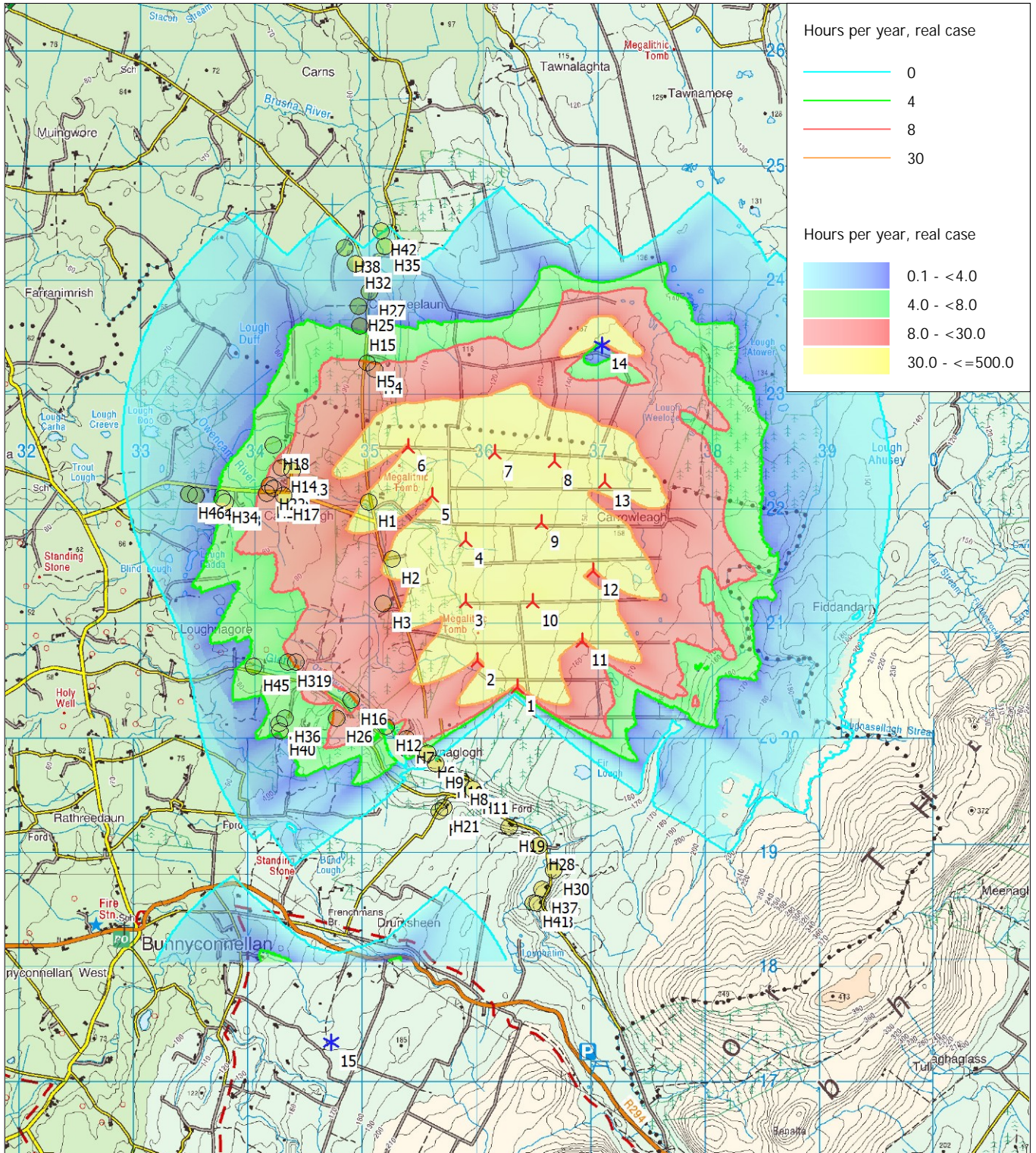


## SHADOW - Map

Calculation: 6129 Firlough Windfarm Specimen Turbine Cumulative real



0 500 1000 1500 2000 m

Map: OSI Basemap(1) , Print scale 1:50,000, Map center Irish ITM-IREN95 (IE), geocentric, GRS80 East: 536,300 North: 821,387

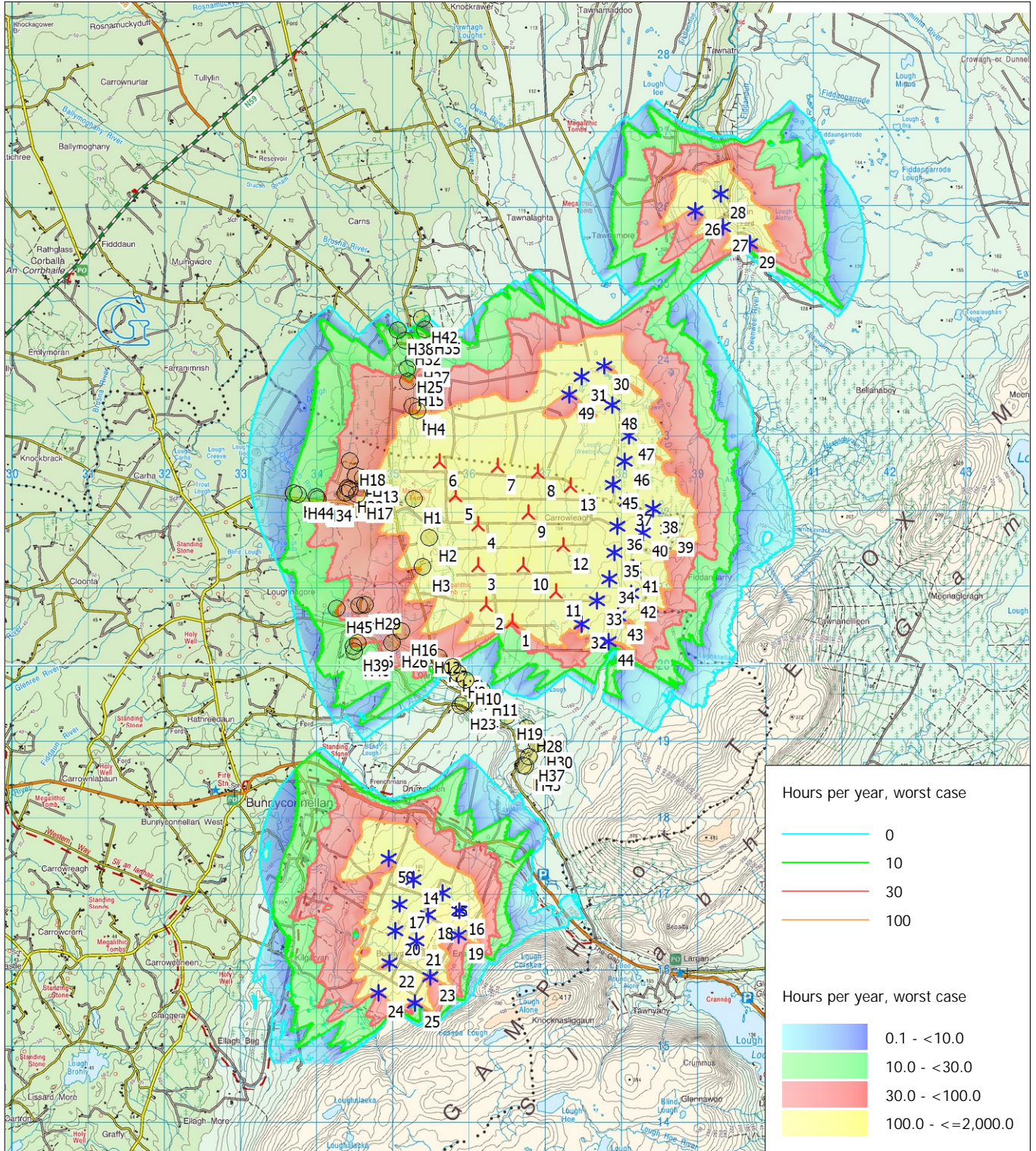
▲ New WTG      \* Existing WTG      ● Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_6129 Firlough WF PID Shadow F\_7.wpo (8)

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

## SHADOW - Map

Calculation: 6129 Firlough Windfarm Specimen Turbine Cumulative worst



Map: OSI Basemap , Print scale 1: 75,000, Map center Irish ITM-IRENET95 (IE), geocentric, GRS80 East: 536,320 North: 821,010  
 ▲ New WTG      \* Existing WTG      ● Shadow receptor  
 Flicker map level: Height Contours: CONTOURLINE\_6129 Firlough WF PID Shadow F\_7.wpo (8)  
 Time step: 2 minutes, Day step: 3 days, Map resolution: 10 m, Visibility resolution: 5 m, Eye height: 1.5 m

Project:

6129 Firlough WF PID Shadow F.

Licensed user:

Jennings O'Donovan  
 Finisklin Business Park  
 IE-F91 RHH9 Sligo  
 +353719161416  
 abyrne / abyrne@jodireland.com  
 Calculated:  
 27/02/2023 14:58/3.6.355

## SHADOW - Main Result

Calculation: 6129 Firlough Windfarm Specimen Turbine Cumulative worst

### 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

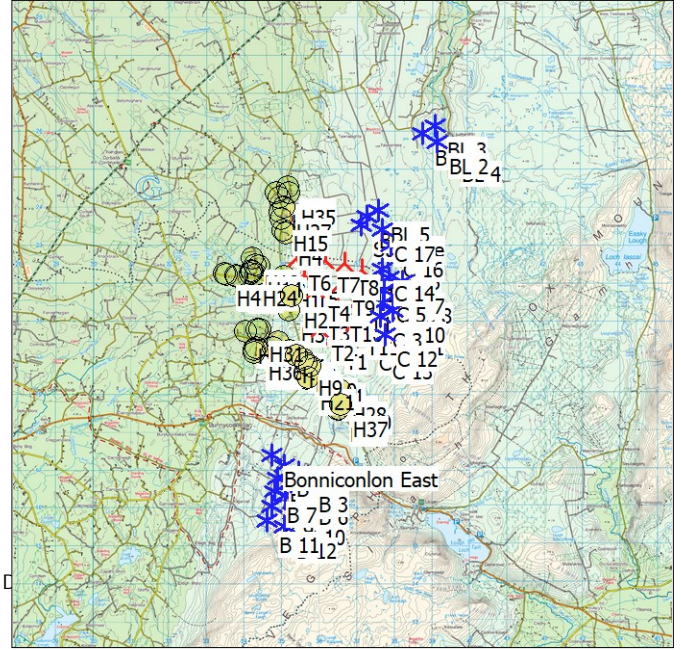
Sunshine probability S (Average daily sunshine hours) [BELMULLET]  
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 1.36 2.16 2.65 4.82 5.79 4.41 4.42 4.07 3.73 2.48 1.71 0.89

Operational time  
 N NNE NE ENE E ESE SE SSE S SSW SW WSW  
 424 378 265 294 296 469 549 535 778 860 982 872

W WNW NW NNW Sum  
 756 512 428 362 8,760

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\_6129 Firlough WF PID  
 Receptor grid resolution: 1.0 m

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



Scale 1:200,000  
 \* New WTG \* Existing WTG Shadow receptor

### WTGs

Row data/Description	Easting	Northing	Z [m]	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
				Valid	Manufact.	Type-generator				Calculation distance [m]	RPM [RPM]
1	536,363	820,481	145.4	No	Siemens Gamesa	SG 6.0 6600-6,600	6,600	155.0	107.5	2,500	9.3
2	536,014	820,710	135.2	No	Siemens Gamesa	SG 6.0 6600-6,600	6,600	155.0	107.5	2,500	9.3
3	535,913	821,226	130.1	No	Siemens Gamesa	SG 6.0 6600-6,600	6,600	155.0	107.5	2,500	9.3
4	535,914	821,771	126.8	No	Siemens Gamesa	SG 6.0 6600-6,600	6,600	155.0	107.5	2,500	9.3
5	535,621	822,155	115.6	No	Siemens Gamesa	SG 6.0 6600-6,600	6,600	155.0	107.5	2,500	9.3
6	535,412	822,586	111.1	No	Siemens Gamesa	SG 6.0 6600-6,600	6,600	155.0	107.5	2,500	9.3
7	536,172	822,533	128.0	No	Siemens Gamesa	SG 6.0 6600-6,600	6,600	155.0	107.5	2,500	9.3
8	536,697	822,453	139.1	No	Siemens Gamesa	SG 6.0 6600-6,600	6,600	155.0	107.5	2,500	9.3
9	536,577	821,915	139.3	No	Siemens Gamesa	SG 6.0 6600-6,600	6,600	155.0	107.5	2,500	9.3
10	536,501	821,222	143.2	No	Siemens Gamesa	SG 6.0 6600-6,600	6,600	155.0	107.5	2,500	9.3
11	536,933	820,878	161.5	No	Siemens Gamesa	SG 6.0 6600-6,600	6,600	155.0	107.5	2,500	9.3
12	537,030	821,486	159.5	No	Siemens Gamesa	SG 6.0 6600-6,600	6,600	155.0	107.5	2,500	9.3
13	537,134	822,272	151.7	No	Siemens Gamesa	SG 6.0 6600-6,600	6,600	155.0	107.5	2,500	9.3
14	535,040	817,113	173.6	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
15	535,425	816,935	195.8	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
16	535,645	816,695	211.8	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
17	534,858	816,788	174.8	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
18	535,235	816,643	202.3	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
19	535,635	816,371	224.0	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
20	534,799	816,430	184.1	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
21	535,083	816,302	205.0	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
22	534,723	816,008	192.3	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
23	535,262	815,832	216.8	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
24	534,577	815,621	188.2	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
25	535,052	815,487	216.1	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
26	538,781	825,870	128.8	Yes	ENERCON	E-92 2,3 MW-2,350	2,350	92.0	78.3	1,517	16.0
27	539,144	825,657	133.3	Yes	ENERCON	E-92 2,3 MW-2,350	2,350	92.0	78.3	1,517	16.0
28	539,112	826,092	135.3	Yes	ENERCON	E-92 2,3 MW-2,350	2,350	92.0	78.3	1,517	16.0
29	539,494	825,438	144.3	Yes	ENERCON	E-92 2,3 MW-2,350	2,350	92.0	78.3	1,517	16.0
30	537,580	823,847	139.9	Yes	ENERCON	E-92 2,3 MW-2,350	2,350	92.0	78.3	1,517	16.0
31	537,275	823,701	139.8	Yes	ENERCON	E-92 2,3 MW-2,350	2,350	92.0	78.3	1,517	16.0
32	537,266	820,457	172.2	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
33	537,467	820,755	173.0	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0

To be continued on next page...

## SHADOW - Main Result

Calculation: 6129 Firlough Windfarm Specimen Turbine Cumulative worst

...continued from previous page

	Easting	Northing	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
34	537,629	821,048	169.3	C 3	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
35	537,698	821,389	167.7	C 4	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
36	537,742	821,743	160.6	C 5	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
37	537,870	822,063	149.7	C 6	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
38	538,206	821,972	150.7	C 7	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
39	538,414	821,700	154.7	C 8	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
40	538,075	821,652	156.7	C 9	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
41	537,953	821,185	164.2	C 10	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
42	537,924	820,857	174.5	C 11	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
43	537,750	820,554	178.1	C 12	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
44	537,624	820,227	182.3	C 13	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
45	537,681	822,289	157.4	C 14	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
46	537,838	822,595	151.3	C 15	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
47	537,902	822,923	149.4	C 16	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
48	537,679	823,331	139.9	C 17	Yes	ENERCON	E-70 E4 2,3 MW-2,300	2,300	71.0	64.0	1,644	20.0
49	537,114	823,466	142.0	Stokane	Yes	ENERCON	E-115 EP3 E3-4,200	4,200	115.7	92.0	1,622	13.2
50	534,715	817,385	153.6	Bonniconlon East	No	ENERCON	E-138 EP3-3,500	3,500	138.6	81.0	1,684	10.8

## 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	535,070	822,103	96.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
B	H2	535,267	821,598	109.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
C	H3	535,188	821,210	107.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
D	H4	535,124	823,263	102.7	2.0	2.0	0.5	90.0	"Green house mode"	2.5
E	H5	535,061	823,316	97.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
F	H6	535,574	819,899	128.1	2.0	2.0	0.5	90.0	"Green house mode"	2.5
G	H7	535,387	820,024	125.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
H	H8	535,857	819,660	114.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
I	H9	535,644	819,809	127.2	2.0	2.0	0.5	90.0	"Green house mode"	2.5
J	H10	535,747	819,724	119.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
K	H11	535,966	819,584	109.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
L	H12	535,210	820,136	101.1	2.0	2.0	0.5	90.0	"Green house mode"	2.5
M	H13	534,401	822,381	84.2	2.0	2.0	0.5	90.0	"Green house mode"	2.5
N	H14	534,306	822,410	78.7	2.0	2.0	0.5	90.0	"Green house mode"	2.5
O	H15	534,999	823,644	94.2	2.0	2.0	0.5	90.0	"Green house mode"	2.5
P	H16	534,907	820,371	97.1	2.0	2.0	0.5	90.0	"Green house mode"	2.5
Q	H17	534,321	822,162	82.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
R	H18	534,233	822,602	79.2	2.0	2.0	0.5	90.0	"Green house mode"	2.5
S	H19	536,282	819,253	117.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
T	H20	534,230	822,231	76.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
U	H21	535,711	819,425	128.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
V	H22	534,198	822,255	75.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
W	H23	535,670	819,393	128.7	2.0	2.0	0.5	90.0	"Green house mode"	2.5
X	H24	534,175	822,187	77.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
Y	H25	534,988	823,817	92.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
Z	H26	534,775	820,212	97.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AA	H27	535,082	823,941	90.2	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AB	H28	536,542	819,091	122.8	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AC	H29	534,421	820,709	89.1	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AD	H30	536,673	818,878	127.7	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AE	H31	534,352	820,705	87.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AF	H32	534,961	824,183	86.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AG	H33	533,812	822,112	73.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AH	H34	533,788	822,143	73.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AI	H35	535,220	824,333	93.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AJ	H36	534,326	820,215	104.3	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AK	H37	536,569	818,707	133.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AL	H38	534,868	824,326	86.6	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AM	H39	534,270	820,167	102.1	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AN	H40	534,280	820,106	104.4	2.0	2.0	0.5	90.0	"Green house mode"	2.5

To be continued on next page...

## SHADOW - Main Result

Calculation: 6129 Firlough Windfarm Specimen Turbine Cumulative worst

...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]
AO H41		536,492	818,590	140.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AP H42		535,188	824,469	92.8	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AQ H43		536,527	818,584	145.0	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AR H44		533,553	822,169	70.9	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AS H45		534,052	820,668	77.5	2.0	2.0	0.5	90.0	"Green house mode"	2.5
AT H46		533,495	822,184	70.1	2.0	2.0	0.5	90.0	"Green house mode"	2.5

## Calculation Results

Shadow receptor

No.	Name	Shadow, worst case			Shadow, expected values	
		Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]	
A	H1	229:28	314	1:30	37:16	
B	H2	233:59	321	1:16	36:55	
C	H3	108:30	236	1:10	19:10	
D	H4	88:09	134	0:55	9:29	
E	H5	79:31	131	0:50	8:31	
F	H6	11:11	41	0:23	1:54	
G	H7	54:55	95	0:47	10:26	
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	74:33	244	0:36	12:07	
N	H14	62:44	220	0:33	10:06	
O	H15	30:33	106	0:25	3:17	
P	H16	34:14	90	0:33	6:49	
Q	H17	76:36	242	0:34	13:27	
R	H18	39:27	133	0:31	6:08	
S	H19	0:00	0	0:00	0:00	
T	H20	63:34	215	0:31	10:47	
U	H21	0:00	0	0:00	0:00	
V	H22	54:04	193	0:30	9:05	
W	H23	0:00	0	0:00	0:00	
X	H24	53:13	192	0:29	9:11	
Y	H25	26:12	94	0:23	2:41	
Z	H26	49:34	146	0:34	9:42	
AA	H27	24:26	82	0:22	2:17	
AB	H28	0:00	0	0:00	0:00	
AC	H29	45:18	184	0:24	8:28	
AD	H30	0:00	0	0:00	0:00	
AE	H31	40:40	150	0:23	7:26	
AF	H32	15:52	70	0:19	1:26	
AG	H33	26:15	122	0:23	4:44	
AH	H34	25:18	118	0:22	4:30	
AI	H35	9:01	40	0:16	0:43	
AJ	H36	32:41	141	0:21	6:08	
AK	H37	0:00	0	0:00	0:00	
AL	H38	6:44	32	0:16	0:31	
AM	H39	30:28	137	0:21	5:42	
AN	H40	27:01	128	0:21	5:04	
AO	H41	0:00	0	0:00	0:00	
AP	H42	0:00	0	0:00	0:00	
AQ	H43	0:00	0	0:00	0:00	
AR	H44	13:15	67	0:20	2:21	
AS	H45	27:39	133	0:19	5:10	
AT	H46	12:13	63	0:19	2:09	

Project:

6129 Firlough WF PID Shadow F.

Licensed user:

Jennings O'Donovan  
Finisklin Business Park  
IE-F91 RHH9 Sligo  
+353719161416  
abyrne / abyrne@jodireland.com  
Calculated:  
27/02/2023 14:58/3.6.355

## SHADOW - Main Result

Calculation: 6129 Firlough Windfarm Specimen Turbine Cumulative worst

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	1	127:04	20:22
2	2	141:30	20:05
3	3	162:43	25:51
4	4	159:33	28:00
5	5	136:53	24:26
6	6	152:39	23:01
7	7	108:48	16:04
8	8	78:31	11:54
9	9	74:03	11:38
10	10	67:22	11:27
11	11	47:56	8:09
12	12	17:59	3:00
13	13	22:46	4:20
14	B 1	0:00	0:00
15	B 2	0:00	0:00
16	B 3	0:00	0:00
17	B 4	0:00	0:00
18	B 5	0:00	0:00
19	B 6	0:00	0:00
20	B 7	0:00	0:00
21	B 8	0:00	0:00
22	B 9	0:00	0:00
23	B 10	0:00	0:00
24	B 11	0:00	0:00
25	B 12	0:00	0:00
26	BL 1	0:00	0:00
27	BL 2	0:00	0:00
28	BL 3	0:00	0:00
29	BL 4	0:00	0:00
30	BL 5	0:00	0:00
31	BL 6	0:00	0:00
32	C 1	0:00	0:00
33	C 2	0:00	0:00
34	C 3	0:00	0:00
35	C 4	0:00	0:00
36	C 5	0:00	0:00
37	C 6	0:00	0:00
38	C 7	0:00	0:00
39	C 8	0:00	0:00
40	C 9	0:00	0:00
41	C 10	0:00	0:00
42	C 11	0:00	0:00
43	C 12	0:00	0:00
44	C 13	0:00	0:00
45	C 14	0:00	0:00
46	C 15	0:00	0:00
47	C 16	0:00	0:00
48	C 17	0:00	0:00
49	Stokane	0:00	0:00
50	Bonniconlon East	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.

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.