Proposed Ballynalacken Windfarm Project

Environmental Impact Assessment Report

Chapter 11: Shadow Flicker Assessment

Topic Chapter Authors:

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Glossary of Terms

Term	Definition
Ballynalacken Windfarm Project	Ballynalacken Windfarm including 12 No. turbines, turbine foundations and hardstanding areas, Windfarm Site Roads, Internal Windfarm Cabling, Windfarm Control Building, Site Entrances, ancillary works at and for the windfarm, along with the Internal Cable Link, Tinnalintan Substation and ancillary works, and Ballynalacken Grid Connection and grid connection works to the Eirgrid Ballyragget Substation. The Project also involves works and activities along the turbine component haul route remote from the site, including the construction of a temporary Blade Transfer Area at HR8

EIAR 11.1 INTRODUCTION

This chapter assesses the potential impact from the proposed Turbines at Ballynalacken Windfarm, Co. Kilkenny (*the Development*). The Development comprises of 12 no. turbines. The developer proposes turbines with the tip height of 155 metres (m) (except for T4 which has a tip height of 142.5m).

This report describes any likely significant changes in shadow flicker resulting from the proposed turbines.

EIAR 11.1.1 Objective

The objective of this report is to comprehensively assess the potential shadow flicker effects during the operational phase of the Development. No shadow flicker will occur during the construction or decommissioning phases.

EIAR 11.1.2 Author Competency

This report was written by Aileen Byrne (BA, H.Dip) who is an environmental scientist. Aileen has experience across a variety of environmental topics including Shadow Flicker and WindPRO software. Aileen has completed numerous shadow flicker assessments for inclusion in EIARs.

The report was reviewed by Ms. Sarah Moore (BSc, MSc) and Mr. David Kiely of Jennings O'Donovan (JOD) consulting engineers. Ms. Sarah Moore is an environmental scientist with over 17 years of environmental consultancy experience. Sarah is involved in the preparation of EIARs including numerous shadow flicker assessments. Mr. David Kiely has prepared numerous EIS/EIARs for wind farms throughout Ireland. Mr. David Kiely has 41 years' experience in the civil engineering and environmental sector. He has obtained a bachelor's degree in civil engineering and a Masters in Environmental Protection, has overseen the construction of over 50 wind farms and has carried out numerous soils and geology assessments for EIAR's. He has been responsible in the overall preparation of in excess of 60 EIA Reports (EIAR's).

EIAR 11.1.3 Scope of the Assessment

Wind turbines, like other tall structures, can cast long shadows when the sun is low in the sky. The effect known as "shadow flicker" occurs where the rotating blades of a wind turbine cast a moving shadow which, if it passes over a window in a nearby house or other property results in a rapid change or flicker in the incoming sunlight. This effect will occur only for a short period during a given day and only under specific concurrent circumstances, namely when:

- the sun is shining and is at a low angle (after dawn and before sunset), and
- there is sufficient direct sunlight to cause shadows (cloud, mist, fog or air pollution could limit solar energy levels), and
- a turbine is directly between the sun and the affected property, and within a distance that the shadow has not diminished below perceptible levels, and
- there is enough wind energy to ensure that the turbine blades are moving.

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 (Parsons Brinckerhoff – Update of UK Shadow Flicker Evidence Base (2011). 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 and the property. 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.

The Department of Environment, Community and Local Government in its Wind Energy Development Guidelines (2006) (the 2006 Guidelines) states that:
"*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*".

A minimum separation distance from all occupied dwellings of 500m has been achieved as part of the Project design. However with the increase in size of wind turbines, it is the norm in 2024 to assess all dwellings/offices within 10-rotor diameters of a turbine. The 2006 Guidelines state that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

The potential for shadow flicker occurrence within a 10-rotor diameter Study Area of 1170m was modelled. There are 72 No. sensitive receptors within the Study Area. See **Figure 11.1 House and Turbine Location map** which shows the sensitive receptors locations relative to the proposed turbines.

Computer model WindPRO 4.0 was used to calculate the occurrence of shadow flicker at the sensitive receptors. The output from the modelling is analysed to identify and assess potential shadow flicker effects. The results for a theoretical worst-case and then a more realistic scenario taking into account the above meteorological and relative geographical locational parameters, are presented and discussed (**Section EIAR 11.3**).

Cumulative effects relates to additional minutes per day/hours per annum experienced at a sensitive receptor at different times, from various turbines within the study areas. A cumulative study area which combined a 10-rotor diameter distance from the Ballynalacken turbines and also from other wind turbines was used to determine if there was any potential for overlapping or combined effects. A review of other windfarms (existing, consented or proposed) was carried out. The nearest windfarm is the consented Pinewood Windfarm which is c.4km from the Ballynalacken turbines. The rotor diameter of the consented Pinewood turbines is also 117m. A cumulative study area of 2340m was used to account for the sum of 1170m from the nearest Ballynalacken turbine and 1170m from the Pinewood turbines. Because the Pinewood turbines are located substantially beyond 2340m, no cumulative shadow flicker will occur. In addition, there are no other wind turbines either constructed, permitted or proposed within the cumulative study area therefore there is no potential for cumulative effects from other turbines on sensitive receptors. Therefore, cumulative effects from other turbines in the area are scoped out from this report.

EIAR 11.2 SHADOW FLICKER MODELLING METHODOLOGY

In general, the shadow flicker assessment methodology involves the identification of houses within a defined study area, which have the potential to be adversely impacted by shadow flicker (***sensitive receptors***). In line with best practice guidance, the study area is usually limited to a distance (between a house and wind turbine) equivalent in length to 10 of the proposed wind turbine rotor diameters. Determining shadow flicker based on using the 10-rotor diameter rule has been widely accepted across Ireland and Europe and is deemed to be an appropriate assessment area (Parsons Brinckerhoff, 2011[1]).

An industry standard wind farm assessment software package, WindPRO from EMD International Version 4.0 was used to prepare a model of the Development. The programme facilitates the analysis of a wind farm for possible shadow flicker occurrence at sensitive receptors. It allows for the production of maps, and shadow flicker prediction. The data output from the programme has been analysed and the receptors potentially vulnerable to shadow flicker were identified and the predicted amount of shadow flicker was quantified. The significance of shadow flicker effects was assessed.

Generic windows of 2m width, 2m height and 0.5m from bottom line above ground are applied in the model to each side of the house. The model assumes the receptor will not face any particular direction, but instead will face all directions. These windows represent an approximation of the existing windows on the houses facing north, south, east and west and provide an estimate of potential shadow flicker to a window on each side of the house. The software determines the times of day/year when the sun will be in line with the rotational components of the turbine and the house/receptor, thereby having the potential to cause shadow flicker. The software outputs details of potential shadow flicker, in this case by mean and maximum duration of the shadow flicker events, days per year and times of occurrence and maximum hours per year and maximum minutes per day of shadow flicker.

The following data inputs were required and used to produce an estimate of the effect of shadow flicker from the wind farm:

- Digital elevation model of the Development and areas around all properties within the model (10m resolution – OS X, Y, and Z data points)
- Turbine locations
- Turbine dimensions (rotor diameter and hub height)
- Receptor locations (i.e., property locations) mapped using OSI, Google Earth, site surveys
- Bottom line height above ground 'window' (0.5m above ground level)

The software creates a mathematical model of the proposed turbines and geographical surroundings and uses this information to calculate specific theoretical times and durations of flicker effects for the identified properties. The following 'worst-case' theoretical assumptions were initially incorporated into the shadow flicker modelling:

- there are no clouds and sunlight is always bright and direct
- the turbines are always rotating whereas this will not be the case due to wind speeds below the turbine blade rotational threshold, maintenance works or curtailment by the grid operator
- there is no intervening structures or vegetation (other than topography) that may restrict the visibility of a turbine, preventing or reducing the effect
- a limit to human perception of shadow flicker is not considered by the model

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

The model operates by simulating the path of the sun during the year. The results of the model provide a calculation of theoretical specific times and durations of flicker effects for the identified properties. As previously stated, given the assumptions incorporated into the model, the calculations overestimate the duration of effects. The worst-case theoretical assumption is considered to be sufficient for the purposes of this assessment as it assumes the sky is always clear, the turbines are always aligned face-on to each window (which depends on wind direction) and that there is a clear and undisturbed line of sight between the windows of the receptors and the turbines are operating. In reality, this will not occur; clouds will obscure the sun and line of sight may also be obscured (for example, by trees or buildings); the turbines will not always be orientated to face the receptor depending on wind direction; there may be no windows facing the turbines and the turbines will not always be operating. Therefore the flicker effects will be substantially less than the theoretical scenario predicts.

The model also outputs a more realistic scenario. In this scenario, the only change in assumptions is that the statistically likely monthly sunshine frequency. This assessment only changes the annual hours per year metric and is not applied to the daily data. This is because it could be sunny on any individual day. The additional data used in the realistic model was the:

- Long-term sunshine probability data from the Met Éireann synoptic station in Kilkenny

EIAR 11.2.1 Key Factors which influence Shadow Flicker occurrence

The key factors related to shadow flicker occurrence are discussed in the following sections.

EIAR 11.2.1.1 Wind Direction

The shadow flicker analysis assumes that the turbine rotor plane (blade sets) are facing the receptor. However, the angle between the sun and the rotor plane plays a determining role for both shadow flicker occurrence and intensity. The rotor plane of the turbine is determined by the direction of the wind: because the turbine rotor continuously yaws to face the wind, the rotor plane will always be perpendicular to the wind direction. Shadow flicker will be most pronounced when the rotor plane is perpendicular to the sun-receptor line of sight.

EIAR 11.2.1.2 Sunshine Hours

The shadow flicker analysis assumes the sun is always shining, which in Ireland is not the case. It is reasonable to factor any results by the percentage of time the sun is actually shining. Ireland normally gets between 1100 and 1600 hours of sunshine each year. The sunniest months are May and June. During these months sunshine duration averages between 5 and 6.5 hours per day over most of the country. December is the dullest month, with an average daily sunshine ranging from about 1 hour in the north to almost 2 hours in the extreme southeast. Over the year as a whole, most areas get an average of between 3 1/4 and 3 3/4 hours of sunshine each day[2].

It was possible using the 30-year average sunshine data available from Met Éireann for Kilkenny (Kilkenny Meteorological Station) to determine the percentage of time shadow flicker could actually occur at the site. These are presented in **Table 11.1**.

[2] http://met.ie

Table 11.1 Average Hours of Sunshine and Average Hours of Day

Month	Average hours of sunshine per day	Average Length of daylight hours	Proportion of daylight hours with sunshine
Jan	1.8	8	23%
Feb	2.3	10	23%
Mar	3.2	12	27%
Apr	4.9	14	35%
May	5.6	16	35%
Jun	4.9	17	29%
Jul	4.7	16	29%
Aug	4.7	14	34%
Sept	4.0	13	31%
Oct	3.0	11	27%
Nov	2.2	9	24%
Dec	1.6	8	20%
Average		**Yearly Average**	**28%**

EIAR 11.2.2 Modelling Assumptions

EIAR 11.2.2.1 Theoretical Scenario Assumptions (Worst Case)

Theoretical shadow flicker simulation uses the following assumptions:

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

EIAR 11.2.2.2 Realistic Scenario Assumptions

A more realistic simulation could make the following assumptions:

1. The sun will not always be shining; therefore, it is only necessary to calculate shadow flicker for the fraction of time when the sun would be shining. Average sunshine hours used in this assessment are based on average monthly figures from the years 1981 to 2010, from the Kilkenny Meteorological Station (see **Table 11.1**).
2. The rotor will not be turning all the time. For example, a turbine would not be rotating during low wind conditions or maintenance works.
3. Trees, absence of windows facing the turbine and buildings in the vicinity of the receptor, will reduce shadow or eliminate shadow flicker.

EIAR 11.2.2.3 Combination of Theoretical & Realistic Assumptions used for modelling

The potential for shadow flicker occurrence was calculated using industry-standard simulation software *WindPRO 4.0*, a tool which has been successfully applied to similar studies around the world.

The modelling used herein for the Ballynalacken Windfarm turbines, uses theoretical scenario assumptions 2, 3 and 4 above in-combination with realistic scenario assumption 1 above, as per:

1. **Realistic Scenario:** The sun will not always be shining; therefore, it is only necessary to calculate shadow flicker for the fraction of time when the sun would be shining. Average sunshine hours used in this assessment are based on average monthly figures from the years 1981 to 2010, from the Kilkenny Meteorological Station (see **Table 11.1 above**);
2. **Theoretic Scenario**: The wind will blow continuously throughout the day and always above cut-in speed, i.e. the turbine will always be rotating; and
3. **Theoretic Scenario**: The wind will always be blowing from a direction such that the turbine rotor blades are always perpendicular to the sun-receptor view line; and
4. **Theoretic Scenario**: There will be no screening by vegetation or trees, i.e. the Windfarm model uses Ordnance Survey Ireland digital 10m height contour data as its only topographical reference. Simulations are run on a 'bare earth scenario' without allowing for the obscuring effect of vegetation between the location of the residence and the position of the sun in the sky. Nor does the model consider any obscuring features around residences itself, which would minimise views of the site and hence further reduce the potential for shadow flicker.

As the modelling is based on mainly theoretical worst case assumptions, the predicted annual shadow flicker effect presented in **Section EIAR 11.3**, is an overestimation.

EIAR 11.2.3 Shadow flicker Locations (Houses) in the Study Area

The sensitive receptor locations are illustrated on **Figure 11.1** below. The study area is 1170m from each turbine, based on ten-times the rotor diameter of 117m.

During the shadow flicker assessment, 72 houses were modelled (H1 to H144) within the study area. The closest house to the proposed turbines is H47, which is located 535m to the nearest wind turbine.

Note, House numbers are used throughout the EIAR, in particularly Chapter 10 Noise and Vibration. For this reason some house numbers are missing (e.g. H54) in **Table 11.2** below as they fall outside of the 1170m Shadow Flicker Study Area but have been assessed in another chapter.

Generally the layout extends in a north-south axis, and as a result houses are predominantly east or west of the turbines. These relative locations suggest that there is a high likelihood of the potential for shadow flicker.

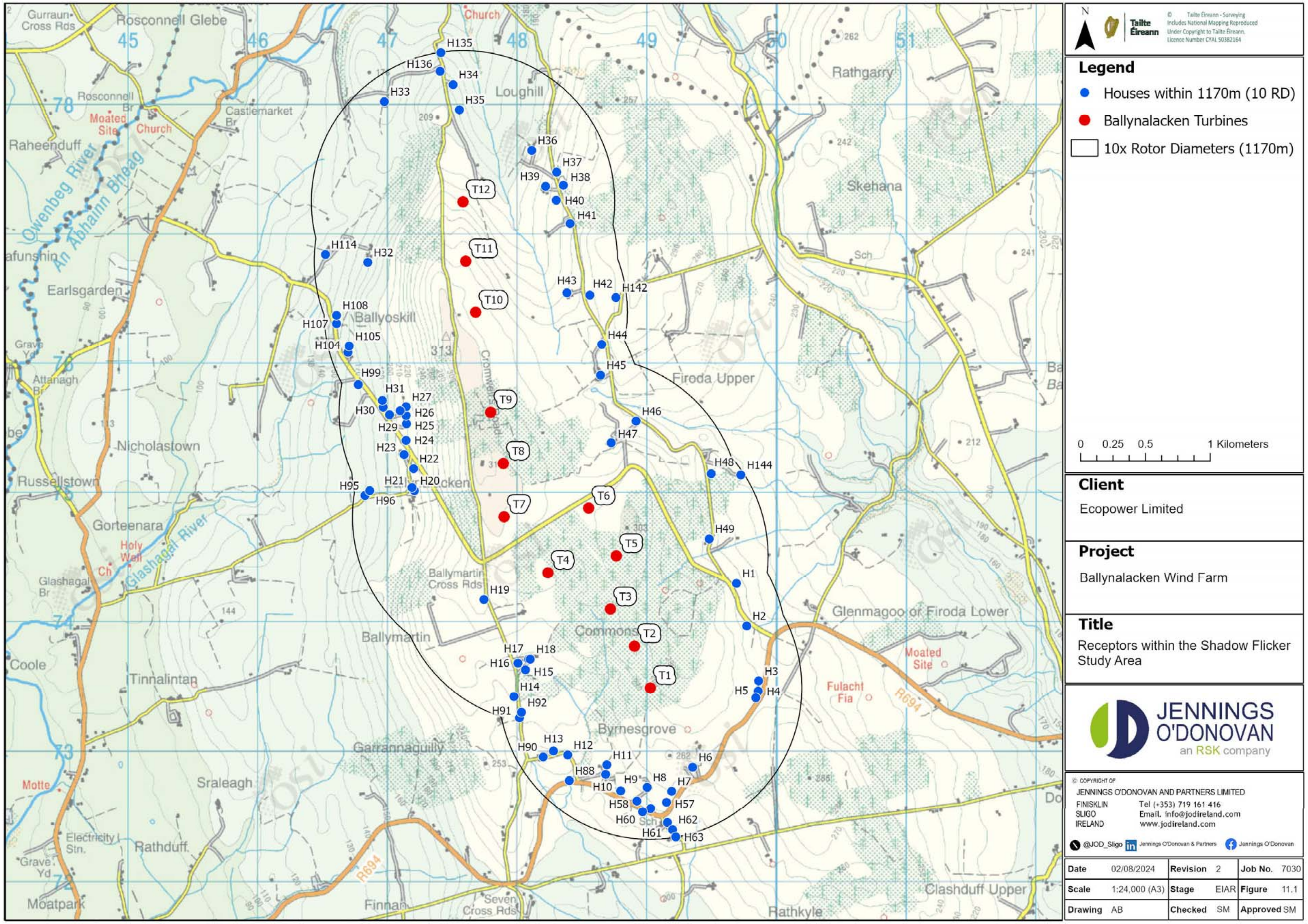

Figure 11.1 - House and Turbine Location - See Table 11.2 below for predicted Shadow Flicker occurrence hours per annum at each house location.

EIAR 11.2.4 Modelling Parameters for Wind Turbines

EIAR 11.2.4.1 Proposed Turbines at Ballynalacken Windfarm

Twelve Vestas V117 (with a hub height of 96.5m and a rotor diameter of 117m) has been modelled in these analyses for the Ballynalacken Windfarm.

EIAR 11.3 SHADOW FLICKER MODELLING RESULTS - UNMITIGATED

This section presents the results of the shadow flicker modelling for the Ballynalacken Windfarm turbines. The modelling presented is the predominately Theoretical Scenario – only the use of average sunshine hours has been applied from the Realistic Scenario (see Section EIAR 11.2.2).

The results of the modelling are presented in **Table 11.2 and Figure 11.2 below.** Values are highlighted in orange in Table 11.2 where shadow flicker modelling results exceeds 30 min/day and/or 30 hr/year.

It should also be noted that these results do not include any mitigation measures or consideration of wind direction.

Table 11.2: Shadow Flicker Modelling Results - Theoretical Scenario with Realistic sunshine hours

House ID	Stakeholder	Distance to closest turbine (m)	Max minutes per day (hh:mm)	Guideline thresholds mins per day (hh:mm)	Expected Total hours per year (hh:mm)	Guideline thresholds hours per year (hh:mm)
H1		922	00:31	**00:30**	29:03	**30:00**
H2		878	00:34	**00:30**	23:01	**30:00**
H3		840	00:32	**00:30**	17:28	**30:00**
H4		835	00:37	**00:30**	19:41	**30:00**
H5		820	00:40	**00:30**	20:29	**30:00**
H6		695	00:00	**00:30**	00:00	**30:00**
H7		817	00:00	**00:30**	00:00	**30:00**
H8		770	00:00	**00:30**	00:00	**30:00**
H9	Stakeholder	829	00:00	**00:30**	00:00	**30:00**
H10		752	00:00	**00:30**	00:00	**30:00**
H11		684	00:00	**00:30**	00:00	**30:00**
H12		822	00:00	**00:30**	00:00	**30:00**
H13		891	00:30	**00:30**	06:01	**30:00**
H14		1003	00:29	**00:30**	10:46	**30:00**
H15		803	00:33	**00:30**	12:37	**30:00**
H16	Stakeholder	770	00:36	**00:30**	18:55	**30:00**
H17	Stakeholder	718	00:38	**00:30**	19:15	**30:00**
H18	Stakeholder	715	00:37	**00:30**	18:39	**30:00**
H19		574	00:55	**00:30**	33:58	**30:00**
H20		717	00:54	**00:30**	25:50	**30:00**
H21		729	00:50	**00:30**	22:53	**30:00**

House ID	Stakeholder	Distance to closest turbine (m)	Max minutes per day (hh:mm)	Guideline thresholds mins per day (hh:mm)	Expected Total hours per year (hh:mm)	Guideline thresholds hours per year (hh:mm)
H22		693	00:51	**00:30**	20:00	**30:00**
H23		745	00:40	**00:30**	27:27	**30:00**
H24		689	00:42	**00:30**	32:15	**30:00**
H25		657	00:42	**00:30**	26:01	**30:00**
H26		652	00:42	**00:30**	23:44	**30:00**
H27		655	00:41	**00:30**	21:45	**30:00**
H28		699	00:38	**00:30**	20:39	**30:00**
H29		782	00:35	**00:30**	17:31	**30:00**
H30		830	00:32	**00:30**	12:06	**30:00**
H31		842	00:32	**00:30**	11:25	**30:00**
H32		757	00:36	**00:30**	21:05	**30:00**
H33		985	00:30	**00:30**	07:43	**30:00**
H34		910	00:00	**00:30**	00:00	**30:00**
H35	Stakeholder	713	00:32	**00:30**	03:40	**30:00**
H36	Stakeholder	663	00:42	**00:30**	13:26	**30:00**
H37	Stakeholder	757	00:36	**00:30**	12:41	**30:00**
H38		785	00:35	**00:30**	13:34	**30:00**
H39		648	00:42	**00:30**	17:04	**30:00**
H40		720	00:38	**00:30**	17:34	**30:00**
H41		844	00:33	**00:30**	13:22	**30:00**
H42		890	00:31	**00:30**	13:17	**30:00**
H43		719	00:38	**00:30**	14:56	**30:00**
H44	Stakeholder	1003	00:28	**00:30**	17:48	**30:00**
H45	Stakeholder	894	00:30	**00:30**	16:43	**30:00**
H46	Stakeholder	766	00:36	**00:30**	16:19	**30:00**
H47	Stakeholder	535	00:54	**00:30**	25:37	**30:00**
H48		968	00:42	**00:30**	15:20	**30:00**
H49		727	00:44	**00:30**	25:36	**30:00**
H57		895	00:00	**00:30**	00:00	**30:00**
H58		882	00:00	**00:30**	00:00	**30:00**
H59		934	00:00	**00:30**	00:00	**30:00**
H60		960	00:00	**00:30**	00:00	**30:00**
H61		1050	00:00	**00:30**	00:00	**30:00**
H62		1110	00:00	**00:30**	00:00	**30:00**
H63		1169	00:00	**00:30**	00:00	**30:00**
H88		951	00:00	**00:30**	00:00	**30:00**
H90		983	00:29	**00:30**	06:23	**30:00**
H91		1035	00:29	**00:30**	11:55	**30:00**
H92		1010	00:30	**00:30**	13:28	**30:00**
H95		1085	00:41	**00:30**	11:28	**30:00**
H96		1050	00:40	**00:30**	12:48	**30:00**
H99		1045	00:26	**00:30**	07:15	**30:00**

House ID	Stakeholder	Distance to closest turbine (m)	Max minutes per day (hh:mm)	Guideline thresholds mins per day (hh:mm)	Expected Total hours per year (hh:mm)	Guideline thresholds hours per year (hh:mm)
H104		1033	00:28	**00:30**	11:47	**30:00**
H105		1010	00:28	**00:30**	10:53	**30:00**
H107		1078	00:26	**00:30**	13:26	**30:00**
H108		1073	00:27	**00:30**	14:22	**30:00**
H114		1085	00:25	**00:30**	11:39	**30:00**
H135		1164	00:00	**00:30**	00:00	**30:00**
H136		1025	00:00	**00:30**	00:00	**30:00**
H142		1088	00:25	**00:30**	08:05	**30:00**
H144		1146	00:37	**00:30**	09:32	**30:00**

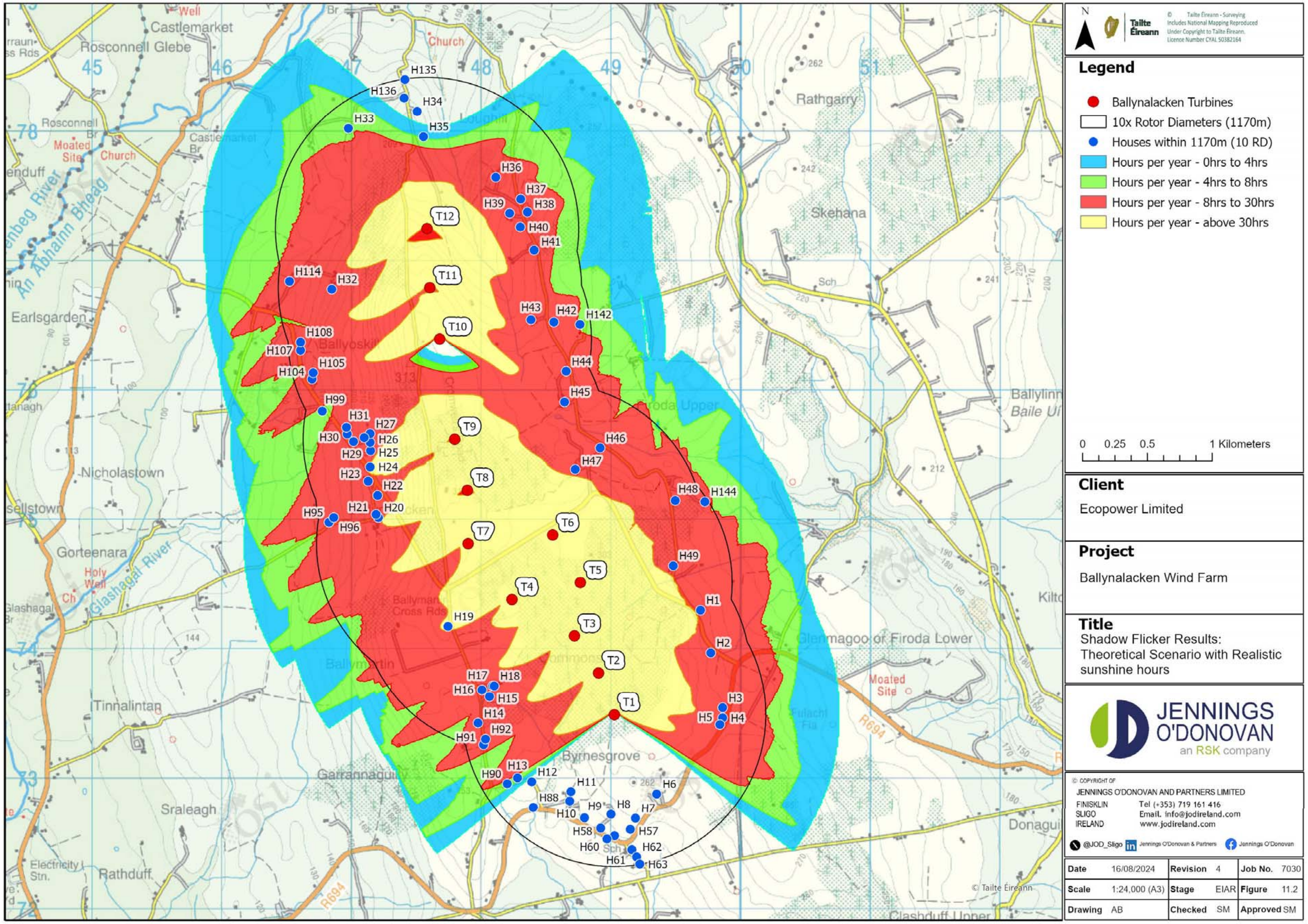

Figure 11.2 - Shadow Flicker Modelling Results - Theoretical Scenario with Realistic sunshine hours

EIAR 11.3.1 Discussion of Modelling Results

The results in **Table 11.2** show that, without applying mitigation measures there is the potential for the level of shadow flicker occurrence from the Proposed Ballynalacken Windfarm to exceed the daily thresholds recommended by the 2006 Guidelines at sensitive receptors in the study area. Under worst-case scenario modelling, the results show that there are 72 houses within the study area and of these 43 may experience Shadow Flicker exceeding the daily 2006 Guidelines guidance and that 2 might exceed the yearly guidance of 30 hours per year. As the 2006 Guidelines limits are being exceeded, the daily and yearly exceedances would be considered significant and require mitigation measures. The mitigation measures to avoid this exceedance is outlined in **Section EIAR 11.4**.

It is important to note that the results presented in **Table 11.2** are predominately a theoretical worst-case, and while average sunshine levels have been applied in the modelling, no allowance is included in the theoretical scenario for the periods when the blades are not turning (such as during low wind speeds or during maintenance), nor for periods when the wind direction has turned the rotor plane away from the sensitive receptor, nor for any screening provided by trees or buildings which may occur between a house and the turbine(s). Therefore the results in **Table 11.2** are an overestimate. However, should this project be granted planning there will be planning conditions controlling shadow flicker. These will likely be based on either the current Wind Energy Guidelines (2006) or the Draft Revised Wind Energy Development Guidelines, December 2019 if these guidelines are adopted at the time of the planning decision. In the 2019 Draft Guidelines it is recommended that *"a condition should be attached to all planning permissions for wind energy development to ensure that there will be no shadow flicker at any existing nearby dwelling or other relevant existing affected sensitive property and that the necessary measures outlined in the shadow flicker assessment submitted with the application, such as turbine shut down during the associated time periods, should be taken by the wind energy developer or operator to eliminate the shadow flicker"*.

EIAR 11.4 MITIGATION

EIAR 11.4.1 Shadow Flicker Control Modules

In any case and regardless of any planning condition attached to a planning grant, modern turbines such as those proposed for the Ballynalacken Windfarm can be fitted with shadow flicker control modules that can control the amount of shadow flicker that can occur at a given sensitive receptor. Selected turbines will be fitted with a shadow flicker module, comprising a central process unit (CPU) and light sensors. The control module monitors exposure to shadow flicker at identified sensitive receptors and calculates whether shadow flicker effect can occur at these properties, based on information from the light sensors measuring the light intensity prevailing, whether the turbine is operating and the blade position relative to the receptor. The results of the measurements predict whether shadow flicker is possible at the given sensitive receptor, under these conditions. The CPU logs all shadow events and can be set to automatically turn off the turbine if the defined parameters for shadow flicker events, at a given sensitive receptor, are predicted to occur.

The developer commits to the installation of Shadow Flicker Control Modules as a mitigation measure (OMM19): The wind turbines will be fitted with a Shadow Flicker Control Module, comprising a central processing unit (CPU) and light sensors. Should a complaint/request regarding shadow flicker be received from a neighbouring resident, the occurrence of shadow flicker at the receptor will be investigated and the Control Module can be set to automatically turn off the turbine if the defined parameters for shadow flicker events, at a given sensitive receptor, are predicted to occur. This will eliminate shadow flicker at the residence in question.

The operation and performance of the shadow flicker control measures will be monitored on an ongoing basis.

EIAR 11.5 RESIDUAL IMPACTS

Shadow Flicker Control Measures will be installed in the Proposed Ballynalacken Windfarm turbines to ensure that shadow flicker arising from the development will not exceed the authorised levels, or will not occur at a residence where a request is received, and therefore **no significant residual impacts are predicted to occur.**

EIAR 11.6 CONCLUSION

This report has evaluated the potential for shadow flicker from the proposed turbines at the Ballynalacken Windfarm development. Worst-case scenario modelling shows that shadow flicker above 30 min/day and/or 30 hr/year could occur at 43 No. sensitive receptors under certain meteorological conditions, without the installation of Shadow Flicker Control Measures on the wind turbines.

Modern wind turbines allow a great degree of remote and automatic control which can be deployed automatically to operate the turbines to limit the occurrence of shadow flicker to within the allowable levels or eliminate it completely at certain times, if so required.

Shadow Flicker Control Measures will be installed in the proposed Ballynalacken turbines to ensure that shadow flicker arising from the development will not exceed the authorised levels, and therefore no significant residual impacts are predicted to occur and it is concluded that that the proposed **Ballynalacken Windfarm will not result in a significant impact on the sensitive receptors in the locality**.

EIAR 11.7 REFERENCE LIST FOR SHADOW FLICKER

Geodirectory (n.d.) Residential Addresses dataset in 2024.

Google Earth & Street View (n.d.) *Ireland* [map].

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Ordnance Survey (n.d.) *Ireland* [map], 1:25,000.

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

APPENDIX 11.1 - WINDPRO SHADOW FLICKER MODELLING RESULTS

Appendix to Chapter 11: Shadow Flicker

Appendix 11.1: WindPRO Shadow Flicker Modelling Results

Project:
7030 Ballylackan

Description:
12 No. turbine SID windfarm

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abyrne / abyrne@jodireland.com
Calculated:
12/04/2024 11:06/4.0.531

SHADOW - Main Result

Calculation: 7030 Ballynalacken Expected Case Rev1

Assumptions for shadow calculations

Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.80	2.30	3.20	4.90	5.60	4.90	4.70	4.70	4.00	3.00	2.20	1.60

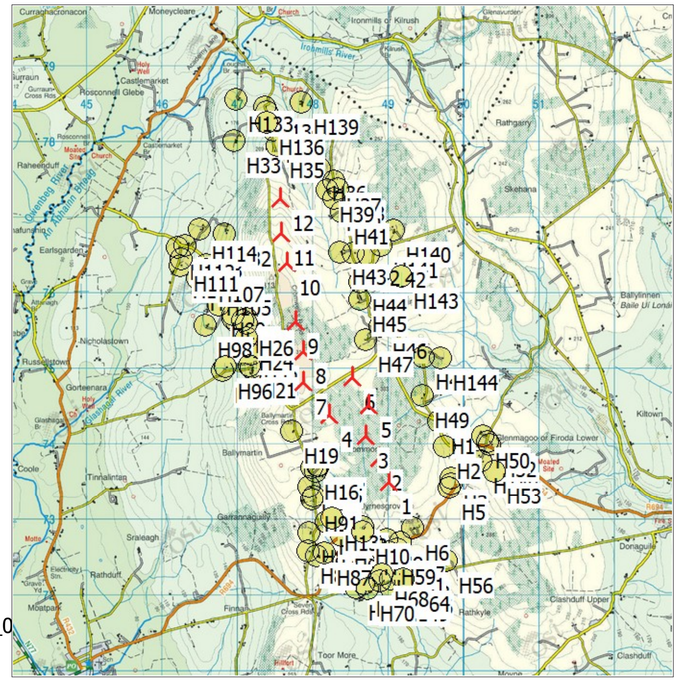
Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
263	276	354	236	136	176	319	1,031	1,059	795	990	868

W	WNW	NW	NNW	Sum
730	764	403	360	8,760

Yearly aggregation of real case reduction
A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Height Contours: CONTOURLINE_7030 Ballynalackan_0
Receptor grid resolution: 1.0 m

All coordinates are in
Irish ITM-IRENET95 (IE), geocentric, GRS80



New WTG
Scale 1:100,000
Shadow receptor

WTGs

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
1	648,966	673,528	272.7	T1	Yes	VESTAS	V150-6.0-6,000	6,000	150.0	95.0	1,902	-
2	648,846	673,851	280.7	T2	Yes	VESTAS	V150-6.0-6,000	6,000	150.0	95.0	1,902	-
3	648,660	674,135	287.2	T3	Yes	VESTAS	V150-6.0-6,000	6,000	150.0	95.0	1,902	-
4	648,178	674,417	288.7	T4	Yes	VESTAS	V150-6.0-6,000	6,000	150.0	95.0	1,902	-
5	648,706	674,547	297.8	T5	Yes	VESTAS	V150-6.0-6,000	6,000	150.0	95.0	1,902	-
6	648,492	674,915	302.2	T6	Yes	VESTAS	V150-6.0-6,000	6,000	150.0	95.0	1,902	-
7	647,840	674,849	300.9	T7	Yes	VESTAS	V150-6.0-6,000	6,000	150.0	95.0	1,902	-
8	647,833	675,261	309.5	T8	Yes	VESTAS	V150-6.0-6,000	6,000	150.0	95.0	1,902	-
9	647,737	675,658	309.5	T9	Yes	VESTAS	V150-6.0-6,000	6,000	150.0	95.0	1,902	-
10	647,621	676,430	306.0	T10	Yes	VESTAS	V150-6.0-6,000	6,000	150.0	95.0	1,902	-
11	647,545	676,826	277.1	T11	Yes	VESTAS	V150-6.0-6,000	6,000	150.0	95.0	1,902	-
12	647,523	677,284	245.7	T12	Yes	VESTAS	V150-6.0-6,000	6,000	150.0	95.0	1,902	-

Shadow receptor-Input

No.	Name	Easting	Northing	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
				[m]	[m]	[m]	[m]	[°]		[m]
A	H1	649,631	674,335	261.2	2.0	2.0	0.5	90.0	"Green house mode"	2.5
B	H2	649,710	674,006	251.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
C	H3	649,804	673,580	247.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
D	H4	649,801	673,501	248.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
E	H5	649,782	673,451	249.1	2.0	2.0	0.5	90.0	"Green house mode"	2.5
F	H6	649,294	672,915	259.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
G	H7	649,131	672,728	258.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
H	H8	648,942	672,758	255.8	2.0	2.0	0.5	90.0	"Green house mode"	2.5
I	H9	648,740	672,730	254.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
J	H10	648,623	672,859	255.2	2.0	2.0	0.5	90.0	"Green house mode"	2.5
K	H11	648,633	672,931	256.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
L	H12	648,330	673,008	254.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
M	H13	648,221	673,039	254.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
N	H14	647,917	673,461	262.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
O	H15	648,004	673,668	268.2	2.0	2.0	0.5	90.0	"Green house mode"	2.5

To be continued on next page...

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SHADOW - Main Result

Calculation: 7030 Ballynalacken Expected Case Rev1

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No.	Name	Easting	Northing	Z [m]	Width [m]	Height [m]	Elevation a.g.l. [m]	Slope of window [°]	Direction mode	Eye height (ZVI) a.g.l. [m]
P	H16	647,947	673,720	269.7	2.0	2.0	0.5	90.0	"Green house mode"	2.5
Q	H17	648,028	673,750	270.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
R	H18	648,042	673,750	270.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
S	H19	647,685	674,209	284.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
T	H20	647,147	675,051	271.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
U	H21	647,128	675,075	271.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
V	H22	647,141	675,222	276.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
W	H23	647,067	675,332	270.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
X	H24	647,083	675,441	262.1	2.0	2.0	0.5	90.0	"Green house mode"	2.5
Y	H25	647,086	675,570	251.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
Z	H26	647,085	675,633	245.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AA	H27	647,083	675,699	239.8	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AB	H28	647,038	675,670	239.8	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AC	H29	646,955	675,639	237.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AD	H30	646,908	675,696	229.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AE	H31	646,900	675,750	224.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AF	H32	646,788	676,815	217.7	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AG	H33	646,917	678,060	178.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AH	H34	647,445	678,191	198.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AI	H35	647,494	677,996	205.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AJ	H36	648,053	677,682	237.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AK	H37	648,244	677,514	254.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AL	H38	648,297	677,412	262.8	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AM	H39	648,160	677,405	258.8	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AN	H40	648,243	677,296	268.8	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AO	H41	648,350	677,116	284.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AP	H42	648,501	676,562	304.1	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AQ	H43	648,324	676,580	305.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AR	H44	648,594	676,180	303.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AS	H45	648,584	675,945	303.2	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AT	H46	648,857	675,589	300.1	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AU	H47	648,666	675,421	301.7	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AV	H48	649,437	675,181	266.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AW	H49	649,421	674,680	276.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AX	H50	650,225	674,145	236.7	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AY	H51	650,286	674,069	237.1	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AZ	H52	650,315	674,030	237.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BA	H53	650,381	673,664	241.2	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BB	H56	649,744	672,480	259.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BC	H57	649,093	672,642	257.2	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BD	H58	648,864	672,652	254.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BE	H59	648,971	672,594	255.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BF	H60	648,911	672,570	254.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BG	H61	649,103	672,487	256.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BH	H62	649,140	672,432	255.7	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BI	H63	649,166	672,376	255.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BJ	H64	649,165	672,245	254.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BK	H65	649,171	672,243	254.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BL	H66	649,196	672,198	254.2	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BM	H67	648,996	672,234	253.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BN	H68	648,886	672,310	253.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BO	H69	648,852	672,220	252.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BP	H70	648,686	672,107	248.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BQ	H71	648,647	672,177	248.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BR	H72	648,544	672,131	246.1	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BS	H85	647,904	672,611	247.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BT	H86	648,011	672,548	246.7	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BU	H87	648,116	672,582	247.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BV	H88	648,342	672,810	252.7	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BW	H89	647,913	672,853	250.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BX	H90	648,141	672,993	253.2	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BY	H91	647,957	673,296	259.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
BZ	H92	647,974	673,337	261.1	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CA	H95	646,767	675,013	242.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5

To be continued on next page...

SHADOW - Main Result

Calculation: 7030 Ballynalacken Expected Case Rev1

...continued from previous page

No.	Name	Easting	Northing	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
				[m]	[m]	[m]	[m]	[°]		[m]
CB	H96	646,804	675,052	246.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CC	H98	646,530	675,606	213.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CD	H99	646,714	675,872	202.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CE	H104	646,636	676,120	176.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CF	H105	646,646	676,168	174.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CG	H106	646,434	676,233	153.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CH	H107	646,547	676,342	159.1	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CI	H108	646,548	676,408	161.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CJ	H110	646,200	676,402	130.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CK	H111	646,217	676,483	130.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CL	H112	646,167	676,638	127.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CM	H113	646,261	676,670	128.8	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CN	H114	646,461	676,876	163.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CO	H133	646,941	678,605	163.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CP	H134	647,318	678,501	185.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CQ	H135	647,353	678,436	188.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CR	H136	647,346	678,294	191.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CS	H139	647,808	678,559	207.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CT	H140	649,031	676,867	300.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CU	H141	648,873	676,659	301.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CV	H142	648,703	676,544	303.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CW	H143	649,135	676,260	282.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CX	H144	649,666	675,173	265.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CY	H148	650,199	673,808	241.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
CZ	H149	649,012	672,117	252.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5

Calculation Results

Shadow receptor

		Shadow, worst case			Shadow, expected values
No.	Name	Shadow hours per year	Shadow days per year	Max shadow hours per day	Shadow hours per year
		[h/year]	[days/year]	[h/day]	[h/year]
A	H1	160:25	340	0:47	27:47
B	H2	121:23	243	0:46	21:39
C	H3	91:43	180	0:48	17:37
D	H4	95:11	167	0:53	18:25
E	H5	104:37	161	0:56	20:00
F	H6	0:00	0	0:00	0:00
G	H7	0:00	0	0:00	0:00
H	H8	0:00	0	0:00	0:00
I	H9	0:00	0	0:00	0:00
J	H10	0:00	0	0:00	0:00
K	H11	0:00	0	0:00	0:00
L	H12	0:00	0	0:00	0:00
M	H13	32:36	63	0:41	5:55
N	H14	51:02	122	0:36	10:06
O	H15	71:13	154	0:42	13:22
P	H16	90:47	173	0:46	16:56
Q	H17	98:12	178	0:49	18:15
R	H18	97:42	178	0:49	18:09
S	H19	151:41	232	1:09	28:16
T	H20	141:19	234	1:09	25:33
U	H21	120:25	206	1:06	21:51
V	H22	115:52	217	0:58	20:20
W	H23	150:51	263	0:58	26:25
X	H24	173:54	301	0:53	30:18
Y	H25	140:56	268	0:54	24:26
Z	H26	129:59	244	0:53	22:27
AA	H27	120:16	222	0:52	20:26
AB	H28	113:35	227	0:49	19:21
AC	H29	97:18	231	0:44	16:39
AD	H30	86:20	217	0:42	14:31
AE	H31	83:34	204	0:41	13:44

To be continued on next page...

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SHADOW - Main Result

Calculation: 7030 Ballynalacken Expected Case Rev1

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No.	Name	Shadow, worst case Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow, expected values Shadow hours per year [h/year]
AF	H32	125:26	244	0:46	21:54
AG	H33	57:57	92	0:49	8:12
AH	H34	0:00	0	0:00	0:00
AI	H35	32:51	54	0:46	4:46
AJ	H36	88:05	142	0:54	13:26
AK	H37	81:42	158	0:46	12:48
AL	H38	80:50	172	0:44	12:39
AM	H39	105:49	180	0:54	16:57
AN	H40	99:28	195	0:47	16:14
AO	H41	75:11	178	0:41	12:45
AP	H42	72:19	200	0:39	12:11
AQ	H43	81:22	170	0:49	14:24
AR	H44	93:26	237	0:36	15:45
AS	H45	94:50	238	0:39	16:05
AT	H46	94:46	240	0:47	15:26
AU	H47	150:43	231	1:09	24:44
AV	H48	99:27	224	0:54	16:12
AW	H49	137:59	262	0:55	23:53
AX	H50	47:23	165	0:26	8:39
AY	H51	35:30	127	0:25	6:30
AZ	H52	33:57	123	0:24	6:16
BA	H53	35:30	137	0:25	6:47
BB	H56	0:00	0	0:00	0:00
BC	H57	0:00	0	0:00	0:00
BD	H58	0:00	0	0:00	0:00
BE	H59	0:00	0	0:00	0:00
BF	H60	0:00	0	0:00	0:00
BG	H61	0:00	0	0:00	0:00
BH	H62	0:00	0	0:00	0:00
BI	H63	0:00	0	0:00	0:00
BJ	H64	0:00	0	0:00	0:00
BK	H65	0:00	0	0:00	0:00
BL	H66	0:00	0	0:00	0:00
BM	H67	0:00	0	0:00	0:00
BN	H68	0:00	0	0:00	0:00
BO	H69	0:00	0	0:00	0:00
BP	H70	0:00	0	0:00	0:00
BQ	H71	0:00	0	0:00	0:00
BR	H72	0:00	0	0:00	0:00
BS	H85	0:00	0	0:00	0:00
BT	H86	0:00	0	0:00	0:00
BU	H87	0:00	0	0:00	0:00
BV	H88	0:00	0	0:00	0:00
BW	H89	26:21	66	0:31	4:47
BX	H90	31:34	65	0:38	5:43
BY	H91	54:16	120	0:37	10:16
BZ	H92	60:48	127	0:38	11:31
CA	H95	67:03	164	0:50	12:12
CB	H96	73:45	171	0:53	13:18
CC	H98	35:46	104	0:29	6:23
CD	H99	51:13	149	0:33	8:24
CE	H104	81:26	219	0:35	14:11
CF	H105	74:36	207	0:36	12:56
CG	H106	58:22	164	0:29	10:30
CH	H107	71:59	183	0:34	12:57
CI	H108	80:37	197	0:34	14:36
CJ	H110	39:16	136	0:26	7:28
CK	H111	46:32	148	0:26	8:42
CL	H112	54:13	172	0:26	10:02
CM	H113	60:21	173	0:27	11:06
CN	H114	71:26	193	0:32	13:12
CO	H133	0:00	0	0:00	0:00
CP	H134	0:00	0	0:00	0:00

To be continued on next page...

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SHADOW - Main Result

Calculation: 7030 Ballynalacken Expected Case Rev1

...continued from previous page

No.	Name	Shadow, worst case Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow, expected values Shadow hours per year [h/year]
CQ	H135	0:00	0	0:00	0:00
CR	H136	0:00	0	0:00	0:00
CS	H139	0:00	0	0:00	0:00
CT	H140	19:17	107	0:22	3:10
CU	H141	30:08	141	0:27	5:08
CV	H142	47:05	188	0:32	8:09
CW	H143	28:13	121	0:24	4:56
CX	H144	64:13	183	0:48	10:16
CY	H148	46:50	156	0:28	8:52
CZ	H149	0:00	0	0:00	0:00

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	T1	277:02	48:31
2	T2	317:45	58:21
3	T3	267:50	46:41
4	T4	261:21	45:31
5	T5	203:16	36:11
6	T6	256:01	42:33
7	T7	224:04	35:34
8	T8	387:09	67:31
9	T9	487:37	86:18
10	T10	362:57	64:00
11	T11	342:36	59:50
12	T12	334:21	57:00

Total times in Receptor wise and WTG wise tables can differ, as a WTG can lead to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more WTGs simultaneously.

The calculation of the total expected values for a given receptor assumes a weighted average directional reduction for all WTGs contributing to shadow flicker within the same day. In the case where shadow flicker from different WTGs is not concurrent within the day, the total expected time at a given receptor may deviate marginally from the individual flicker time caused by each turbine separately.

Project:
7030 Ballylackan

Description:
12 No. turbine SID windfarm

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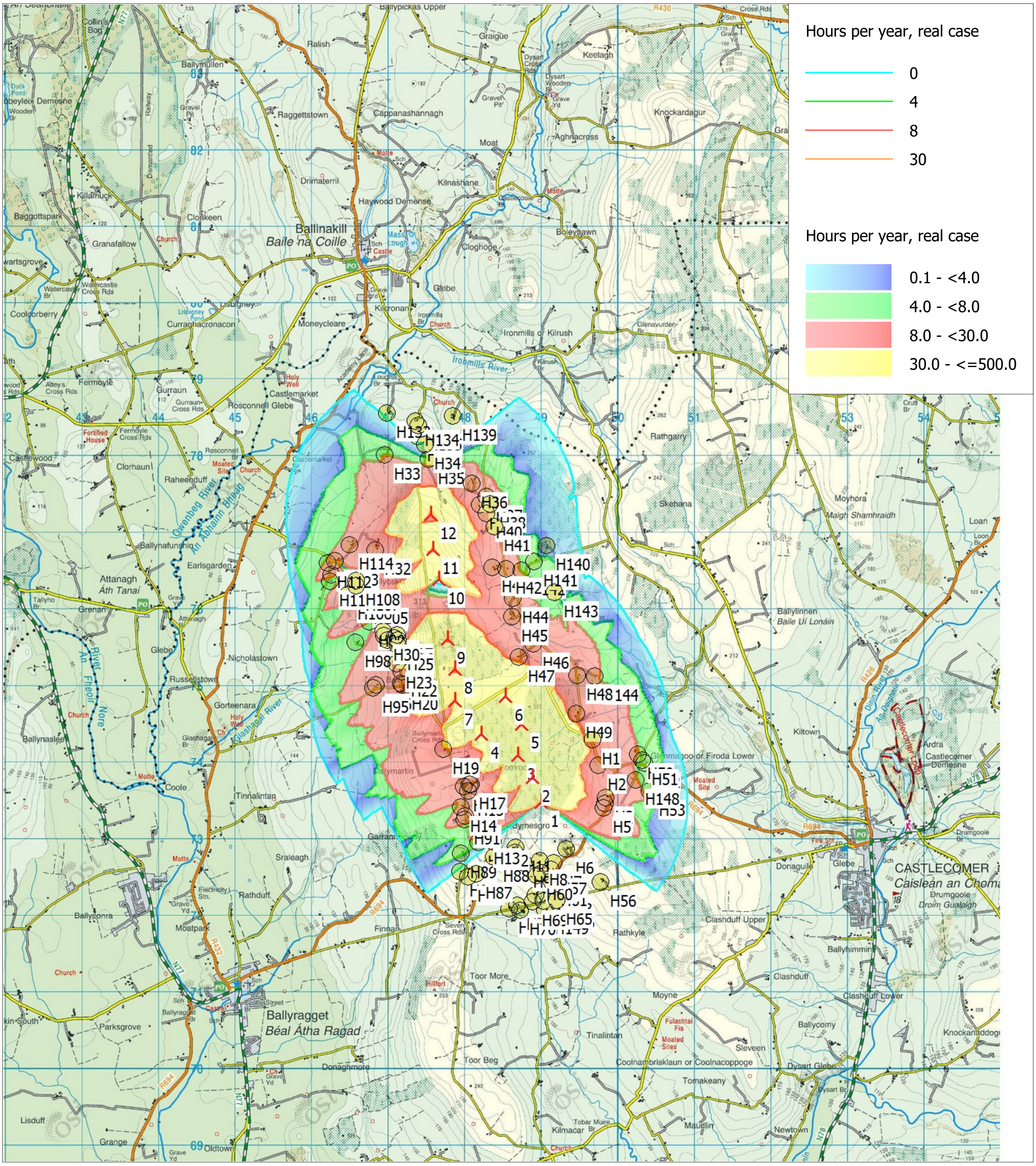
Calculated:
12/04/2024 11:06/4.0.531

SHADOW - Map

Calculation: 7030 Ballynalacken Expected Case Rev1



0 1 2 3 4 km

Map: Map , Print scale 1:75,000, Map center Irish ITM-IRENET95 (IE), geocentric, GRS80 East: 648,520 North: 676,320

New WTG Shadow receptor

Flicker map level: Height Contours: CONTOURLINE_7030 Ballynalacken_0.wpo (1)

Time step: 2 minutes, Day step: 3 days, Map resolution: 10 m, Visibility resolution: 5 m, Eye height: 1.5 m