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CONSULTANTS IN ENGINEERING, ENVIRONMENTAL SCIENCE & PLANNING

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED COOM GREEN ENERGY PARK, COUNTY CORK

VOLUME 2 – MAIN EIAR

CHAPTER 12 – SHADOW FLICKER

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12 SHADOW FLICKER

12.1 Introduction

This chapter considers potential shadow flicker effects at nearby buildings associated with the operation of Coom Green Energy Park. The specific objectives of the chapter are to:

- describe the 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.

This assessment has been undertaken by TNEI Services Ltd. Please refer to Chapter 1 for experience and skills of the competent experts associated with this EIAR..

12.1.1 Scope of Assessment

12.1.1.1 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 the effects are typically considered to occur up to a maximum distance of 10 times the rotor diameter from each wind turbine. The Wind Energy Development Guidelines (2006) state in Section 5.12 that *"At distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low".*

12.1.1.2 Study Area

A study area of 1,380m from each of the 22 wind turbines was selected for this assessment. This is based upon ten times the maximum rotor diameter (138 m) that would be used within the proposed development in in accordance with current guidelines. The assessment considers all identified potential shadow flicker sensitive receptors within the study area. For this assessment, dwellings and offices have been identified as sensitive receptors, in line with the guidance in the Wind Energy Development Guidelines (2006). The Draft Revised Wind Energy Development Guidelines (2019) states that no existing dwelling or other affected property (e.g. existing work places or schools) should experience shadow flicker. 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 work space. The receptor locations are detailed on Figure 12.1, and presented in tabulated format in Appendix 12.1.

12.1.1.3 Effects to be Assessed

This chapter presents the potential shadow flicker effects at all of the identified receptors and quantifies the maximum number of hours per annum where shadow flicker may occur at a property .

12.2 Methodology

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. These predictions can then be used to identify the times when shadow flicker is theoretically possible. We use this information to inform the strategy to mitigate the effects of shadow flicker as discussed in Section 12.5. The assessment assumes that 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 (strong shadows are only cast when the sun is shining);
7. the wind direction (which impacts on turbine orientation); and
8. the wind speed (shadow flicker can only occur when the turbine blades are moving);
9. the presence of particular obstructions between a window and a turbine.

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 cannot be accounted for accurately, therefore the software model assumes cloudless skies 100% of the time (estimates of typical weather conditions can be factored in at a later stage). Where obstructions are present between a window and turbine, this can be accounted for when setting up the software model.

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 the maximum proposed turbine dimensions.

12.2.1 Relevant Guidance

In assessing the potential shadow flicker impacts of the development, the following guidance and policy documents have been considered:

Cork County Development Plan 2014-2020

The Cork County Development Plan (Cork County Council, 2014) states the following in relation to shadow flicker:

"Commercial wind energy development is normally encouraged in these areas subject to protection of residential amenity particularly in respect of … shadow flicker";

"Commercial wind energy development is open to consideration in these areas where proposals can avoid adverse impacts on … Residential amenity particularly in respect of … shadow flicker"; and,

"The Council will consider proposals where it can be shown that significant impacts on … Residential amenity particularly in respect of … shadow flicker… can be avoided."

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."

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 draft revised guidelines state:

> *"Modern wind turbines have the facility to measure sunlight levels and to reduce or stop turbine rotation if the conditions that would lead to shadow flicker at any neighbouring property occur. With careful site design and appropriate mitigation, and most critically the use of appropriate equipment and computer software, no existing dwelling or other affected property (e.g. existing work places or schools) should experience shadow flicker."*

The draft revised guidelines state that 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. Furthermore, if shadow flicker is not eliminated for any dwelling or other potentially affected property then clearly specified measures which provide for automated turbine shut down to eliminate shadow flicker should be required.

In line with the draft revised guidelines, shadow flicker analysis is presented for the proposed CGEP. Where shadow flicker has been identified to occur at sensitive receptors, mitigation has been set out as recommended by the draft revised guidelines.

The 2019 revised guidelines are currently at draft stage and were subject to consultation and liable to change before the final version is issued. However, with respect to shadow flicker, the CGEP has been designed in full accordance with the 2019 draft revised guidelines.

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"*

12.2.2 Field Assessment

Building location data was supplied by Fehily Timoney & Company for use in this assessment, derived from a combination of site surveys and supplementary GIS data. The supplied dataset covered an area greater than the study area considered in this assessment, therefore the dataset was refined by removing all buildings greater than 10 rotor diameters from a turbine. The dataset was then further refined through the use of aerial imagery to identify building condition (habitable, derelict etc.), orientation from north and building dimensions; the building centre-point co-ordinates were also refined where required. 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.

Only one receptor was identified within the WEDG 500m assessment area and in total, 95 buildings were included within the shadow flicker study area shown on Figure 12.1. The receptor identified within 500m of the turbines is an administration building at the Bottlehill Residual Landfill Facility (Receptor 31). This building is not currently in regular use.

The locations of all of the receptors identified within the study area are shown on Figure 12.1 and Appendix 12.1 contains the model input data for all of the receptors and windows.

12.2.3 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 worst-case theoretical 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 this will not occur; the turbines will not always be orientated as described, and clouds will obscure the sun and line of sight may be obscured, for example, from leaves on trees.

The worst-case theoretical 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 and only experienced when the room where shadow flicker effects are present is occupied.

In order to provide a more realistic prediction 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 Coom Green Energy Park (Cork Airport) has been used to determine the average sunshine hours over a 30 year period (1981 to 2010); this data is presented in Table 12-1.

Table 12-1: Average Monthly Sunshine Hours at Cork Airport (1981-2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Daily Duration[i]	1.8	2.4	3.3	5.3	6.2	5.8	5.4	5.2	4.3	3	2.3	1.7	3.9
Daylight Hours[ii]	8.3	9.9	11.8	13.9	15.6	16.6	16.1	14.6	12.6	10.6	8.8	7.8	12.2
% Sunshine	22%	24%	28%	38%	40%	35%	34%	36%	34%	28%	26%	22%	32%

i Based on meteorological data from Cork Airport 1981-2010 (https://www.met.ie/climate-ireland/1981-2010/cork.html)

ii Based on sunrise and sunset times for Cork 2019 (https://www.sunrise-and-sunset.com)

The annual average % of sunshine hours is 32%, therefore a correction factor of 32% 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. The 'likely' levels of shadow flicker are, therefore, still considered to be a theoretical conservative estimate. This is only used by the developer to estimate the likely effect of shadow flicker mitigation. The actual curtailment will be applied when conditions are such that there is a potential for shadow flicker.

12.2.4 Modelling Parameters

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.

The shadow flicker model accounts for screening effects due to topography only, and does not consider other structures / buildings or vegetation, which may prevent line of sight between a receptor and the turbines.

12.3 Existing Environment

In total, 115 properties have been identified within 10 rotor diameters (1,380m) of the turbines, and of these 95 have been identified as either dwellings or offices (or could not be ruled out as either) and are therefore considered potential shadow flicker receptors. This can be broken down into 93 residential receptors (4 of which are currently uninhabited) and 2 commercial properties. There is 1 non-residential receptor within 500m of the proposed wind turbines.

This is the Bottlehill Landfill Administrative Office, a commercial building currently not in use. The receptor code for this building is Receptor 31 as illustrated in Figure 12.1 and listed in Table 12.2.

The remaining 20 buildings have been classified as uninhabited, derelict or otherwise insensitive to shadow flicker (such as agricultural or storage buildings);; these have not been considered as part of the shadow flicker assessment. Occupied residential receptors do not occur within 750m of the proposed development.

Legend

- Proposed Wind Turbine
- Shadow Flicker Receptor
- 10 Rotor Diameter Study Area
- 500m From Turbines
- Maximum Extent of Shadow Coverage Within Study Area

0 500 1,000 Metres

N

Project	Coom Green Energy Park
Client	Fehily Timoney & Company
Title	Shadow Flicker Study Area and Receptors
Figure No.	12.1
Scale	1:35,000 @A3
Doc. Ref.	13609-002

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12.4 Potential Impacts

The shadow flicker model calculates all possible instances of shadow flicker that may occur throughout the year, based on the sun's path across the sky relative to the turbine and receptor locations i.e. the total theoretical amount of shadow flicker that may be possible.

A full listing of the predicted levels of shadow flicker by both receptor and turbine can be found in Appendix 12.2. The calculated maximum extent of shadow coverage within study area (within which there is the potential for shadow flicker to occur) is shown on Figure 12.1.

There is the potential for shadow flicker to occur at 72 of the 95 receptors considered within the overall study area (10 rotor diameters); this includes Receptor 31 which is within 500m of the proposed turbines. The remaining 23 receptors are located outside of the maximum extent of shadow coverage, and as such no shadow flicker effects are predicted.

12.4.1 Annual Impacts

The shadow flicker model for potential annual impacts sets out the total theoretical hours per year which each receptor can potentially receive shadow flicker. However, the annual average sunshine hours received in the south of Ireland have been taken into account, as detailed in section 12.2.3. Therefore, with due consideration of the annual average sunshine hours, the predicted levels of shadow flicker exceed the WEDG (2006) recommended 30 hours per year at receptor 31, and at a further 3 residential receptors within the overall study area, Receptors 21, 22 and 24.

Of the remaining 91 receptors, shadow flicker occurs at 68 of the receptors but is anticipated to be less than 30 hours per year based on likely levels. 23 of the receptors will not receive shadow flicker throughout the year. See table 12.2 for the list of predicted levels of shadow flicker by receptor.

12.4.2 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 54 receptors within the overall study area. Of the 54 receptors, 2 receptors have been identified as commercial (receptors 31 and 49) and the remainder are residential. See table 12.2 for a list of predicted levels of shadow flicker by receptor.

Table 12-2: Shadow Flicker Predicted Levels by Receptor

Receptor ID	Easting (IRENET 95)	Northing (IRENET 95)	Total Theoretical Days Per Year	Maximum Theoretical Hours Per Day	Average Duration of Shadow Flicker Effects (Hours)	Total Theoretical Hours Per Year	'Likely' Hours Per Year
1	561700	589779	70	0.62	0.49	34.2	10.9
2	562234	591344	80	0.48	0.33	26.4	8.4
3	562303	591259	97	0.51	0.36	35	11.2
4	562401	591238	80	0.53	0.39	31.3	10.0
5	562467	591161	127	0.57	0.35	45	14.4
6	562568	592193	64	0.5	0.36	22.9	7.3
7	562620	592352	31	0.44	0.36	11.1	3.6
8	562639	591230	102	0.64	0.5	51.3	16.4
9	562669	591125	130	0.79	0.47	61.4	19.6
10	562680	592401	71	0.48	0.37	26.4	8.4
11	562687	592664	30	0.46	0.38	11.4	3.6
12	562701	591670	94	0.61	0.31	28.8	9.2
13	562721	591696	115	0.63	0.29	33.3	10.7
14	562725	591740	114	0.65	0.39	44.4	14.2
15	562734	592202	158	0.55	0.41	64.7	20.7
16	562734	592466	73	0.49	0.38	27.8	8.9
17	562758	592346	126	0.5	0.38	48.4	15.5
18	562768	591871	81	0.65	0.43	34.7	11.1
19	562774	592302	130	0.5	0.39	51.1	16.4
20	563032	593040	118	0.61	0.43	51.2	16.4
21	563052	591927	213	0.93	0.56	118.9	38.0
22	563055	591937	212	0.91	0.56	118.8	38.0
23	563075	593045	116	0.63	0.48	55.2	17.7
24	563092	591923	205	0.97	0.58	119.1	38.1
25	563165	593153	93	0.64	0.42	38.9	12.4
26	563228	593228	67	0.65	0.49	32.9	10.5
27	563273	593269	86	0.68	0.49	41.8	13.4
28	563375	593784	0	0	0	0	0.0
29	563427	588573	0	0	0	0	0.0
30	563445	593694	0	0	0	0	0.0
31	563461	589923	239	2.38	1.54	368.9	118.0
32	563640	593549	67	0.5	0.37	24.8	7.9
33	564135	593568	0	0	0	0	0.0
34	565109	593612	0	0	0	0	0.0
35	565181	593496	50	0.54	0.45	22.7	7.3
36	565255	590371	73	0.79	0.66	48.3	15.5
37	565372	590222	53	0.58	0.47	25.1	8.0
38	565417	590279	76	0.63	0.55	42	13.4
39	565502	590140	56	0.54	0.45	25.1	8.0
40	565537	590073	44	0.45	0.36	16	5.1
41	565926	591755	47	0.61	0.48	22.5	7.2
42	565949	591741	47	0.6	0.46	21.5	6.9
43	565974	592159	136	0.7	0.55	75.4	24.1

Receptor ID	Easting (IRENET 95)	Northing (IRENET 95)	Total Theoretical Days Per Year	Maximum Theoretical Hours Per Day	Average Duration of Shadow Flicker Effects (Hours)	Total Theoretical Hours Per Year	'Likely' Hours Per Year
44	565989	591469	49	0.58	0.45	22	7.0
45	566010	591724	43	0.58	0.45	19.4	6.2
46	566085	591683	42	0.55	0.42	17.5	5.6
47	566116	591659	42	0.54	0.41	17.1	5.5
48	566123	591597	40	0.52	0.41	16.2	5.2
49	566156	592518	47	0.6	0.46	21.8	7.0
50	566205	591339	44	0.52	0.4	17.4	5.6
51	566221	591561	37	0.48	0.38	14.1	4.5
52	566544	593365	62	0.52	0.43	26.7	8.5
53	566562	593714	54	0.56	0.43	23.3	7.5
54	566710	593596	94	0.62	0.52	48.9	15.6
55	566816	593451	32	0.38	0.3	9.7	3.1
56	566894	593327	36	0.47	0.36	12.8	4.1
57	567025	593340	101	0.51	0.39	39.7	12.7
58	567070	593074	87	0.54	0.38	33.3	10.7
59	567084	593311	136	0.54	0.4	54.1	17.3
60	567129	591916	38	0.52	0.41	15.6	5.0
61	567150	593198	110	0.58	0.46	50.1	16.0
62	567274	590969	36	0.38	0.3	10.8	3.5
63	567285	590810	0	0	0	0	0.0
64	567291	590969	30	0.32	0.25	7.5	2.4
65	567294	593195	91	0.67	0.44	39.7	12.7
66	567493	592481	116	0.58	0.48	55.5	17.8
67	567514	591914	154	0.78	0.5	76.3	24.4
68	567629	591282	50	0.64	0.51	25.6	8.2
69	567651	591264	30	0.41	0.33	10	3.2
70	567829	592466	75	0.76	0.5	37.7	12.1
71	567972	590789	0	0	0	0	0.0
72	568217	590453	0	0	0	0	0.0
73	568253	590437	0	0	0	0	0.0
74	568545	590358	0	0	0	0	0.0
75	568642	590465	0	0	0	0	0.0
76	568651	590617	0	0	0	0	0.0
77	568658	590509	0	0	0	0	0.0
78	568843	590820	0	0	0	0	0.0
79	568946	590887	0	0	0	0	0.0
80	568965	591409	117	0.86	0.69	81.2	26.0
81	569002	590833	0	0	0	0	0.0
82	569046	590783	0	0	0	0	0.0
83	569082	593126	87	0.68	0.49	42.3	13.5
84	569504	593047	115	0.6	0.42	48.3	15.5
85	569930	593119	0	0	0	0	0.0
86	562810	588431	0	0	0	0	0.0
87	562483	588588	0	0	0	0	0.0
88	561529	590780	40	0.51	0.39	15.8	5.1
89	562132	591406	24	0.28	0.22	5.3	1.7

Receptor ID	Easting (IRENET 95)	Northing (IRENET 95)	Total Theoretical Days Per Year	Maximum Theoretical Hours Per Day	Average Duration of Shadow Flicker Effects (Hours)	Total Theoretical Hours Per Year	'Likely' Hours Per Year
90	561396	590661	37	0.49	0.37	13.8	4.4
91	561849	590666	45	0.64	0.49	22.2	7.1
92	567522	591281	74	0.75	0.62	46.1	14.8
93	568497	590349	0	0	0	0	0.0
94	561700	589779	0	0	0	0	0
95	562234	591344	0	0	0	0	0
TOTALS				**Number of Receptors which May Experience:**			
				> 30 Minutes/Day		**> 30 Hours/Year**	
				54	11	37	4

12.4.3 Potential Impact of Zero Shadow Flicker

It is possible to ensure the complete elimination of shadow flicker at all receptors within 10 rotor diameters by ensuring that the turbines do not operate during the times and conditions that shadow flicker may occur. This will result in energy yield losses, which can be estimated based on the total theoretical predictions of shadow flicker as well as considering the 'likely' levels.

Table 12-3: Shadow Flicker Predicted Levels by Turbine

Turbine ID	Easting (IRENET 95)	Northing (IRENET 95)	Total Theoretical Days Per Year	Maximum Theoretical Hours Per Day	Average Duration of Shadow Flicker Effects (Hours)	Total Theoretical Hours Per Year	'Likely' Hours Per Year
2	562583	590234	213	1.79	0.78	167	53.4
3	563227	589449	95	1.29	1.09	103.2	33
4	563039	589951	175	1.49	0.97	169.8	54.3
5	563936	589713	95	1.23	0.93	88.1	28.2
6	564212	590214	206	0.94	0.6	124.3	39.8
7	563907	590734	41	0.52	0.37	15	4.8
8	563567	591306	249	1.33	0.78	194.8	62.3
9	564146	591247	51	0.55	0.42	21.2	6.8
10	564550	590806	77	1.01	0.79	60.7	19.4
11	564002	592625	292	1.15	0.6	175.2	56.1
12	563969	592119	223	0.93	0.61	136.9	43.8
13	564515	591909	0	0	0	0	0
14	564961	591567	150	1.02	0.65	97.6	31.2
15	564661	592686	91	0.75	0.53	48	15.4
16	565156	592556	139	0.7	0.57	78.7	25.2
17	568267	591705	250	1.65	0.88	220.8	70.7

Turbine ID	Easting (IRENET 95)	Northing (IRENET 95)	Total Theoretical Days Per Year	Maximum Theoretical Hours Per Day	Average Duration of Shadow Flicker Effects (Hours)	Total Theoretical Hours Per Year	'Likely' Hours Per Year
18	568612	592430	254	0.76	0.49	124.4	39.8
19	568206	593193	90	1.65	0.97	86.9	27.8
20	568229	593738	105	0.85	0.67	70.7	22.6
21	567708	593928	130	0.99	0.74	95.8	30.7
22	568905	593906	0	0	0	0	0
23	569943	593950	0	0	0	0	0
TOTAL			**2926**	**20.6**	**13.4**	**2079.1**	**665.3**

The assessment found that for shadow flicker levels to be reduced to zero at all sensitive receptors within the study area the turbines would need to be shut down for approximately 1.08% of the maximum potential operating time (assuming worst-case conditions). However, considering the 'likely' levels of shadow flicker this may be reduced to 0.35% of the maximum potential operating time. Given that the 'likely' levels are still a conservative estimate, we consider the actual impact upon energy yield will be lower...

Table 12-4: Total % of Operational Hours Where Shadow Flicker May Occur

	Total Theoretical Predicted Levels (Assumes 100% Sunshine Hours)	'Likely' Predicted Levels (Assumes 32% Sunshine Hours)
Predicted Hours of Shadow Flicker Per Year	2079.1	665.3
% of Total Operational Hours Per Year	1.08%*	0.35%**

*Based on 2079.1 Total Predicted Hours divided by 192720 operational hours per year (24 hours X 365 days X 22 turbines).

** Based on 665.3 'Likely' Predicted Hours divided by 192720 operational hours per year.

12.4.4 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. There is one permitted wind turbine located at Moneygorm, approximately 1.2km south east of T23. This turbine was permitted in 2013 (CCC ref. 116168, ABP ref. PL 04.241037) but remains unconstructed. The turbine consent allows for a hub height max 76m, rotor diameter 56m and blade tip height max 100m. This permitted turbine is considered in relation to potential cumulative impacts of shadow flicker.

In relation to shadow flicker, in the board's assessment of the single turbine development, the Board's inspector noted that the potential for shadow flicker beyond 560m from the turbine is very low, and there are no dwellings within 560m of the turbine location.

An Bord Pleanála's Inspector's report states the following:

> *"It is recommended that shadow flicker at neighbouring 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. Turbine diameter in this case is 56m, such that ten rotor diameters would equate to a distance of 560m. The closest dwellings to the site are located approximately 594m from the site. Having regard to the separation distances and scale of the turbine, I do not consider that significant shadow flicker impacts are likely to arise in this case."*

A Shadow Flicker Assessment Report which accompanied the planning application sets out potential impacts from the single turbine and is included as Appendix 13.3. The report identifies a range of residential receptors and agricultural yards and sheds and it assesses properties up to 2km from the turbine site. The report states:

> *"As the wind energy planning guidelines state at distances of greater than 10 rotor diameters shadow flicker potential becomes negligible. A rotor diameter of 56 metres will have very little potential to cause shadow flicker a distance greater than approximately 560(m).*
>
> *All dwellings within approximately 2,000m of the turbine were included in the assessment. This distance is much greater than the zone of influence, as defined by the Wind Energy Planning Guidelines."*

The report identifies potential shadow flicker impact on properties beyond 560m, however, properties beyond this distance are not likely to experience strong enough shadows to result in shadow flicker. Therefore, impact of shadow flicker from the permitted turbine is considered negligible.

The zone of influence of shadow flicker for the CGEP, as illustrated in Figure 12.1, does not interact with the zone of influence of shadow flicker of the single permitted wind turbine at Moneygorm. Furthermore, there are no dwellings within the zone of influence of the permitted turbine. Therefore, it can be concluded that the potential cumulative impact of shadow flicker is negligible when considering the potential impacts of the CGEP in combination with the permitted single wind turbine at Moneygorm.

12.5 Mitigation Measures

Shadow flicker control modules, consisting of light sensors and specialised software, will be installed on the turbines as part of a system to prevent operation during periods when shadow flicker may occur to attain 'zero shadow flicker'. The calculated potential shadow flicker periods will be input into the turbine control software and when the correct conditions are met i.e. the light intensity is sufficient and during a potential period of shadow flicker, and when the thresholds identified in Table 12-2 have been exceeded individual turbines will cease operation until the conditions for shadow flicker are no longer present. This method of mitigation will be used to fully mitigate all shadow flicker effects resulting in zero shadow flicker. These are standard widely accepted control modules that are installed in most wind turbines. Appendix 12.2 contains a list of times when each turbine could be shut down to ensure zero hours of shadow flicker from CGEP.

Appendix 12.2 contains all calculated potential shadow flicker periods for each turbine, which will be input into the turbine control software. When a sufficient light intensity is measured during any of these periods, the corresponding turbine will be shut down if required to ensure zero hours of shadow flicker from CGEP.

12.6 Residual Impacts

The results of the shadow flicker assessment predict that Coom Green Energy Park has the potential to introduce shadow flicker at 72 receptors.

The implementation mitigation to cease operation of the turbines during periods of potential shadow flicker will ensure that no shadow flicker effects are experienced at any sensitive receptor within 10 rotor diameters of a turbine.

Coom Green Energy Park will comply with the recommended limits of 30 hours per year and 30 minutes per day detailed within the Wind Energy Development Guidelines (2006) and the zero shadow flicker policy as set out in the Draft Revised Wind Energy Development Guidelines (2019). Following implementation of mitigation measures described in Section 12.5, the residual impact as a result of shadow flicker will be imperceptible. Accordingly, it is considered that there will be no residual impact as a result of shadow flicker.

12.7 Do-Nothing Scenario

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

12.8 References

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Department of Housing, Planning and Local Government (2019), Draft Revised Wind Energy Development Guidelines. Available at: https://www.housing.gov.ie/sites/default/files/public-consultation/files/draft_revised_wind_energy_development_guidelines_december_2019.pdf

Irish Wind Energy Association (2012). Best Practice Guidelines for the Irish Wind Energy Industry. Available at: https://www.iwea.com/images/files/9660bdfb5a4f1d276f41ae9ab54e991bb600b7.pdf

ReSoft Ltd (2014), WindFarm Release 4.2.1.9. (1997-2014).

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