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TECHNICAL APPENDICES (VOLUME 3)

Acronyms and Abbreviations

AA	Appropriate Assessment
ACP	An Coimisiún Pleanála
AWEA	American Wind Energy Association
BAI	Broadcasting Authority Ireland
CAP24	Climate Action Plan 2024
CDP	County Development Plan
CEMP	Construction Environmental Management Plan
CFRAM	Catchment Flood Risk Assessment and Management
CLO	Community Liaison Office
CRM	Collision Risk Model
CSO	Central Statistics Office
DCCAE	Department of Communications, Climate Action and Environment
DOEHLG	Department of the Environment Heritage and Local Government
DTM	Digital Terrain Model
EDs	Electoral Divisions
EHSRs	Essential Health and Safety Requirements
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
ELF	Extremely Low Frequency
EMF	Electromagnetic Field
EMP	Emergency Response Plan
EPA	Environmental Protection Agency
EPS	Emergency Power Supply
ERP	Emergency Response Plan
ESB	Electricity Supply Board
EU	European Union
EWC	European Works Council
EWEA	European Wind Energy Association
FWD	Falling Weight Deflectometer survey
GCP	Grid Connection Point
Grid Connection Route (GCR)	Refers to the proposed Grid Connection Route as defined in Chapter 1 of this EIAR.
GSI	Geological Survey Ireland
GVA	Gross Value Additional
GW	Gigawatt

HSA	Health and Safety Authority
HSE	Health Service Executive
HV	High Voltage
IARC	International Agency for Research on Cancer
ICNIRP	International Commission on Non-Ionising Radiation Protection
IFI	Inland Fisheries Ireland
IR	Infra-Red
IW	Irish Water
IWEA	Irish Wind Energy Association
km	kilometres
kV	Kilowatts
LVIA	Landscape and Visual Impact Assessment
Main Wind Farm Development Site	The site where the Proposed Development is located. As defined in Chapter 1 of this EIAR.
MCC	Mayo County Council
MCDP	Mayo County Development Plan 2022 - 2028
MW	Megawatt
NDP	National Development Plan
NESC	National Economic and Social Council
NGO's	Non-Governmental Organisations
NIAH	National Inventory of Architectural Heritage
NIFM	National Indicative Fluvial Mapping
NIS	Natura Impact Statement
NM	Nautical Miles
NPWS	National Parks and Wildlife Service
NTS	Non-Technical Summary
OS	Ordnance Survey
PCE	Pre-Connection Enquiry
PCS	Pavement Condition Survey
pNHA	Proposed Natural Heritage Area
PPE	Personal Protective Equipment
Proposed Project	Refers to the Proposed Development including the GCR.
PSO	Public Service Obligation levy
PWS	Public Water Scheme
RESS	Renewable Energy Support Scheme
SAC/cSAC	Special Area of Conservation/ candidate Special Area of Conservation
SEAI	Sustainable Energy Authority of Ireland

SEI	Sustainable Energy Ireland
SLR	SLR Consulting Limited
SPA/cSPA	Special Protection Area/ candidate Special Protection Area
SSE	SSE Renewable (Ireland) Limited
SuDS	Sustainable Drainage Scheme
SWMP	Surface Water Management Plan
TBC	To be Confirmed
Turbine Delivery Route (TDR)	Refers to the proposed turbine delivery route as defined in Chapter 1 of this EIAR.
WEDG	Wind Energy Development Guidelines
WEG	Wind Energy Guidelines
WEI	Wind Energy Ireland
WFD	Water Framework Directive
WHO	World Health Organisation
ZOI	Zone of Influence
ZTV	Zone of Theoretical Visibility

11.0 SHADOW FLICKER INTRODUCTION

Background

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

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.

Statement of Authority

11.3 This technical assessment has been undertaken by Jack Hughes (BSc, MSc) and Jacob Scoble (BSc) of SLR Consulting Ltd, with a review undertaken by Gareth Hughes.

- Jack is a Senior EIA Consultant who has over two years of experience in undertaking wind farm design and EIAs; and has undertaken numerous shadow flicker assessments in the UK and Ireland.
- Jacob is a Senior GIS Analyst with over seven years of GIS Experience in consultancy. At SLR, Jacob works within the GIS team providing support to other technical disciplines through mapping outputs and data analysis. He has over three years of experience working on wind farm projects and other major projects, with around two years involvement in Shadow Flicker Analysis.
- Gareth has over 15 years' experience specialises in managing multi-disciplinary Environmental Impact Assessment (EIA) projects. Gareth has also undertaken and reviewed numerous shadow flicker assessments.

Scope and Consultation

Scope of the Assessment

11.4 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. This effect is known as shadow flicker.

11.5 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;
- 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).

11.6 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.

11.7 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.

Consultation

11.8 **Table 11-1** below summarises the key consultation feedback relevant to shadow flicker.

Table 11-1: Summary of key consultation relevant to Shadow Flicker

Consultee	Summary of Key Issues	Where Addressed in Chapter
Mayo County Council Planning Section scoping response (August 2024)	"Noise and shadow flicker are the major points of contention in respect of Windfarm development. Despite 2006 Guidelines in respect of acceptable noise levels arising from the development, many complaints and enforcement cases on windfarm developments are received by Mayo County Council. There are several dwellings in the general area of the project location, in particular along the L1205, L1206 and L-5252 routes, while there is a more concentrated number of dwellings and properties in Gweesalia village. Impact of the proposed development on the residential amenity must adequately assess and have due regard for sensitive receptors in the area particularly – dwellings, businesses, hospitality and associated amenity. It is noted that the scoping report provided indicates that it does not intend to regard the parameters set out in the Draft Wind Energy Development Guidelines published in 2019." "It is understood that it is intended that the new Guidelines are set to be published in Q4 of 2024 and issued under section 28 of the Act, as per written response provided by the Minister for HLGH	The Shadow Flicker assessment has adequately assessed and had due regard for sensitive receptors in the shadow flicker study area. As detailed in the Mitigation Measures section of this chapter, mitigation is currently proposed in line with the 2006 Wind Energy Guidelines, as the 2019 Draft Wind Energy Development Guidelines have not yet been adopted. However, the proposed mitigation can be amended such that the Proposed Project would adhere to the 2019 Guidelines, should they be adopted.

Consultee	Summary of Key Issues	Where Addressed in Chapter
	(Parliamentary Debate/March 2024). In this regard, it may be required to revisit the proposed assessment methodology in respect of noise and shadow flicker prior to making a formal application"	

Legislation, Guidance and Policy

11.9 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 Project is summarised below.

IWEA Best Practice Guidelines

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

11.11 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 Wind Energy Development Guidelines (WEDG) (DoEHLG, 2006), 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."

Mayo County Development Plan (2022-2028)

11.12 Section 11.7 of the Mayo County Development Plan (MCDP, 2022) references Renewable Energy, with Section 11.7.6 setting out the council's support for wind energy projects that *"accord with the Mayo RES, the Landscape Appraisal of County Mayo and relevant Section 28 ministerial guidelines"*.

Mayo County Council Renewable Energy Strategy

11.13 The supporting documentation 'Mayo County Council (MCC) Renewable Energy Strategy' (MCC, 2011) references shadow flicker, stating that *"Renewable energy technology can lead to impacts such as noise, odour, signal interference and shadow flicker which can cause a nuisance to neighbouring properties".* However, no guidance is given to the level of effect that could cause a nuisance. The Draft Renewable Energy Strategy for County Mayo (2026) has also been considered.

Wind Energy Development Guidelines (WEDG, 2006)

11.14 The 2006 Wind Energy Development 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."

11.15 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."

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

Draft Revised Wind Energy Development Guidelines (WEDG, 2019)

11.17 Draft WEDGs (DoHPLG, 2019) were published in December 2019. It is noted that at the time of writing (April 2026) the Draft 2019 WEDGs have not yet been adopted and the 2006 Guidelines referred to above remain in place. Nonetheless, this EIA Report is cognisant of the content and ensures that should the Draft WEDGs be adopted, mitigation measures can be implemented to adhere 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".

11.18 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."

11.19 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"

11.20 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 would need to 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

11.21 As mentioned, 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.

11.22 If the 2019 document is published in final form within the determination period of the Proposed Project, An Coimisiún Pleanála 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 considers both requirements nonetheless.

11.23 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 of this EIA Report and the developer commits that the impacts from the selected machine will be no greater than what is assessed and committed to within this EIA Report.

11.24 If the Proposed Project is consented, post-construction monitoring will be carried out to confirm the impacts from shadow flicker to sensitive receptors and ensure these are no more than what is allowable. Any significant effects above allowable limits will be mitigated for as set out in this EIA Report.

11.25 A summary of the response of the shadow flicker assessment in relation to the guidance outlined above in provided in **Table 11-2**.

Table 11-2: Summary of national and local policy relevant to Shadow Flicker

Relevant Policy	Summary of Relevant Policy Framework	How and Where Considered in the EIA Report
IWEA Best Practice Guidelines	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 state *"The assessment of potentially sensitive locations or receptors within a distance of ten rotor diameters from proposed turbine locations will normally be suitable for EIA purposes."*	The assessment for shadow flicker has been undertaken on all potentially sensitive receptors within ten rotor diameters of the proposed turbines.
Mayo County Development Plan 2022-2028	MCC will support wind energy projects that *"accord with the Mayo RES, the Landscape Appraisal of County Mayo and relevant Section 28 ministerial guidelines".* The Mayo RES states that *"Renewable energy technology can lead to impacts such as noise, odour, signal interference and shadow flicker which can cause a nuisance to neighbouring properties".*	The potential impact of shadow flicker on neighbouring properties has been assessed in this chapter.
Wind Energy Development Guidelines (2006)	The 2006 Wind Energy Development 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."* 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."*	The shadow flicker modelling approach in this assessment is consistent with these recommendations.
Draft Revised Wind Energy Development Guidelines (WEDG) (2019)*	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"* They also emphasise that shadow flicker is predictable based on turbine and property locations, and that:	It is noted that at the time of writing* the Draft 2019 WEDGs have not yet been adopted and the 2006 Guidelines referred to above remain in place. Nonetheless, this EIA Report is cognisant of

Relevant Policy	Summary of Relevant Policy Framework	How and Where Considered in the EIA Report
	"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." The draft guidelines also advise that if modelling indicates that there is potential for shadow flicker to occur, 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"* This approach in the current draft provides for the prevention of shadow flicker by automatic shutdown of the turbines. This means that turbines will need to 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.	the content and ensures that should the Draft WEDGs be adopted, mitigation measures can be implemented to adhere to the proposed measures set out in the Draft 2019 WEDGs.
*not yet adopted at the time of writing (April 2026).		

Approach and Methodology

Study Area

11.26 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 study area and receptor locations for this assessment are shown on **Figure 11-1** and presented in tabulated format in **Technical Appendix 11-1**.

11.27 The candidate turbine has not yet been determined but will be one of three models as follows: Nordex N149, with a rotor diameter of 149 m (tip height 179m); Vestas V150 with a rotor diameter of 150 m (tip height 180m); and Nordex N163 with a rotor diameter of 163 m (tip height 180m). As requested by An Coimisiún Pleanála in its Design Flexibility Response, all three candidate turbines have been appraised in the shadow flicker assessment. This approach ensures that all possible permutations in the range have been covered by the assessment – no permutation would result in a greater shadow flicker effect than the worst-case scenario assessed.

11.28 The study area for each of the candidate turbines assessed is defined as 10 times the rotor diameter, as outlined previously. 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, in line with the WEDG (2006).

Nordex N149 Study Area (Scenario 1)

11.29 Using the Nordex N149 as the candidate turbine model gives an overall shadow flicker study area of 1,490 m from each of the wind turbines, as shown on **Figure 11-1**. This is based

upon ten times the rotor diameter (149 m) in accordance with current guidelines if this turbine model were procured post consent.

Vestas V150 Study Area (Scenario 2)

11.30 Using the Vestas V150 as the candidate turbine model gives an overall shadow flicker study area of 1,500 m from each of the wind turbines, as shown on **Figure 11-1**. This is based upon ten times the rotor diameter (150 m) in accordance with current guidelines if this turbine were procured post consent.

Nordex N163 Study Area (Scenario 3)

11.31 Using the Nordex N163 as the candidate turbine model gives an overall shadow flicker study area of 1,630 m from each of the wind turbines, as shown on **Figure 11-1.** This is based upon ten times the rotor diameter (163 m) in accordance with current guidelines if this turbine model were procured post consent.

Information and Data Sources

11.32 The sources of information and data referred to in the undertaking of the shadow flicker assessment is set out in **Table 11-3**.

Table 11-3: Information and Data Sources

Topic	Source of Information
Residential Properties Location in relation to Main Wind Farm Development Site	GeoDirectory - Residential Addresses OpenStreetMap contributors, and the GIS User Community
Topography Height Data	Copernicus 25m DTM data

Desk Study

11.33 Building location data was obtained from GeoDirectory – Residential Addresses dataset. The supplied dataset covered an area 10 rotor diameters from the turbines. The dataset was then further refined through the use of aerial imagery to identify any additional buildings omitted from the dataset, as well as identifying building condition (habitable, derelict etc.)

11.34 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.

11.35 Three receptors within the study area were identified as being non-residential in nature:

- a vacant industrial facility, located within the northern cluster, at 476176E, 823264N, which has been discounted from the assessment of potential effects; and
- St Colmcille's Church (receptor ID 88), and a neighbouring health centre (receptor ID 86). These receptors have been retained in the assessment for completeness, as it was not possible to confirm definitively that they are uninhabited; the church may be lived in, the health centre does not appear on the health service executive (HSE) directory, and the street imagery hasn't been updated in over five years. Whilst included in the model and assessment, neither of these receptors has been assessed as receiving any level of shadow flicker effect.

11.36 Three turbine models have been considered for this assessment; one with a 149 m rotor diameter (Scenario 1), one with a 150 m rotor diameter (Scenario 2), and one with a 163 m rotor diameter (Scenario 3). As the shadow flicker study area is defined by the diameter of the rotor, three modelling scenarios have been used as follows. As the rotor diameters represent the range of effects, all permutations within the range which the planning application is seeking permission for will be within the identified effects.

11.37 No receptors have been identified within the 2006 WEDG 500 m assessment area, and in total up to 92 receptors have been identified within the 1,490 m, 1,500 m and 1,630 m shadow flicker study areas, as shown on **Figure 11-1**.

11.38 The closest receptor is approximately 740 m from the nearest proposed wind turbine. **Technical Appendix 11-1** contains the model input data for all of the receptors and their windows.

Modelling Parameters

11.39 The shadow flicker assessment comprises numerical modelling of the proposed turbines and receptors within the defined study area. SLR use one of the industry standard software packages, ReSoft Wind Farm software (version 5.0.1.2).

11.40 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 4 m/s and 25 m/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.

11.41 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 3 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.

11.42 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 (however, for completeness, all properties within 10 rotor diameters were included in the model and assessment);
- The dimensions and orientations of windows facing the Main Wind Farm Development Site;
- The surrounding topography (Copernicus Digital Terrain Model); and
- The locations and dimensions of the turbines.

11.43 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 which is located between the wind turbines and the property.

Assumptions, Limitations, and Confidence

11.44 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 this part of Ireland, sunshine typically occurs for approximately 29.3% of daylight hours (see **Table 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.

11.45 Only those properties within the study area of the proposed turbines have been included in the calculations. The model has been run using Copernicus 25 DTM data.

Average Sunshine Hours

11.46 The closest meteorological station to the Main Wind Farm Development Site with historical measurements compiled by Met Éireann is located at Belmullet, approximately 10 km north-west. This data, found in **Table** , represents the average sunshine per day as recorded over a 30 year period (1991 – 2020). The actual sunshine (daylight) hours at the Main Wind Farm Development Site and therefore the average percentage of time shadow flicker could actually occur per year is 29.3%.

Table 11-4: Average Sunshine Hours for period 1991-2020

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual Average
Mean Daily Duration[1]	1.4	2.4	3.5	5.3	6.3	5.6	4.4	4.6	4	3	1.7	1.2	3.6
Daylight Hours[2]	8.0	9.8	12.0	14.2	16.1	17.1	16.5	14.7	12.6	10.4	8.5	7.4	12.3
% Sunshine	17.5	24.5	29.2	37.3	39.1	32.7	26.7	31.3	31.7	28.9	20	16.2	29.3

[1] https://www.met.ie/cms/assets/uploads/2023/09/www_met_ie_belmullet_9120.htm

[2] https://weatherspark.com/y/32111/Average-Weather-in-Belmullet-Ireland-Year-Round

Baseline Conditions

Existing Environment

Scenario 1

11.47 60 residential properties have been identified which fall within the 1,490 m study area. These properties could theoretically be affected by shadow flicker from the proposed turbines (**Figure 11-1**). Summary details of these properties are identified in **Table** , with additional details of the properties found in **Technical Appendix 11-1**.

Scenario 2

11.48 One additional residential property compared to Scenario 1 falls into the slightly larger study area of 1,500 m associated with Scenario 2. This property could theoretically be affected by shadow flicker from the proposed turbines (**Figure 11-1**). Summary details of these properties are identified in **Table** , with additional details of the properties found in **Technical Appendix 11-1**.

Scenario 3

11.49 31 additional residential properties compared to Scenario 1 and 2 have been identified which fall within the 1,630 m study area associated with Scenario 3. These properties could theoretically be affected by shadow flicker from the proposed turbines (**Figure 11-1**). Summary details of these properties are identified in **Table** , with additional details of the properties found in **Technical Appendix 11-1.**

Table 11-5: Identified Receptors Within Shadow Flicker Study Areas

SLR ID No.*	Easting	Northing	Distance from Nearest Proposed Turbine (m)	Applicable Study Area(s)
1	474732	824803	1,409	All Scenarios
2	474693	824797	1,435	All Scenarios
3	474626	824785	1,480	All Scenarios
4	474904	824643	1,174	All Scenarios
5	474393	824630	1,595	Scenario 3 only
6	474445	824612	1,540	Scenario 3 only
7	474442	824611	1,542	Scenario 3 only
8	474758	824580	1,254	All Scenarios
9	474386	824553	1,567	Scenario 3 only
10	474388	824546	1,562	Scenario 3 only
11	474629	824300	1,246	All Scenarios
12	474504	824289	1,361	All Scenarios
13	474566	824269	1,296	All Scenarios
14	474504	824222	1,343	All Scenarios
15	474499	824187	1,340	All Scenarios

SLR ID No.*	Easting	Northing	Distance from Nearest Proposed Turbine (m)	Applicable Study Area(s)
16	474638	823988	1,172	All Scenarios
17	474501	823978	1,308	All Scenarios
18	474703	823940	1,104	All Scenarios
19	474515	823938	1,292	All Scenarios
20	474743	823920	1,063	All Scenarios
21	474716	823749	1,099	All Scenarios
22	474381	823646	1,446	All Scenarios
24	474404	823635	1,425	All Scenarios
25	474286	823585	1,550	Scenario 3 only
27	478693	823193	1,129	All Scenarios
28	478648	823153	1,084	All Scenarios
29	478835	823092	1,274	All Scenarios
31	479019	823019	1,463	All Scenarios
32	479061	822967	1,511	Scenario 3 only
33	475277	822926	1,100	All Scenarios
34	475345	822862	1,057	All Scenarios
35	475364	822837	1,032	All Scenarios
36	475411	822789	974	All Scenarios
38	475484	822665	880	All Scenarios
39	475515	822623	845	All Scenarios
40	475541	822545	816	All Scenarios
41	475474	822522	884	All Scenarios
42	475598	822377	780	All Scenarios
43	475607	822347	779	All Scenarios
44	475620	822297	782	All Scenarios
45	478283	822153	1,177	All Scenarios
46	478228	822137	1,120	All Scenarios
47	477842	822082	739	All Scenarios
48	477988	821954	841	All Scenarios
49	478321	821932	1,166	All Scenarios
50	478069	821882	910	All Scenarios
51	478269	821784	1,105	All Scenarios
52	478203	821780	1,039	All Scenarios
53	478432	821724	1,270	All Scenarios
54	478467	821721	1,305	All Scenarios

SLR ID No.*	Easting	Northing	Distance from Nearest Proposed Turbine (m)	Applicable Study Area(s)
55	478587	821637	1,431	All Scenarios
56	475624	821125	740	All Scenarios
57	475613	821049	798	All Scenarios
58	475606	821029	817	All Scenarios
59	477440	821010	826	All Scenarios
60	477320	820969	834	All Scenarios
61	477192	820882	906	All Scenarios
62	477174	820879	909	All Scenarios
63	477157	820865	923	All Scenarios
64	477016	820855	945	All Scenarios
65	475729	820850	878	All Scenarios
66	477217	820761	1,028	All Scenarios
67	476644	820414	1,260	All Scenarios
68	476853	820292	1,456	All Scenarios
69	475575	820240	1,489	All Scenarios
70	475479	820233	1,537	Scenario 3 only
71	475576	820225	1,502	Scenario 3 only
72	475532	820216	1,529	Scenario 3 only
73	475579	820214	1,511	Scenario 3 only
74	476374	820203	1,400	All Scenarios
75	475599	820202	1,514	Scenario 3 only
76	475586	820191	1,529	Scenario 3 only
77	475409	820182	1,616	Scenario 3 only
78	475576	820173	1,549	Scenario 3 only
79	475575	820159	1,563	Scenario 3 only
80	475581	820153	1,566	Scenario 3 only
81	475468	820148	1,618	Scenario 3 only
82	475597	820144	1,568	Scenario 3 only
83	475544	820129	1,603	Scenario 3 only
84	475615	820106	1,596	Scenario 3 only
85	475585	820103	1,610	Scenario 3 only
86	476260	820101	1,492	Scenario 2 and Scenario 3
87	475633	820090	1,605	Scenario 3 only
88	475600	820083	1,623	Scenario 3 only
89	475644	820076	1,614	Scenario 3 only

SLR ID No.*	Easting	Northing	Distance from Nearest Proposed Turbine (m)	Applicable Study Area(s)
90	475651	820067	1,620	Scenario 3 only
93	476030	819980	1,621	Scenario 3 only
94	476023	819972	1,629	Scenario 3 only
97	474410	823067	1,621	Scenario 3 only
98	475393	820204	1,605	Scenario 3 only
99	475492	820231	1,533	Scenario 3 only
100	478401	821724	1,239	All Scenarios
*100 residential receptors were initially identified within the shadow flicker study area. Further refinements resulted in the removal of receptors 23, 26, 30, 37, 91, 92, 95, and 96 from the model and assessment. Limitations in the modelling software has meant that the remaining receptors have not been renumbered.				

Cumulative Situation

11.50 There are no consented, operational, or application wind farms in the vicinity of the Main Wind Farm Development Site such that cumulative shadow flicker effects could be experienced at any of the receptors. Cumulative shadow flicker effects would only have the potential to occur if there were receptors located within 10 rotor diameters of the Main Wind Farm Development Site and another wind farm.

Future Baseline

11.51 In the absence of the Proposed Project, the Proposed Project would not be constructed and the potential impacts from shadow flicker on local receptors would not occur. The current baseline of zero-shadow flicker on local residential receptors would remain, and the current land use (as set out in **Chapter 2**) would be unchanged.

Assessment of Effects

Potential Impacts

11.52 As discussed previously, three turbine models have been considered in this assessment. In terms of EIA, the turbine with the 163 m rotor diameter is considered to be the worst case as it includes more receptors into its assessment area and covers all design permutations that have been set out in **Chapter 2** of this EIA Report. All models of turbines, comprising the 149 m, 155 m and 163 m diameter rotors have been assessed and the results presented below.

11.53 The make or model of turbine which is eventually selected for installation 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 this EIA Report.

Scenario 1 Impacts (Nordex N149)

11.54 **Figure 11-2** shows the estimated annual hours of shadow flicker effect across the study area for Scenario 1. Based on the predictive modelling technique outlined above, there is predicted to be shadow flicker effects of up to 208.1 hours per year, with the highest potential effect found on receptor 44, (shown in **Table**) assuming the worst-case scenario. Of the 60 receptors in the study area, five would not experience any shadow flicker effects arising as a result of the operational phase of the wind farm.

11.55 The theoretical results shown in **Table** are based on the 'worst-case scenario ', 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 (29.3%) recorded at the nearest Met Éireann Met Station (see **Table 11-3**).

Table 11-6: Shadow Flicker Effects - Scenario 1 (Nordex N149)

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Minutes Per Day	Total Theoretical Hours Per Year	Likely Hours Per Year
1	54	30	22.8	20.5	6.0
2	50	29.4	22.8	18.8	5.5
3	46	28.8	21.6	16.7	4.9
4	94	35.4	27	42.1	12.3
8	48	33	25.2	20.2	5.9
11	42	31.8	24	17	5.0
12	37	29.4	22.8	14.2	4.2
13	39	30.6	24	15.5	4.5
14	38	30	22.8	14.4	4.2
15	38	30	22.8	14.4	4.2
16	43	33.6	25.8	18.5	5.4
17	39	30	23.4	15.1	4.4
18	55	53.4	35.4	32.5	9.5
19	39	30.6	24	15.5	4.5
20	56	54.6	36.6	34.4	10.1
21	50	47.4	36.6	30.4	8.9
22	38	28.2	21.6	13.7	4.0
24	40	28.2	21.6	14.3	4.2
27	103	34.2	23.4	40.3	11.8
28	122	36	24.6	50.6	14.8
29	90	30.6	19.8	29.8	8.7
31	33	25.8	16.2	9	2.6
33	88	34.8	24.6	36.2	10.6
34	93	37.2	26.4	40.8	12.0
35	95	37.8	27	42.3	12.4
36	137	40.2	25.8	59.2	17.3
38	192	43.8	29.4	93.6	27.4
39	201	45.6	30	100.2	29.4
40	213	47.4	31.8	113.1	33.1

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Minutes Per Day	Total Theoretical Hours Per Year	Likely Hours Per Year
41	218	43.8	30	109.8	32.2
42	283	56.4	35.4	167	48.9
43	296	60.6	36	178.6	52.3
44	328	66	37.8	208.1	61.0
45	88	33.6	22.8	33.7	9.9
46	90	34.8	24.6	37	10.8
47	196	72	38.4	124.5	36.5
48	130	61.2	36	77.6	22.7
49	87	33	22.2	31.9	9.3
50	121	51	30.6	61.8	18.1
51	99	34.8	23.4	38.6	11.3
52	110	37.2	24.6	45.6	13.4
53	86	31.2	21	30.1	8.8
54	39	30	21.6	14.1	4.1
55	37	27.6	19.8	12.3	3.6
56	47	30	24	18.7	5.5
57	25	16.8	13.8	5.6	1.6
58	18	12.6	9.6	2.9	0.8
59	56	30	22.8	21.5	6.3
60	92	32.4	22.8	34.6	10.1
61	71	34.8	30	35.8	10.5
62	68	35.4	30	34.1	10.0
63	62	34.8	29.4	30.4	8.9
64	28	19.8	15.6	7.4	2.2
65	0	0	0	0	0.0
66	51	30	24	20.5	6.0
67	0	0	0	0	0.0
68	0	0	0	0	0.0
69	0	0	0	0	0.0
74	0	0	0	0	0.0
100	89	31.8	21.6	31.9	9.3

Scenario 2 Impacts (Vestas V150)

11.56 **Figure 11-3** shows the estimated annual hours of shadow flicker effect across the study area for Scenario 2. Based on the predictive modelling technique outlined above, there is

predicted to be shadow flicker effects of up to 210.5 hours per year, with the highest potential effect found on receptor 44, (shown in **Table 11-7**) assuming the worst-case scenario. Of the 61 receptors in the study area, six would not experience any shadow flicker effects arising as a result of the operational phase of the wind farm.

11.57 The theoretical results shown in **Table 11-7** are based on the 'worst-case scenario ', 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 (29.3%) recorded at the nearest Met Éireann Met Station (see **Table 11-4**).

Table 11-7: Shadow Flicker Effects - Scenario 2 (Vestas V150)

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Minutes Per Day	Total Theoretical Hours Per Year	Likely Hours Per Year
1	54	30	22.8	20.7	6.1
2	52	29.4	22.2	19.1	5.6
3	46	28.8	22.2	16.8	4.9
4	94	35.4	27	42.5	12.5
8	76	33	25.8	32.9	9.6
11	42	32.4	24.6	17.2	5.0
12	37	29.4	23.4	14.4	4.2
13	39	31.2	24	15.7	4.6
14	38	30	22.8	14.6	4.3
15	38	30	22.8	14.6	4.3
16	43	33.6	26.4	18.7	5.5
17	39	30.6	23.4	15.3	4.5
18	56	53.4	35.4	32.8	9.6
19	40	30.6	23.4	15.7	4.6
20	56	54.6	37.2	34.7	10.2
21	52	48	35.4	30.8	9.0
22	39	28.2	21.6	13.9	4.1
24	40	28.8	21.6	14.5	4.2
27	106	34.8	23.4	40.9	12.0
28	124	36	24.6	51.4	15.1
29	91	30.6	19.8	30.3	8.9
31	33	25.8	16.8	9.1	2.7
33	88	34.8	25.2	36.6	10.7
34	93	37.2	26.4	41.2	12.1
35	132	38.4	25.2	55.2	16.2

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Minutes Per Day	Total Theoretical Hours Per Year	Likely Hours Per Year
36	138	40.2	26.4	60.1	17.6
38	194	44.4	29.4	94.7	27.7
39	202	45.6	30	101.6	29.8
40	216	47.4	31.8	114.4	33.5
41	218	44.4	30.6	111.1	32.6
42	284	57	36	169.1	49.5
43	297	61.2	36.6	180.8	53.0
44	328	66.6	38.4	210.5	61.7
45	89	33.6	22.8	34.2	10.0
46	92	35.4	24.6	37.4	11.0
47	199	72.6	37.8	126	36.9
48	130	61.2	36	78.5	23.0
49	87	33.6	22.2	32.4	9.5
50	122	51	30.6	62.6	18.3
51	99	34.8	23.4	39.1	11.5
52	110	37.8	25.2	46.2	13.5
53	86	31.2	21	30.5	8.9
54	39	30.6	22.2	14.3	4.2
55	37	28.2	20.4	12.4	3.6
56	47	30.6	24	18.8	5.5
57	25	16.8	13.8	5.7	1.7
58	19	12.6	9.6	3	0.9
59	56	30.6	23.4	21.8	6.4
60	98	32.4	21.6	35.7	10.5
61	71	35.4	30.6	36	10.5
62	68	35.4	30	34.3	10.0
63	62	35.4	29.4	30.6	9.0
64	28	19.8	15.6	7.4	2.2
65	0	0	0	0	0.0
66	51	30	24	20.6	6.0
67	0	0	0	0	0.0
68	0	0	0	0	0.0
69	0	0	0	0	0.0

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Minutes Per Day	Total Theoretical Hours Per Year	Likely Hours Per Year
74	0	0	0	0	0.0
86	0	0	0	0	0.0
100	89	31.8	21.6	32.3	9.5

Scenario 3 Impacts (Nordex N163)

11.58 **Figure 11-4** shows the estimated annual hours of shadow flicker effect across the study area for Scenario 3. Based on the predictive modelling technique outlined above, there is predicted to be shadow flicker effects of up to 276 hours per year, with the highest potential effect found on receptor 44 (shown in **Table**), when assuming the worst-case scenario. Of the 92 receptors in the study area, 29 receptors would not experience any shadow flicker effects arising as a result of the operational phase of the wind farm.

11.59 The theoretical results shown in **Table** are based on the 'worst-case scenario', 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 considers the long-term average sunshine hours per year (29.3%) recorded at the nearest Met Éireann Met Station (see **Table 11-3**).

Table 11-8: Shadow Flicker Effects - Scenario 3 (Nordex N163)

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Minutes Per Day	Total Theoretical Hours Per Year	Likely Hours Per Year
1	91	32.4	23.4	35.9	10.5
2	56	31.8	22.8	21.2	6.2
3	50	30.6	22.2	18.6	5.4
4	100	38.4	28.8	47.9	14.0
5	40	28.2	19.8	13.2	3.9
6	40	28.8	21	14.2	4.2
7	40	28.8	21	14.1	4.1
8	80	35.4	27.6	36.5	10.7
9	38	28.2	21	13.3	3.9
10	38	28.2	21	13.4	3.9
11	65	43.8	28.8	31	9.1
12	42	31.8	22.8	16	4.7
13	62	43.8	27.6	28.7	8.4
14	40	31.8	24.6	16.2	4.7
15	41	32.4	24	16.3	4.8
16	57	53.4	34.8	32.8	9.6

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Minutes Per Day	Total Theoretical Hours Per Year	Likely Hours Per Year
17	43	32.4	24	17	5.0
18	59	55.8	36.6	35.8	10.5
19	42	33	25.2	17.5	5.1
20	61	57	37.2	38	11.1
21	55	49.8	36.6	33.3	9.8
22	42	30	21.6	15.3	4.5
24	42	30.6	22.8	15.9	4.7
25	38	28.2	21.6	13.6	4.0
27	109	37.2	24	43.9	12.9
28	131	38.4	25.2	55.3	16.2
29	96	31.8	20.4	32.3	9.5
31	79	27.6	16.8	22.5	6.6
32	76	26.4	16.8	21.4	6.3
33	156	37.8	21	54.5	16.0
34	173	43.8	26.4	75.6	22.2
35	173	43.8	27	78.5	23.0
36	219	45	26.4	96.7	28.3
38	252	47.4	29.4	122.3	35.8
39	264	49.2	30.6	133.4	39.1
40	282	51	32.4	153.3	44.9
41	282	47.4	31.2	147.5	43.2
42	312	72	40.2	209.8	61.5
43	321	77.4	42	225.7	66.1
44	339	82.2	48.6	276	80.9
45	168	36	23.4	65.7	19.3
46	163	37.8	24	65.9	19.3
47	212	76.2	39.6	138.9	40.7
48	175	63	33	96.4	28.2
49	90	35.4	23.4	34.7	10.2
50	158	52.8	29.4	78	22.9
51	104	37.8	24.6	42.2	12.4
52	116	40.8	25.8	50	14.7
53	91	33.6	21.6	32.9	9.6

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Minutes Per Day	Total Theoretical Hours Per Year	Likely Hours Per Year
54	87	33	21.6	31	9.1
55	39	30	20.4	13.4	3.9
56	53	36	27.6	24.1	7.1
57	36	21.6	16.8	9.9	2.9
58	31	18	14.4	7.3	2.1
59	82	32.4	19.8	27.4	8.0
60	102	34.8	23.4	39.3	11.5
61	76	37.8	31.8	39.9	11.7
62	73	38.4	31.2	38.3	11.2
63	68	38.4	30.6	34.7	10.2
64	39	24.6	18.6	12	3.5
65	0	0	0	0	0.0
66	57	33.6	25.2	23.9	7.0
67	0	0	0	0	0.0
68	0	0	0	0	0.0
69	0	0	0	0	0.0
70	0	0	0	0	0.0
71	0	0	0	0	0.0
72	0	0	0	0	0.0
73	0	0	0	0	0.0
74	0	0	0	0	0.0
75	0	0	0	0	0.0
76	0	0	0	0	0.0
77	0	0	0	0	0.0
78	0	0	0	0	0.0
79	0	0	0	0	0.0
80	0	0	0	0	0.0
81	0	0	0	0	0.0
82	0	0	0	0	0.0
83	0	0	0	0	0.0
84	0	0	0	0	0.0
85	0	0	0	0	0.0
86	0	0	0	0	0.0

SLR ID No.	Total Theoretical Days Per Year	Maximum Theoretical Minutes Per Day	Average Theoretical Minutes Per Day	Total Theoretical Hours Per Year	Likely Hours Per Year
87	0	0	0	0	0.0
88	0	0	0	0	0.0
89	0	0	0	0	0.0
90	0	0	0	0	0.0
93	0	0	0	0	0.0
94	0	0	0	0	0.0
97	83	28.8	22.2	31	9.1
98	0	0	0	0	0.0
99	0	0	0	0	0.0
100	93	34.2	22.8	34.9	10.2

Further Survey Requirements and Monitoring

11.60 As the shadow flicker assessment comprises a desk based exercise, there will be no further survey requirements, or monitoring. If a complaint is made regarding shadow flicker, an investigation will take place which considers the weather conditions at the time of the alleged shadow flicker, to determine which turbines were, or were not, creating the effect and the extent of the shadow flicker created. If the investigation confirms a loss of residential amenity at any location, the technical mitigation measures built into these turbines would be activated.

Summary of Predicted Effects

Annual Impacts

Scenario 1

11.61 There are no properties located within 500 m of the proposed turbines. Based on the theoretical worst-case results in **Table 11-6**, 31 receptors would theoretically experience shadow flicker effects in excess of 30 hours per year, with the property experiencing the highest annual hours being receptor 44, experiencing 208.1 hrs per annum on a worst-case model basis. A further 24 properties would experience shadow flicker effects, but of less than 30 hours per year, and five properties would experience no shadow flicker effects as a result of the proposed turbines.

11.62 Applying the average sunshine hours to the model results in a more likely situation with six properties exceeding the 30 hours per annum guidance. The property experiencing the highest annual hours is again receptor 44 which would experience up to 61 hrs of shadow flicker per annum. These properties would therefore have the potential to experience **significant** levels of shadow flicker effect prior to the implementation of mitigation.

11.63 A further 49 properties would experience shadow flicker effects, but of less than 30 hours per year (and therefore **non-significant**), and five properties would experience no shadow flicker effects as a result of the proposed turbines.

Scenario 2

11.64 There are no properties located within 500 m of the proposed turbines. Based on the theoretical worst-case results in **Table** , 33 receptors would theoretically experience shadow flicker effects in excess of 30 hours per year, with the property experiencing the highest annual hours being receptor 44, experiencing 210.5 hrs per annum on a worst-case model basis. A further 22 properties would experience shadow flicker effects, but of less than 30 hours per year, and six properties would experience no shadow flicker effects as a result of the proposed turbines.

11.65 Applying the average sunshine hours to the model results in 6 properties likely to exceed the 30 hours per annum guidance, the property experiencing the highest annual hours is again receptor 44 which would experience up to 61.7 hrs of shadow flicker per annum. These properties would therefore have the potential to experience **significant** levels of shadow flicker effect prior to the implementation of mitigation.

11.66 A further 49 properties would experience shadow flicker effects, but of less than 30 hours per year (and therefore **non-significant**), and six properties would experience no shadow flicker effects as a result of the proposed turbines

Scenario 3

11.67 There are no properties located within 500 m of the proposed turbines. Based on the theoretical worst-case results in **Table** , 38 receptors would theoretically experience shadow flicker effects in excess of 30 hours per year, with the property experiencing the highest annual hours being receptor 44, experiencing 276 hrs per annum on a worst-case model basis. A further 25 properties would experience shadow flicker effects, but of less than 30 hours per year, and 29 properties would experience no shadow flicker effects as a result of the proposed turbines.

11.68 Applying the average sunshine hours to the model results in 8 properties likely exceeding the 30 hours per annum guidance, the property experiencing the highest annual hours is again receptor 44 which would experience up to 80.9 hrs of shadow flicker per annum. These properties would therefore have the potential to experience **significant** levels of shadow flicker effect prior to the implementation of mitigation.

11.69 A further 55 properties would experience shadow flicker effects, but of less than 30 hours per year (and therefore **non-significant**), and 29 properties would experience no shadow flicker effects as a result of the proposed turbines.

Daily Impacts

Scenario 1

11.70 Based on the theoretical worst-case results above, a maximum of 37 receptors would experience shadow flicker effects in excess of 30 minutes per day, with the property experiencing the highest daily exposure being receptor number 47, experiencing a maximum of 72 minutes in a day on a worst-case basis, although it is noted that all the properties are in excess of 500 m from the nearest turbine. These 37 receptors could experience **significant** shadow flicker effects prior to the implementation of mitigation. 18 receptors could experience **non-significant** shadow flicker effects, and five would experience no shadow flicker due to the proposed turbines.

Scenario 2

11.71 Based on the theoretical worst-case results above, a maximum of 41 receptors would experience shadow flicker effects in excess of 30 minutes per day, with the property experiencing the highest daily exposure being receptor number 47, experiencing a maximum of 72.6 minutes in a day on a worst-case basis, although it is noted that all the properties are in excess of 500 m from the nearest turbine. These 41 receptors could experience **significant** shadow flicker effects prior to the implementation of mitigation. 14 receptors could experience **non-significant** shadow flicker effects, and six would experience no shadow flicker due to the proposed turbines.

Scenario 3

11.72 Based on the theoretical worst-case results above, a maximum of 49 receptors would experience shadow flicker effects in excess of 30 minutes per day, with the property experiencing the highest daily exposure being receptor number 44, experiencing a maximum of 82.2 minutes in a day on a worst-case basis, although it is noted that all the properties are in excess of 500 m from the nearest turbine. These 49 receptors could experience **significant** shadow flicker effects prior to the implementation of mitigation. 14 receptors could experience **non-significant** shadow flicker effects, and 29 would experience no shadow flicker due to the proposed turbines.

Mitigation Measures

Shadow Flicker Shutdown Protocol

11.73 Shadow flicker control modules, consisting of light sensors and specialised software, will be installed on all turbines, irrespective of which turbine model 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.

11.74 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.

11.75 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. This will ensure that mitigation is implemented when shadow flicker exceeds the thresholds as set out in the assessment criteria. The operation and performance of the shadow flicker control measures will be monitored on an ongoing basis.

11.76 Under the WEDG 2006 guidance shut down periods cover the periods of potential nuisance in excess of 30 hrs per year. It is noted that, as might be required by potential adoption of the 2019 draft wind energy guidelines, shadow flicker control modules can be used to ensure that a near zero level of shadow flicker is achieved, allowing for the reaction time of the shadow flicker control modules and also allowing for a short period of time for the turbine blades to slow down to a stop.

11.77 During operation of the proposed turbines, any complaints relating to shadow flicker will be fully investigated by the Developer and the shadow flicker control system updated accordingly. Should the 2019 draft wind energy guidelines be adopted, the Applicant is committed to adhering to these through a near 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 (allowing for the reaction time of the shadow flicker control modules and also allowing for a short period of time for the turbine blades to slow down to a stop). Under this approach there would be no shadow flicker experienced at any property, and therefore no impacts on any receptors.

11.78 Details of the potential shut down times of the turbines are provided in **Technical Appendix 11-2** (Scenario 1), **Technical Appendix 11-3** (Scenario 2) and **Technical Appendix 11-4** (Scenario 3). Applying these shutdown times would result in near zero shadow flicker, however the information in these appendices can be utilised to determine shut down times to avoid breaching significance thresholds.

Residual Significant Effects

11.79 The results of the shadow flicker assessment predict that the Proposed Project has the potential to introduce significant shadow flicker effects at up to eight receptors, under Scenario 3, which is the worst-case scenario. The implementation of mitigation in the form of a shutdown protocol, means there would be no residual significant effects due to shadow flicker from the Proposed Project.

Cumulative Impacts

11.80 As the shadow flicker control measures will ensure no shadow flicker effects from the Proposed Project, there will be no cumulative impacts with any nearby wind farms.

Summary of Predicted Effects

11.81 A shadow flicker assessment has been undertaken on up to 92 receptors within 10 rotor diameters of the proposed turbines, under three study area scenarios. These study areas cover all potential permutations in the range of turbine sizes being applied for.

11.82 When considering the ‘Maximum Theoretical Minutes Per Day’ (accounting for any day in which shadow flicker is predicted to occur) then shadow flicker exceeds 30 minutes at 37 receptors under Scenario 1, 41 receptors under Scenario 2, and 49 receptors under Scenario 3. The shadow flicker effects experienced at these receptors would be **significant** prior to the implementation of mitigation.

11.83 When considering the ‘Total Theoretical Hours Per Year’, 31 receptors are predicted to exceed the WEDG 2006 threshold of more than 30 hours per year under Scenario 1, 33 under Scenario 2, and 38 under Scenario 3.

11.84 However, when accounting for a more ‘likely’ scenario, where the average annual sunshine hours are taken into account, six receptors are predicted to exceed more than 30 hours per year under Scenario 1 and Scenario 2, and eight receptors are predicted to exceed more than 30 hours per year under Scenario 3. The Proposed Project would therefore have the potential to cause **significant** shadow flicker effects upon six receptors under Scenario 1 and 2, and eight receptors under Scenario 3, prior to the implementation of mitigation. Under Scenarios 1 and 2, 49 receptors would experience **non-significant** shadow flicker effects, whilst 55 receptors would experience **non-significant** shadow flicker effects under Scenario 3.

11.85 The results of the conservative shadow flicker assessment predict that the Proposed Project has the potential to introduce shadow flicker impacts at some receptors surrounding the Main Wind Farm Development Site. However, the Applicant is committed to implementing mitigation, through a shadow flicker shut down protocol. This will be undertaken by shutting down turbines during times when wind and climactic conditions are such that shadow flicker could breach significance thresholds, 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 significant shadow flicker could occur. The shadow flicker control module can also be programmed to achieve a near zero shadow flicker strategy in line with the 2019 Draft Revised Wind Energy Development Guidelines, should they be adopted.

11.86 The implementation of the proposed mitigation measures, namely a shadow flicker shutdown protocol, will ensure that shadow flicker at all buildings is below significance thresholds, resulting in no significant effects to receptors. The residual shadow flicker effect would be **not significant**.

Statement of Significance

11.87 The effect of shadow flicker has been assessed using appropriate guidance. Following the implementation of mitigation measures, potential residual shadow flicker effects due to the Proposed Project are considered **not significant** under the EIA Regulations.

References

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Figures

Technical Appendices

Technical Appendix 11-1 Shadow Flicker Modelling Input Data

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

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

Technical Appendix 11-4 Shadow Flicker Shutdown Times by Turbine Scenario 3

(Refer to EIAR Volume 3 for Technical Appendices)

474000 476000 478000 480000

826000 824000 822000

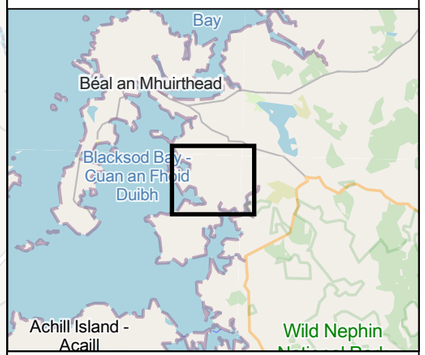
N

LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Location
- Shadow Flicker Study Area Nordex N149 Turbine (1490 m)
- Shadow Flicker Study Area Vestas V150 (1500 m)
- Shadow Flicker Study Area Nordex N163 Turbine (1630 m)

Residential Receptor Location

- Within all Study Areas
- Only within Nordex N163 Study Area
- Within Vestas V150 and Nordex N163 Study Areas



RWE

SLR

MUINGMORE WIND FARM

SHADOW FLICKER

SHADOW FLICKER STUDY AREAS

FIGURE 11-1

Scale 1:25,000 @ A3

Date MARCH 2026

0 1 2 Kilometres

402.064443.00001.0107.1 Shadow Flicker Study Area

474000 476000 478000 480000

826000 824000 822000

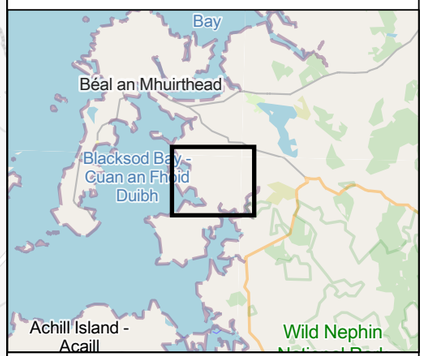
N

LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Location
- Shadow Flicker Study Area Nordex N149 Turbine (1490 m)
- Residential Receptor Location

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



RWE

SLR

MUINGMORE WIND FARM

SHADOW FLICKER

SHADOW FLICKER RESULTS NORDEX N149 TURBINE (SCENARIO 1)

FIGURE 11-2

Scale 1:25,000 @ A3

Date MARCH 2026

0 1 2 Kilometres

402.064443.00001.0122.0 Shadow Flicker Results N149

474000 476000 478000 480000

826000 824000 822000

N

Lough Nahelly

L1205

T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12 T13

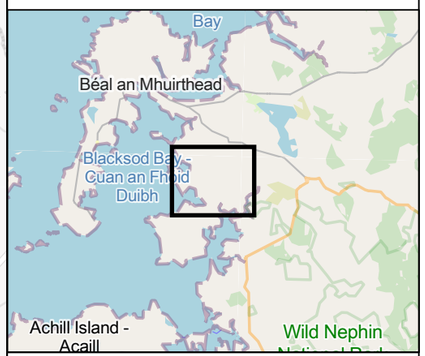
1 2 3 4 8 11 12 13 14 15 16 17 18 19 20 21 22 24 27 28 29 31 33 34 35 36 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 74 86 100

LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Location
- Shadow Flicker Study Area Vestas V150 (1500 m)
- Residential Receptor Location

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



0 1 2

Kilometres

RWE

SLR

MUINGMORE WIND FARM

SHADOW FLICKER

SHADOW FLICKER RESULTS VESTAS V150 TURBINE (SCENARIO 2)

FIGURE 11-3

Scale 1:25,000 @ A3

Date MARCH 2026

402.064443.00001.0123.0 Shadow Flicker Results V150

474000 476000 478000 480000

826000 824000 822000

N

Lough Nahelly

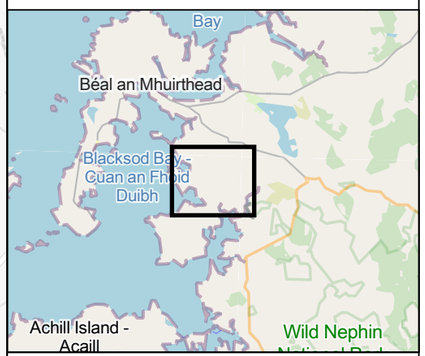
L1205

LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Location
- Shadow Flicker Study Area Nordex N163 Turbine (1630 m)
- Residential Receptor Location

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



0 1 2

Kilometres

RWE

SLR

MUINGMORE WIND FARM

SHADOW FLICKER

SHADOW FLICKER RESULTS NORDIX N163 TURBINE (SCENARIO 3)

FIGURE 11-4

Scale 1:25,000 @ A3

Date MARCH 2026

402.064443.00001.0124.0 Shadow Flicker Results N163