

**APPENDIX E.3**  
**SHADOW FLICKER CALCULATIONS**  
**70 m TOWERS & 56 m BLADES**

### SHADOW - Main Result

Calculation: Shadow Flicker\_38 x Vestas V112\_126m Tips\_44 Properties\_16th July 2015

#### Assumptions for shadow calculations

Maximum distance for influence 1,120 m  
 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) [VALENTIA OBS.]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.30	2.04	2.89	4.92	5.79	4.99	4.32	4.35	3.60	2.54	1.64	1.06

Operational hours are calculated from WTGs in calculation and wind distribution:

Mast G1\_80m\_FDT

Operational time

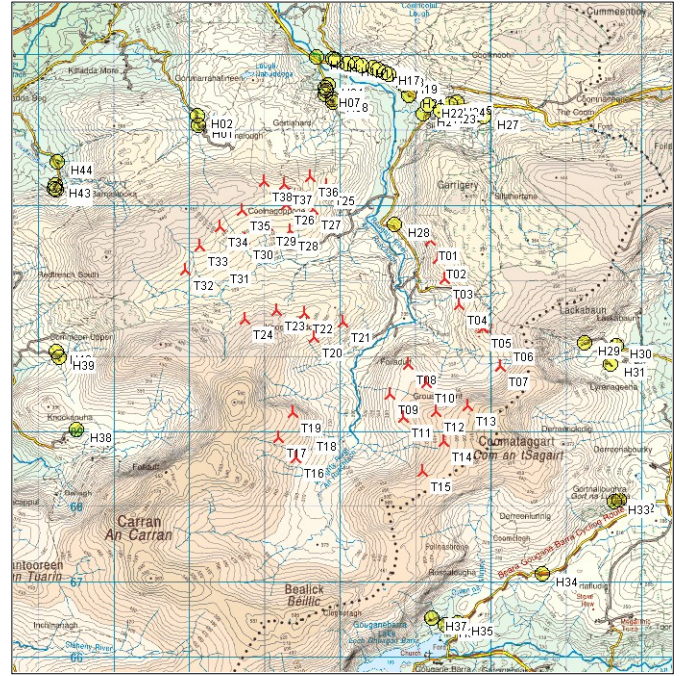
N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
496	265	220	383	657	519	734	1,062	1,150	1,402	667	800	8,357

Idle start wind speed: Cut in wind speed from power curve

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: Grousemount Contours with Spot Heights  
 Obstacles used in calculation  
 Eye height: 1.5 m  
 Grid resolution: 10.0 m

All coordinates are in IG



▲ New WTG

● Shadow receptor

#### WTGs

	X(East)	Y(North)	Z	Row data/Description	WTG type				Rotor diameter [m]	Hub height [m]	RPM [RPM]
					Valid	Manufact.	Type-generator	Power, rated [kW]			
				[m]							
T01	109,198	71,536	314.9	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T02	109,303	71,293	338.8	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T03	109,391	71,027	325.0	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T04	109,584	70,682	309.1	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T05	109,901	70,374	390.0	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T06	110,195	70,193	407.3	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T07	110,128	69,868	373.6	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T08	108,900	69,894	390.0	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T09	108,666	69,493	383.2	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T10	109,145	69,655	390.0	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T11	108,836	69,186	405.7	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T12	109,270	69,265	460.3	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T13	109,691	69,348	490.7	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T14	109,379	68,878	468.7	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T15	109,095	68,482	456.0	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T16	107,411	68,657	406.3	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T17	107,185	68,919	459.6	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T18	107,579	69,008	407.3	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T19	107,369	69,254	460.0	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T20	107,650	70,250	370.5	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T21	108,033	70,450	350.8	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T22	107,524	70,570	390.0	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T23	107,157	70,609	386.0	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T24	106,741	70,496	404.2	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T25	107,817	72,261	327.6	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T26	107,284	72,015	381.8	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T27	107,646	71,952	343.2	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T28	107,337	71,667	343.1	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T29	107,046	71,734	351.0	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T30	106,731	71,551	349.6	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T31	106,426	71,233	345.8	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T32	105,944	71,141	369.0	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT... No		VESTAS	V112-3,000	3,000	112.0	70.0	12.8

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## SHADOW - Main Result

Calculation: Shadow Flicker\_38 x Vestas V112\_126m Tips\_44 Properties\_16th July 2015

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	X(East)	Y(North)	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	RPM [RPM]
					Valid	Manufact.	Type-generator				
T33	106,136	71,463	390.9	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT...	No	VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T34	106,407	71,717	391.0	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT...	No	VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T35	106,704	71,934	391.4	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT...	No	VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T36	107,609	72,376	361.1	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT...	No	VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T37	107,257	72,283	392.8	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT...	No	VESTAS	V112-3,000	3,000	112.0	70.0	12.8
T38	106,996	72,310	394.2	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT...	No	VESTAS	V112-3,000	3,000	112.0	70.0	12.8

## Shadow receptor-Input

No.	X(East)	Y(North)	Z	Width	Height	Height	Degrees from	Slope of	Direction mode
			[m]	[m]	[m]	a.g.l.	south cw	window	
			[m]	[m]	[m]	[m]	[°]	[°]	
H01	106,128	73,058	244.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H02	106,116	73,190	237.9	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H03	107,688	73,959	160.8	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H04	107,849	73,595	178.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H05	107,802	73,554	184.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H06	107,823	73,522	185.4	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H07	107,805	73,465	190.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H08	107,913	73,406	190.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H09	107,908	73,365	192.4	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H10	107,916	73,939	167.4	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H11	107,954	73,925	168.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H12	108,097	73,869	175.7	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H13	108,216	73,874	183.9	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H14	108,298	73,850	184.7	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H15	108,450	73,818	193.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H16	108,514	73,800	196.8	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H17	108,602	73,763	200.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H18	108,656	73,736	201.6	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H19	108,825	73,644	206.6	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H20	108,856	73,591	205.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H21	108,922	73,450	191.4	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H22	109,176	73,330	205.6	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H23	109,333	73,253	210.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H24	109,470	73,341	223.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H25	109,550	73,367	231.4	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H26	109,108	73,207	197.4	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H27	109,912	73,169	236.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H28	108,721	71,736	224.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H29	111,255	70,179	243.7	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H30	111,674	70,135	216.9	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H31	111,595	69,894	233.9	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H32	111,706	68,081	242.7	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H33	111,646	68,050	244.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H34	110,696	67,099	246.8	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H35	109,565	66,446	180.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H36	109,399	66,427	173.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H37	109,219	66,516	183.8	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H38	104,506	69,022	274.6	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H39	104,278	69,977	239.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H40	104,234	70,052	240.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H41	104,241	72,200	192.3	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H42	104,208	72,218	184.4	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H43	104,229	72,260	183.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H44	104,248	72,574	160.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"

## SHADOW - Main Result

Calculation: Shadow Flicker\_38 x Vestas V112\_126m Tips\_44 Properties\_16th July 2015

### Calculation Results

Shadow receptor

No.	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]
H01	0:00	0	0:00	0:00
H02	0:00	0	0:00	0:00
H03	0:00	0	0:00	0:00
H04	0:00	0	0:00	0:00
H05	0:00	0	0:00	0:00
H06	0:00	0	0:00	0:00
H07	6:02	26	0:17	0:29
H08	15:49	46	0:25	1:18
H09	19:22	52	0:27	1:37
H10	0:00	0	0:00	0:00
H11	0:00	0	0:00	0:00
H12	0:00	0	0:00	0:00
H13	0:00	0	0:00	0:00
H14	0:00	0	0:00	0:00
H15	0:00	0	0:00	0:00
H16	0:00	0	0:00	0:00
H17	0:00	0	0:00	0:00
H18	0:00	0	0:00	0:00
H19	0:00	0	0:00	0:00
H20	0:00	0	0:00	0:00
H21	0:00	0	0:00	0:00
H22	0:00	0	0:00	0:00
H23	0:00	0	0:00	0:00
H24	0:00	0	0:00	0:00
H25	0:00	0	0:00	0:00
H26	0:00	0	0:00	0:00
H27	0:00	0	0:00	0:00
H28	102:03	237	0:48	15:43
H29	0:00	0	0:00	0:00
H30	0:00	0	0:00	0:00
H31	0:00	0	0:00	0:00
H32	0:00	0	0:00	0:00
H33	0:00	0	0:00	0:00
H34	0:00	0	0:00	0:00
H35	0:00	0	0:00	0:00
H36	0:00	0	0:00	0:00
H37	0:00	0	0:00	0:00
H38	0:00	0	0:00	0:00
H39	0:00	0	0:00	0:00
H40	0:00	0	0:00	0:00
H41	0:00	0	0:00	0:00
H42	0:00	0	0:00	0:00
H43	0:00	0	0:00	0:00
H44	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]
T01	VESTAS V112 3000 112.0 IO! hub: 70.0 m (TOT: 126.0 m) (418)	37:35	6:09
T02	VESTAS V112 3000 112.0 IO! hub: 70.0 m (TOT: 126.0 m) (419)	21:19	2:54
T03	VESTAS V112 3000 112.0 IO! hub: 70.0 m (TOT: 126.0 m) (420)	17:46	1:51
T04	VESTAS V112 3000 112.0 IO! hub: 70.0 m (TOT: 126.0 m) (421)	0:00	0:00
T05	VESTAS V112 3000 112.0 IO! hub: 70.0 m (TOT: 126.0 m) (422)	0:00	0:00
T06	VESTAS V112 3000 112.0 IO! hub: 70.0 m (TOT: 126.0 m) (423)	0:00	0:00
T07	VESTAS V112 3000 112.0 IO! hub: 70.0 m (TOT: 126.0 m) (424)	0:00	0:00
T08	VESTAS V112 3000 112.0 IO! hub: 70.0 m (TOT: 126.0 m) (425)	0:00	0:00
T09	VESTAS V112 3000 112.0 IO! hub: 70.0 m (TOT: 126.0 m) (426)	0:00	0:00
T10	VESTAS V112 3000 112.0 IO! hub: 70.0 m (TOT: 126.0 m) (427)	0:00	0:00
T11	VESTAS V112 3000 112.0 IO! hub: 70.0 m (TOT: 126.0 m) (428)	0:00	0:00
T12	VESTAS V112 3000 112.0 IO! hub: 70.0 m (TOT: 126.0 m) (429)	0:00	0:00
T13	VESTAS V112 3000 112.0 IO! hub: 70.0 m (TOT: 126.0 m) (430)	0:00	0:00

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## SHADOW - Main Result

Calculation: Shadow Flicker\_38 x Vestas V112\_126m Tips\_44 Properties\_16th July 2015

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No.	Name	Worst case [h/year]	Expected [h/year]
T14	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (431)	0:00	0:00
T15	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (432)	0:00	0:00
T16	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (433)	0:00	0:00
T17	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (434)	0:00	0:00
T18	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (435)	0:00	0:00
T19	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (436)	0:00	0:00
T20	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (437)	0:00	0:00
T21	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (438)	0:00	0:00
T22	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (439)	0:00	0:00
T23	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (440)	0:00	0:00
T24	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (441)	0:00	0:00
T25	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (442)	13:41	2:27
T26	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (443)	0:00	0:00
T27	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (444)	11:42	2:22
T28	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (445)	0:00	0:00
T29	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (446)	0:00	0:00
T30	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (447)	0:00	0:00
T31	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (448)	0:00	0:00
T32	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (449)	0:00	0:00
T33	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (450)	0:00	0:00
T34	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (451)	0:00	0:00
T35	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (452)	0:00	0:00
T36	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (453)	25:32	2:07
T37	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (454)	0:00	0:00
T38	VESTAS V112 3000 112.0 !O! hub: 70.0 m (TOT: 126.0 m) (455)	0:00	0:00