

Proposed Gathabawn Windfarm Project

Environmental Impact Assessment Report

Chapter 11: Shadow Flicker



September 2026

Table of Contents

CHAPTER 11 SHADOW FLICKER.....	11-4
EIAR 11.1 INTRODUCTION	11-4
EIAR 11.1.1 Competent Expert	11-4
EIAR 11.1.2 Sources of Information	11-4
EIAR 11.1.3 Methodology Used.....	11-4
EIAR 11.1.4 Statement on Certainty and Sufficiency of Information Provided	11-4
EIAR 11.2 SENSITIVE ASPECTS	11-5
EIAR 11.2.1 Overview of Shadow Flicker in the Local Environment	11-5
EIAR 11.2.2 Zone of Influence/Study Areas.....	11-5
EIAR 11.3 BASELINE ENVIRONMENT	11-6
EIAR 11.3.1 Context and Characteristics	11-6
EIAR 11.3.2 Existing Sources of Impacts.....	11-11
EIAR 11.3.3 Importance, Sensitivity and Vulnerability to Change	11-11
EIAR 11.3.4 Evolution of the Baseline Environment (the 'Do-Nothing' scenario)	11-11
EIAR 11.4 IMPACT OF THE PROPOSED DEVELOPMENT.....	11-12
EIAR 11.4.1 Criteria and Methodology	11-12
EIAR 11.4.2 Source-Pathway-Receptor	11-12
EIAR 11.4.3 Overview of the Proposed Development	11-12
EIAR 11.4.4 Evaluation of effects on Residential Receptors	11-12
EIAR 11.5 CUMULATIVE EFFECTS WITH OTHER PROJECTS.....	11-24
EIAR 11.5.1 Evaluation of Cumulative Impacts with Individual Other Projects	11-24
EIAR 11.6 SUMMARY CONCLUSION	11-32
EIAR 11.7 Glossary, List of Abbreviations.....	11-33
EIAR 11.8 Reference List.....	11-33
EIAR 11.9 List of Appendices	11-33
Figures	11-34

List of Figures

Figure No.	Figure Title	EIAR Location
Figure 11.1	Sensitive Receptors within 10 Rotor Diameters of Gathabawn Windfarm	Section EIAR 11.3.1

List of Appendices

Appendix No.	Appendix Title	Location
Appendix 11.1	Methodology for the evaluation of Shadow Flicker	End of this Chapter
Appendix 11.2	Shadow Flicker Graphs	End of this Chapter

CHAPTER 11 SHADOW FLICKER

EIAR 11.1 INTRODUCTION

EIAR 11.1.1 Competent Expert

The Shadow Flicker analysis has been carried out by Ms. Kathlyn Feeney of Jennings O'Donovan & Partners Limited. Kathlyn Feeney is an Environmental Scientist, who holds a Bachelor (Hons) Degree in Environmental Science from the Atlantic Technological University, Sligo. She forms part of the Environmental team responsible for preparing EIAR Chapters. Kathlyn has experience writing EIARs, Feasibility Studies and Shadow Flicker analysis.

The analysis has been reviewed by Ms. Sarah Moore of Jennings O'Donovan & Partners Limited. Sarah Moore Environmental Scientist with over 19 years of environmental consultancy experience. She has obtained a MSc in Environmental Engineering from Queens University, Belfast, and a BSc in Environmental Science from University of Limerick. Since joining JOD, Sarah has been involved as a Project Environmental Scientist on a range of renewable energy, wastewater, structures and commercial projects. She has experience in the preparation of Appropriate Assessments, Ecological Impact Assessments and Geographic Information Systems.

EIAR 11.1.2 Sources of Information

Consultation, desktop studies and fieldwork were carried out in order to gather information on the baseline environment.

Table 11-1: Sources of Baseline Information for Shadow Flicker

Desktop Sources
• Review of local residences and community facility locations
Fieldwork
• Calculation of the occurrence of shadow flicker at relevant receptors using the WindPRO 4.2 computer model.

EIAR 11.1.3 Methodology Used

The evaluations for Shadow Flicker herein have been carried out in accordance with the *Wind Energy Development Guidelines* (Department of the Environment, Heritage and Local Government, 2006), the *Best Practice Guidelines for the Irish Wind Energy Industry* (Irish Wind Energy Association, 2012) and the *Draft Revised Wind Energy Development Guidelines* (Department of Housing, Local Government and Heritage, 2019). This methodology can be found in [Appendix 11.1: Methodology for the evaluation of Shadow Flicker](#). The competent experts extensive experience with EIA preparation also informs this report.

EIAR 11.1.4 Statement on Certainty and Sufficiency of Information Provided

A clear documentary trail is provided throughout this chapter and chapter appendices to the competency of data and methods used and the rationale for selection of same.

No material limitations or difficulties were encountered during the modelling of shadow flicker occurrence as a result of the turbines at Gathabawn.

EIAR 11.2 SENSITIVE ASPECTS

EIAR 11.2.1 Overview of Shadow Flicker in the Local Environment

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 casts 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. Shadow flicker lasts only for a short period and happens only in certain specific combined circumstances. The circumstances required for shadow flicker to occur are:

- The sun is shining,
- The turbine is directly between the sun and the affected property,
- There is enough wind energy to ensure that the turbine blades are moving, and
- The turbine blades are positioned so as to cast a shadow on the receptor.

If any one of these conditions are absent, shadow flicker cannot occur. The 2019 Draft Revised Wind Energy Development Guidelines also added that:

- “There is sufficient direct sunlight to cause shadows (cloud, mist, fog or air pollution could limit solar energy levels)” and noted 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”.

The path of the sun varies over the seasons resulting in a changing potential for a shadow to be cast throughout the year. Similarly, the sun’s position in the sky over the course of a day is changing such that the shadow cast by a turbine is constantly changing. Shadow flicker is more likely to occur on sunny winter days when the sun is lower in the sky and shadows cast a greater distance from the turbine. Shadow flicker is more likely to occur to the east or west of the wind farm site.

EIAR 11.2.2 Zone of Influence/Study Areas

The area or zone of influence around the proposed Gathabawn Windfarm Project within which the sensitive aspects of the environment could be affected by the Project is called the Study Area herein. The Study Areas for the Sensitive Aspects of the Shadow Flicker environment are set out in the table below.

Table 11-2: Study Area of the Project in relation to sensitive aspects of the Shadow Flicker environment

Sensitive Aspect	Zone of Influence/Study Area	Justification for the Study Area extent
Residential Receptors	10 rotor diameters of the turbines – i.e. 1360m	As per best practice

EIAR 11.3 BASELINE ENVIRONMENT

The context and characteristics of the baseline environment, and the trends and evolution thereof, in relation to *Residential Receptors* are described in the subsections below.

The result of desktop surveys are summarised in the sections below, illustrated on the mapping listed below, with the detailed data included in the Appendices listed:

EIAR Figures:

Figure 11.1: Sensitive Receptors within 10 Rotor Diameters of Gathabawn Windfarm

EIAR Appendices (included at the end of this Chapter):

Appendix 11.2: Shadow Flicker Graphs

EIAR 11.3.1 Context and Characteristics

EIAR 11.3.1.1 Residential Receptors

Jennings O'Donovan examined maps to identify receptors within a Study Area, a distance ten times the proposed rotor diameter of the proposed turbine ($10 \times 136\text{m} = 1360\text{m}$). The properties were identified using a combination of Ordnance Survey of Ireland (OSI) Maps, AutoCAD drawings and from internet mapping resources including *Eircode Finder*, *Google Street View*, *Google Earth*, *Bing Maps*, a planning permission search using the Kilkenny County Council web resource and from a visit to the Study Area. There are 134 properties within the shadow flicker Study Area radius. The coordinates of each dwelling and its distance to the closest proposed turbine are listed in the table below and are shown in Figure 11.1.

Table 11-3: Properties within the Shadow Flicker Study Area

Current House ID	Easting ITM	Northing ITM	Closest Turbine	Distance to Turbine (m)
H1	633552	672356	T1	807
H2	633544	672320	T1	783
H3	633319	672353	T1	959
H4	633274	672047	T1	824
H5	633210	672057	T1	886
H6	633053	671840	T2	948
H7	632918	671738	T2	948
H8	633375	671516	T2	511
H9	633400	671529	T2	515
H10	633004	671495	T2	720
H11	632935	671182	T2	643
H12	632882	671174	T2	694
H13	632760	671062	T2	803
H14	632894	670801	T2	710
H15	633016	670785	T2	603
H16	633022	670639	T2	673
H17	633048	670426	T2	801
H18	633132	670225	T4	780
H19	633193	670128	T4	755
H20	633430	669756	T4	817
H21	633615	669694	T5	715

Current House ID	Easting ITM	Northing ITM	Closest Turbine	Distance to Turbine (m)
H22	633673	669670	T5	687
H23	634381	669308	T6	611
H24	634674	668605	T6	898
H25	634845	668835	T6	630
H26	634875	668852	T6	608
H27	635203	668793	T6	697
H28	635293	668831	T6	697
H29	635319	668839	T6	702
H30	635453	668684	T6	904
H31	635899	669191	T6	960
H32	635945	669331	T6	977
H33	635590	669486	T6	615
H34	635896	669473	T6	921
H35	635928	669530	T6	956
H36	635542	669799	T7	604
H37	635563	670039	T7	650
H38	635346	670161	T7	509
H39	634661	670329	T5	521
H40	634679	670367	T5	552
H41	634787	670391	T7	559
H42	634808	670456	T7	617
H43	635331	670445	T7	709
H44	635237	670523	T7	732
H45	635272	670630	T7	844
H46	635238	670671	T7	870
H47	635152	670681	T7	862
H48	637774	669205	T8	693
H49	637690	668970	T11	776
H50	637714	668847	T11	720
H51	638242	667686	T12	897
H52	639647	668665	T10	919
H53	639548	668789	T9	778
H54	639479	668800	T9	715
H55	639426	668788	T9	681
H56	639354	668740	T10	617
H57	639319	668877	T9	542
H58	639684	669271	T9	780
H59	639729	669335	T9	831
H60	639519	669545	T9	691
H61	639505	669789	T9	822
H62	639191	669991	T9	815
H63	638867	670224	T9	997
H64	638524	669902	T9	775
H65	638407	669816	T8	704
H66	634218	672868	T1	1185
H67	634241	672762	T1	1085

Current House ID	Easting ITM	Northing ITM	Closest Turbine	Distance to Turbine (m)
H68	633867	672707	T1	1019
H69	632804	672150	T1	1297
H70	632856	671951	T2	1153
H71	632798	671911	T2	1159
H72	632704	672053	T2	1328
H75	632577	671339	T2	1030
H76	632310	671345	T2	1289
H77	632562	671234	T2	1019
H78	632549	670874	T2	1027
H80	633085	669396	T4	1310
H84	633271	669148	T5	1342
H85	633329	669143	T5	1307
H86	633702	669162	T5	1086
H87	633715	669148	T5	1093
H88	633740	669132	T5	1097
H89	633738	669043	T5	1180
H90	633777	669031	T5	1178
H91	633661	668945	T5	1300
H92	633838	668878	T6	1273
H93	633804	668815	T6	1333
H94	634101	668902	T6	1032
H95	634097	668823	T6	1080
H98	635103	668155	T6	1303
H99	635457	668193	T6	1348
H101	635629	668489	T6	1164
H102	635756	668463	T6	1260
H103	635678	668525	T6	1163
H104	635655	668576	T6	1108
H105	635621	668561	T6	1100
H106	635609	668570	T6	1086
H107	635526	668603	T6	1012
H108	635601	668607	T6	1051
H109	635613	668615	T6	1052
H110	635714	668731	T6	1032
H111	635972	669211	T6	1025
H112	635052	671884	T1	1047
H113	637728	669825	T8	1021
H115	637207	668836	T11	1221
H116	637198	668632	T11	1226
H117	637248	668607	T11	1178
H118	637170	668587	T11	1258
H119	637221	668579	T11	1208
H120	637162	668558	T11	1269
H121	637149	668537	T11	1284
H122	637136	668516	T11	1300
H123	637134	668426	T11	1319

Current House ID	Easting ITM	Northing ITM	Closest Turbine	Distance to Turbine (m)
H124	637168	668404	T11	1291
H125	637201	668379	T11	1265
H126	637365	668195	T11	1176
H127	637419	668042	T11	1205
H128	638131	667593	T12	1037
H129	638265	667461	T12	1082
H130	638305	667382	T12	1138
H131	638371	667321	T12	1123
H144	639970	668257	T12	1247
H146	639936	668373	T12	1202
H147	639838	668512	T12	1105
H148	639834	668561	T12	1106
H149	639795	668683	T9	1043
H150	639297	670273	T9	1117
H151	639288	670302	T9	1141
H152	639657	670304	T9	1313
H153	639538	670382	T9	1317
H156	639271	670497	T9	1321
H159	639111	670551	T9	1339
H160	639123	670496	T9	1287
H161	638947	670309	T9	1082
H264	633420	669213	T5	1195
H265	635345	668275	T6	1233
H267	638438	667240	T12	1232
H268	638908	667139	T12	1308
H269	638958	667274	T12	1183
H270	639035	667319	T12	1156

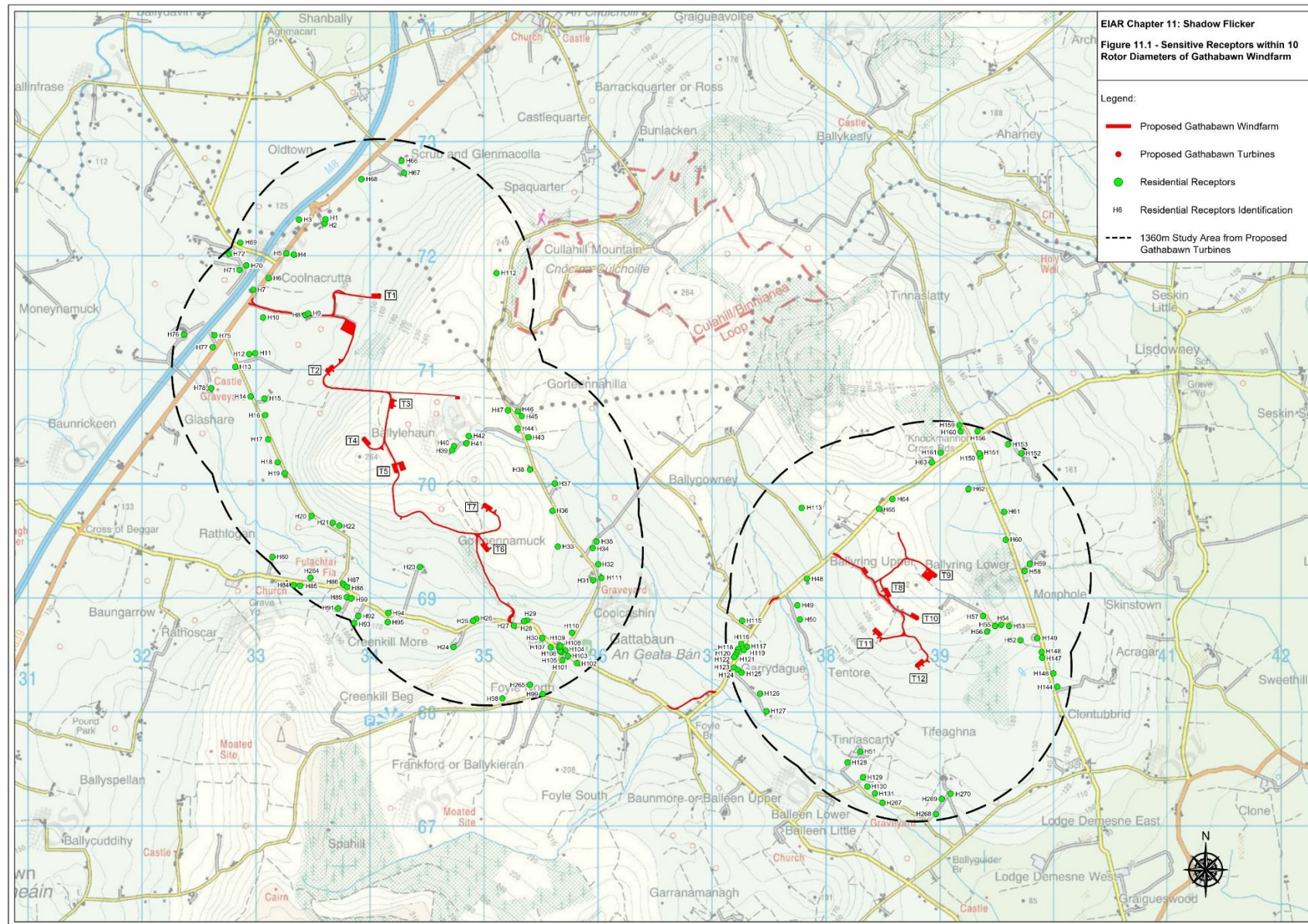


Figure 11.1: Sensitive Receptors within 10 Rotor Diameters of Gathabawn Windfarm (Full size figure at the end of this chapter)

EIAR 11.3.2 Existing Sources of Impacts

The occurrence of existing shadow flicker in the areas on or around the location of the Project has also been considered. Lisdowney Wind Farm, located 1.2km north of the closest Gathabawn Windfarm turbine location (T9), is considered to be an existing source of shadow flicker in the environment.

EIAR 11.3.3 Importance, Sensitivity and Vulnerability to Change

EIAR 11.3.3.1 Importance

Residential amenity is important to the quality of life for local residents.

EIAR 11.3.3.2 Sensitivity

Residential receptors are sensitive to shadow flicker as a distraction or disturbance preventing enjoyment of their property during the day. At night, shadow flicker cannot occur.

It is noted that the shadow flicker criteria derived from the Wind Energy Development Guidelines 2006 are designed to protect amenity at residential receptors.

EIAR 11.3.4 Evolution of the Baseline Environment (the 'Do-Nothing' scenario)

Trends in Key Indicators over time:

There has been a trend of renewable energy development in the area, with Lisdowney Wind Farm becoming operational in 2016. The addition of further wind energy development will mean additional shadow flicker sources in the area and an increase in shadow flicker levels albeit within the bounds of the limits as imposed by conditions of planning.

In the absence of this proposed development proceeding, the baseline levels will increase in line with the trends identified above.

EIAR 11.4 IMPACT OF THE PROPOSED DEVELOPMENT

This Section comprises an evaluation of the impacts of the proposal on the receiving Shadow Flicker environment.

EIAR 11.4.1 Criteria and Methodology

The criteria used for impact evaluation in this report is based on the *Wind Energy Development Guidelines* (Department of the Environment, Heritage and Local Government, 2006), the *Best Practice Guidelines for the Irish Wind Energy Industry* (Irish Wind Energy Association, 2012) and the *Draft Revised Wind Energy Development Guidelines* (Department of Housing, Local Government and Heritage, 2019), as outlined in [Appendix 11.1](#).

EIAR 11.4.2 Source-Pathway-Receptor

The following sources of impacts and pathways for these impacts to the identified receptors (sensitive aspects) of Shadow Flicker are listed below.

EIAR 11.4.2.1 Sources of Impact

Operational Phase

- Operating Turbines

EIAR 11.4.2.2 Pathways

- Air
- Visibility

EIAR 11.4.2.3 Receptors

- People inside local residences

EIAR 11.4.3 Overview of the Proposed Development

The proposed Gathabawn Windfarm Project comprises 12 wind turbines with an overall blade tip height of 150m for T6, T7 and T9, and 170m for all other turbines, and all associated foundations and hard-standing areas in respect of each turbine, cabling, access roads, windfarm substation, lattice tower meteorological mast 30m in height and all ancillary associated and facilitating works and activities.

EIAR 11.4.4 Evaluation of effects on Residential Receptors

The potential for shadow flicker is presented for two scenarios – a worst-case scenario, and a ‘realistic’ scenario.

Under the ‘worst case’ scenario, it is assumed that the sun is shining 100% of the time during potential sunshine hours. ‘*Potential sunshine hours*’ refers to the intervening time period between modelled sunrise and sunset. The ‘worst case’ scenario will not materialise - in reality, the sun does not shine all the time. The potential for shadow flicker to occur is reduced by cloudy, hazy or misty weather.

In order to calculate more realistic and ‘*real world*’ occurrences of shadow flicker for the receptors that are identified as potentially vulnerable to shadow flicker, it is necessary to identify the likely meteorological conditions which are expected to be experienced at the Site. To estimate the likely duration of sunshine occurrence at the Site and the likely wind direction, historical meteorological data from Met Éireann and SEAI is automatically uploaded by the software.

Data from Kilkenny meteorological observatory was used as this Met Éireann observatory is the closest to the Site and also measures multiple environmental parameters (Table 11-4). This gives a good representation of data for the development location. This data was utilised to consider the probability of sunshine occurrence and this allow the determination of ‘*projected*’ values for shadow flicker occurrence.

Table 11-4: Average daily sunshine hours from Kilkenny Weather Station

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.68	2.20	3.08	4.72	5.31	4.94	4.67	4.36	3.78	2.74	2.15	1.32

Long-term wind rose data from the SEAI Wind Mapping System was used to determine the likely wind direction over the year.

The modelling results are presented as follows:

Worst Case’ Daily Shadow Flicker: The expected daily shadow flicker cannot be predicted as this depends on multiple variable factors such as wind direction, wind speed, cloud cover and sunshine, and there is potential for any individual day to be sunny for whole day. Therefore the modelling result present the worst case for daily shadow flicker occurrence.

Predicted Annual Shadow Flicker occurrence: As this is the result for the total hours of shadow flicker in a year, the average sunshine for the site and average wind direction are used and the reductive factor is applied, resulting in a more realistic modelling of shadow flicker occurrence – i.e. the expected shadow flicker values per year which are likely to be experienced by each receptor within the shadow flicker study area.

The results of the modelling are presented in the table below. The potential for shadow flicker throughout the year is also illustrated graphically in [Appendix 11.2: Shadow Flicker Graphs](#).

Table 11-5: Summary of Potential Shadow Flicker Listing for All Properties

Dwelling ID	'Worst Case' Shadow Flicker			'Expected' Shadow Flicker		
	Compliance Threshold [h/day] (hrs:mins)	Gathabawn Wind Farm Flicker Levels Max. Shadow [h/day] (hrs:mins)	Level of Exceedance 2006 WEDGS	Compliance Threshold [h/year] (hrs:mins)	Predicted Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Level of Exceedance 2006 Guidelines
H1	00:30	00:42	00:12	30:00	06:47	0:00
H2	00:30	00:42	00:12	30:00	07:21	0:00
H3	00:30	00:34	00:04	30:00	03:43	0:00
H4	00:30	00:38	00:08	30:00	05:46	0:00
H5	00:30	00:35	00:05	30:00	05:23	0:00
H6	00:30	00:36	00:06	30:00	08:05	0:00
H7	00:30	00:51	00:21	30:00	11:23	0:00
H8	00:30	01:24	00:54	30:00	28:38	0:00
H9	00:30	01:28	00:58	30:00	29:45	0:00
H10	00:30	00:59	00:29	30:00	13:40	0:00
H11	00:30	00:48	00:18	30:00	14:45	0:00
H12	00:30	00:46	00:16	30:00	13:10	0:00
H13	00:30	00:39	00:09	30:00	11:46	0:00
H14	00:30	00:47	00:17	30:00	18:33	0:00
H15	00:30	00:56	00:26	30:00	20:46	0:00
H16	00:30	00:35	00:05	30:00	08:23	0:00
H17	00:30	00:37	00:07	30:00	10:14	0:00
H18	00:30	01:06	00:36	30:00	16:13	0:00

Dwelling ID	'Worst Case' Shadow Flicker			'Expected' Shadow Flicker		
	Compliance Threshold [h/day] (hrs:mins)	Gathabawn Wind Farm Flicker Levels Max. Shadow [h/day] (hrs:mins)	Level of Exceedance 2006 WEDGS	Compliance Threshold [h/year] (hrs:mins)	Predicted Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Level of Exceedance 2006 Guidelines
H19	00:30	00:35	00:05	30:00	05:33	0:00
H20	00:30	00:31	00:01	30:00	05:40	0:00
H21	00:30	00:23	0:00	30:00	03:08	0:00
H22	00:30	00:25	0:00	30:00	03:32	0:00
H23	00:30	00:53	00:23	30:00	15:43	0:00
H24	00:30	00:00	0:00	30:00	00:00	0:00
H25	00:30	00:00	0:00	30:00	00:00	0:00
H26	00:30	00:00	0:00	30:00	00:00	0:00
H27	00:30	00:00	0:00	30:00	00:00	0:00
H28	00:30	00:00	0:00	30:00	00:00	0:00
H29	00:30	00:00	0:00	30:00	00:00	0:00
H30	00:30	00:00	0:00	30:00	00:00	0:00
H31	00:30	00:34	00:04	30:00	08:31	0:00
H32	00:30	00:33	00:03	30:00	10:27	0:00
H33	00:30	00:51	00:21	30:00	16:11	0:00
H34	00:30	00:44	00:14	30:00	09:47	0:00
H35	00:30	00:43	00:13	30:00	09:05	0:00
H36	00:30	01:10	00:40	30:00	17:53	0:00
H37	00:30	00:48	00:18	30:00	15:17	0:00

Dwelling ID	'Worst Case' Shadow Flicker			'Expected' Shadow Flicker		
	Compliance Threshold [h/day] (hrs:mins)	Gathabawn Wind Farm Flicker Levels Max. Shadow [h/day] (hrs:mins)	Level of Exceedance 2006 WEDGS	Compliance Threshold [h/year] (hrs:mins)	Predicted Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Level of Exceedance 2006 Guidelines
H38	00:30	01:02	00:32	30:00	19:57	0:00
H39	00:30	01:01	00:31	30:00	28:46	0:00
H40	00:30	00:59	00:29	30:00	24:51	0:00
H41	00:30	00:59	00:29	30:00	24:12	0:00
H42	00:30	00:49	00:19	30:00	24:14	0:00
H43	00:30	00:48	00:18	30:00	13:33	0:00
H44	00:30	00:42	00:12	30:00	10:29	0:00
H45	00:30	00:28	0:00	30:00	06:28	0:00
H46	00:30	00:29	0:00	30:00	05:53	0:00
H47	00:30	00:31	00:01	30:00	07:13	0:00
H48	00:30	01:12	00:42	30:00	15:57	0:00
H49	00:30	00:48	00:18	30:00	16:55	0:00
H50	00:30	01:03	00:33	30:00	23:05	0:00
H51	00:30	00:00	0:00	30:00	00:00	0:00
H52	00:30	00:52	00:22	30:00	12:51	0:00
H53	00:30	00:45	00:15	30:00	15:55	0:00
H54	00:30	00:54	00:24	30:00	16:23	0:00
H55	00:30	01:02	00:32	30:00	19:09	0:00
H56	00:30	01:17	00:47	30:00	27:23	0:00

Dwelling ID	'Worst Case' Shadow Flicker			'Expected' Shadow Flicker		
	Compliance Threshold [h/day] (hrs:mins)	Gathabawn Wind Farm Flicker Levels Max. Shadow [h/day] (hrs:mins)	Level of Exceedance 2006 WEDGS	Compliance Threshold [h/year] (hrs:mins)	Predicted Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Level of Exceedance 2006 Guidelines
H57	00:30	00:58	00:28	30:00	23:02	0:00
H58	00:30	00:40	00:10	30:00	10:15	0:00
H59	00:30	00:37	00:07	30:00	08:35	0:00
H60	00:30	01:01	00:31	30:00	11:52	0:00
H61	00:30	00:59	00:29	30:00	11:29	0:00
H62	00:30	00:54	00:24	30:00	05:36	0:00
H63	00:30	00:00	0:00	30:00	00:00	0:00
H64	00:30	00:36	00:06	30:00	02:37	0:00
H65	00:30	00:44	00:14	30:00	06:41	0:00
H66	00:30	00:00	0:00	30:00	00:00	0:00
H67	00:30	00:00	0:00	30:00	00:00	0:00
H68	00:30	00:00	0:00	30:00	00:00	0:00
H69	00:30	00:26	0:00	30:00	03:57	0:00
H70	00:30	00:40	00:10	30:00	07:01	0:00
H71	00:30	00:44	00:14	30:00	08:15	0:00
H72	00:30	00:40	00:10	30:00	06:11	0:00
H75	00:30	00:34	00:04	30:00	05:57	0:00
H76	00:30	00:32	00:02	30:00	04:22	0:00
H77	00:30	00:39	00:09	30:00	06:43	0:00

Dwelling ID	'Worst Case' Shadow Flicker			'Expected' Shadow Flicker		
	Compliance Threshold [h/day] (hrs:mins)	Gathabawn Wind Farm Flicker Levels Max. Shadow [h/day] (hrs:mins)	Level of Exceedance 2006 WEDGS	Compliance Threshold [h/year] (hrs:mins)	Predicted Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Level of Exceedance 2006 Guidelines
H78	00:30	00:31	00:01	30:00	09:03	0:00
H80	00:30	00:17	0:00	30:00	01:54	0:00
H84	00:30	00:18	0:00	30:00	02:28	0:00
H85	00:30	00:19	0:00	30:00	02:46	0:00
H86	00:30	00:25	0:00	30:00	06:52	0:00
H87	00:30	00:25	0:00	30:00	06:44	0:00
H88	00:30	00:26	0:00	30:00	06:29	0:00
H89	00:30	00:25	0:00	30:00	05:01	0:00
H90	00:30	00:26	0:00	30:00	04:18	0:00
H91	00:30	00:23	0:00	30:00	03:49	0:00
H92	00:30	00:27	0:00	30:00	04:22	0:00
H93	00:30	00:25	0:00	30:00	04:39	0:00
H94	00:30	00:32	00:02	30:00	04:30	0:00
H95	00:30	00:23	0:00	30:00	02:00	0:00
H98	00:30	00:00	0:00	30:00	00:00	0:00
H99	00:30	00:00	0:00	30:00	00:00	0:00
H101	00:30	00:00	0:00	30:00	00:00	0:00
H102	00:30	00:00	0:00	30:00	00:00	0:00
H103	00:30	00:00	0:00	30:00	00:00	0:00

Dwelling ID	'Worst Case' Shadow Flicker			'Expected' Shadow Flicker		
	Compliance Threshold [h/day] (hrs:mins)	Gathabawn Wind Farm Flicker Levels Max. Shadow [h/day] (hrs:mins)	Level of Exceedance 2006 WEDGS	Compliance Threshold [h/year] (hrs:mins)	Predicted Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Level of Exceedance 2006 Guidelines
H104	00:30	00:00	0:00	30:00	00:00	0:00
H105	00:30	00:00	0:00	30:00	00:00	0:00
H106	00:30	00:00	0:00	30:00	00:00	0:00
H107	00:30	00:00	0:00	30:00	00:00	0:00
H108	00:30	00:00	0:00	30:00	00:00	0:00
H109	00:30	00:00	0:00	30:00	00:00	0:00
H110	00:30	00:00	0:00	30:00	00:00	0:00
H111	00:30	00:32	00:02	30:00	09:07	0:00
H112	00:30	00:21	0:00	30:00	01:36	0:00
H113	00:30	00:34	00:04	30:00	05:30	0:00
H115	00:30	00:36	00:06	30:00	07:13	0:00
H116	00:30	00:38	00:08	30:00	08:17	0:00
H117	00:30	00:39	00:09	30:00	09:23	0:00
H118	00:30	00:37	00:07	30:00	08:18	0:00
H119	00:30	00:38	00:08	30:00	09:13	0:00
H120	00:30	00:36	00:06	30:00	08:28	0:00
H121	00:30	00:35	00:05	30:00	08:28	0:00
H122	00:30	00:34	00:04	30:00	08:30	0:00
H123	00:30	00:32	00:02	30:00	10:12	0:00

Dwelling ID	'Worst Case' Shadow Flicker			'Expected' Shadow Flicker		
	Compliance Threshold [h/day] (hrs:mins)	Gathabawn Wind Farm Flicker Levels Max. Shadow [h/day] (hrs:mins)	Level of Exceedance 2006 WEDGS	Compliance Threshold [h/year] (hrs:mins)	Predicted Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Level of Exceedance 2006 Guidelines
H124	00:30	00:32	00:02	30:00	10:28	0:00
H125	00:30	00:32	00:02	30:00	10:19	0:00
H126	00:30	00:43	00:13	30:00	10:16	0:00
H127	00:30	00:24	0:00	30:00	05:06	0:00
H128	00:30	00:00	0:00	30:00	00:00	0:00
H129	00:30	00:00	0:00	30:00	00:00	0:00
H130	00:30	00:00	0:00	30:00	00:00	0:00
H131	00:30	00:00	0:00	30:00	00:00	0:00
H144	00:30	00:37	00:07	30:00	11:04	0:00
H146	00:30	00:41	00:11	30:00	09:36	0:00
H147	00:30	00:46	00:16	30:00	09:59	0:00
H148	00:30	00:45	00:15	30:00	10:03	0:00
H149	00:30	00:41	00:11	30:00	13:30	0:00
H150	00:30	00:20	0:00	30:00	01:03	0:00
H151	00:30	00:17	0:00	30:00	00:40	0:00
H152	00:30	00:31	0:01	30:00	03:34	0:00
H153	00:30	00:20	0:00	30:00	01:42	0:00
H156	00:30	00:00	0:00	30:00	00:00	0:00
H159	00:30	00:00	0:00	30:00	00:00	0:00

Dwelling ID	'Worst Case' Shadow Flicker			'Expected' Shadow Flicker		
	Compliance Threshold [h/day] (hrs:mins)	Gathabawn Wind Farm Flicker Levels Max. Shadow [h/day] (hrs:mins)	Level of Exceedance 2006 WEDGS	Compliance Threshold [h/year] (hrs:mins)	Predicted Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Level of Exceedance 2006 Guidelines
H160	00:30	00:00	0:00	30:00	00:00	0:00
H161	00:30	00:00	0:00	30:00	00:00	0:00

EIAR 11.4.4.1 Discussion of Modelling Results

The Shadow Flicker evaluation examined the potential for shadow flicker from the proposed Gathabawn Windfarm turbines at all houses within 1360m of the nearest turbine.

In Table 11-5, the calculated worst-case shadow flicker occurrences assumes the sun is always shining, that there is no cloud cover, the blades are rotating and facing the house, that there is a window facing the turbines and not obscured by vegetation/buildings and that the dwelling is occupied. The calculation is based on topography alone and excludes vegetation, buildings and other man-made structures.

In Table 11-5, the calculated realistic shadow flicker occurrences consider average sunshine levels and average wind direction in the modelling. However, no allowance is included for the periods when the blades are not turning (such as during low wind speeds or during maintenance), nor for any screening provided by trees or buildings which may occur between a house and the turbine(s). Therefore, even the realistic results are an overestimate.

It is shown in Table 11-5, that there will be 102 out of 134 receptors that will experience some degree of shadow flicker.

With regard to daily shadow flicker occurrence, the 2006 Wind Energy Guidelines (WEG Guidelines) recommend a threshold limit of 30 minutes in a given day. There are 80 sensitive receptors which exceed the Guidelines of a maximum of 30 minutes of shadow flicker, in a given day in the worst-case scenario (only worst case scenario can be modelled for occurrences on given days). The closest receptor, H38, is 509m from the closest turbine (T7). This receptor exceeds the day limit by 32mins under the worse-case occurrence scenario modelling. H38 is predicted to experience 19 hours and 57 minutes in the year, in the realistic occurrence scenario.

No shadow flicker is predicted to be experienced at the 32 remaining receptors.

With regard to yearly shadow flicker occurrence, the WEG Guidelines recommend a threshold limit of 30 hours per year. None of the receptors are expected to experience the WEG Guidelines recommendation of 30 hours or more of shadow flicker per year in a realistic occurrence scenario. The worst affected receptor is H9 which is predicted to experience a total annual shadow flicker of 29 hours and 45 minutes, in the realistic scenario.

As the 2006 Wind Energy Development Guideline limits are being exceeded at some houses on a given day, this would be considered significant and require mitigation measures. The mitigation measures to avoid these exceedances are outlined in Section EIAR 11.4.4.2.

However notwithstanding theoretical or realistic modelling scenarios should the development be granted planning permission, there will be planning conditions controlling shadow flicker. These will likely be based on either the current Wind Energy Guidelines (2006) or Draft Revised Wind Energy 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 11.4.4.2 Mitigation Measures – Shadow Flicker Control Modules

In any case, although significant impacts are not predicted, and regardless of any planning condition attached to a planning grant, modern turbines such as those proposed for Gathabawn 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. The Gathabawn turbines will be fitted with a shadow flicker module, comprising a central processing 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 flicker events and can be set to automatically turn off the turbine if the threshold limits for shadow flicker, at a given sensitive receptor, are predicted to be exceeded.

The developer commits to the installation of Shadow Flicker Control Modules in the turbines as a mitigation measure (WM109), and the turbines will be set to enter pause mode and stop rotating where required to keep the shadow flicker levels to within the permitted threshold limits.

Should a complaint regarding shadow flicker be received from a resident, the occurrence of shadow flicker at the receptor will be investigated and the Control Module in the turbine(s) can be set to automatically turn off the turbine(s) if shadow flicker will occur, thereby eliminating shadow flicker at the residence in question.

EIAR 11.4.4.3 Residual Impact

With the implementation of the shadow flicker modules in the turbines, no exceedances of the threshold levels outlined in the WED Guidelines will occur. In addition, if a resident makes a complaint about shadow flicker, it will be investigated. Where required, the control system can be adjusted so that the relevant turbine automatically stops when conditions could cause shadow flicker at that property.

The residual effects will be Not Significant/Neutral.

EIAR 11.5 CUMULATIVE EFFECTS WITH OTHER PROJECTS

Other existing and permitted projects and projects advanced in the planning system were examined for their potential to cumulatively affect Residential Receptors with the Proposed Gathabawn Windfarm. These projects are referred to as 'Other Projects' herein. The potential for off-site and secondary consequential development is also considered.

A Cumulative Study Area is set out below and Other Projects located within this Study Area are identified and examined for in-combination effects.

Cumulative Study Areas: The Irish Wind Energy Industry (IWEA) Guidelines recommend that all existing and/or permitted wind farm developments within 2km of a proposed development should be considered in a cumulative shadow flicker assessment. There is only one other wind farm within the cumulative study area, Lisdowney Wind Farm, located 1.2km north of the closest proposed Gathabawn Windfarm turbine (T9).

EIAR 11.5.1 Evaluation of Cumulative Impacts with Individual Other Projects

The table below presents the assessment of worst-case and realistic case scenarios for the cumulative shadow flicker from Gathabawn Windfarm turbines and Lisdowney Wind Farm turbines.

The assessment showed 5 no. receptors (H63, H156, H159, H160 and H161) are predicted to be affected by the operational Lisdowney Wind Farm and not the proposed Gathabawn Windfarm.

Out of the 134 sensitive receptors examined for Gathabawn Windfarm alone, two receptors have been identified to have additional periods of Shadow Flicker when modelled cumulatively (Gathabawn and Lisdowney windfarms together). The results are for a given day in minutes

- H150 will increase from 20 mins to 36 mins
- H151 will increase from 17 mins to 38 mins.

These two houses exceed the WEG Guidelines of 30 minutes of shadow flicker on a given day in the cumulative scenario only. No sensitive receptors exceed the 30 hours or more of shadow flicker per year in the realistic cumulative scenario.

Table 11-6: Predicted Cumulative Shadow Flicker Impacts on Residential Receptors from Gathabawn Windfarm and the Operational Lisdowney Wind Farm

Dwelling ID	'Worst Case' Shadow Flicker		'Expected' Shadow Flicker	
	Gathabawn Wind Farm Shadow Flicker Worst Case Shadow [h/day] (hrs:mins)	Predicted Cumulative Shadow Flicker Worst Case Shadow [h/day] (hrs:mins)	Gathabawn Wind Farm Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Predicted Cumulative Shadow Flicker Expected Shadow [h/year] (hrs:mins)
H1	00:42	00:42	06:47	06:47
H2	00:42	00:42	07:21	07:21
H3	00:34	00:34	03:43	03:43
H4	00:38	00:38	05:46	05:46
H5	00:35	00:35	05:23	05:23
H6	00:36	00:36	08:05	08:05
H7	00:51	00:51	11:23	11:23
H8	01:24	01:24	28:38	28:38
H9	01:28	01:28	29:45	29:45
H10	00:59	00:59	13:40	13:40
H11	00:48	00:48	14:45	14:45
H12	00:46	00:46	13:10	13:10
H13	00:39	00:39	11:46	11:46
H14	00:47	00:47	18:33	18:33
H15	00:56	00:56	20:46	20:46
H16	00:35	00:35	08:23	08:23
H17	00:37	00:37	10:14	10:14
H18	01:06	01:06	16:13	16:13
H19	00:35	00:35	05:33	05:33
H20	00:31	00:31	05:40	05:40

Dwelling ID	'Worst Case' Shadow Flicker		'Expected' Shadow Flicker	
	Gathbawn Wind Farm Shadow Flicker Worst Case Shadow [h/day] (hrs:mins)	Predicted Cumulative Shadow Flicker Worst Case Shadow [h/day] (hrs:mins)	Gathbawn Wind Farm Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Predicted Cumulative Shadow Flicker Expected Shadow [h/year] (hrs:mins)
H21	00:23	00:23	03:08	03:08
H22	00:25	00:25	03:32	03:32
H23	00:53	00:53	15:43	15:43
H24	00:00	00:00	00:00	00:00
H25	00:00	00:00	00:00	00:00
H26	00:00	00:00	00:00	00:00
H27	00:00	00:00	00:00	00:00
H28	00:00	00:00	00:00	00:00
H29	00:00	00:00	00:00	00:00
H30	00:00	00:00	00:00	00:00
H31	00:34	00:34	08:31	08:31
H32	00:33	00:33	10:27	10:27
H33	00:51	00:51	16:11	16:11
H34	00:44	00:44	09:47	09:47
H35	00:43	00:43	09:05	09:05
H36	01:10	01:10	17:53	17:53
H37	00:48	00:48	15:17	15:17
H38	01:02	01:02	19:57	19:57
H39	01:01	01:01	28:46	28:46
H40	00:59	00:59	24:51	24:51
H41	00:59	00:59	24:12	24:12
H42	00:49	00:49	24:14	24:14

Dwelling ID	'Worst Case' Shadow Flicker		'Expected' Shadow Flicker	
	Gathbawn Wind Farm Shadow Flicker Worst Case Shadow [h/day] (hrs:mins)	Predicted Cumulative Shadow Flicker Worst Case Shadow [h/day] (hrs:mins)	Gathbawn Wind Farm Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Predicted Cumulative Shadow Flicker Expected Shadow [h/year] (hrs:mins)
H43	00:48	00:48	13:33	13:33
H44	00:42	00:42	10:29	10:29
H45	00:28	00:28	06:28	06:28
H46	00:29	00:29	05:53	05:53
H47	00:31	00:31	07:13	07:13
H48	01:12	01:12	15:57	15:57
H49	00:48	00:48	16:55	16:55
H50	01:03	01:03	23:05	23:05
H51	00:00	00:00	00:00	00:00
H52	00:52	00:52	12:51	12:51
H53	00:45	00:45	15:55	15:55
H54	00:54	00:54	16:23	16:23
H55	01:02	01:02	19:09	19:09
H56	01:17	01:17	27:23	27:23
H57	00:58	00:58	23:02	23:02
H58	00:40	00:40	10:15	10:15
H59	00:37	00:37	08:35	08:35
H60	01:01	01:01	11:52	11:52
H61	00:59	00:59	11:29	12:25*
H62	00:54	00:54	05:36	08:16*
H63	00:00	00:26**	00:00	04:24**
H64	00:36	00:36	02:37	02:37

Dwelling ID	'Worst Case' Shadow Flicker		'Expected' Shadow Flicker	
	Gathbawn Wind Farm Shadow Flicker Worst Case Shadow [h/day] (hrs:mins)	Predicted Cumulative Shadow Flicker Worst Case Shadow [h/day] (hrs:mins)	Gathbawn Wind Farm Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Predicted Cumulative Shadow Flicker Expected Shadow [h/year] (hrs:mins)
H65	00:44	00:44	06:41	06:41
H66	00:00	00:00	00:00	00:00
H67	00:00	00:00	00:00	00:00
H68	00:00	00:00	00:00	00:00
H69	00:26	00:26	03:57	03:57
H70	00:40	00:40	07:01	07:01
H71	00:44	00:44	08:15	08:15
H72	00:40	00:40	06:11	06:11
H75	00:34	00:34	05:57	05:57
H76	00:32	00:32	04:22	04:22
H77	00:39	00:39	06:43	06:43
H78	00:31	00:31	09:03	09:03
H80	00:17	00:17	01:54	01:54
H84	00:18	00:18	02:28	02:28
H85	00:19	00:19	02:46	02:46
H86	00:25	00:25	06:52	06:52
H87	00:25	00:25	06:44	06:44
H88	00:26	00:26	06:29	06:29
H89	00:25	00:25	05:01	05:01
H90	00:26	00:26	04:18	04:18
H91	00:23	00:23	03:49	03:49
H92	00:27	00:27	04:22	04:22

Dwelling ID	'Worst Case' Shadow Flicker		'Expected' Shadow Flicker	
	Gathbawn Wind Farm Shadow Flicker Worst Case Shadow [h/day] (hrs:mins)	Predicted Cumulative Shadow Flicker Worst Case Shadow [h/day] (hrs:mins)	Gathbawn Wind Farm Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Predicted Cumulative Shadow Flicker Expected Shadow [h/year] (hrs:mins)
H93	00:25	00:25	04:39	04:39
H94	00:32	00:32	04:30	04:30
H95	00:23	00:23	02:00	02:00
H98	00:00	00:00	00:00	00:00
H99	00:00	00:00	00:00	00:00
H101	00:00	00:00	00:00	00:00
H102	00:00	00:00	00:00	00:00
H103	00:00	00:00	00:00	00:00
H104	00:00	00:00	00:00	00:00
H105	00:00	00:00	00:00	00:00
H106	00:00	00:00	00:00	00:00
H107	00:00	00:00	00:00	00:00
H108	00:00	00:00	00:00	00:00
H109	00:00	00:00	00:00	00:00
H110	00:00	00:00	00:00	00:00
H111	00:32	00:32	09:07	09:07
H112	00:21	00:21	01:36	01:36
H113	00:34	00:34	05:30	05:30
H115	00:36	00:36	07:13	07:13
H116	00:38	00:38	08:17	08:17
H117	00:39	00:39	09:23	09:23
H118	00:37	00:37	08:18	08:18

Dwelling ID	'Worst Case' Shadow Flicker		'Expected' Shadow Flicker	
	Gathbawn Wind Farm Shadow Flicker Worst Case Shadow [h/day] (hrs:mins)	Predicted Cumulative Shadow Flicker Worst Case Shadow [h/day] (hrs:mins)	Gathbawn Wind Farm Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Predicted Cumulative Shadow Flicker Expected Shadow [h/year] (hrs:mins)
H119	00:38	00:38	09:13	09:13
H120	00:36	00:36	08:28	08:28
H121	00:35	00:35	08:28	08:28
H122	00:34	00:34	08:30	08:30
H123	00:32	00:32	10:12	10:12
H124	00:32	00:32	10:28	10:28
H125	00:32	00:32	10:19	10:19
H126	00:43	00:43	10:16	10:16
H127	00:24	00:24	05:06	05:06
H128	00:00	00:00	00:00	00:00
H129	00:00	00:00	00:00	00:00
H130	00:00	00:00	00:00	00:00
H131	00:00	00:00	00:00	00:00
H144	00:37	00:37	11:04	11:04
H146	00:41	00:41	09:36	09:36
H147	00:46	00:46	09:59	09:59
H148	00:45	00:45	10:03	10:03
H149	00:41	00:41	13:30	13:30
H150	00:20	00:36*	01:03	06:19*
H151	00:17	00:38*	00:40	05:59*
H152	00:31	00:31	03:34	05:46*
H153	00:20	00:20	01:42	04:16*

Dwelling ID	'Worst Case' Shadow Flicker		'Expected' Shadow Flicker	
	Gathbawn Wind Farm Shadow Flicker Worst Case Shadow [h/day] (hrs:mins)	Predicted Cumulative Shadow Flicker Worst Case Shadow [h/day] (hrs:mins)	Gathbawn Wind Farm Shadow Flicker Expected Shadow [h/year] (hrs:mins)	Predicted Cumulative Shadow Flicker Expected Shadow [h/year] (hrs:mins)
H156	00:00	00:25**	00:00	04:04**
H159	00:00	00:36**	00:00	05:41**
H160	00:00	00:33**	00:00	06:05**
H161	00:00	01:11**	00:00	18:54**

*Impacted Cumulatively

**Impacted by Lisdowney Wind Farm only

EIAR 11.6 SUMMARY CONCLUSION

RESIDENTIAL RECEPTORS: This report has evaluated the potential for shadow flicker from the proposed Gathabawn Windfarm turbines.

Worst-case scenario modelling shows that shadow flicker could occur at 102 no. local residences, out of which 80 residences could exceed the daily shadow flicker threshold (of 30mins) on a given day. In the realistic case scenario, no residential receptors will experience shadow flicker which exceeds the yearly threshold of 30 hours per year.

When shadow flicker was modelled cumulatively with the existing Lisdowney Wind Farm, the assessment showed 5 no. receptors are predicted to be affected by the operational Lisdowney Wind Farm and not the proposed Gathabawn Windfarm. Out of the 134 sensitive receptors examined for Gathabawn Windfarm alone, two receptors have been identified to have additional periods of Shadow Flicker when modelled cumulatively. These two houses exceed the WEG Guidelines of 30 minutes of shadow flicker on a given day in the cumulative scenario only. No sensitive receptors exceed the 30 hours or more of shadow flicker per year in the realistic cumulative scenario.

However, the realistic Shadow Flicker occurrence using the average sunshine values and wind direction for the site indicates that shadow flicker occurrence in general will be much lower than the worst-case modelling scenario.

Modern wind turbines allow a great degree of remote and automatic control, and shadow flicker modules will be installed in the turbines to automatically 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.

Therefore, no significant residual impacts are predicted to occur, and it is concluded that the proposed Gathabawn Windfarm will result in Not Significant or Neutral impacts on the sensitive receptors in the locality.

EIAR 11.7 Glossary, List of Abbreviations

Glossary of Terms

Term	Definition
Gathabawn Windfarm	Twelve wind turbines are proposed for two areas – seven turbines in the Ballylehaun area and five turbines in the Ballyring area. In addition to the turbines and their hardstanding areas, the windfarm also includes site access roads, two Control Buildings; a met mast, underground cabling, temporary works to facilitate turbine deliveries, and other associated and ancillary works.
Candidate Gathabawn Grid Connection	Underground cabling between the Ballylehaun and Ballyring Areas (Ballylehaun-Ballyring UGC), underground cabling from the Ballyring Area (from Ballyring Control Building) to a new substation at Parksgrove (Ballyring-Parksgrove UGC), the Parksgrove Substation, and underground cabling from the substation to the existing Eirgrid Ballyragget Substation in Moatpark (Parksgrove-Moatpark UGC). The Candidate Gathabawn Grid Connection is not included as part of this Planning Application, it will be subject of a separate Planning Application, at a future date. The Candidate Gathabawn Grid Connection is considered in this EIA Report in order to facilitate the cumulative evaluation of the Whole Project.

EIAR 11.8 Reference List

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

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

Ireland, Department of Housing, Planning and Local Government (2019) *Draft Revised Wind Energy Development Guidelines*.

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

EIAR 11.9 List of Appendices

APPENDICES (overleaf)

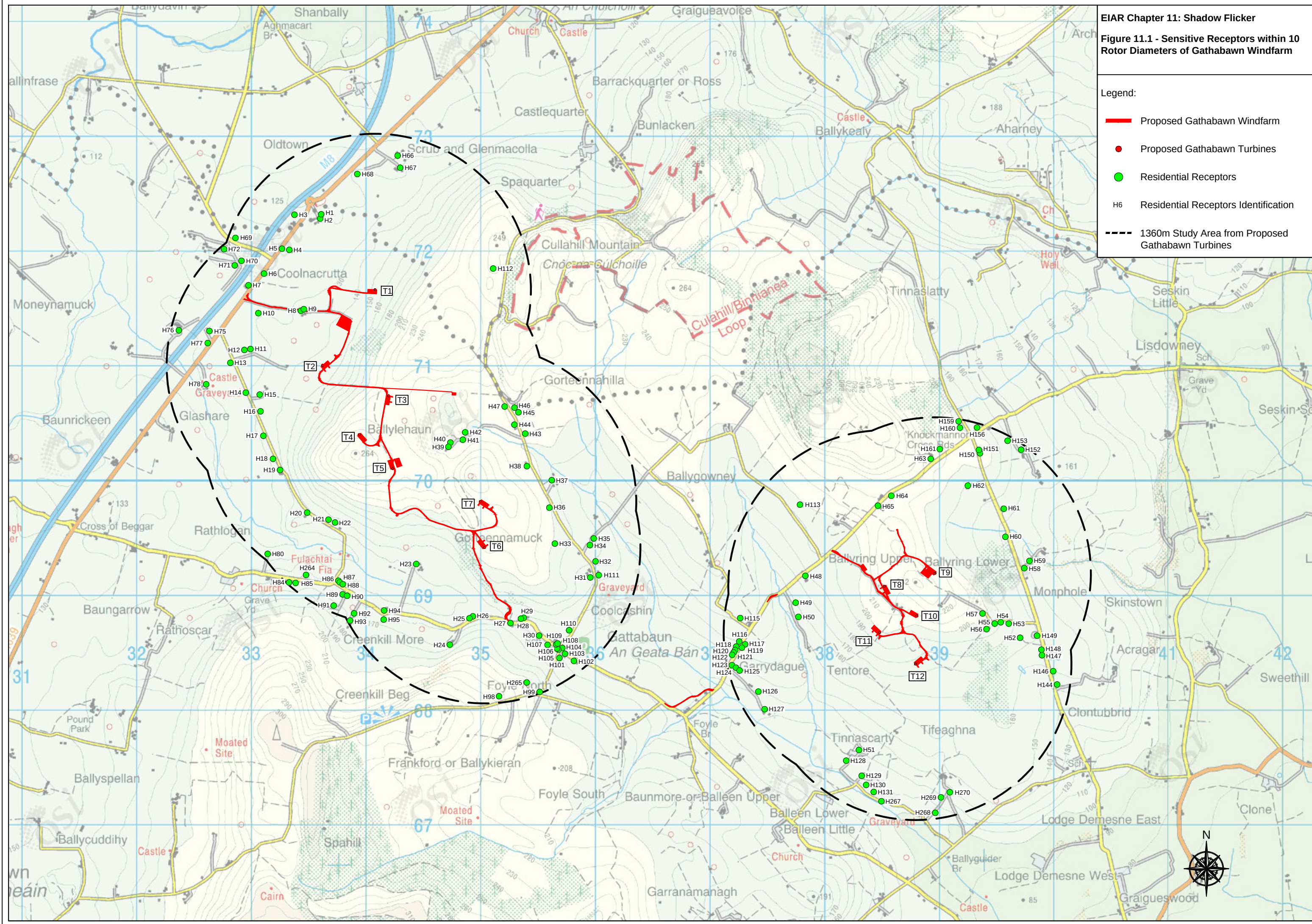
Appendix 11.1	Methodology for the evaluation of Shadow Flicker
Appendix 11.2	Shadow Flicker Graphs

Figures

Figure 11.1 - Sensitive Receptors within 10 Rotor Diameters of Gathabawn Windfarm

Legend:

- Proposed Gathabawn Windfarm
- Proposed Gathabawn Turbines
- Residential Receptors
- H6 Residential Receptors Identification
- 1360m Study Area from Proposed Gathabawn Turbines



Appendix to Chapter 11: Shadow Flicker

Appendix 11.1: Methodology for the evaluation of Shadow Flicker

Contents

Appendix 11.2

A11.1	Methodology for the evaluation of Shadow Flicker	2
A11.1.1	Assessment Methodology	2
A11.1.2	Relevant Guidance	3
A11.1.3	Shadow Flicker Modelling	5

A11.1 Methodology for the evaluation of Shadow Flicker

A11.1.1 Assessment Methodology

This assessment of shadow flicker involved the following:

- Evaluation of potential effects
- Evaluation of the significance of effects
- Identification of measures to avoid and mitigate potential effects

The Study Area is defined as 10 times the potential rotor diameter ($10 \times 136\text{m} = 1,360\text{m}$). A shadow flicker computer model (WindPRO 4.2) was used to calculate the occurrence of shadow flicker at relevant receptors to the Proposed Development. The output from the calculations is analysed to identify and assess potential shadow flicker effects. Wind turbines, like other tall structures, can cast long shadows when the sun is low in the sky.

The 2019 Draft Revised Wind Energy Guidelines confirms that:

“Shadow Flicker occurs when the sun is low in the sky and the rotating blades of a wind turbine casts 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. The time period in which a neighbouring property may be affected by shadow flicker is completely predictable.”

There are two candidate turbines which have been assessed in this analysis. The parameters for assessment are:

- Overall ground to blade tip height of 150m - 170m,
- Rotor diameter of 136m,
- Hub height range of 82m - 102m.

The Irish Wind Energy Industry (IWEA) Guidelines recommend that all existing and / or permitted wind farm developments within 2km of a proposed development should be considered in a cumulative shadow flicker assessment. There is only one nearby wind farm (within 2km), therefore the cumulative effect of the latter has also been assessed. The nearest wind farm is Lisdowney Wind Farm located 1.2km north of the closest Gathabawn Windfarm turbine location (T9). Cumulative effects are assessed in Section EIAR 11.5 of Chapter 11.

Where negative effects are predicted, this section identifies appropriate mitigation strategies. The assessment considers the potential effects during the operational phase of the Proposed Development.

A shadow flicker computer model (WindPRO 4.2) was used to calculate the occurrence of shadow flicker at relevant receptors to the Proposed Development. The output from the calculations is analysed to identify and assess potential shadow flicker effects.

The 2006 Wind Energy Guidelines state that shadow flicker lasts only for a short period and occurs only during certain specific combined circumstances, as follows:

- the sun is shining and is at a low angle in the sky i.e. just after dawn and before sunset; and
- the turbine is directly between the sun and the affected property; and
- there is enough wind energy to ensure that the turbine blades are moving; and
- the turbine blades are positioned so as to cast a shadow on the receptor.

If any one of these conditions is absent, shadow flicker cannot occur.

The 2019 Draft Revised the Wind Energy Development Guidelines (WEDG)¹ also added the circumstance where:

- *“there is sufficient direct sunlight to cause shadows (cloud, mist, fog or air pollution could limit solar energy levels)” and 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”.*

Shadow flicker may have the potential to cause disturbance and annoyance to residents if it affects occupied rooms of a house. Persons with photosensitive epilepsy can be sensitive to flickering light between 3 and 60 Hertz (Hz). This is supported by research in recent years asserting that flicker from turbines must interrupt or reflect sunlight at frequencies greater than 3 Hz to pose a potential risk of inducing photosensitive seizures. The frequencies of flicker caused by modern wind turbines are less than 1Hz and are well below the frequencies known to trigger effects in susceptible individuals. Therefore, any potential shadow flicker effect from the Proposed Development is considered an effect on residential amenity, rather than having the potential to affect the health of residents.

Careful site selection, design and planning, and good use of relevant software to control the turbine operation can help reduce the possibility of shadow flicker. Modern wind turbines have the facility to measure sunlight levels and to reduce or stop turbine rotation if the conditions exist that would lead to any shadow flicker at neighbouring properties.

The distance and direction between the turbine and property is of significance because:

- The duration of the shadow will be shorter the greater the distance (i.e., it will pass by faster)
- The shadow flicker cast by rotating wind turbine blades will be reduced, the further a dwelling is from an operating turbine.

The path of the sun varies over the seasons resulting in a changing potential for a shadow to be cast throughout the year. Similarly, the sun’s position in the sky over the course of a day is changing such that the shadow cast by a turbine is constantly changing. Shadow flicker is more likely to occur on sunny winter days when the sun is lower in the sky and shadows cast a greater distance from the turbine. Shadow flicker is more likely to occur to the east or west of the wind farm site. This can be seen in [Appendix 11.2](#).

A11.1.2 Relevant Guidance

The relevant Irish guidance for shadow flicker is derived from the ‘*Wind Energy Development Guidelines*’ (Department of the Environment, Heritage and Local Government (DoEHLG), 2006) the ‘*Best Practice Guidelines for the Irish Wind Energy Industry*’ (Irish Wind Energy Association, 2012), and the Draft Revised Wind Energy Development Guidelines (Department of Housing, Local Government and Heritage, 2019).

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

¹Department of Housing, Planning and Local Government, 2019. *Draft Revised Wind Energy Development Guidelines*, Dublin. Government of Ireland. [Available Online: <https://assets.gov.ie/46097/6e68ea81b8084ac5b7f9343d04f0b0ef.pdf>]

“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 2006 Guidelines also state 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 used for the Project design. There are 134 No. dwellings within 1.36km of any proposed wind turbine location. The closest house to the turbine is H38 located c. 509m southeast of T7.

Although the DoEHLG thresholds apply to dwellings located within 500 metres of a proposed turbine location, for the purposes of this assessment, the guideline thresholds of 30 hours per year or 30 minutes per day have been applied to all properties located within ten rotor diameters (i.e., 1,360 metres (136m)) of the proposed turbine within the Wind Farm Site (as per IWEA guidelines, 2012²). The 2006 Guidelines state that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

The adopted 2006 DoEHLG guidelines are currently under review. The Department of Housing, Local Government and Heritage released the ‘Draft Revised Wind Energy Development Guidelines’ in December 2019. The Draft Revised Wind Energy Development Guidelines (2019) provides for zero shadow flicker:

“Computational models can be used to accurately predict the strength and duration of potential shadow flicker during daylight hours for every day of the year. 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.

If a suitable shadow flicker prediction model indicates that there is potential for shadow flicker to occur at any particular dwelling or other potentially affected property, then a review of site design involving the possible relocation of one or more turbines to explore the possibility of eliminating the occurrence of potential flicker is required. Following such a review, if shadow flicker is not eliminated for any dwelling or other potentially affected property then clearly specified measures which provide for automated turbine shut down to eliminate shadow flicker should be required as a condition of a grant of permission.”

The Draft 2019 Guidelines are based on the recommendations set out in the ‘Proposed Revisions to Wind Energy Development Guidelines 2006 – Targeted Review in relation to Noise, Proximity and Shadow Flicker’ (December 2013) and the ‘Review of the Wind Energy Development Guidelines 2006 – Preferred Draft Approach’ (June 2017).

The assessment herein is based on compliance with the current DoEHLG Guidelines limit (30 hours per year or 30 minutes per day). However, it should also be noted the Proposed Development can be brought in line with the requirements of the 2019 draft guidelines, should they be adopted while this application is in the planning system, through the implementation of the mitigation measures outlined herein.

² Irish Wind Energy Association, 2012. *Best Practice Guidelines for the Irish Wind Energy Industry*, Cork: Wind Skillnet. [Available online: <https://windenergyireland.com/images/files/9660bdfb5a4f1d276f41ae9ab54e991bb600b7.pdf>]

A11.1.3 Shadow Flicker Modelling

An industry standard wind farm assessment software package, WindPRO from EMD International Version 4.2 was used to prepare a model of the Proposed Development. The programme facilitates the analysis of a wind farm for possible shadow flicker occurrence at nearby houses. 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. The significance of shadow flicker effects was assessed.

Generic windows of 1m width, 1m height and 0.5m 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)
- Bottom line height above ground ‘window’ (0.5m above ground level)
- Wind speed and direction for the Site to determine the period that the wind turbine will be in operation from the different wind directions during the year

The software creates a mathematical model of the Proposed Development and its surroundings and uses this information to calculate specific theoretical times and durations of flicker effects for the identified properties. The following ‘worst-case’ 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 might not be the case due to maintenance works, break downs, wind speeds below the turbine threshold or curtailment
- 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

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 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 and

that there is a clear and undisturbed line of sight between the windows of the receptors and the turbines (except where this is prevented due to topography). In reality, this will not occur; the turbines will not always be orientated as described, clouds will obscure the sun and line of sight may also be obscured (for example, from leaves on trees). The flicker effects will be substantially less than this and will not meet the results of the worst-case assumption.

The model also outputs a more realistic scenario, or “expected values”. In this scenario, the only change in assumptions is that the statistically likely monthly sunshine frequency and wind direction frequency data is assessed. This assessment only changes the annual hours per year value and is not applied to the daily data. This is because it could be sunny, with the wind coming from the relevant direction, on any individual day. The data used in the model was the:

- Long-term sunshine probability data from the Met Éireann synoptic station in Kilkenny
- Long-term wind rose data from the SEAI Wind Mapping System (ITM co-ordinates 634021E, 671699N).

Appendix to Chapter 11: Shadow Flicker: Population

Appendix 11.2: Shadow Flicker Graphs

SHADOW - Main Result

Calculation: Real Case & Worst Case (Additional Houses)

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) [KILKENNY]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.68	2.20	3.08	4.72	5.31	4.94	4.67	4.36	3.78	2.74	2.15	1.32

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
250	322	334	249	119	185	397	957	725	893	1,049	914

W	WNW	NW	NNW	Sum
667	748	620	331	8,760

Monthly 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:

DHM: Elevation Grid Data Object: EUDEM_PanEuropean_DSM_25m_grid_Vers

Receptor grid resolution: 1.0 m

Topographic shadow included in calculation

All coordinates are in

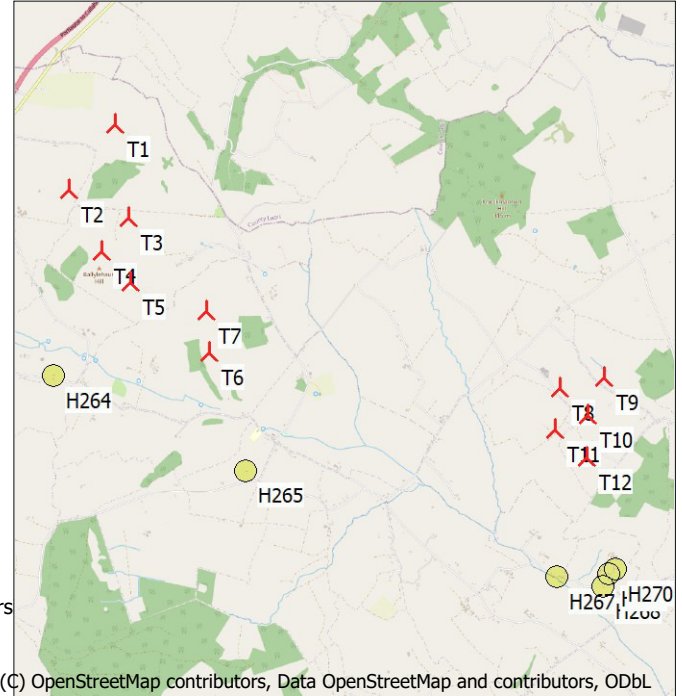
Irish ITM-IRENET95 (IE), geocentric, GRS80

WTGs

	Easting	Northing	Z	Row data/Description	WTG type			Power, rated	Rotor diameter	Hub height	Shadow data	
					Valid	Manufact.	Type-generator				Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
1	634,021	671,699	151.1	T1	No	ENERCON	-2,300	2,300	136.0	102.0	2,500	-
2	633,563	671,040	141.7	T2	No	ENERCON	-2,300	2,300	136.0	102.0	2,500	-
3	634,149	670,774	222.7	T3	No	ENERCON	-2,300	2,300	136.0	102.0	2,500	-
4	633,883	670,436	240.3	T4	No	ENERCON	-2,300	2,300	136.0	102.0	2,500	-
5	634,175	670,140	238.5	T5	No	ENERCON	-2,300	2,300	136.0	102.0	2,500	-
6	634,975	669,452	209.7	T6	No	ENERCON	-2,300	2,300	136.0	82.0	2,500	-
7	634,940	669,853	230.6	T7	No	ENERCON	-2,300	2,300	136.0	82.0	2,500	-
8	638,462	669,114	219.8	T8	No	ENERCON	-2,300	2,300	136.0	102.0	2,500	-
9	638,905	669,227	221.3	T9	No	ENERCON	-2,300	2,300	136.0	82.0	2,500	-
10	638,747	668,855	210.3	T10	No	ENERCON	-2,300	2,300	136.0	102.0	2,500	-
11	638,422	668,711	197.1	T11	No	ENERCON	-2,300	2,300	136.0	102.0	2,500	-
12	638,735	668,436	178.6	T12	No	ENERCON	-2,300	2,300	136.0	102.0	2,500	-

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	H264	633,420	669,213	158.5	1.0	1.0	0.5	90.0	"Green house mode"	1.5
B	H265	635,345	668,275	203.5	1.0	1.0	0.5	90.0	"Green house mode"	1.5
C	H267	638,438	667,240	106.7	1.0	1.0	0.5	90.0	"Green house mode"	1.5
D	H268	638,908	667,139	106.3	1.0	1.0	0.5	90.0	"Green house mode"	1.5
E	H269	638,958	667,274	119.7	1.0	1.0	0.5	90.0	"Green house mode"	1.5
F	H270	639,035	667,319	127.3	1.0	1.0	0.5	90.0	"Green house mode"	1.5



▲ New WTG

● Shadow receptor

SHADOW - Main Result

Calculation: Real Case & Worst Case (Additional Houses)

Calculation Results

Shadow receptor

No.	Name	Shadow, worst case		Max shadow hours per day	Shadow, expected values	
		Shadow hours per year [h/year]	Shadow days per year [days/year]		Shadow hours per year [h/year]	
A	H264	16:18	65	0:20	3:12	
B	H265	0:00	0	0:00	0:00	
C	H267	0:00	0	0:00	0:00	
D	H268	0:00	0	0:00	0:00	
E	H269	0:00	0	0:00	0:00	
F	H270	0:00	0	0:00	0:00	

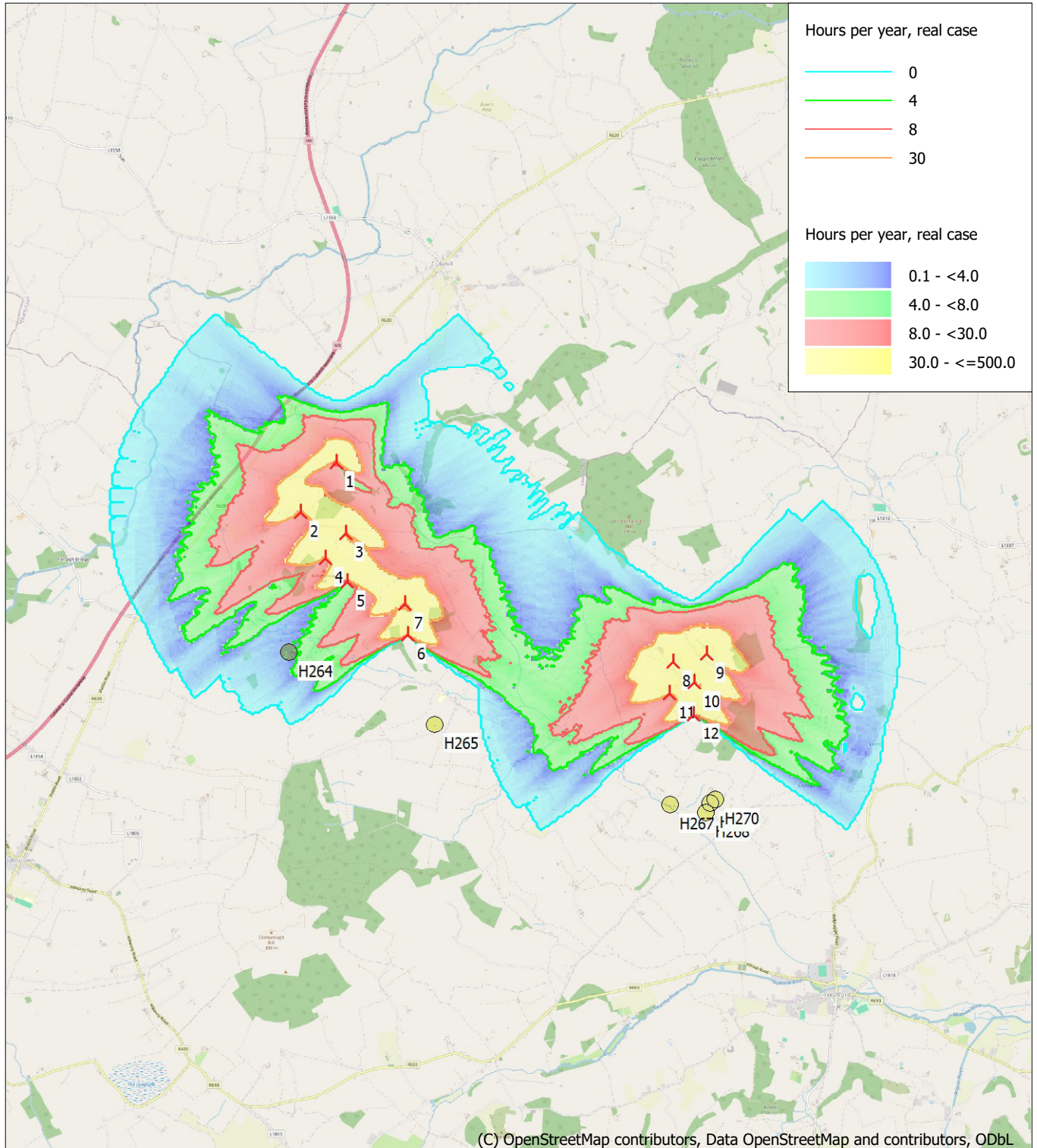
Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	T1	0:00	0:00
2	T2	0:00	0:00
3	T3	0:00	0:00
4	T4	0:00	0:00
5	T5	0:00	0:00
6	T6	6:40	1:18
7	T7	9:38	1:54
8	T8	0:00	0:00
9	T9	0:00	0:00
10	T10	0:00	0:00
11	T11	0:00	0:00
12	T12	0:00	0:00

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.

SHADOW - Map

Calculation: Real Case & Worst Case (Additional Houses)

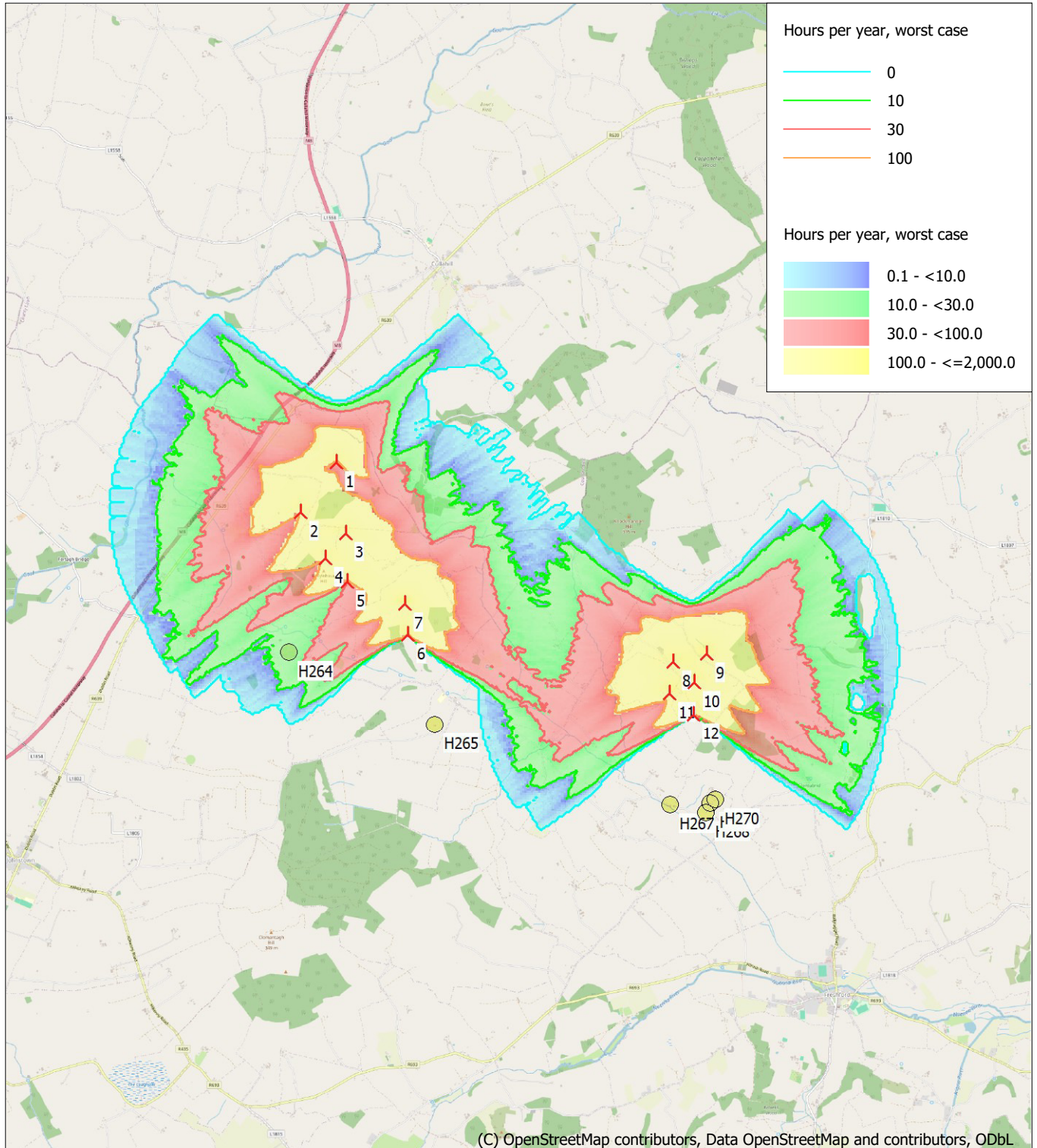


0 1 2 3 4 km

Map: EMD OpenStreetMap , Print scale 1:75,000, Map center Irish ITM-IRENET95 (IE), geocentric, GRS80 East: 636,240 North: 670,080
 New WTG Shadow receptor
 Flicker map level: Elevation Grid Data Object: EUDEM_PanEuropean_DSM_25m_grid_Version_1.1_40km_x_40km.wpg (1)
 Time step: 4 minutes, Day step: 14 days, Map resolution: 30 m, Visibility resolution: 15 m, Eye height: 1.5 m

SHADOW - Map

Calculation: Real Case & Worst Case (Additional Houses)



Map: EMD OpenStreetMap , Print scale 1:75,000, Map center Irish ITM-IRENET95 (IE), geocentric, GRS80 East: 636,240 North: 670,080
 New WTG Shadow receptor
 Flicker map level: Elevation Grid Data Object: EUDEM_PanEuropean_DSM_25m_grid_Version_1.1_40km_x_40km.wpg (1)
 Time step: 4 minutes, Day step: 14 days, Map resolution: 30 m, Visibility resolution: 15 m, Eye height: 1.5 m

SHADOW - Main Result

Calculation: Real & Worst Case (Additional Houses) (Cumulative)

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) [KILKENNY]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.68	2.20	3.08	4.72	5.31	4.94	4.67	4.36	3.78	2.74	2.15	1.32

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
250	322	334	249	119	185	397	957	725	893	1,049	914

W	WNW	NW	NNW	Sum
667	748	620	331	8,760

Monthly 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:

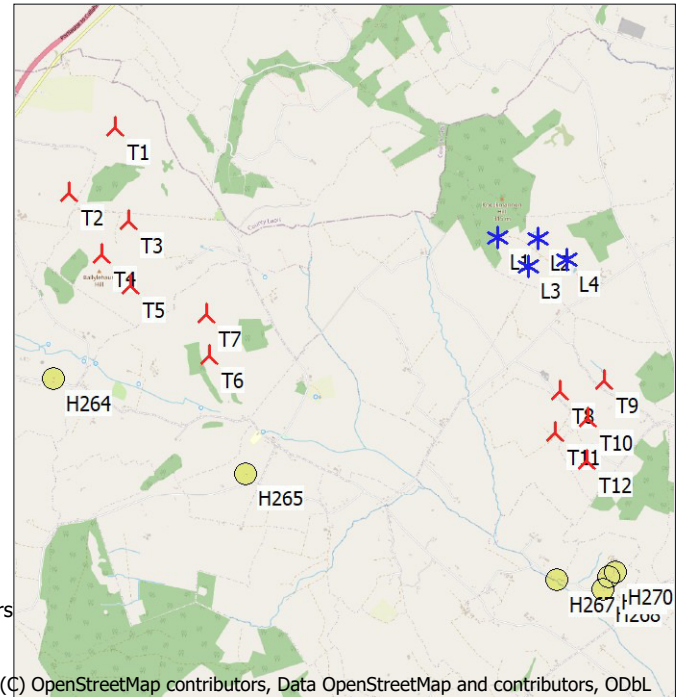
DHM: Elevation Grid Data Object: EUDEM_PanEuropean_DSM_25m_grid_Vers

Receptor grid resolution: 1.0 m

Topographic shadow included in calculation

All coordinates are in

Irish ITM-IRENET95 (IE), geocentric, GRS80



(C) OpenStreetMap contributors, Data OpenStreetMap and contributors, ODbL

Scale 1:75,000
 ▲ New WTG ★ Existing WTG ● Shadow receptor

WTGs

	Easting	Northing	Z	Row data/Description	WTG type				Power, rated	Rotor diameter	Hub height	Shadow data	
					Valid	Manufact.	Type-generator					Calculation distance	RPM
			[m]						[kW]	[m]	[m]	[m]	[RPM]
L1	637,825	670,634	295.2	L1	Yes	ENERCON	E-82 E2-2,300		2,300	82.0	80.5	1,603	18.0
L2	638,225	670,628	276.5	L2	Yes	ENERCON	E-82 E2-2,300		2,300	82.0	80.5	1,603	18.0
L3	638,140	670,356	267.4	L3	Yes	ENERCON	E-82 E2-2,300		2,300	82.0	80.5	1,603	18.0
L4	638,526	670,422	256.3	L4	Yes	ENERCON	E-82 E2-2,300		2,300	82.0	80.5	1,603	18.0
T1	634,021	671,699	151.1	T1	No	ENERCON	-2,300		2,300	136.0	102.0	2,500	-
T10	638,747	668,855	210.3	T10	No	ENERCON	-2,300		2,300	136.0	102.0	2,500	-
T11	638,422	668,711	197.1	T11	No	ENERCON	-2,300		2,300	136.0	102.0	2,500	-
T12	638,735	668,436	178.6	T12	No	ENERCON	-2,300		2,300	136.0	102.0	2,500	-
T2	633,563	671,040	141.7	T2	No	ENERCON	-2,300		2,300	136.0	102.0	2,500	-
T3	634,149	670,774	222.7	T3	No	ENERCON	-2,300		2,300	136.0	102.0	2,500	-
T4	633,883	670,436	240.3	T4	No	ENERCON	-2,300		2,300	136.0	102.0	2,500	-
T5	634,175	670,140	238.5	T5	No	ENERCON	-2,300		2,300	136.0	102.0	2,500	-
T6	634,975	669,452	209.7	T6	No	ENERCON	-2,300		2,300	136.0	82.0	2,500	-
T7	634,940	669,853	230.6	T7	No	ENERCON	-2,300		2,300	136.0	82.0	2,500	-
T8	638,462	669,114	219.8	T8	No	ENERCON	-2,300		2,300	136.0	102.0	2,500	-
T9	638,905	669,227	221.3	T9	No	ENERCON	-2,300		2,300	136.0	82.0	2,500	-

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	H264	633,420	669,213	158.5	1.0	1.0	0.5	90.0	"Green house mode"	1.5
B	H265	635,345	668,275	203.5	1.0	1.0	0.5	90.0	"Green house mode"	1.5
C	H267	638,438	667,240	106.7	1.0	1.0	0.5	90.0	"Green house mode"	1.5
D	H268	638,908	667,139	106.3	1.0	1.0	0.5	90.0	"Green house mode"	1.5
E	H269	638,958	667,274	119.7	1.0	1.0	0.5	90.0	"Green house mode"	1.5
F	H270	639,035	667,319	127.3	1.0	1.0	0.5	90.0	"Green house mode"	1.5

SHADOW - Main Result

Calculation: Real & Worst Case (Additional Houses) (Cumulative)

Calculation Results

Shadow receptor

No.	Name	Shadow, worst case		Max shadow hours per day	Shadow, expected values	
		Shadow hours per year [h/year]	Shadow days per year [days/year]		Shadow hours per year [h/year]	
A	H264	16:18	65	0:20	3:12	
B	H265	0:00	0	0:00	0:00	
C	H267	0:00	0	0:00	0:00	
D	H268	0:00	0	0:00	0:00	
E	H269	0:00	0	0:00	0:00	
F	H270	0:00	0	0:00	0:00	

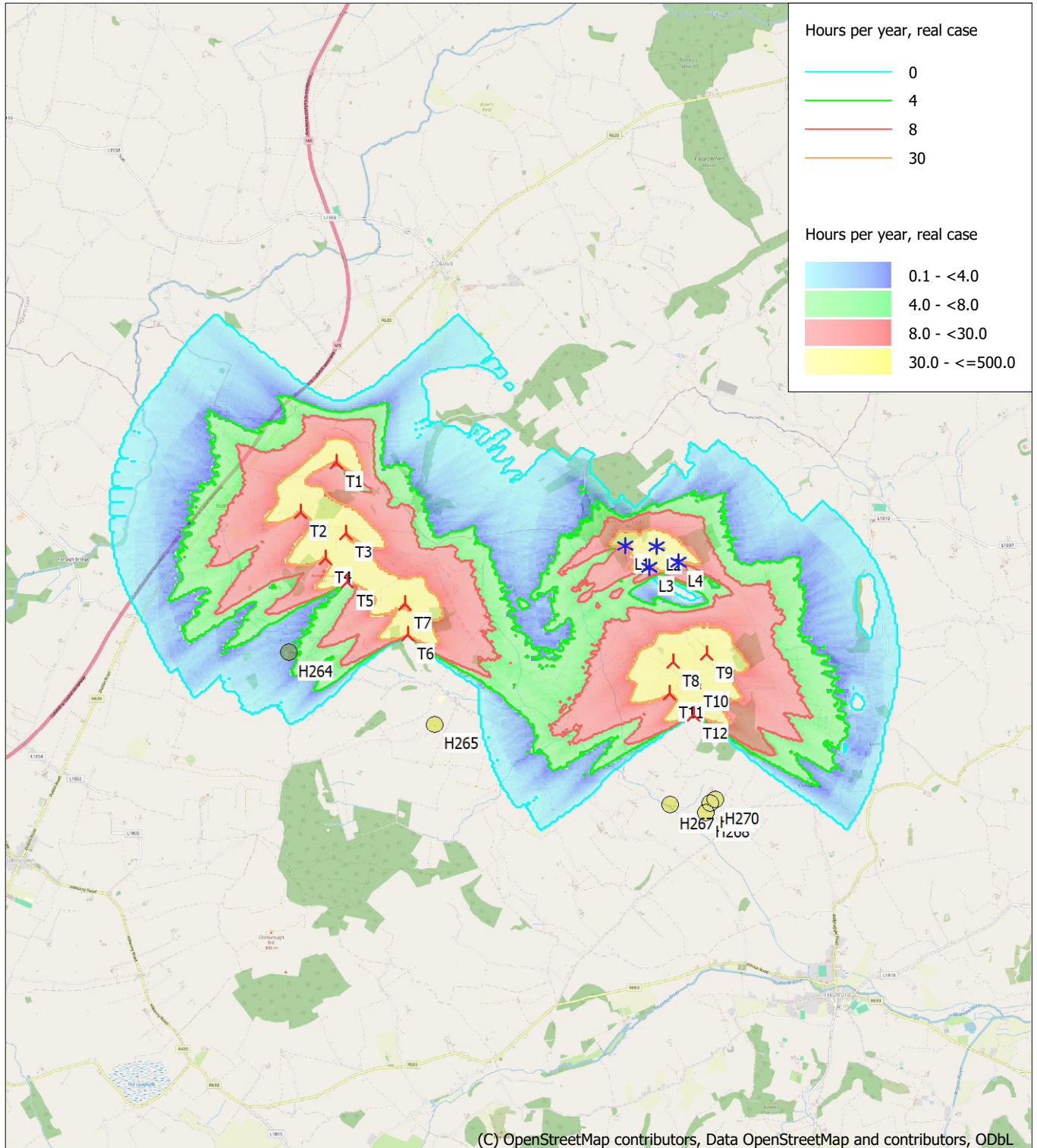
Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case	Expected
		[h/year]	[h/year]
L1	L1	0:00	0:00
L2	L2	0:00	0:00
L3	L3	0:00	0:00
L4	L4	0:00	0:00
T1	T1	0:00	0:00
T10	T10	0:00	0:00
T11	T11	0:00	0:00
T12	T12	0:00	0:00
T2	T2	0:00	0:00
T3	T3	0:00	0:00
T4	T4	0:00	0:00
T5	T5	0:00	0:00
T6	T6	6:40	1:18
T7	T7	9:38	1:54
T8	T8	0:00	0:00
T9	T9	0:00	0:00

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.

SHADOW - Map

Calculation: Real & Worst Case (Additional Houses) (Cumulative)

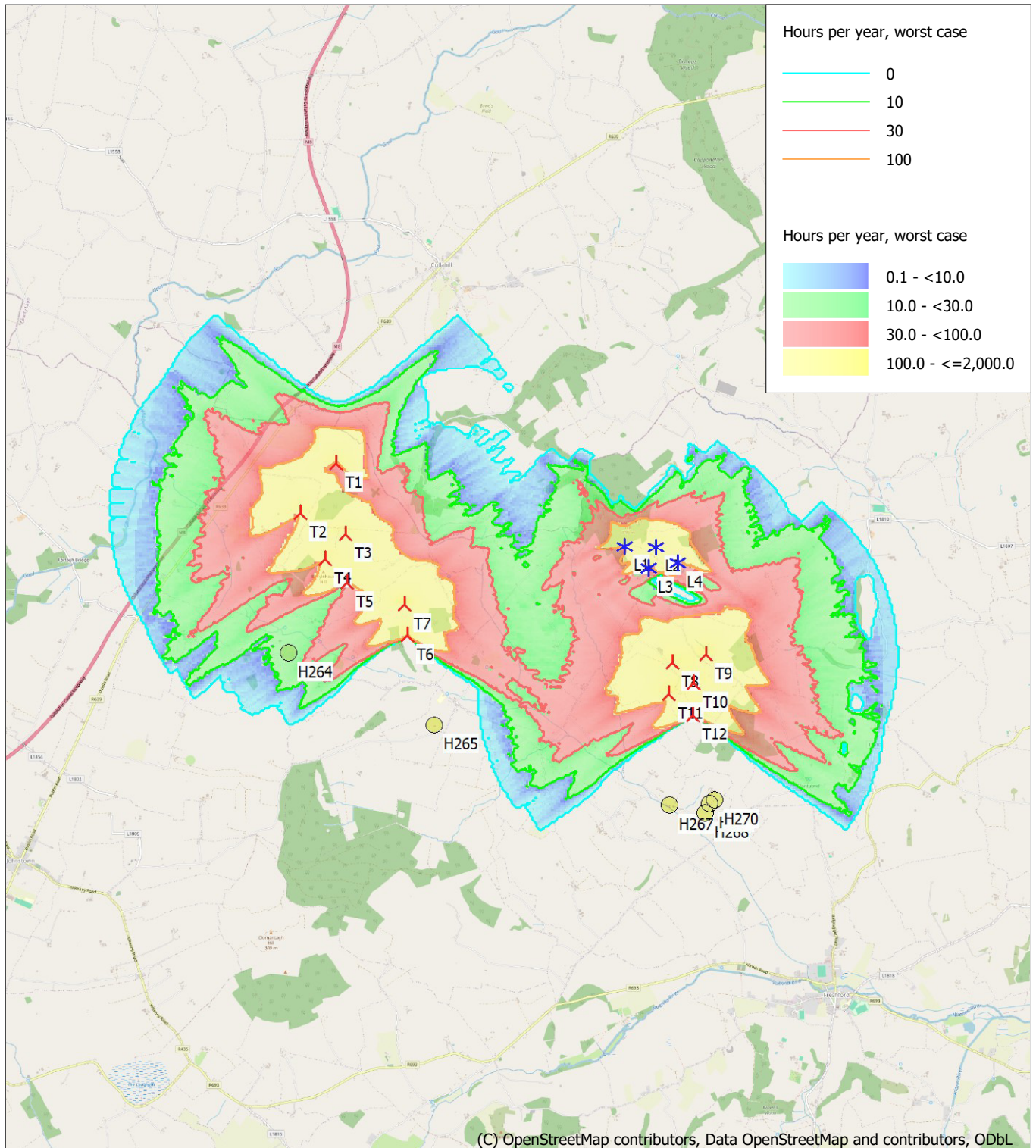


0 1 2 3 4 km

Map: EMD OpenStreetMap , Print scale 1:75,000, Map center Irish ITM-IRENET95 (IE), geocentric, GRS80 East: 636,240 North: 670,080
 New WTG Existing WTG Shadow receptor
 Flicker map level: Elevation Grid Data Object: EUDEM_PanEuropean_DSM_25m_grid_Version_1.1_40km_x_40km.wpg (1)
 Time step: 4 minutes, Day step: 14 days, Map resolution: 30 m, Visibility resolution: 15 m, Eye height: 1.5 m

SHADOW - Map

Calculation: Real & Worst Case (Additional Houses) (Cumulative)



0 1 2 3 4 km

Map: EMD OpenStreetMap , Print scale 1:75,000, Map center Irish ITM-IRENET95 (IE), geocentric, GRS80 East: 636,240 North: 670,080
 New WTG Existing WTG Shadow receptor
 Flicker map level: Elevation Grid Data Object: EUDEM_PanEuropean_DSM_25m_grid_Version_1.1_40km_x_40km.wpg (1)
 Time step: 4 minutes, Day step: 14 days, Map resolution: 30 m, Visibility resolution: 15 m, Eye height: 1.5 m