MWP

Chapter 15 Shadow Flicker

Balinlee Wind Farm

Ballinlee Green Energy Ltd.

September 2025

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15. Shadow Flicker

15.1 Introduction

Ballinlee Green Energy Ltd. are applying for planning consent for a renewable energy development comprising of seventeen (17) No. wind turbines referred to as the Ballinlee Wind Farm.

Table 2-1 of Volume II, Chapter 02 Description of the Proposed Development of this EIAR sets out the characteristics of the project elements for which development consent is being sought and all other associated project components.

This chapter considers the potential impact to Population and Human Health from shadow flicker generated by the proposed development during the operational phase. This chapter relates solely to the operational wind turbines. Shadow flicker is defined as the alternating light intensity produced by a wind turbine as the rotating blade casts shadows on the ground and stationary objects, such as the window of a residence. Shadow flicker can only occur if there is an unobstructed direct line of sight from within a dwelling to a turbine.

No flicker will occur when the turbines are stationary or when the sun is obscured by clouds or fog, or if blinds or curtains are drawn at the receptor location.

The shadow flicker assessment described herein will inform the Shadow Flicker Control Measures (SFCM) that will be designed for each turbine to ensure that shadow flicker does not occur at a receptor location.

15.1.1 Scope of Assessment

In general, the shadow flicker assessment methodology involves the identification of houses and other sensitive receptors within a defined study area, which have the potential to be adversely impacted by shadow flicker. The Wind Energy Development Guidelines (2006) provide that *"At distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low"*. In line with best practice guidance, the study area is usually limited to a distance (between a house and wind turbine) equivalent in length to 10 of the proposed wind turbine rotor diameters.

Computer software is then used to predict the occurrence of shadow flicker at each receptor within the study area, which is known to over-estimate the possible impact. This is explained in more detail in Section 15.3.4.

The results are compared against the criteria in the existing 2006 Wind Energy Development Guidelines. Consideration has also been given to the 2019 Draft Revised Wind Energy Development Guidelines.

15.1.2 Competency of the Assessor

This technical assessment was undertaken by Jeremy King and Kieran Barry of Malachy Walsh and Partners (MWP).

Jeremy is the lead GIS technician in MWP assisting the Civil and Environmental departments. Jeremy has qualifications in Computer Aided Design (CAD) and GIS. Jeremy has prepared the shadow flicker impact model for this assessment and has prepared numerous models which form part of the assessments for inclusion in various other wind farm Environmental Impact Assessment Reports.

Kieran is an experienced Environmental Scientist BEng, PgDip, CEnv who works on a variety of infrastructure projects conducting environmental assessments and supporting the delivery of a number of environmental deliverables including Environmental Impact Assessment (EIA) Screening Reports, feasibility and constraints studies, route option assessments and Environmental Impact Assessment Reports (EIAR).

15.1.3 Statement on Limitations and Difficulties Encountered

No limitations or difficulties were encountered when undertaking this assessment or compiling the chapter. The data sources for identifying receptors include the Limerick City and County Council Planning database and GeoDirectory Database.

15.2 Study Area

15.2.1 Site Location and Description

The proposed development is located in a rural area of east Limerick approximately 18km south of Limerick City and approximately 3km southwest of Bruff. **Figure 15-1** outlines the location of the proposed development and indicates the planning application boundary included in the planning application. The area within this boundary is approximately 255.12 ha. A detailed description of the proposed development site is included in **Volume II**, **Chapter 02** Description of the Proposed Development of this EIAR.

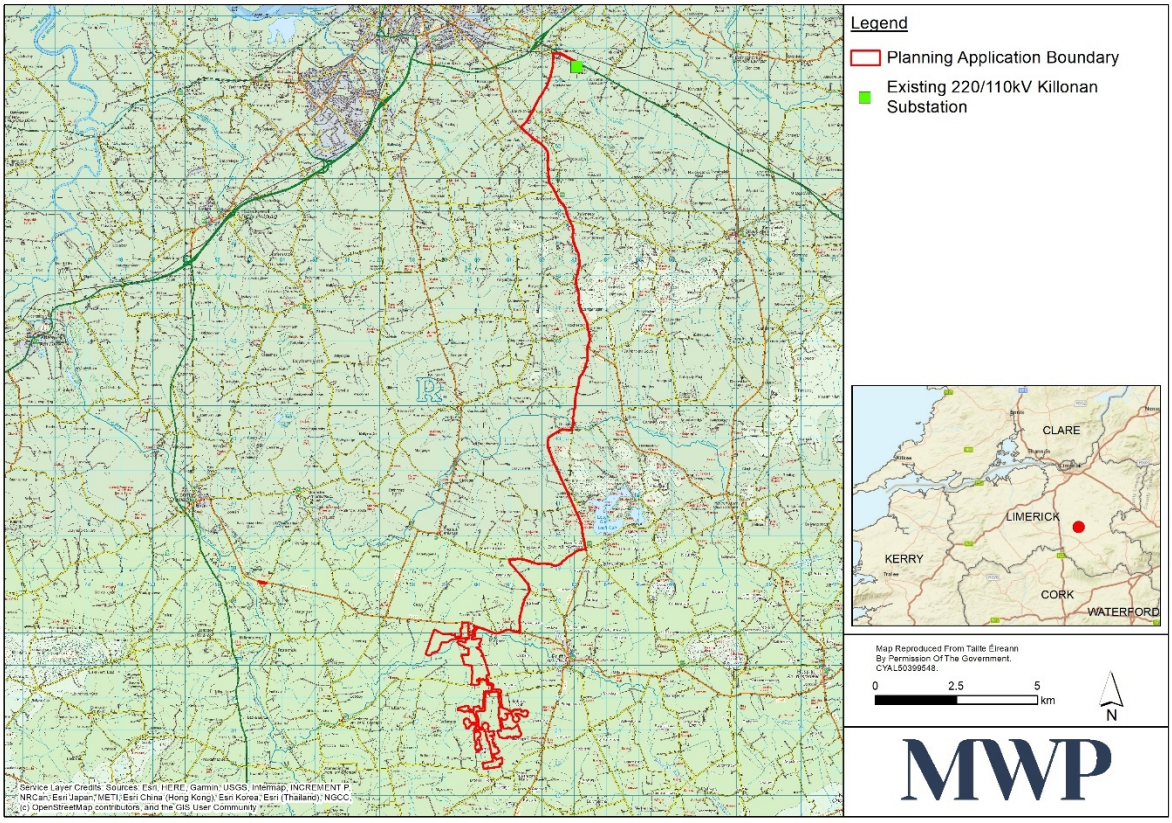

Figure 15-1: Site Location

15.2.2 Study Area

In line with best practice guidance, the study area is limited to a distance (between a house and wind turbine) equivalent in length to 10 of the proposed wind turbine rotor diameters. Determining shadow flicker based on the 10-rotor diameter rule has been widely accepted across different European countries and is deemed to be an appropriate assessment area (Parsons Brinckerhoff, 2011).

All residential properties located within this area were identified using a combination of the Limerick City and County Council Planning database and the GeoDirectory database. These dwellings were then included in the shadow flicker modelling exercise. The location of the study area in relation to the proposed turbines and identified receptors is shown in **Figure 15-3**.

The assessment therefore focuses on residential receptors within this defined study area, as receptors outside this boundary are considered unlikely to experience shadow flicker to any significant degree.

15.3 Methodology

The three key factors related to shadow flicker occurrence (measured in number of hours per year) are i) the spatial relationships between a wind turbine and the receptor, ii) the wind direction and iii) the sunshine hours. These are discussed below.

15.3.1 Spatial Relationships

At distances of greater than approximately 500 metres between a turbine and a receptor, shadow flicker generally occurs only at sunrise or sunset when the cast shadows are extremely long. It is generally considered that the occurrence of shadow flicker is very low "at distances greater than 10 rotor diameters from a turbine".[1] or at a distance greater than 1 kilometre (km). This is because at such separation distance, the rotor of a wind turbine will not appear to be chopping light, but the turbine will be regarded as an object with the sun behind it[2].

Figure 15-2 shows an approximation of the shadow cast by a turbine at various times during the day, where the red shading represents the area where shadow flicker may occur.

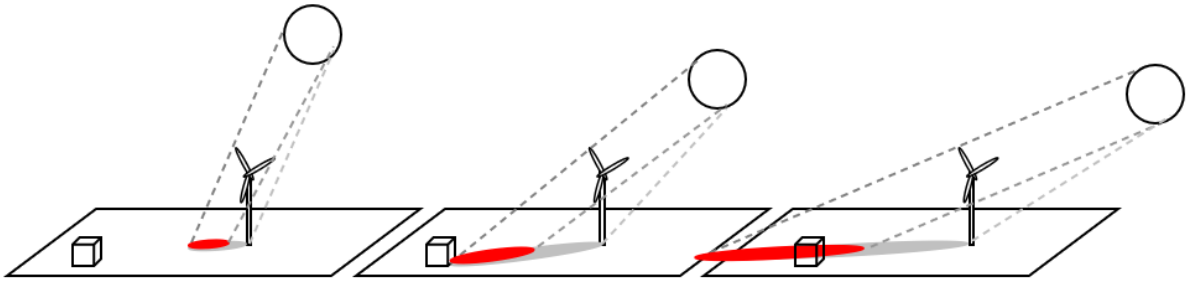

Figure 15-2: Area prone to shadow as a function of time of day

15.3.2 Wind Direction

The angle between the sun and the rotor plane also plays a determining role for both shadow flicker occurrence and intensity. The rotor plane is determined by the direction of the wind. As the turbine rotor continuously yaws to face the wind, the rotor plane will always be perpendicular to the wind direction. Shadow flicker will be most pronounced when the rotor plane is perpendicular to the sun-receptor line of sight.

15.3.3 Sunshine Hours

The shadow flicker analysis assumes the sun is always shining. It is reasonable to factor any results by the percentage of time the sun is actually shining. Ireland normally gets between 1,100 and 1,600 hours of sunshine each year. The sunniest months are May and June. During these months, sunshine duration averages between 5.5 and 5.9 hours per day over most of the country. The extreme southeast gets most sunshine, averaging over 7 hours a day in early summer. December is the dullest month, with an average daily sunshine ranging from about 1 hour in the north to almost 2 hours in the extreme southeast. Over the year as a whole, most areas get an average of between 3.25 and 3.75 hours of sunshine each day[3].

Using the 30-year average sunshine data available from Met Éireann for County Limerick it has been possible to determine the percentage of time shadow flicker may actually occur. These are presented in Table 15-1. Based on this data, the conditions necessary for shadow flicker (clouds not present) are only predicted to be present for approximately 29% of the day on average.

[1] Extract from the DoEHLG 2006 Guidelines, on occurrence of shadow flicker

[2] http://xn--drmstrre-64ad.dk/wp-content/wind/miller/windpower%20web/en/tour/env/shadow/shadow2.htm

[3] http://met.ie

Table 15-1: Average Hours of Sunshine and Average Hours of Day for County Limerick 1991-2020 (Shannon Airport Meteorological Station)

Month	Mean Daily Duration (hours)	Average Length of day (hours)	Proportion of day with sunshine (%)
Jan	1.7	8	21
Feb	2.4	10	24
Mar	3.6	12	30
Apr	5.4	14	39
May	5.9	16	37
Jun	5.5	17	32
Jul	4.4	16	28
Aug	4.6	14	33
Sept	3.9	13	30
Oct	3	11	27
Nov	2.1	9	23
Dec	1.5	8	19
Average		**Yearly Average**	**29%**

15.3.4 Theoretical Model Worst Case Assumptions

Shadow flicker was calculated for the proposed wind turbines using industry-standard simulation software *WindFarm*, a tool which has been successfully applied to a number of similar studies around the world. The model uses Ordnance Survey Ireland digital height data as its topographical reference. Simulations are run on a 'bare earth scenario' without allowing for the obscuring effect of vegetation between the location of the residence and the position of the sun in the sky, further contributing to the results being a worst case scenario. The model also does not consider any obscuring features around residences itself, which would minimise views of the site and hence reduce the potential for shadow flicker. Therefore, the *WindFarm* model uses a theoretical worst case scenario when reporting shadow flicker results for the existing environment. The model assumes that:

1. The sun will always be shining during daylight hours, with no cloud cover or fog.
2. The wind will blow continuously throughout the day and always above cut-in speed, i.e. the turbine will always be rotating.
3. The wind will always be blowing from a direction such that the turbine rotor is aligned with the sun-receptor line. In other words, the rotor will yaw in parallel with the sun such that the rotor blades are always perpendicular to the sun-receptor view line.
4. There will be no screening by vegetation or trees, i.e. a bare earth scenario.

An assumption is also made that the windows of the rooms, where the effects may occur, (i) directly face the development, (ii) that the rooms are occupied and (iii) that the curtains or blinds if present are open.

A more realistic simulation would use the following assumptions:

1. The sun will not always be shining therefore, it is only necessary to calculate shadow flicker for the fraction of time when the sun would be shining. Average sunshine hours used in this assessment are based on average monthly figures from the years 1991 to 2020, from the Shannon Airport Meteorological Station.
2. The rotor will not be turning all the time. For example, a turbine would not be rotating during maintenance works or no wind conditions.
3. The rotor blades will not always be perpendicular to the sun-receptor view line.
4. Trees, vegetation, local topography and buildings in the vicinity of the receptor will reduce shadow flicker or eliminate shadow flicker.

15.3.5 Realistic Scenario

The *Best Practice Guidelines for the Irish Wind Energy Industry, Irish Wind Energy Association, 2012* states that calculations for shadow flicker modelling generally assume 100% sunshine, and that it is reasonable in Ireland's climate to modify these figures. Therefore, the theoretical maximum shadow flicker as predicted by *WindFarm* was multiplied by the 'sunniness' factor of 0.29 (29 percent) to evaluate potential effects of the wind turbines (see Table 15-1).

Table 15-2 presents the Worst Case (Total hours per year) and the Realistic Scenario (modified to reflect cloud cover in the region). The shadow flicker software provides a conservative estimate as it simulates the worst case scenario, in terms of the yearly number of hours when the receptors are exposed to shadow flicker. The main assumptions of the model are:

- The sky is always clear. Therefore, cloud cover or fog is not considered.
- The turbine is facing the sun 100% of the time. Changes in wind direction are not considered.

- The turbine is continuously rotating, so that stopping due to low or high wind speed is not considered. Periods of maintenance when the wind turbine is stopped are also not considered.
- The shielding effects of close obstacles like trees or buildings are not considered.

In reality the sun is not always visible and often covered by clouds and therefore, the actual number of shadow flicker hours that a receptor experiences is lower than what the conservative software model simulates. As a result, the more realistic scenario is 29% of the worst case scenario predicted by the model (Total hours per year column) and is presented as such in the last column of **Table 15-2**. However, even this realistic estimate is still expected to overestimate the real case because:

- The orientation of the rotor was assumed to constantly be perpendicular to the sun-turbine axis and follow the sun's diurnal path. In reality the turbines yaw, i.e. turns on the tower, several times per day as the wind changes. As the predominant wind direction is south to south west, the effect of rotor orientation could be large.
- The rotor was assumed to be rotating constantly, which will not be the case, if the threshold, cut-in wind speeds are not reached.
- Vegetation was not considered in the assessment. Trees, shelter belts or other obstacles surrounding the receptor might reduce or cancel the shadow flicker effect.

As a result, the predicted annual shadow flicker effect presented is still conservative.

15.4 Assessment Criteria

Current assessment criteria are described in the Department of the Environment, Heritage and Local Government, Wind Energy Development Guidelines, 2006. These guidelines are currently under review and replacement Draft Wind Energy Development Guidelines were published in December 2019.

Until the revised guidelines are published in final form, the Government has advised that the current 2006 guidelines remain in force. However, with mitigation measures employed in full, the criteria in both documents can be achieved.

15.4.1 Wind Energy Development Guidelines (2006)

The current 2006 Wind Energy Development Guidelines recommend that shadow flicker at offices and dwellings within 500m of a turbine should not exceed 30 hours per year or 30 minutes per day. The guidelines also state that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

15.4.2 Draft Wind Energy Development Guidelines (2019)

The shadow flicker criteria described in the 2019 Draft Wind Energy Development Guidelines are extracted below.

The planning authority or An Coimisiún 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 and the wind energy development shall be installed and operated in accordance with the shadow flicker study submitted to accompany the planning application, including any measures required.

15.5 Baseline Environment

The Study Area for the purpose of this assessment on Shadow Flicker primarily focuses on the local receiving human environment and residential properties in the vicinity of the proposed wind farm development site, refer to **Figure 15-3**. Details in relation to the local receiving environment are outlined in **Chapter 05 Population and Human Health**.

In line with best practice, the scope of this assessment extends to a distance of 10 times the maximum rotor diameter (1.36km).

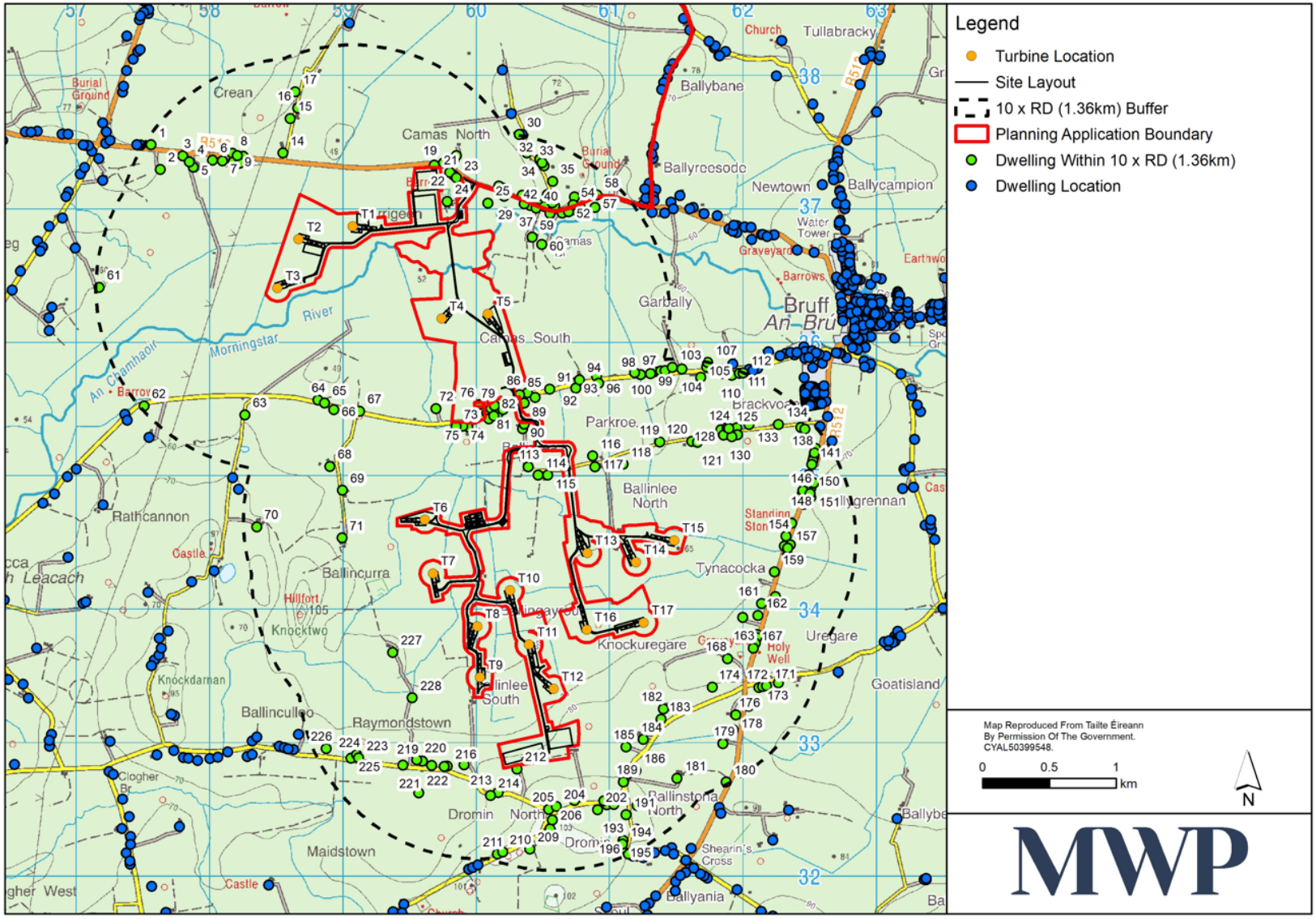

Figure 15-3: Wind Turbine and Dwelling Locations

15.6 Assessment of Impacts and Effects

15.6.1 Construction/Decommissioning Phase

The effects of shadow flicker are only applicable during the operational phase of the proposed development.

15.6.2 Operational Phase

The results of the shadow flicker model for all houses within 1.36 km (10 rotor diameters) are presented in **Table 15-2**.

Table 15-2: Shadow Flicker Modelling Results

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
1	557525	637529	44	0.45	27	15.5	4.5	0.13
2	557593	637345	113	0.5	30	44.5	12.9	0.15
3	557761	637446	87	0.55	33	32.8	9.5	0.16
4	557812	637402	121	0.58	34.8	48.1	13.9	0.17
5	557840	637362	127	0.6	36	52.9	15.3	0.17
6	557984	637414	138	0.65	39	64.5	18.7	0.19
7	558058	637409	137	0.65	39	71.7	20.8	0.19
8	558134	637465	124	0.67	40.2	64.7	18.8	0.19
9	558164	637448	125	0.7	42	67.9	19.7	0.20
10	558169	637448	125	0.7	42	67.8	19.7	0.20
11	558215	637443	124	0.72	43.2	67.9	19.7	0.21
12	558140	637402	134	0.71	42.6	77	22.3	0.21

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
13	558187	637392	135	0.75	45	80.3	23.3	0.22
14	558511	637468	99	0.86	51.6	65.3	18.9	0.25
15	558566	637726	35	0.44	26.4	12	3.5	0.13
16	558623	637805	0	0	0	0	0.0	0.00
17	558604	637926	0	0	0	0	0.0	0.00
18	559647	637376	80	1.16	69.6	60.1	17.4	0.34
19	559714	637395	71	1.05	63	50.6	14.7	0.30
20	559812	637448	66	0.93	55.8	41	11.9	0.27
21	559761	637323	60	0.93	55.8	41	11.9	0.27
22	559788	637303	56	0.88	52.8	37.1	10.8	0.26
23	559813	637282	54	0.83	49.8	33.7	9.8	0.24
24	559742	637105	58	0.74	44.4	34.7	10.1	0.21
25	560047	637092	41	0.54	32.4	17.8	5.2	0.16

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
26	560128	637220	38	0.5	30	15.2	4.4	0.15
27	560155	637207	39	0.49	29.4	14.6	4.2	0.14
28	560182	637195	37	0.48	28.8	14	4.1	0.14
29	560167	637143	37	0.49	29.4	14.3	4.1	0.14
30	560282	637606	0	0	0	0	0.0	0.00
31	560340	637468	0	0	0	0	0.0	0.00
32	560435	637421	0	0	0	0	0.0	0.00
33	560452	637394	0	0	0	0	0.0	0.00
34	560467	637372	0	0	0	0	0.0	0.00
35	560533	637256	37	0.38	22.8	11.4	3.3	0.11
36	560304	637151	58	0.44	26.4	17.4	5.0	0.13
37	560320	637088	79	0.47	28.2	28.3	8.2	0.14
38	560362	637106	79	0.46	27.6	28.2	8.2	0.13

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
39	560363	637074	87	0.48	28.8	32.4	9.4	0.14
40	560409	637054	61	0.49	29.4	26.6	7.7	0.14
41	560427	637081	58	0.48	28.8	24.2	7.0	0.14
42	560471	637067	65	0.66	39.6	29.6	8.6	0.19
43	560504	637058	69	0.81	48.6	37.3	10.8	0.23
44	560493	637155	51	0.45	27	19.2	5.6	0.13
45	560511	637138	56	0.46	27.6	21.9	6.4	0.13
46	560530	637095	65	0.69	41.4	30.7	8.9	0.20
47	560540	637082	69	0.78	46.8	36	10.4	0.23
48	560546	637071	71	0.83	49.8	39.9	11.6	0.24
49	560539	637046	75	0.88	52.8	45.8	13.3	0.26
50	560511	637014	77	0.92	55.2	50.2	14.6	0.27
51	560603	637018	85	0.94	56.4	59	17.1	0.27

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
52	560651	637028	87	0.92	55.2	55.6	16.1	0.27
53	560690	637043	88	0.89	53.4	53.1	15.4	0.26
54	560686	637079	82	0.87	52.2	52.2	15.1	0.25
55	560696	637139	74	0.83	49.8	44.6	12.9	0.24
56	560742	637055	90	0.86	51.6	51.2	14.8	0.25
57	560850	637059	77	0.52	31.2	32.9	9.5	0.15
58	560863	637153	63	0.48	28.8	25.5	7.4	0.14
59	560377	636836	131	1.21	72.6	104.5	30.3	0.35
60	560450	636783	112	1.29	77.4	98.3	28.5	0.37
61	557134	636461	33	0.43	25.8	11.1	3.2	0.12
62	557473	635572	0	0	0	0	0.0	0.00
63	558228	635506	0	0	0	0	0.0	0.00
64	558775	635617	126	0.55	33	55.6	16.1	0.16

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
65	558824	635595	110	0.51	30.6	46	13.3	0.15
66	558894	635545	134	0.5	30	56	16.2	0.15
67	559087	635532	74	0.43	25.8	25	7.3	0.12
68	558864	635118	137	0.69	41.4	66	19.1	0.20
69	558957	634940	162	0.83	49.8	87.2	25.3	0.24
70	558315	634666	35	0.45	27	12.4	3.6	0.13
71	558954	634583	187	0.92	55.2	113.6	32.9	0.27
72	559658	635552	0	0	0	0	0.0	0.00
73	559810	635417	0	0	0	0	0.0	0.00
74	559858	635421	71	0.6	36	30.9	9.0	0.17
75	559895	635416	69	0.78	46.8	35.3	10.2	0.23
76	559983	635581	0	0	0	0	0.0	0.00
77	560041	635519	34	0.69	41.4	16.3	4.7	0.20

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
78	560068	635554	19	0.44	26.4	6.4	1.9	0.13
79	560096	635574	19	0.24	14.4	3.4	1.0	0.07
80	560122	635588	21	0.27	16.2	4.5	1.3	0.08
81	560054	635475	41	0.89	53.4	30.3	8.8	0.26
82	560093	635498	43	0.78	46.8	24.5	7.1	0.23
83	560127	635519	43	0.59	35.4	17.7	5.1	0.17
84	560162	635545	42	0.46	27.6	15.7	4.6	0.13
85	560284	635656	36	0.4	24	11.6	3.4	0.12
86	560344	635671	55	0.44	26.4	16.8	4.9	0.13
87	560320	635593	54	0.47	28.2	21.2	6.1	0.14
88	560400	635635	80	0.46	27.6	27.4	7.9	0.13
89	560318	635436	81	0.9	54	55.2	16.0	0.26
90	560307	635400	86	0.92	55.2	61.1	17.7	0.27

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
91	560510	635697	130	0.62	37.2	60.4	17.5	0.18
92	560705	635747	104	0.53	31.8	45.5	13.2	0.15
93	560707	635706	98	0.53	31.8	37.2	10.8	0.15
94	560733	635767	110	0.64	38.4	54.7	15.9	0.19
95	560862	635791	124	0.63	37.8	66.1	19.2	0.18
96	560877	635742	116	0.62	37.2	59.8	17.3	0.18
97	561146	635822	51	0.5	30	20	5.8	0.15
98	561192	635808	50	0.48	28.8	18.3	5.3	0.14
99	561264	635814	44	0.45	27	15.7	4.6	0.13
100	561292	635829	42	0.45	27	14.8	4.3	0.13
101	561341	635833	0	0	0	0	0.0	0.00
102	561373	635837	0	0	0	0	0.0	0.00
103	561428	635861	0	0	0	0	0.0	0.00

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
104	561501	635849	0	0	0	0	0.0	0.00
105	561642	635786	0	0	0	0	0.0	0.00
106	561686	635864	0	0	0	0	0.0	0.00
107	561693	635898	0	0	0	0	0.0	0.00
108	561796	635814	0	0	0	0	0.0	0.00
109	561832	635817	0	0	0	0	0.0	0.00
110	561873	635802	0	0	0	0	0.0	0.00
111	561932	635815	0	0	0	0	0.0	0.00
112	561959	635820	0	0	0	0	0.0	0.00
113	560349	635117	140	1.58	94.8	149.1	43.2	0.46
114	560423	635053	154	1.73	103.8	166.8	48.4	0.50
115	560495	635055	156	1.7	102	164.5	47.7	0.49
116	560831	635197	128	0.64	38.4	60.2	17.5	0.19

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
117	560850	635115	142	1.37	82.2	92.4	26.8	0.40
118	561059	635135	83	1.75	105	96.4	28.0	0.51
119	561335	635301	41	0.47	28.2	15.7	4.6	0.14
120	561575	635308	69	0.5	30	29.7	8.6	0.15
121	561617	635299	75	0.51	30.6	31	9.0	0.15
122	561794	635393	9	0.11	6.6	0.8	0.2	0.03
123	561825	635397	19	0.22	13.2	3.3	1.0	0.06
124	561839	635410	17	0.21	12.6	2.8	0.8	0.06
125	561851	635402	23	0.27	16.2	5.1	1.5	0.08
126	561874	635397	30	0.52	31.2	9.9	2.9	0.15
127	561912	635409	34	0.64	38.4	14.4	4.2	0.19
128	561811	635354	81	0.73	43.8	37.8	11.0	0.21
129	561851	635355	36	0.74	44.4	18.6	5.4	0.21

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
130	561875	635341	43	0.9	54	28.3	8.2	0.26
131	561889	635366	39	0.81	48.6	22.7	6.6	0.23
132	561916	635356	45	0.91	54.6	30.7	8.9	0.26
133	562003	635432	43	0.82	49.2	25.2	7.3	0.24
134	562224	635434	64	0.49	29.4	26.6	7.7	0.14
135	562391	635411	82	0.47	28.2	30.6	8.9	0.14
136	562422	635399	77	0.47	28.2	26	7.5	0.14
137	562501	635254	47	0.47	28.2	17	4.9	0.14
138	562493	635220	46	0.47	28.2	17	4.9	0.14
139	562488	635191	46	0.48	28.8	17	4.9	0.14
140	562480	635160	46	0.49	29.4	17	4.9	0.14
141	562473	635133	44	0.49	29.4	17.1	5.0	0.14
142	562448	635058	43	0.51	30.6	17.6	5.1	0.15

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
143	562440	635028	45	0.52	31.2	17.8	5.2	0.15
144	562431	635003	43	0.53	31.8	18	5.2	0.15
145	562422	634970	44	0.53	31.8	18.4	5.3	0.15
146	562405	634938	52	0.55	33	22.1	6.4	0.16
147	562401	634912	52	0.55	33	22.9	6.6	0.16
148	562489	634996	42	0.5	30	16.4	4.8	0.15
149	562466	634954	43	0.52	31.2	17	4.9	0.15
150	562461	634916	42	0.52	31.2	17.1	5.0	0.15
151	562466	634886	42	0.52	31.2	17.2	5.0	0.15
152	562412	634835	55	0.59	35.4	24.8	7.2	0.17
153	562323	634693	112	0.7	42	49.7	14.4	0.20
154	562281	634595	120	0.76	45.6	56.7	16.4	0.22
155	562311	634532	120	0.73	43.8	54.6	15.8	0.21

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
156	562267	634521	124	0.74	44.4	59.6	17.3	0.21
157	562293	634507	123	0.7	42	56.9	16.5	0.20
158	562292	634455	126	0.65	39	57.7	16.7	0.19
159	562194	634328	160	0.72	43.2	77.2	22.4	0.21
160	562201	634142	181	0.68	40.8	93.6	27.1	0.20
161	562097	634092	172	0.68	40.8	86.2	25.0	0.20
162	562069	634003	135	0.64	38.4	64	18.6	0.19
163	561956	633987	181	0.73	43.8	100.1	29.0	0.21
164	562064	633858	152	0.65	39	76.4	22.2	0.19
165	562063	633837	151	0.65	39	76.1	22.1	0.19
166	562050	633793	147	0.67	40.2	74	21.5	0.19
167	562035	633757	141	0.69	41.4	70.7	20.5	0.20
168	561842	633678	190	1.09	65.4	131.9	38.3	0.32

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
169	562022	633548	142	0.65	39	66	19.1	0.19
170	562222	633498	60	0.53	31.8	24.6	7.1	0.15
171	562134	633474	87	0.57	34.2	36.5	10.6	0.17
172	562104	633468	98	0.59	35.4	44.9	13.0	0.17
173	562077	633463	94	0.6	36	47.6	13.8	0.17
174	561729	633465	102	0.56	33.6	42.3	12.3	0.16
175	562000	633320	100	0.52	31.2	38.2	11.1	0.15
176	561905	633256	73	0.47	28.2	25.6	7.4	0.14
177	561999	633180	0	0	0	0	0.0	0.00
178	561885	633146	73	0.46	27.6	29.9	8.7	0.13
179	561808	633041	81	0.44	26.4	26.3	7.6	0.13
180	561833	632753	0	0	0	0	0.0	0.00
181	561463	632782	65	0.54	32.4	29.8	8.6	0.16

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
182	561361	633302	112	0.67	40.2	55.2	16.0	0.19
183	561344	633225	144	0.77	46.2	68.2	19.8	0.22
184	561210	633072	126	1.19	71.4	98.4	28.5	0.35
185	561081	633016	107	0.69	41.4	50.4	14.6	0.20
186	561157	632838	0	0	0	0	0.0	0.00
187	561090	632808	79	0.46	27.6	31.7	9.2	0.13
188	561068	632788	74	0.47	28.2	30.7	8.9	0.14
189	561061	632755	68	0.47	28.2	27.9	8.1	0.14
190	561165	632578	0	0	0	0	0.0	0.00
191	561082	632508	0	0	0	0	0.0	0.00
192	561162	632400	0	0	0	0	0.0	0.00
193	561060	632316	0	0	0	0	0.0	0.00
194	561054	632288	0	0	0	0	0.0	0.00

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
195	561050	632259	0	0	0	0	0.0	0.00
196	561100	632214	0	0	0	0	0.0	0.00
197	561002	632621	0	0	0	0	0.0	0.00
198	560991	632587	0	0	0	0	0.0	0.00
199	560977	632590	0	0	0	0	0.0	0.00
200	560939	632583	0	0	0	0	0.0	0.00
201	560917	632612	0	0	0	0	0.0	0.00
202	560870	632546	0	0	0	0	0.0	0.00
203	560696	632616	0	0	0	0	0.0	0.00
204	560558	632570	0	0	0	0	0.0	0.00
205	560502	632548	0	0	0	0	0.0	0.00
206	560531	632468	0	0	0	0	0.0	0.00
207	560512	632402	0	0	0	0	0.0	0.00

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
208	560447	632344	0	0	0	0	0.0	0.00
209	560361	632250	0	0	0	0	0.0	0.00
210	560157	632230	0	0	0	0	0.0	0.00
211	560120	632213	0	0	0	0	0.0	0.00
212	560265	632851	0	0	0	0	0.0	0.00
213	560124	632676	0	0	0	0	0.0	0.00
214	560066	632652	0	0	0	0	0.0	0.00
215	559870	632882	17	0.21	12.6	2.8	0.8	0.06
216	559743	632872	55	0.56	33.6	24.8	7.2	0.16
217	559720	632871	59	0.58	34.8	27.7	8.0	0.17
218	559627	632878	75	0.56	33.6	37.1	10.8	0.16
219	559557	632909	89	0.54	32.4	40	11.6	0.16
220	559515	632919	95	0.52	31.2	35.4	10.3	0.15

			Theoretical Worst-Case Scenario				Realistic Scenario	
House	Easting	Northing	Days per year	Max hours per day	Max Minutes per day	Total hours	Realistic Scenario - 29% of Total hours	Realistic Scenario - 29% of Max hours per day
221	559410	632879	66	0.48	28.8	24	7.0	0.14
222	559530	632672	43	0.41	24.6	14.5	4.2	0.12
223	559079	632934	69	0.56	33.6	33.9	9.8	0.16
224	559063	632959	77	0.56	33.6	38.2	11.1	0.16
225	559021	632933	77	0.53	31.8	36.6	10.6	0.15
226	558836	633005	56	0.47	28.2	20.2	5.9	0.14
227	559334	633725	236	1.32	79.2	171.3	49.7	0.38
228	559480	633385	173	1.44	86.4	160.8	46.6	0.42

The results in Table 15-2 show the locations within the study area which may experience shadow flicker. Current shadow flicker thresholds may potentially be exceeded at some locations. The 30-hour threshold limit per year may be reached or exceeded at 100 locations. Theoretically 99 houses are expected to exceed the 30-hour threshold limit per year and 126 are expected to exceed the 30-minute threshold per day. When sunshine hours are accounted for, the shadow flicker, if unmitigated, reduces to well below the 30 hours per year threshold value at most locations except for H59, H71, H113, H114, H115, H168, H227 and H228. One house (H118) will exceed the 30-minute threshold per day. Refer to Figure 15-3 which indicates location of all receptors.

The realistic scenario results refer to hours per year rather than minutes per day. Given the short time frames, it is very difficult to accurately predict the actual or realistic occurrence of shadow flicker in minutes per day and consequently it is not corrected. In reality, the actual results are likely to be much lower. The proposed shadow flicker modules will compensate for this as they measure the real world conditions present which result in shadow flicker.

The unmitigated results presented in the tables above, although corrected, can still be considered a very conservative overestimate. One of the reasons, as outlined earlier, is that the model does not take into account the hours when the wind is blowing in the direction needed to orient the turbine perpendicular to the house. This will be considerably less than 100% for any dwelling. Furthermore, when this does happen it will not always coincide with a sunny period. An assumption has also been made that there is a clear line of sight between all dwellings and a wind turbine and that there is a window on the potentially affected wall/gable.

The computer model provides very detailed information, down to the exact times of day when shadow flicker is predicted to occur, and from which turbine for each receptor. This information will be used to program the shadow flicker modules to assist in eliminating shadow flicker at a receptor. As the model predicts that shadow flicker will be experienced at some receptors, the effect of shadow flicker without mitigation would have a long-term significant effect for these locations.

15.6.3 Do Nothing

The shadow flicker effect examined in this chapter is solely related to the proposed development. Therefore, should the development not proceed the effects described and examined in this chapter will not occur.

15.6.4 Cumulative Impacts and Effects

A desk study was undertaken to identify other existing and proposed projects with which significant cumulative effects could plausibly occur with the proposed Ballinlee Wind Farm, substation and grid connection development. The existing and proposed projects are listed in Section 1.4.4 of Volume II, Chapter 01 Introduction of this EIAR.

Due to considerable intervening distance between the proposed development and other planned and existing wind farm developments, no cumulative shadow flicker effects are possible.

15.7 Mitigation

15.7.1 Construction/Decommissioning Phase

Mitigation measures for the effects of shadow flicker are not required during the construction/decommissioning phases as effects of shadow flicker are only applicable during the operation phase of the proposed development.

15.7.2 Operational Phase

The model has identified that there is the potential for shadow flicker to occur and has identified the times and hours when this could happen. The developer commits to address shadow flicker by the following:

15.7.2.1 Wind Turbine Control Measures

A programmable shadow flicker module will be installed in order to allow the control of turbines to eliminate shadow flicker at a receptor.

Shadow Flicker Control Modules (SFCM) is a standard element of commercial wind turbine packages which requires the identified dates and times of day of potential occurrence of shadow flicker at dwellings within the shadow flicker study area to be inserted into the SFCM computer program. This software considers factors such as weather conditions, which will then automatically stop each wind turbine at times when shadow flicker could otherwise occur within any of the houses within the study area. Once the conditions for shadow flicker to occur no longer apply (e.g. when the sun has passed the relevant position in the sky or once it has been clouded over), the wind turbine is restarted.

The shadow flicker computer model assessment provides very detailed information, down to the exact times of day when shadow flicker is predicted to occur and from which turbine for each receptor. This information will be used to program the shadow flicker modules to eliminate shadow flicker at a receptor making sure it does not occur at any property.

Following the implementation of this mitigation, the proposed development will be fully compliant with the 2006 WEDGs, and no residual significant effects on human health or population are expected.

Should the Draft Revised Wind Energy Development Guidelines (2019) be formally adopted, the same control system can be adapted to meet the updated requirements. The development is therefore not only compliant under current policy but also future-proofed for alignment with forthcoming regulatory changes.

15.8 Residual Impacts

The installation of a programmable shadow flicker module will allow the control of turbines in order to eliminate shadow flicker at a receptor and comply with 2006 Wind Energy Development Guidelines. As a result, after this mitigation is applied, there will be no residual likely significant effects on human health and population from the operation of the proposed development. The operation and performance of the shadow flicker control measures will be monitored on an ongoing basis by the operator.

Table 15-3: Residual Effects

Potential Effect	Significance of Unmitigated Effect	Mitigation	Residual Effect
Shadow Flicker disturbance at dwellings within 10 rotor diameters.	99 houses are expected to exceed the 30-hour threshold limit per year and 126 are expected to exceed the 30-minute threshold per day. Realistically the total hours thresholds may be reached or exceeded at 8 locations (H59, H71, H113, H114, H115, H168, H227and H228). One house (H118) will exceed the 30-minute threshold per day.	Shadow Flicker Control Measures will be installed to eliminate any shadow flicker effect from the proposed turbines at a receptor in accordance with conditions of planning.	As shadow flicker will be eliminated at receptors there will be no significant residual effect.

15.9 Conclusion

The shadow flicker model, when adjusted to reflect average annual sunshine hours, predicts that shadow flicker would exceed the 30-hour-per-year threshold at eight properties within the 10 rotor diameter study area, as set out in the 2006 Wind Energy Development Guidelines (WEDGs). Without mitigation, this would constitute a significant, adverse, long-term effect on population and human health and would represent non-compliance with the current guidelines.

To ensure full compliance with the 2006 WEDGs, shadow flicker control modules (SFCMs) will be installed on the relevant turbines. These modules will automatically curtail turbine operation during predicted shadow flicker events—based on sun angle, turbine position, and time of day, thereby eliminating shadow flicker at all affected receptors.

Following the implementation of this mitigation, the proposed development will be fully compliant with the 2006 WEDGs, and no residual significant effects on human health or population are expected.

Should the Draft Revised Wind Energy Development Guidelines (2019) be formally adopted, the same control system can be adapted to meet the updated requirements. The development is therefore not only compliant under current policy but also future-proofed for alignment with forthcoming regulatory changes.

References

Update of UK Shadow Flicker Evidence Base. Final Report. Parsons Brinckerhoff for the Department of Energy and Climate Change in the UK (2011).

Wind Energy Development Guidelines, Department of Environment Heritage and Local Government (DoEHLG) 2006.

Met Éireann, Climate Averages, Accessed on 14/05/2025 www.met.ie, 2025.