	0.1	1.4
121	40	39.6	0.54	21.6	6.4	11.8
122	157	28.8	0.32	50.8	15.1	8.6
123	110	30.6	0.4	43.8	13.1	9.1
124	71	86.4	1.03	73.1	21.8	25.7
125	80	30	0.36	29.2	8.7	8.9
126	98	29.4	0.34	33.2	9.9	8.8
127	84	30	0.32	26.5	7.9	8.9
128	119	54	0.76	90.4	26.9	16.1
129	108	32.4	0.38	40.7	12.1	9.7
130	113	33.6	0.39	43.7	13.0	10.0
131	120	34.8	0.4	47.4	14.1	10.4
132	48	30	0.36	17.4	5.2	8.9
133	159	39.6	0.53	84.8	25.3	11.8
134	176	66.6	0.7	123.8	36.9	19.8
135	120	36.6	0.42	49.9	14.9	10.9
136	148	61.8	0.82	121.4	36.2	18.4
137	154	63	0.81	124.3	37.0	18.8
138	171	43.8	0.58	99.6	29.7	13.1

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Hours Per Day	Total Theoretical Hours Per Year	Likely[7] Hours Per Year	Likely[4] Average Minutes per day
139	89	31.2	0.37	32.7	9.7	9.3
140	89	31.2	0.37	32.7	9.7	9.3
141	189	66.6	0.69	130.7	38.9	19.8
142	201	78.6	0.77	154.6	46.1	23.4
143	203	78.6	0.73	147.8	44.0	23.4
144	135	55.2	0.51	68.5	20.4	16.4
145	203	76.2	0.67	135.5	40.4	22.7
146	204	77.4	0.68	139	41.4	23.1
147	191	36	0.45	85.6	25.5	10.7
148	203	75.6	0.61	123.9	36.9	22.5
149	209	83.4	0.67	140	41.7	24.9
150	193	37.2	0.47	91.4	27.2	11.1
151	82	32.4	0.37	30.5	9.1	9.7
152	217	68.4	0.64	138.6	41.3	20.4
153	128	36	0.39	49.7	14.8	10.7
154	130	36.6	0.39	51.3	15.3	10.9
155	196	40.2	0.41	81.3	24.2	12.0
156	163	45	0.46	75.6	22.5	13.4
157	190	42.6	0.44	83.9	25.0	12.7
158	155	41.4	0.44	68.6	20.4	12.3
159	159	42.6	0.45	71.9	21.4	12.7
160	189	44.4	0.46	87.3	26.0	13.2
161	37	28.2	0.33	12.1	3.6	8.4
162	235	55.8	0.6	140.8	42.0	16.6
163	182	44.4	0.46	83.9	25.0	13.2
164	41	30.6	0.36	14.8	4.4	9.1
165	179	45.6	0.49	88.4	26.3	13.6
166	192	44.4	0.46	88.1	26.3	13.2
167	214	45.6	0.48	103	30.7	13.6
168	169	46.8	0.52	88.3	26.3	13.9
169	208	46.2	0.53	111.1	33.1	13.8
170	165	51.6	0.55	91	27.1	15.4
171	202	47.4	0.58	116.5	34.7	14.1
172	132	55.8	0.57	75.2	22.4	16.6

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Hours Per Day	Total Theoretical Hours Per Year	Likely[7] Hours Per Year	Likely[4] Average Minutes per day
173	189	49.8	0.6	112.9	33.6	14.8
174	188	51	0.6	113.5	33.8	15.2
175	121	66.6	0.59	71.6	21.3	19.8
176	176	57	0.65	114	34.0	17.0
177	169	55.8	0.62	104.4	31.1	16.6
178	129	69	0.65	83.6	24.9	20.6
179	151	40.8	0.53	80.3	23.9	12.2
180	37	29.4	0.35	13.1	3.9	8.8
181	166	57	0.54	90	26.8	17.0
182	154	75.6	0.8	123	36.7	22.5
183	159	53.4	0.58	91.7	27.3	15.9
184	152	51	0.6	91.9	27.4	15.2
185	145	51	0.63	91.5	27.3	15.2
186	105	39	0.41	43.2	12.9	11.6
187	55	33.6	0.4	22.2	6.6	10.0
188	55	33.6	0.4	22.2	6.6	10.0
189	69	33.6	0.47	32.4	9.7	10.0
190	69	33	0.46	31.7	9.4	9.8
191	42	24	0.29	12.4	3.7	7.2
192	42	24	0.29	12.4	3.7	7.2
193	53	27.6	0.34	17.8	5.3	8.2
194	60	28.2	0.34	20.1	6.0	8.4
195	60	28.2	0.34	20.1	6.0	8.4
196	87	30.6	0.41	35.2	10.5	9.1
197	74	28.2	0.33	24.6	7.3	8.4
198	0	0	0	0	0.0	0.0
199	0	0	0	0	0.0	0.0
200	0	0	0	0	0.0	0.0
201	0	0	0	0	0.0	0.0
202	0	0	0	0	0.0	0.0
203	0	0	0	0	0.0	0.0
204	0	0	0	0	0.0	0.0
205	0	0	0	0	0.0	0.0
206	31	13.2	0.16	4.9	1.5	3.9

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Hours Per Day	Total Theoretical Hours Per Year	Likely[7] Hours Per Year	Likely[4] Average Minutes per day
207	0	0	0	0	0.0	0.0
208	0	0	0	0	0.0	0.0
209	0	0	0	0	0.0	0.0
210	0	0	0	0	0.0	0.0
211	0	0	0	0	0.0	0.0

Annual Impacts

Scenario 1

11.51 There are no properties located within 500 m of the proposed turbines. Based on the theoretical worst-case results in **Table 11-4** 74 receptors would experience shadow flicker effects in excess of 30 hours per year, with the property experiencing the highest annual hours being house receptor 142, experiencing 145 hrs per annum on a worst-case model basis.

11.52 Applying the average sunshine hours to the model results in 18 properties exceeding the 30 hours per annum guidance, the property experiencing the highest annual hours is again house number 142 which would experience 43.2 hrs of shadow flicker per annum.

Scenario 2

11.53 There are no properties located within 500 m of the proposed turbines. Based on the theoretical worst-case results in **Table 11-4**, 83 receptors would experience shadow flicker effects in excess of 30 hours per year, with the property experiencing the highest annual hours being house receptor 142, experiencing 154.6 hrs per annum on a worst-case model basis.

11.54 Applying the average sunshine hours to the model results in 23 properties exceeding the 30 hours per annum guidance, the property experiencing the highest annual hours is again house number 142 which would experience 46.1 hrs of shadow flicker per annum.

Daily Impacts

Scenario 1

11.55 Based on the theoretical worst-case results above, 84 receptors would experience average shadow flicker effects in excess of 30 minutes per day, with the property experiencing the highest daily exposure being receptor number 124, experiencing 81.6 minutes per day on a worst-case basis, although it is noted that all the properties are in excess of 500m from the nearest turbine.

11.56 Applying the average sunshine hours to the model would mean no property is likely to experience more than 24.3 minutes per day of shadow flicker without mitigation.

Scenario 2

11.57 Based on the theoretical worst-case results above, 92 receptors would experience average shadow flicker effects in excess of 30 minutes per day, with the property experiencing the highest daily exposure being house number 124 (an involved property), experiencing 86.4 minutes per day on a worst-case basis, although it is noted that all the properties are in excess of 500m from the nearest turbine.

11.58 Applying the average sunshine hours to the model would mean no property is likely to experience more than 25.7 minutes per day of shadow flicker.

Potential Impact of Zero Shadow Flicker

11.59 Shadow flicker control modules, consisting of light sensors and specialised software, will be installed on all turbines, irrespective of which turbine is installed. This is to prevent operation during periods when shadow flicker is experienced at nearby properties if it is determined there is an issue post-construction.

11.60 The shadow flicker control module consists of bespoke software, a clock, a timer, a switch, a wind direction sensor and a light sensor. The module can control a specific turbine (or turbines) which would be programmed to shut down on specific dates at specific times when the sun is bright enough, there is sufficient wind to rotate the blades and the wind direction is such that nuisance shadow flicker could occur.

11.61 The installation of a programmable shadow flicker module will allow future conditional control of turbines in order to eliminate shadow flicker, irrespective of which turbine in the range is installed. The correct operation of the installed shadow flicker control measures will ensure that there will be no impact from shadow flicker. The operation and performance of the shadow flicker control measures will be monitored on an ongoing basis.

11.62 Under the WEG (2006) guidance shut down periods cover the periods of potential nuisance in excess of 30 hrs per year. The applicant is committed to a zero-shadow flicker strategy which means that the turbines shadow flicker module will be programmed to shut down whenever the conditions for shadow flicker at a property are met, irrespective of which turbine in the range is installed.

11.63 Under this approach there would be no shadow flicker experienced at any property, and therefore no impacts on any receptors.

11.64 Details of the potential shut down times of the turbines are provided in **Appendix 11-2** (Scenario 1) and **Appendix 11-3** (Scenario 2).

Do nothing Scenario

11.65 In the 'Do-Nothing' Scenario, the Proposed Development would not be constructed and the potential impacts from shadow flicker on local receptors would not occur. It follows that no mitigation measures would be required under this scenario.

Cumulative Impacts

11.66 As the Shadow Flicker Control Measures will ensure no shadow flicker effects from Knockanarragh Wind Farm, there will be no cumulative impacts with any nearby wind farms.

Conclusion

11.67 A shadow flicker assessment has been undertaken on up to 211 receptors within 10 rotor diameters of the proposed turbines, under two study area scenarios. When considering the 'Average Theoretical Minutes Per Day', (accounting for any day in which shadow flicker is predicted to occur) then shadow flicker exceeds 30 minutes at 84 receptors under Scenario 1, and 92 receptors under Scenario 2.

11.68 When considering the 'Total Theoretical Hours Per Year', 74 receptors are predicted to exceed the WEDG 2006 threshold of more than 30 hours per year under Scenario 1, and 83 under Scenario 2.

11.69 However, when accounting for a more 'likely' scenario, where the average annual sunshine hours are taken into account, 18 receptors are predicted to exceed more than 30 hours per year under Scenario 1, and 23 properties are predicted to exceed more than 30 hours per year under Scenario 2.

11.70 The results of the conservative shadow flicker assessment predict that the Proposed Development has the potential to introduce shadow flicker impacts at some buildings surrounding the wind farm. However, the applicant is committed to implementing a zero-shadow flicker approach in line with the 2019 Draft Revised Wind Energy Development Guidelines. This will be undertaken by shutting down turbines during times when wind and climactic conditions are such that shadow flicker could occur, using appropriate mitigation measures such as the turbines inbuilt shadow flicker control module. The module would control a specific turbine (or turbines) which would be programmed to shut down on specific dates at specific times when the sun is bright enough, there is sufficient wind to rotate the blades and the wind direction is such that nuisance shadow flicker could occur.

11.71 The implementation of the proposed mitigation measures, namely a zero-shadow flicker approach, will ensure that shadow flicker at all buildings is eliminated resulting in no impacts to receptors.

References

- Department of the Environment, Heritage and Local Government (DoEHLG) (2006). Wind Energy Development Guidelines. Available at: https://www.opr.ie/wp-content/uploads/2019/08/2006-Wind-Energy-Development1.pdf
- Department of Housing, Planning and Local Government (2019), Draft Revised Wind Energy Development Guidelines. Available at: https://www.housing.gov.ie/sites/default/files/publicconsultation/files/draft_revised_wind_energy_development_guidelines_december_2019.pdf
- Meath County Council Local Development Plan 2021-2027. Available at: https://consult.meath.ie/en/consultation/meath-adopted-county-development-plan
- Westmeath County Council Development Plan 2021-2027. Available at: https://www.westmeathcoco.ie/en/ourservices/planning/developmentplans/countydevelopmentplan2021-2027/

Figures

660000 661000 662000 663000 664000 665000 666000 667000

770000 769000 768000 767000 766000 765000

MEATH
WESTMEATH

T1 T2 T3 T4 T5 T6 T7 T8

Killallon Close
Raiskeen Place
Cluaine Mhor

N

LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Location
- Proposed Access Point
- Proposed Internal Cable Route
- Proposed Cable Route
- Proposed Access Track
- Proposed Construction Compound
- Proposed Operational Compound
- Proposed Substation Location
- Proposed Borrow Pit Search Area
- Proposed Crane Hardstanding
- Existing High Voltage Transmission Line
- County Boundary
- Residential Receptor
- Shadow Flicker Study Area Scenario 1

Oldcastle Kells Delvin Athboy

0 0.5 1
Kilometres

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SHADOW FLICKER

SHADOW FLICKER STUDY AREA SCENARIO 1

FIGURE 11-1

Scale 1:25,000 @ A3

Date MARCH 2024

02036.00812.0126.0 Shadow Flicker Study Area

660000 661000 662000 663000 664000 665000 666000 667000

770000 769000 768000 767000 766000

MEATH
WESTMEATH

T1 T2 T3 T4 T5 T6 T7 T8

N

LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Location
- Proposed Access Point
- Proposed Main Ring Unit
- Proposed Internal Cable Route
- Proposed Cable Route
- Proposed Access Track
- Proposed Construction Compound
- Proposed Operational Compound
- Proposed Substation Location
- Proposed Borrow Pit Search Area
- Proposed Crane Hardstanding
- Existing High Voltage Transmission Line
- County Boundary
- Residential Receptor
- Shadow Flicker Study Area Scenario 2

Killallon Close
Kilaskeen Place
Cluaine Mhor

Oldcastle
Kells
Delvin
Athboy

0 0.5 1
Kilometres

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SHADOW FLICKER

SHADOW FLICKER STUDY AREA SCENARIO 2

FIGURE 11-2

Scale 1:25,000 @ A3

Date MARCH 2024

02036.00812.0133.0 Shadow Flicker Study Area Scenario 2

660000 661000 662000 663000 664000 665000 666000 667000

770000 769000 768000 767000 766000

MEATH
WESTMEATH

T1 T2 T3 T4 T5 T6 T7 T8

N

Killallon Close

Milestone Cross Roads

Derry's Cross Roads

N52

LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Location
- Proposed Access Point
- Proposed Internal Cable Route
- Proposed Cable Route
- Proposed Access Track
- Proposed Construction Compound
- Proposed Operational Compound
- Proposed Substation Location
- Proposed Borrow Pit Search Area
- Proposed Crane Hardstanding
- Existing High Voltage Transmission Line
- County Boundary
- Residential Receptor
- Shadow Flicker Study Area Scenario 1

Zone of Potential Shadow Flicker Influence (hours per year)

- 0 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 600
- 600 - 700
- 700 - 800
- 800 - 900
- 900 - 1,000
- 1,000 - 11,000

0 0.5 1
Kilometres

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SHADOW FLICKER

SHADOW FLICKER RESULTS SCENARIO 1

FIGURE 11-3

Scale 1:25,000 @ A3

Date MARCH 2024

02036.00812.0134.0 Shadow Flicker Results Scenario 1

660000 661000 662000 663000 664000 665000 666000 667000

770000 769000 768000 767000 766000

MEATH
WESTMEATH

T1 T2 T3 T4 T5 T6 T7 T8

N

LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Location
- Proposed Access Point
- Proposed Internal Cable Route
- Proposed Cable Route
- Proposed Access Track
- Proposed Construction Compound
- Proposed Operational Compound
- Proposed Substation Location
- Proposed Borrow Pit Search Area
- Proposed Crane Hardstanding
- Existing High Voltage Transmission Line
- County Boundary
- Residential Receptor
- Shadow Flicker Study Area Scenario 2

Zone of Potential Shadow Flicker Influence (hours per year)

- 0 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 600
- 600 - 700
- 700 - 800
- 800 - 900
- 900 - 1,000
- 1,000 - 11,000

0 0.5 1
Kilometres

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SHADOW FLICKER

SHADOW FLICKER RESULTS SCENARIO 2

FIGURE 11-4

Scale 1:25,000 @ A3

Date MARCH 2024

02036.00812.0135.0 Shadow Flicker Results Scenario 2

Appendices

Appendix 11-1: Shadow Flicker Modelling Input Data by House / Window

Appendix 11-2: Shadow Flicker Scenario 1 Shutdown Times by Turbine v1

Appendix 11-3: Shadow Flicker Scenario 2 Shutdown Times by Turbine v1

(Refer to EIAR Volume III for Appendices)