RATCH-Australia Corporation

COLLECTOR WIND FARM

SHADOW FLICKER ASSESSMENT

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1. INTRODUCTION

This report discusses the shadow flicker phenomenon and presents an assessment of the associated impacts on nearby residences. The methodology and assumptions included in this assessment are in accordance with the Environment Protection and Heritage Council *Draft National Wind Farm Guidelines – July 2010*.

What is Shadow Flicker?

Wind turbines due to their size cast shadows on their surrounds, when the shadow of a rotating wind turbine falls on a particular location, for example a house, it can cause a fluctuation in light levels. This phenomenon is referred to as "shadow flicker".

Using simple geometry incorporating the sun's path, topography and wind turbine dimensions it is possible to calculate the annual hours a receptor (residence/house) is subject to shadow flicker.

The duration of shadow flicker, its intensity and the locations it affects are most strongly determined by the relative position of the sun, the turbine and the receptor. The relative position of the sun varies with latitude, time of day and time of year. Other influential factors include;

- The size of the wind turbine rotor and the height of the tower
- Surface topography
- Intervening vegetation
- Direction of the wind (and hence the rotor plane of the wind turbine)
- Weather (particularly cloud cover)
- General visibility (including presence of mist, smoke and other particulates)

The key risk associated with shadow flicker is annoyance of residents.

Shadow flicker can theoretically extend for many kilometres from a wind turbine. However, the intensity of the shadow cast by the wind turbine decreases with increasing distance from it.

While acknowledging that different individuals have different levels of sensitivity and may be annoyed by different levels of intensity, this report limits assessment to a moderate level of intensity.

2. SITE DESCRIPTION

The proposed Collector Wind Farm is expected to comprise 68 wind turbines each with a nameplate rating of approximately 3MW. The turbines will have a hub height of around 80-95m and blade length of 45-55m.

At the time of this report; the most likely configuration of the wind farm is a 68 wind turbine configuration.

Two alternative turbines will be investigated in this document;

1. REPower 3xM 104 wind turbines with an overall height of 132m (80m hub and 52m blade).
2. Vestas V112 wind turbines with an overall height of 150m (94m hub height and 56m blade).

The area for the wind farm is located 55km north-east of Canberra and 35km south-west of Goulburn. Situated on the Great Dividing Range, the 3,300ha site is bounded by the Hume highway to the north, Collector Road to the west and south and Collector Creek to the east.

The land can be described as undulating cleared grazing land with scattered trees predominantly covered by native pasture grazed by cattle and sheep.

Residences (Receptors)

A review of the general area has identified 89 residences within the vicinity of the wind farm. This includes the township of Collector, located approximately 4km from the nearest wind turbine, with an approximate number of 60 dwellings. For the purposes of the evaluation the Collector Town is represented by two receptors located in closest proximity to the proposed wind turbines, approximately 3.5km and 3.6km from a turbine.

The relative proximity of these residences and the minimum separation to the wind turbines is included in Appendix B. A summary of the number of residences in proximity to the wind farm is shown in the table below.

Distance from WTG (m)	No. of Residences
500	1
1000	2
2000	8
3000	15
4000	55
5000	89

3. LIMITS, ASSUMPTIONS AND INPUTS

In the simplest of cases (worst case) the turbine is assumed to be operating all the time, is perpendicular to the receptor at all times, with the sun shining at all times of the day. This case will provide the upper bound or maximum to the number of shadow hours expected each year.

A more realistic account of the shadow hours (expected case) can be provided by taking into account the operation of the wind turbines (facing direction, rotational speed and operational status) and the weather conditions experienced (cloud cover) at the site.

This case is still considered to be conservative as it does not take into account any screening (vegetation or structure) between the shadow source and the receptor and still considers the window or the receptor to always be perpendicular to the shadow source.

3.1. *SHADOW DISTANCE*

The intensity of the shadow associated with shadow flicker is directly related to the amount of sunlight blocked by the blade. When the receptor is close to the turbine, 100% of the sunlight is blocked as the blade passes in front of the sun and the receptor experiences alternate full sunlight and full shade. As the receptor moves further away from the turbine, the apparent size of the sun remains effectively constant but the apparent size of the blade decreases. At some point the blade will

no longer fully cover the sun as it passes in front of it and the receptor will alternate full sunlight and partial shade.

Thus, as the distance between the shadow source and the receptor grows so the shadow intensity diminishes.

In South Australia, the government (*Planning SA, Planning Bulletin "Wind Farms, Draft for Consultation", South Australian Government, 2002*) has recommended that outside a distance of 500m the intensity of shadow is sufficiently diminished so as not to have an impact.

The *Draft National Wind Farm Development Guidelines – July 2010* recommend an assessment distance of 265 x the maximum blade chord. For the wind turbines under assessment this equates to a distance of approximately 1100m. (max. blade chord of 4.0m)

For the purposes of an initial investigation a maximum length of the shadow cast from the turbine of 2000m has been used.

3.2. *SHADOW HOURS LIMIT*

The shadow flicker experienced at any residence in the surrounding area must not exceed 30 hours per year as a result of the operation of the wind energy facility. (*"Policy and planning guidelines for development of wind energy facilities in Victoria", Sustainable Energy Authority Victoria, 2003*)

Common practice for wind farm developments within Australia has seen the limit of 30 hours/year imposed, and as such this methodology has been adopted for this assessment.

3.3. *RECEPTOR*

At each residence it is assumed there is a window 1m x 1m in area located 2m above ground facing perpendicular to each WTG comprising the wind farm. In this way any shadow cast from a turbine is assumed to reach a window of the receptor. This is referred to as the "Greenhouse Effect".

In reality the receptor window would be located on the wall of a house and would have a fixed orientation. Under the "Greenhouse Effect" the receptor window and the wall of the house is assumed to be able to move to allow it to always be perpendicular to the turbine under calculation. This is considered to be a conservative approach and provides an upper bound of the shadow impact hours likely.

If a particular residence is found to be experiencing an impact in excess of the recommended limit then a detailed assessment of the residence should be undertaken to provide the exact size and orientation of all the windows to allow the impact to be accurately assessed.

3.4. *WIND TURBINE*

In a worst case assumption the rotor of the wind turbine is considered to be orientated always perpendicular to the sun and the receptor, and is considered as a solid disc.

A more realistic approach is considered where the operational hours of the turbine and hence the direction it faces is taken into account.

OPERATIONAL HOURS - DIRECTION

Wind turbines are controlled such that during operation they are able to rotate to be always facing into the oncoming wind. As the direction the turbine faces changes so

to does the relative geometry of the turbine in respect to the residence/receptor and as such the shadow it would cast. Thus the direction of operation should be included in the shadow impact calculation.

The wind direction is obtained from wind records collected from monitoring on site.

For the Collector site the annual hours in each direction are provided below using the data collected from monitoring tower 4770 (717010E 6132231N Z55 MGA94) which has been operating since April 2003.

	Wind Direction Statistics – Monitoring Tower 4770											
	N	**NNE**	**ENE**	**E**	**ESE**	**SSE**	**S**	**SSW**	**WSW**	**W**	**WNW**	**NNW**
Percentage Data	2.0	2.8	10.8	13.9	8.0	4.3	2.4	1.8	3.1	20.4	22.8	7.8
Annual Operating Hours	175	241	947	1222	698	376	206	160	273	1786	1993	683

3.5. *SUNSHINE PROBABILITY - CLOUD COVER*

The effect of the local weather conditions should also be taken into account when assessing the shadow impact. Obviously a shadow cast will have its greatest intensity on a clear cloudless day with high sunshine. As the amount of cloud cover increases the shadow intensity will decrease to the point where the shadow is negligible on a completely cloudy day.

The calculation of the amount of sunshine for the Collector wind farm site is based on data from the Bureau of Meteorology station at Goulburn located approximately 33km to the northeast of the site and collected since 1971 to current day. A second BoM site at Canberra (49km away) was also investigated with data similar for both sites, but the Goulburn site was preferred due to its closer proximity.

A probability factor is applied for the amount of light experienced for clear days, cloudy days and those in between.

Clear Days – 1.0

Cloudy Days – 0.0

Other Days – 0.5

A definition of what constitutes a Clear Day and a Cloudy Day is provided in the Definitions part of this report and is sourced from the Bureau of Meteorology.

Using these factors we are able to calculate the "Sunshine Probability" – an indication of the amount of time between sun rise and sun set with sunshine.

A summary of the data records obtained and the calculated "Sunshine Probability" is shown in the table below.

	Statistical data for Bureau of Meteorology Station - GOULBURN											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Clear Days	8.4	5.9	7.0	7.6	7.1	5.7	7.1	8.9	8.1	7.6	6.7	8.3
Cloudy Days	9.7	11.4	11.2	10.4	12.3	13.2	11.9	10.4	9.2	10.5	11.4	10.6
Other Days	12.9	10.7	12.8	12.0	11.6	11.1	12.0	11.7	12.7	12.9	11.9	12.1
Sunshine Probability	0.479	0.402	0.432	0.453	0.416	0.375	0.423	0.476	0.482	0.453	0.422	0.463

3.6. *OBSTACLES*

In a worst case evaluation no account is made for the protection that vegetation, surrounding buildings or other obstacles would provide between the shadow source and the receptor.

In a real situation the presence of trees, shrubs and adjacent buildings would provide a barrier between the shadow source and the receptor and thus reduce the shadow impact on the receptor.

4. RESULTS

The program *WindPRO v2.5* was used to perform the calculations for shadow flicker impact. Detailed contour information for the site is used by *WindPRO* to produce an accurate model of the topography of the area. Global positioning is used to define the location of each of the dwellings within this model. The position of the turbines and their dimensions along with the assumptions outlined in the previous section are also included as inputs to the calculation.

4.1. *INITIAL INVESTIGATION (Worst Case)*

Assumptions

- Shadow distance – 2000m
- Receptor – Greenhouse Effect
- Direction – turbine rotor plane is always perpendicular to the line from the WTG and the sun
- Sunshine – sun is shining all day from sunrise to sunset
- Obstacle – no obstacles

Given the shadow distance assumption made in Section 3.1 only the results for the houses generally within 2000m of a wind turbine are shown.

	WORST CASE - Shadow hours / year			
	REPower 3xM wind turbines		**Vestas V112 wind turbines**	
Dwelling	**Estimated hours - Worst Case**	**Allowable**	**Estimated hours - Worst Case**	**Allowable**
G*	10:50	30:00	13:33	30:00
M*	7:17	30:00	9:01	30:00
N*	159:50	30:00	189:46	30:00
S*	8:58	30:00	12:18	30:00
T*	15:57	30:00	21:18	30:00
V	0:00	30:00	0:00	30:00
Z	0:00	30:00	0:00	30:00
BB	1:48	30:00	2:32	30:00
FF	0:00	30:00	0:00	30:00
* - indicates a dwelling belonging to a landholder participating in the project				

The detailed results of the flicker analysis are included as Appendix A.

As can be seen from these results there is one residence (N) which it is predicted will experience more shadow flicker than the recommended limit under the worst case scenario.

This residence is owned by a participant landholder in the project and is currently being considered to be used as an office for construction and operation of the wind farm and as such the impact on it is not considered applicable.

If required vegetation screening could be planted to shield any receptor windows from the shadows cast from the turbines. The windows facing to the east and west of residence would be screened in this way is desired.

4.2. *FURTHER INVESTIGATION (Expected Case)*

In accordance with the methodology outlined in the Environment Protection and Heritage Council *Draft National Wind Farm Guidelines – July 2010*, if the modelling of the shadow flicker hours estimated at the receptors is below the specified limit (30 hours/year) under the worst case scenario then there is no further analysis required.

For a more realistic estimate or "expected case" of the actual hours of shadow impact likely to be experienced a further range of assumptions is used.

Assumptions

- Shadow distance – 265 times the maximum blade chord = 1,100m (max blade chord for V112 – 3.51m, 3xM – 3.8m; allow blade chord of 4m)
- Receptor – Greenhouse Effect
- Direction – from wind data records collected on-site since 2003
- Sunshine – from Bureau of Meteorology records for Goulburn
- Obstacle – no obstacles included

The results of the modelling with these changes in the assumptions are shown below.

It should also be noted there are further changes to assumptions can be included to move closer to the actual situation, such as exact locations and dimensions of windows rather than "greenhouse" and the inclusion of vegetation and obstacles.

	EXPECTED CASE - Shadow hours / year			
	REPower 3xM wind turbines		Vestas V112 wind turbines	
Dwelling	Estimated hours - Worst Case	Allowable	Estimated hours - Worst Case	Allowable
G*	0:00	30:00	0:00	30:00
M*	0:00	30:00	0:00	30:00
N*	51:38	30:00	59:30	30:00
S*	0:00	30:00	0:00	30:00
T*	0:00	30:00	0:00	30:00
V	0:00	30:00	0:00	30:00
Z	0:00	30:00	0:00	30:00
BB	0:00	30:00	0:00	30:00
FF	0:00	30:00	0:00	30:00
* - indicates a dwelling belonging to a landholder participating in the project				

5. SENSITIVITY

Shadow flicker duration can be very sensitive to location, varying by up to 0.8 hours/m of horizontal displacement. Thus in an extreme case, one end of a house may experience no flicker while the other end may exceed prescribed limits.

For this reason it is prudent to assess the variance within 50m from the centre of a dwelling. This assessment also allows for variations in;

- the offset between tower and the rotor of the wind turbine
- minor inaccuracies in the modelling
- annual variation in weather conditions
- topographical variations

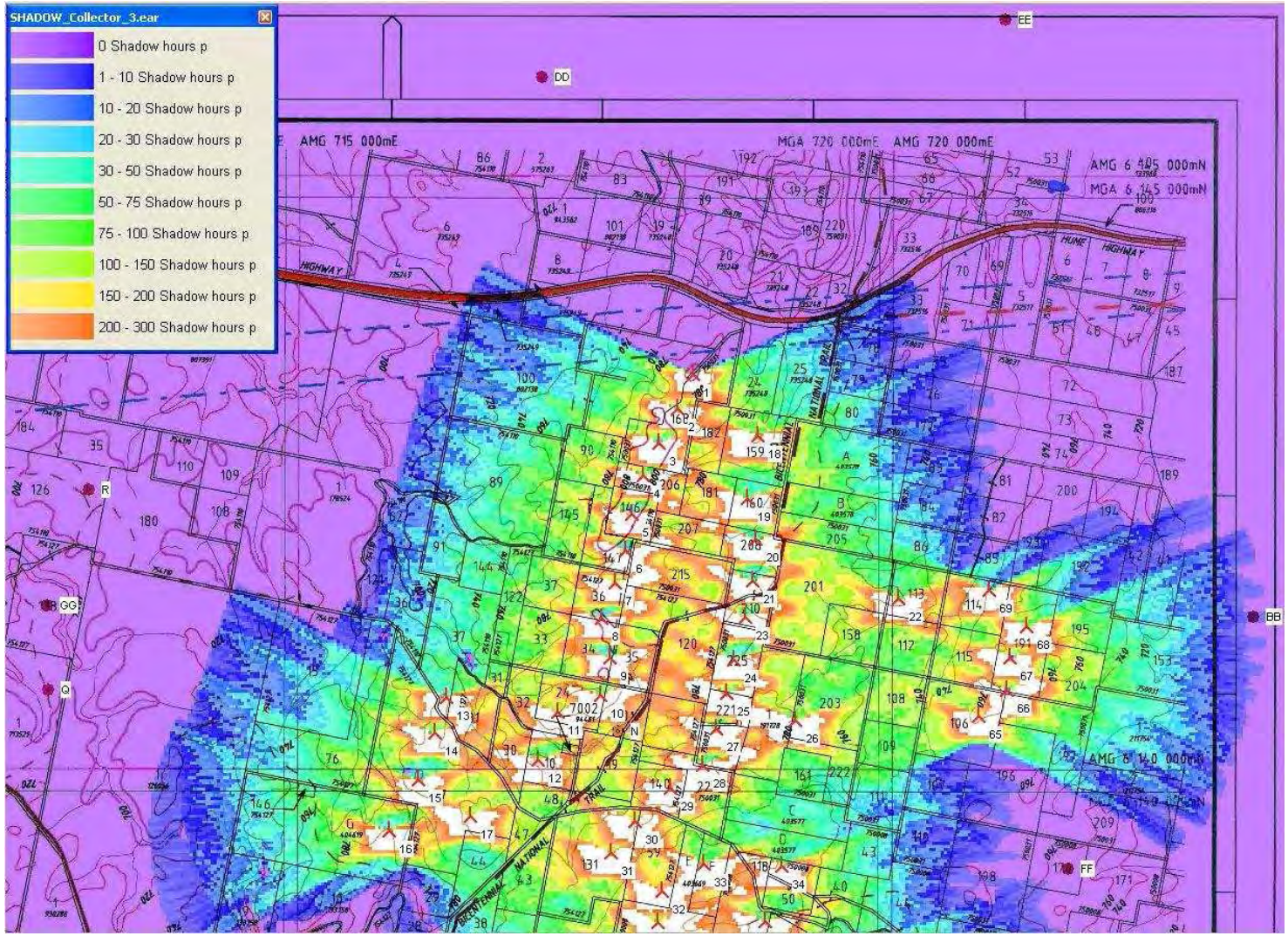
This assessment will also provide for an assessment of the potential for impact for residents using the exterior or yard of a property and the shadow impact the may be subjected to.

A shadow flicker map can be produced to show the variation in flicker in the area of the wind farm.

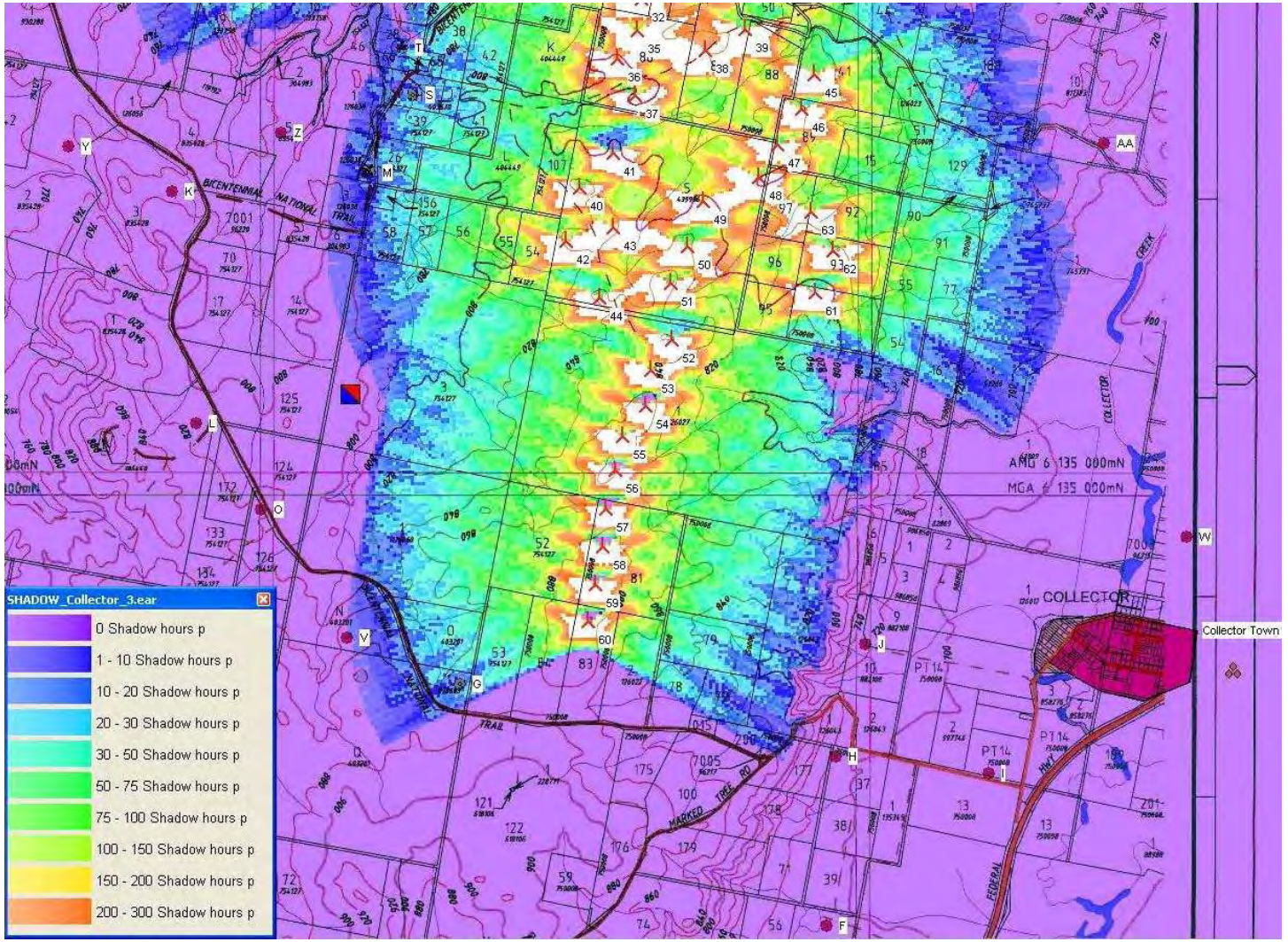
A shadow flicker map for the Vestas V112 option for the “worst case” in the area of the Collector wind farm is shown below, with a resolution of 25m (25m x 25m grid size).

As can be seen from this map the variance in shadow hours in the vicinity of the receptors do not show a marked degree of variation and as such the calculated hours can be considered to occur within +/- 50m of the receptor.

Shadow Flicker Map – Northern Area (Vestas V112 worst case option)



Shadow Flicker Map – Southern Area (Vestas V112 worst case option)



6. DISCUSSION AND CONCLUSION

The results show that even under the worst case conditions, no neighbouring residences would experience an impact greater than the prescribed limit.

Even when considering the participating landholder residences, at only one location is the number of hours experienced greater than the limits.

This location is under consideration to become part of the operational facility of the wind farm and as such is not considered relevant. By incorporating suitable vegetation screening to the east and west of this location the impact of shadow flicker on it will be negated.

Thus, it is stated that the impact of Shadow Flicker on residences around the Collector wind farm is within permissible limits.

Should the actual operation of the wind farm produce an amount of shadow flicker impact above that modelled in this assessment then potential mitigation measures should be investigated.

Potential mitigation measures such as;

- vegetation screening or
- window shades or
- potential operational changes to identified turbines, such as removing them from operation during specific shadow impact periods.

DEFINITIONS

The following definitions have been sourced from the Bureau of Meteorology – Climate Data Online.

Mean number of clear days

Average number of clear days in a calendar month or year, calculated over the period of record. This statistic is derived from cloud cover observations, which are measured in oktas (eighths). The sky is visually inspected to produce an estimate of the number of eighths of the dome of the sky covered by cloud. A completely clear sky is recorded as zero okta, while a totally overcast sky is 8 oktas. The presence of any trace of cloud in an otherwise blue sky is recorded as 1 okta, and similarly any trace of blue on an otherwise cloudy sky is recorded as 7 oktas. A clear day is recorded when the mean of the 9 am and 3 pm cloud observations is less than or equal to 2 oktas. This definition has changed slightly over time. Prior to this, a clear day was defined as having less than or equal to 2.5 oktas averaged over the 9 am and 3 pm observations.

Mean number of cloudy days

Average number of cloudy days in a calendar month or year, calculated over the period of record. This statistic is derived from cloud cover observations, which are measured in oktas (eighths). The sky is visually inspected to produce an estimate of the number of eighths of the dome of the sky covered by cloud. A completely clear sky is recorded as zero okta, while a totally overcast sky is 8 oktas. The presence of any trace of cloud in an otherwise blue sky is recorded as 1 okta, and similarly any trace of blue on an otherwise cloudy sky is recorded as 7 oktas. A cloudy day is recorded when the mean of the 9 am and 3 pm cloud observations is greater than or equal to 6 oktas. This definition has changed slightly over time. Prior to this, a cloudy day was defined as having greater than or equal to 5.5 oktas averaged over the 9 am and 3 pm observations.

APPENDIX A – DETAILED SHADOW FLICKER RESULTS

Project:
Collector

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SHADOW - Main Result

Assumptions for shadow calculations

Maximum distance for influence	1,100	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

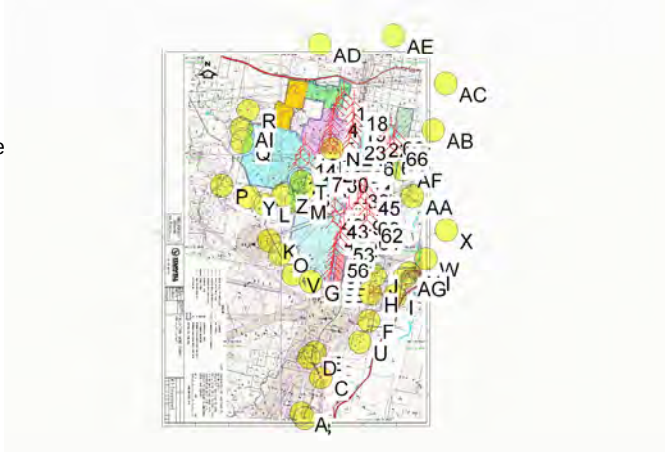
Sun shine probabilities (part of time from sun rise to sun set with sun shine

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.48	0.40	0.43	0.45	0.42	0.38	0.42	0.48	0.48	0.45	0.42	0.46

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
175	241	947	1,222	698	376	206	160	273	1,786	1,993	683	8,760

To avoid flicker from WTGs not visible a ZVI calculation is performed before the flicker calculation. The ZVI calculation is based on the following assumptions
Height contours used: Height Contours: Coll 10m contours.MAP (1)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 100 m



Scale 1:400,000

New WTG Shadow receptor

WTGs

	UTM WGS84 S Zone: 55				WTG type						
	East	North	Z [m]	Row data/Description	Valid	Manufact.	Type	Power [kW]	Diam. [m]	Height [m]	RPM [RPM]
1	718,433	6,143,522	800	1	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
2	718,303	6,143,229	789	2	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
3	718,143	6,142,944	800	3	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
4	718,016	6,142,661	800	4	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
5	717,920	6,142,333	800	5	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
6	717,869	6,142,028	790	6	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
7	717,778	6,141,753	780	7	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
8	717,667	6,141,456	800	8	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
9	717,737	6,141,127	800	9	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
10	717,665	6,140,808	786	10	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
11	717,307	6,140,667	779	11	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
12	717,140	6,140,259	780	12	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
13	716,368	6,140,791	760	13	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
14	716,269	6,140,490	760	14	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
15	716,134	6,140,091	778	15	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
16	715,885	6,139,665	780	16	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
17	716,574	6,139,788	780	17	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
18	718,978	6,143,004	780	18	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
19	718,891	6,142,467	771	19	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
20	718,960	6,142,121	777	20	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
21	718,935	6,141,776	780	21	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
22	720,164	6,141,628	760	22	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
23	718,878	6,141,471	780	23	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
24	718,785	6,141,111	780	24	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
25	718,721	6,140,828	780	25	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
26	719,303	6,140,601	780	26	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
27	718,632	6,140,529	780	27	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
28	718,527	6,140,218	780	28	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
29	718,256	6,140,030	780	29	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
30	717,952	6,139,751	780	30	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
31	717,751	6,139,480	780	31	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
32	718,184	6,139,157	783	32	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
33	718,539	6,139,389	780	33	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
34	719,192	6,139,375	777	34	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
35	718,149	6,138,894	791	35	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
36	717,986	6,138,660	800	36	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
37	718,135	6,138,349	800	37	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
38	718,725	6,138,734	780	38	Yes	VESTAS	V112	3,000	112.0	94.0	12.8

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Project:
Collector

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SHADOW - Main Result

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	UTM WGS84 S Zone: 55					WTG type							
	East	North	Z [m]	Row data/Description		Valid	Manufact.	Type	Power [kW]	Diam. [m]	Height [m]	RPM [RPM]
39	719,054	6,138,902	774	39		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
40	717,678	6,137,581	820	40		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
41	717,952	6,137,867	800	41		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
42	717,564	6,137,136	820	42		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
43	717,954	6,137,251	820	43		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
44	717,848	6,136,663	840	44		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
45	719,633	6,138,534	764	45		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
46	719,531	6,138,241	780	46		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
47	719,325	6,137,942	787	47		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
48	719,170	6,137,671	799	48		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
49	718,708	6,137,467	800	49		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
50	718,574	6,137,092	820	50		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
51	718,443	6,136,785	840	51		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
52	718,448	6,136,312	860	52		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
53	718,277	6,136,058	843	53		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
54	718,233	6,135,757	860	54		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
55	718,042	6,135,504	865	55		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
56	717,976	6,135,216	880	56		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
57	717,905	6,134,890	878	57		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
58	717,877	6,134,568	880	58		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
59	717,815	6,134,260	880	59		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
60	717,758	6,133,946	880	60		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
61	719,646	6,136,708	800	61		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
62	719,793	6,137,054	782	62		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
63	719,612	6,137,380	776	63		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
64	720,847	6,140,638	760	65		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
65	721,081	6,140,856	760	66		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
66	721,100	6,141,132	776	67		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
67	721,245	6,141,392	761	68		Yes	VESTAS	V112	3,000	112.0	94.0	12.8
68	720,925	6,141,697	740	69		Yes	VESTAS	V112	3,000	112.0	94.0	12.8

Shadow receptor-Input

		UTM WGS84 S Zone: 55								
No.	Name	East	North	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
A	A	716,166	6,126,500	840	1.0	1.0	2.0	0.0	90.0	"Green house mode"
B	B	716,366	6,126,247	847	1.0	1.0	2.0	0.0	90.0	"Green house mode"
C	C	717,211	6,128,373	862	1.0	1.0	2.0	0.0	90.0	"Green house mode"
D	D	716,571	6,129,490	830	1.0	1.0	2.0	0.0	90.0	"Green house mode"
E	E	716,897	6,129,714	840	1.0	1.0	2.0	0.0	90.0	"Green house mode"
F	F	719,761	6,131,405	705	1.0	1.0	2.0	0.0	90.0	"Green house mode"
G	G	716,686	6,133,417	866	1.0	1.0	2.0	0.0	90.0	"Green house mode"
H	H	719,839	6,132,819	714	1.0	1.0	2.0	0.0	90.0	"Green house mode"
I	I	721,120	6,132,680	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
J	J	720,081	6,133,755	724	1.0	1.0	2.0	0.0	90.0	"Green house mode"
K	L	714,476	6,135,604	813	1.0	1.0	2.0	0.0	90.0	"Green house mode"
L	K	714,263	6,137,536	772	1.0	1.0	2.0	0.0	90.0	"Green house mode"
M	M	715,919	6,137,699	764	1.0	1.0	2.0	0.0	90.0	"Green house mode"
N	N	717,810	6,140,502	774	1.0	1.0	2.0	0.0	90.0	"Green house mode"
O	O	715,025	6,134,872	820	1.0	1.0	2.0	0.0	90.0	"Green house mode"
P	P	711,956	6,138,527	673	1.0	1.0	2.0	0.0	90.0	"Green house mode"
Q	Q	713,019	6,140,846	694	1.0	1.0	2.0	0.0	90.0	"Green house mode"
R	R	713,357	6,142,531	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
S	S	716,282	6,138,352	780	1.0	1.0	2.0	0.0	90.0	"Green house mode"
T	T	716,186	6,138,745	760	1.0	1.0	2.0	0.0	90.0	"Green house mode"
U	U	719,285	6,130,253	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
V	V	715,744	6,133,809	849	1.0	1.0	2.0	0.0	90.0	"Green house mode"
W	W	722,766	6,134,658	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"

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SHADOW - Main Result

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UTM WGS84 S Zone: 55

No.	Name	East	North	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
X	X	723,865	6,136,136	717	1.0	1.0	2.0	0.0	90.0	"Green house mode"
Y	Y	713,396	6,137,919	734	1.0	1.0	2.0	0.0	90.0	"Green house mode"
Z	Z	715,180	6,138,036	760	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AA	AA	722,062	6,137,959	717	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AB	BB	723,156	6,141,476	720	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AC	CC	723,831	6,143,954	740	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AD	DD	717,150	6,146,019	720	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AE	EE	721,052	6,146,502	720	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AF	FF	721,605	6,139,345	760	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AG	Collector Town 1	721,613	6,133,614	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AH	Collector Town 2	721,868	6,133,898	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AI	GG	713,009	6,141,552	680	1.0	1.0	2.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, worst case: Shadow hours per year [h/year]	Shadow, worst case: Shadow days per year [days/year]	Shadow, worst case: Max shadow hours per day [h/day]	Shadow, expected values: Shadow hours per year [h/year]
A	A	0:00	0	0:00	0:00
B	B	0:00	0	0:00	0:00
C	C	0:00	0	0:00	0:00
D	D	0:00	0	0:00	0:00
E	E	0:00	0	0:00	0:00
F	F	0:00	0	0:00	0:00
G	G	0:00	0	0:00	0:00
H	H	0:00	0	0:00	0:00
I	I	0:00	0	0:00	0:00
J	J	0:00	0	0:00	0:00
K	L	0:00	0	0:00	0:00
L	K	0:00	0	0:00	0:00
M	M	0:00	0	0:00	0:00
N	N	162:35	212	1:14	59:30
O	O	0:00	0	0:00	0:00
P	P	0:00	0	0:00	0:00
Q	Q	0:00	0	0:00	0:00
R	R	0:00	0	0:00	0:00
S	S	0:00	0	0:00	0:00
T	T	0:00	0	0:00	0:00
U	U	0:00	0	0:00	0:00
V	V	0:00	0	0:00	0:00
W	W	0:00	0	0:00	0:00
X	X	0:00	0	0:00	0:00
Y	Y	0:00	0	0:00	0:00
Z	Z	0:00	0	0:00	0:00
AA	AA	0:00	0	0:00	0:00
AB	BB	0:00	0	0:00	0:00
AC	CC	0:00	0	0:00	0:00
AD	DD	0:00	0	0:00	0:00
AE	EE	0:00	0	0:00	0:00
AF	FF	0:00	0	0:00	0:00
AG	Collector Town 1	0:00	0	0:00	0:00
AH	Collector Town 2	0:00	0	0:00	0:00
AI	GG	0:00	0	0:00	0:00

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SHADOW - Main Result

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

No.	Name	Worst case [h/year]
1	1	0:00
2	2	0:00
3	3	0:00
4	4	0:00
5	5	0:00
6	6	0:00
7	7	0:00
8	8	0:00
9	9	0:00
10	10	0:00
11	11	41:32
12	12	46:31
13	13	0:00
14	14	0:00
15	15	0:00
16	16	0:00
17	17	0:00
18	18	0:00
19	19	0:00
20	20	0:00
21	21	0:00
22	22	0:00
23	23	0:00
24	24	0:00
25	25	14:28
26	26	0:00
27	27	16:18
28	28	43:46
29	29	0:00
30	30	0:00
31	31	0:00
32	32	0:00
33	33	0:00
34	34	0:00
35	35	0:00
36	36	0:00
37	37	0:00
38	38	0:00
39	39	0:00
40	40	0:00
41	41	0:00
42	42	0:00
43	43	0:00
44	44	0:00
45	45	0:00
46	46	0:00
47	47	0:00
48	48	0:00
49	49	0:00
50	50	0:00
51	51	0:00
52	52	0:00
53	53	0:00
54	54	0:00
55	55	0:00
56	56	0:00
57	57	0:00
58	58	0:00
59	59	0:00
60	60	0:00
61	61	0:00

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SHADOW - Main Result

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No.	Name	Worst case [h/year]
62	62	0:00
63	63	0:00
64	65	0:00
65	66	0:00
66	67	0:00
67	68	0:00
68	69	0:00

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SHADOW - Main Result

Assumptions for shadow calculations

Maximum distance for influence	2,000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

The calculated times are "worst case" given by the following assumptions:
- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

To avoid flicker from WTGs not visible a ZVI calculation is performed before the flicker calculation. The ZVI calculation is based on the following assumptions
Height contours used: Height Contours: Coll 10m contours.MAP (1)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 100 m

Scale 1:400,000

New WTG Shadow receptor

WTGs

	UTM WGS84 S Zone: 55				WTG type						
	East	North	Z [m]	Row data/Description	Valid	Manufact.	Type	Power [kW]	Diam. [m]	Height [m]	RPM [RPM]
1	718,433	6,143,522	800	1	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
2	718,303	6,143,229	789	2	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
3	718,143	6,142,944	800	3	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
4	718,016	6,142,661	800	4	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
5	717,920	6,142,333	800	5	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
6	717,869	6,142,028	790	6	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
7	717,778	6,141,753	780	7	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
8	717,667	6,141,456	800	8	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
9	717,737	6,141,127	800	9	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
10	717,665	6,140,808	786	10	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
11	717,307	6,140,667	779	11	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
12	717,140	6,140,259	780	12	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
13	716,368	6,140,791	760	13	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
14	716,269	6,140,490	760	14	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
15	716,134	6,140,091	778	15	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
16	715,885	6,139,665	780	16	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
17	716,574	6,139,788	780	17	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
18	718,978	6,143,004	780	18	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
19	718,891	6,142,467	771	19	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
20	718,960	6,142,121	777	20	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
21	718,935	6,141,776	780	21	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
22	720,164	6,141,628	760	22	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
23	718,878	6,141,471	780	23	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
24	718,785	6,141,111	780	24	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
25	718,721	6,140,828	780	25	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
26	719,303	6,140,601	780	26	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
27	718,632	6,140,529	780	27	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
28	718,527	6,140,218	780	28	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
29	718,256	6,140,030	780	29	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
30	717,952	6,139,751	780	30	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
31	717,751	6,139,480	780	31	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
32	718,184	6,139,157	783	32	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
33	718,539	6,139,389	780	33	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
34	719,192	6,139,375	777	34	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
35	718,149	6,138,894	791	35	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
36	717,986	6,138,660	800	36	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
37	718,135	6,138,349	800	37	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
38	718,725	6,138,734	780	38	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8

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SHADOW - Main Result

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	UTM WGS84 S Zone: 55				WTG type						
	East	North	Z [m]	Row data/Description	Valid	Manufact.	Type	Power [kW]	Diam. [m]	Height [m]	RPM [RPM]
39	719,054	6,138,902	774	39	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
40	717,678	6,137,581	820	40	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
41	717,952	6,137,867	800	41	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
42	717,564	6,137,136	820	42	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
43	717,954	6,137,251	820	43	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
44	717,848	6,136,663	840	44	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
45	719,633	6,138,534	764	45	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
46	719,531	6,138,241	780	46	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
47	719,325	6,137,942	787	47	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
48	719,170	6,137,671	799	48	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
49	718,708	6,137,467	800	49	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
50	718,574	6,137,092	820	50	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
51	718,443	6,136,785	840	51	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
52	718,448	6,136,312	860	52	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
53	718,277	6,136,058	843	53	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
54	718,233	6,135,757	860	54	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
55	718,042	6,135,504	865	55	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
56	717,976	6,135,216	880	56	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
57	717,905	6,134,890	878	57	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
58	717,877	6,134,568	880	58	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
59	717,815	6,134,260	880	59	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
60	717,758	6,133,946	880	60	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
61	719,646	6,136,708	800	61	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
62	719,793	6,137,054	782	62	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
63	719,612	6,137,380	776	63	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
64	720,847	6,140,638	760	65	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
65	721,081	6,140,856	760	66	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
66	721,100	6,141,132	776	67	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
67	721,245	6,141,392	761	68	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
68	720,925	6,141,697	740	69	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8

Shadow receptor-Input

		UTM WGS84 S Zone: 55								
No.	Name	East	North	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
A	A	716,166	6,126,500	840	1.0	1.0	2.0	0.0	90.0	"Green house mode"
B	B	716,366	6,126,247	847	1.0	1.0	2.0	0.0	90.0	"Green house mode"
C	C	717,211	6,128,373	862	1.0	1.0	2.0	0.0	90.0	"Green house mode"
D	D	716,571	6,129,490	830	1.0	1.0	2.0	0.0	90.0	"Green house mode"
E	E	716,897	6,129,714	840	1.0	1.0	2.0	0.0	90.0	"Green house mode"
F	F	719,761	6,131,405	705	1.0	1.0	2.0	0.0	90.0	"Green house mode"
G	G	716,686	6,133,417	866	1.0	1.0	2.0	0.0	90.0	"Green house mode"
H	H	719,839	6,132,819	714	1.0	1.0	2.0	0.0	90.0	"Green house mode"
I	I	721,120	6,132,680	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
J	J	720,081	6,133,755	724	1.0	1.0	2.0	0.0	90.0	"Green house mode"
K	L	714,476	6,135,604	813	1.0	1.0	2.0	0.0	90.0	"Green house mode"
L	K	714,263	6,137,536	772	1.0	1.0	2.0	0.0	90.0	"Green house mode"
M	M	715,919	6,137,699	764	1.0	1.0	2.0	0.0	90.0	"Green house mode"
N	N	717,810	6,140,502	774	1.0	1.0	2.0	0.0	90.0	"Green house mode"
O	O	715,025	6,134,872	820	1.0	1.0	2.0	0.0	90.0	"Green house mode"
P	P	711,956	6,138,527	673	1.0	1.0	2.0	0.0	90.0	"Green house mode"
Q	Q	713,019	6,140,846	694	1.0	1.0	2.0	0.0	90.0	"Green house mode"
R	R	713,357	6,142,531	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
S	S	716,282	6,138,352	780	1.0	1.0	2.0	0.0	90.0	"Green house mode"
T	T	716,186	6,138,745	760	1.0	1.0	2.0	0.0	90.0	"Green house mode"
U	U	719,285	6,130,253	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
V	V	715,744	6,133,809	849	1.0	1.0	2.0	0.0	90.0	"Green house mode"
W	W	722,766	6,134,658	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"

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SHADOW - Main Result

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UTM WGS84 S Zone: 55

No.	Name	East	North	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
X	X	723,865	6,136,136	717	1.0	1.0	2.0	0.0	90.0	"Green house mode"
Y	Y	713,396	6,137,919	734	1.0	1.0	2.0	0.0	90.0	"Green house mode"
Z	Z	715,180	6,138,036	760	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AA	AA	722,062	6,137,959	717	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AB	BB	723,156	6,141,476	720	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AC	CC	723,831	6,143,954	740	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AD	DD	717,150	6,146,019	720	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AE	EE	721,052	6,146,502	720	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AF	FF	721,605	6,139,345	760	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AG	Collector Town 1	721,613	6,133,614	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AH	Collector Town 2	721,868	6,133,898	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AI	GG	713,009	6,141,552	680	1.0	1.0	2.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

Shadow, worst case

No.	Name	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
A	A	0:00	0	0:00
B	B	0:00	0	0:00
C	C	0:00	0	0:00
D	D	0:00	0	0:00
E	E	0:00	0	0:00
F	F	0:00	0	0:00
G	G	10:50	49	0:20
H	H	0:00	0	0:00
I	I	0:00	0	0:00
J	J	0:00	0	0:00
K	L	0:00	0	0:00
L	K	0:00	0	0:00
M	M	7:17	41	0:14
N	N	159:50	280	1:08
O	O	0:00	0	0:00
P	P	0:00	0	0:00
Q	Q	0:00	0	0:00
R	R	0:00	0	0:00
S	S	8:58	88	0:10
T	T	15:57	128	0:12
U	U	0:00	0	0:00
V	V	0:00	0	0:00
W	W	0:00	0	0:00
X	X	0:00	0	0:00
Y	Y	0:00	0	0:00
Z	Z	0:00	0	0:00
AA	AA	0:00	0	0:00
AB	BB	1:48	15	0:10
AC	CC	0:00	0	0:00
AD	DD	0:00	0	0:00
AE	EE	0:00	0	0:00
AF	FF	0:00	0	0:00
AG	Collector Town 1	0:00	0	0:00
AH	Collector Town 2	0:00	0	0:00
AI	GG	0:00	0	0:00

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SHADOW - Main Result

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

No.	Name	Worst case [h/year]
1	1	0:00
2	2	0:00
3	3	0:00
4	4	0:00
5	5	0:00
6	6	0:00
7	7	0:00
8	8	0:00
9	9	0:00
10	10	0:00
11	11	36:52
12	12	42:39
13	13	1:25
14	14	1:08
15	15	1:30
16	16	0:00
17	17	0:00
18	18	0:00
19	19	0:00
20	20	0:00
21	21	0:00
22	22	0:00
23	23	0:00
24	24	14:11
25	25	11:30
26	26	2:25
27	27	13:09
28	28	36:59
29	29	0:00
30	30	0:00
31	31	3:29
32	32	0:00
33	33	0:00
34	34	0:00
35	35	2:25
36	36	4:26
37	37	3:16
38	38	0:00
39	39	0:00
40	40	4:58
41	41	9:15
42	42	4:23
43	43	0:00
44	44	0:00
45	45	0:00
46	46	0:00
47	47	0:00
48	48	0:00
49	49	0:00
50	50	0:00
51	51	0:00
52	52	0:00
53	53	0:00
54	54	0:00
55	55	0:00
56	56	0:00
57	57	0:00
58	58	0:00
59	59	0:00
60	60	10:50
61	61	0:00

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SHADOW - Main Result

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No.	Name	Worst case [h/year]
62	62	0:00
63	63	0:00
64	65	0:00
65	66	0:00
66	67	0:00
67	68	1:48
68	69	0:00

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SHADOW - Main Result

Assumptions for shadow calculations

Maximum distance for influence	1,100	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

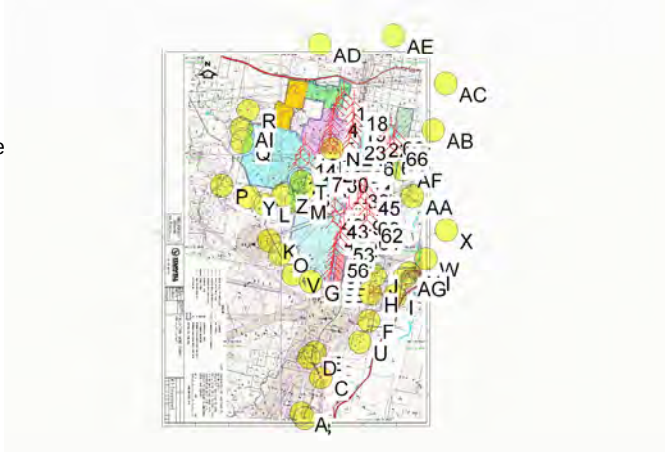
Sun shine probabilities (part of time from sun rise to sun set with sun shine

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.48	0.40	0.43	0.45	0.42	0.38	0.42	0.48	0.48	0.45	0.42	0.46

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
175	241	947	1,222	698	376	206	160	273	1,786	1,993	683	8,760

To avoid flicker from WTGs not visible a ZVI calculation is performed before the flicker calculation. The ZVI calculation is based on the following assumptions
Height contours used: Height Contours: Coll 10m contours.MAP (1)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 100 m



Scale 1:400,000

New WTG Shadow receptor

WTGs

	UTM WGS84 S Zone: 55				WTG type						
	East	North	Z [m]	Row data/Description	Valid	Manufact.	Type	Power [kW]	Diam. [m]	Height [m]	RPM [RPM]
1	718,433	6,143,522	800	1	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
2	718,303	6,143,229	789	2	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
3	718,143	6,142,944	800	3	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
4	718,016	6,142,661	800	4	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
5	717,920	6,142,333	800	5	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
6	717,869	6,142,028	790	6	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
7	717,778	6,141,753	780	7	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
8	717,667	6,141,456	800	8	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
9	717,737	6,141,127	800	9	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
10	717,665	6,140,808	786	10	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
11	717,307	6,140,667	779	11	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
12	717,140	6,140,259	780	12	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
13	716,368	6,140,791	760	13	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
14	716,269	6,140,490	760	14	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
15	716,134	6,140,091	778	15	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
16	715,885	6,139,665	780	16	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
17	716,574	6,139,788	780	17	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
18	718,978	6,143,004	780	18	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
19	718,891	6,142,467	771	19	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
20	718,960	6,142,121	777	20	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
21	718,935	6,141,776	780	21	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
22	720,164	6,141,628	760	22	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
23	718,878	6,141,471	780	23	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
24	718,785	6,141,111	780	24	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
25	718,721	6,140,828	780	25	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
26	719,303	6,140,601	780	26	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
27	718,632	6,140,529	780	27	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
28	718,527	6,140,218	780	28	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
29	718,256	6,140,030	780	29	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
30	717,952	6,139,751	780	30	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
31	717,751	6,139,480	780	31	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
32	718,184	6,139,157	783	32	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
33	718,539	6,139,389	780	33	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
34	719,192	6,139,375	777	34	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
35	718,149	6,138,894	791	35	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
36	717,986	6,138,660	800	36	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
37	718,135	6,138,349	800	37	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
38	718,725	6,138,734	780	38	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8

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SHADOW - Main Result

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	UTM WGS84 S Zone: 55					WTG type						
	East	North	Z [m]	Row data/Description	Valid	Manufact.	Type	Power [kW]	Diam. [m]	Height [m]	RPM [RPM]
39	719,054	6,138,902	774	39	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
40	717,678	6,137,581	820	40	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
41	717,952	6,137,867	800	41	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
42	717,564	6,137,136	820	42	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
43	717,954	6,137,251	820	43	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
44	717,848	6,136,663	840	44	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
45	719,633	6,138,534	764	45	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
46	719,531	6,138,241	780	46	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
47	719,325	6,137,942	787	47	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
48	719,170	6,137,671	799	48	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
49	718,708	6,137,467	800	49	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
50	718,574	6,137,092	820	50	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
51	718,443	6,136,785	840	51	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
52	718,448	6,136,312	860	52	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
53	718,277	6,136,058	843	53	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
54	718,233	6,135,757	860	54	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
55	718,042	6,135,504	865	55	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
56	717,976	6,135,216	880	56	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
57	717,905	6,134,890	878	57	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
58	717,877	6,134,568	880	58	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
59	717,815	6,134,260	880	59	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
60	717,758	6,133,946	880	60	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
61	719,646	6,136,708	800	61	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
62	719,793	6,137,054	782	62	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
63	719,612	6,137,380	776	63	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
64	720,847	6,140,638	760	65	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
65	721,081	6,140,856	760	66	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
66	721,100	6,141,132	776	67	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
67	721,245	6,141,392	761	68	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8
68	720,925	6,141,697	740	69	Yes	REpower	3.XM104	3,370	104.0	80.0	13.8

Shadow receptor-Input

		UTM WGS84 S Zone: 55								
No.	Name	East	North	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
A	A	716,166	6,126,500	840	1.0	1.0	2.0	0.0	90.0	"Green house mode"
B	B	716,366	6,126,247	847	1.0	1.0	2.0	0.0	90.0	"Green house mode"
C	C	717,211	6,128,373	862	1.0	1.0	2.0	0.0	90.0	"Green house mode"
D	D	716,571	6,129,490	830	1.0	1.0	2.0	0.0	90.0	"Green house mode"
E	E	716,897	6,129,714	840	1.0	1.0	2.0	0.0	90.0	"Green house mode"
F	F	719,761	6,131,405	705	1.0	1.0	2.0	0.0	90.0	"Green house mode"
G	G	716,686	6,133,417	866	1.0	1.0	2.0	0.0	90.0	"Green house mode"
H	H	719,839	6,132,819	714	1.0	1.0	2.0	0.0	90.0	"Green house mode"
I	I	721,120	6,132,680	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
J	J	720,081	6,133,755	724	1.0	1.0	2.0	0.0	90.0	"Green house mode"
K	L	714,476	6,135,604	813	1.0	1.0	2.0	0.0	90.0	"Green house mode"
L	K	714,263	6,137,536	772	1.0	1.0	2.0	0.0	90.0	"Green house mode"
M	M	715,919	6,137,699	764	1.0	1.0	2.0	0.0	90.0	"Green house mode"
N	N	717,810	6,140,502	774	1.0	1.0	2.0	0.0	90.0	"Green house mode"
O	O	715,025	6,134,872	820	1.0	1.0	2.0	0.0	90.0	"Green house mode"
P	P	711,956	6,138,527	673	1.0	1.0	2.0	0.0	90.0	"Green house mode"
Q	Q	713,019	6,140,846	694	1.0	1.0	2.0	0.0	90.0	"Green house mode"
R	R	713,357	6,142,531	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
S	S	716,282	6,138,352	780	1.0	1.0	2.0	0.0	90.0	"Green house mode"
T	T	716,186	6,138,745	760	1.0	1.0	2.0	0.0	90.0	"Green house mode"
U	U	719,285	6,130,253	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
V	V	715,744	6,133,809	849	1.0	1.0	2.0	0.0	90.0	"Green house mode"
W	W	722,766	6,134,658	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"

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SHADOW - Main Result

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UTM WGS84 S Zone: 55

No.	Name	East	North	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
X	X	723,865	6,136,136	717	1.0	1.0	2.0	0.0	90.0	"Green house mode"
Y	Y	713,396	6,137,919	734	1.0	1.0	2.0	0.0	90.0	"Green house mode"
Z	Z	715,180	6,138,036	760	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AA	AA	722,062	6,137,959	717	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AB	BB	723,156	6,141,476	720	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AC	CC	723,831	6,143,954	740	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AD	DD	717,150	6,146,019	720	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AE	EE	721,052	6,146,502	720	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AF	FF	721,605	6,139,345	760	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AG	Collector Town 1	721,613	6,133,614	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AH	Collector Town 2	721,868	6,133,898	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AI	GG	713,009	6,141,552	680	1.0	1.0	2.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, worst case: Shadow hours per year [h/year]	Shadow, worst case: Shadow days per year [days/year]	Shadow, worst case: Max shadow hours per day [h/day]	Shadow, expected values: Shadow hours per year [h/year]
A	A	0:00	0	0:00	0:00
B	B	0:00	0	0:00	0:00
C	C	0:00	0	0:00	0:00
D	D	0:00	0	0:00	0:00
E	E	0:00	0	0:00	0:00
F	F	0:00	0	0:00	0:00
G	G	0:00	0	0:00	0:00
H	H	0:00	0	0:00	0:00
I	I	0:00	0	0:00	0:00
J	J	0:00	0	0:00	0:00
K	L	0:00	0	0:00	0:00
L	K	0:00	0	0:00	0:00
M	M	0:00	0	0:00	0:00
N	N	141:09	211	1:08	51:38
O	O	0:00	0	0:00	0:00
P	P	0:00	0	0:00	0:00
Q	Q	0:00	0	0:00	0:00
R	R	0:00	0	0:00	0:00
S	S	0:00	0	0:00	0:00
T	T	0:00	0	0:00	0:00
U	U	0:00	0	0:00	0:00
V	V	0:00	0	0:00	0:00
W	W	0:00	0	0:00	0:00
X	X	0:00	0	0:00	0:00
Y	Y	0:00	0	0:00	0:00
Z	Z	0:00	0	0:00	0:00
AA	AA	0:00	0	0:00	0:00
AB	BB	0:00	0	0:00	0:00
AC	CC	0:00	0	0:00	0:00
AD	DD	0:00	0	0:00	0:00
AE	EE	0:00	0	0:00	0:00
AF	FF	0:00	0	0:00	0:00
AG	Collector Town 1	0:00	0	0:00	0:00
AH	Collector Town 2	0:00	0	0:00	0:00
AI	GG	0:00	0	0:00	0:00

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SHADOW - Main Result

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

No.	Name	Worst case [h/year]
1	1	0:00
2	2	0:00
3	3	0:00
4	4	0:00
5	5	0:00
6	6	0:00
7	7	0:00
8	8	0:00
9	9	0:00
10	10	0:00
11	11	36:52
12	12	42:39
13	13	0:00
14	14	0:00
15	15	0:00
16	16	0:00
17	17	0:00
18	18	0:00
19	19	0:00
20	20	0:00
21	21	0:00
22	22	0:00
23	23	0:00
24	24	0:00
25	25	11:30
26	26	0:00
27	27	13:09
28	28	36:59
29	29	0:00
30	30	0:00
31	31	0:00
32	32	0:00
33	33	0:00
34	34	0:00
35	35	0:00
36	36	0:00
37	37	0:00
38	38	0:00
39	39	0:00
40	40	0:00
41	41	0:00
42	42	0:00
43	43	0:00
44	44	0:00
45	45	0:00
46	46	0:00
47	47	0:00
48	48	0:00
49	49	0:00
50	50	0:00
51	51	0:00
52	52	0:00
53	53	0:00
54	54	0:00
55	55	0:00
56	56	0:00
57	57	0:00
58	58	0:00
59	59	0:00
60	60	0:00
61	61	0:00

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SHADOW - Main Result

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No.	Name	Worst case [h/year]
62	62	0:00
63	63	0:00
64	65	0:00
65	66	0:00
66	67	0:00
67	68	0:00
68	69	0:00

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SHADOW - Main Result

Assumptions for shadow calculations

Maximum distance for influence	2,000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

The calculated times are "worst case" given by the following assumptions:
- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

To avoid flicker from WTGs not visible a ZVI calculation is performed before the flicker calculation. The ZVI calculation is based on the following assumptions
Height contours used: Height Contours: Coll 10m contours.MAP (1)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 100 m

Scale 1:400,000

New WTG Shadow receptor

WTGs

	UTM WGS84 S Zone: 55				WTG type							
	East	North	Z [m]	Row data/Description	Valid	Manufact.	Type	Power [kW]	Diam. [m]	Height [m]	RPM [RPM]
1	718,433	6,143,522	800	1	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
2	718,303	6,143,229	789	2	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
3	718,143	6,142,944	800	3	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
4	718,016	6,142,661	800	4	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
5	717,920	6,142,333	800	5	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
6	717,869	6,142,028	790	6	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
7	717,778	6,141,753	780	7	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
8	717,667	6,141,456	800	8	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
9	717,737	6,141,127	800	9	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
10	717,665	6,140,808	786	10	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
11	717,307	6,140,667	779	11	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
12	717,140	6,140,259	780	12	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
13	716,368	6,140,791	760	13	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
14	716,269	6,140,490	760	14	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
15	716,134	6,140,091	778	15	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
16	715,885	6,139,665	780	16	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
17	716,574	6,139,788	780	17	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
18	718,978	6,143,004	780	18	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
19	718,891	6,142,467	771	19	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
20	718,960	6,142,121	777	20	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
21	718,935	6,141,776	780	21	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
22	720,164	6,141,628	760	22	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
23	718,878	6,141,471	780	23	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
24	718,785	6,141,111	780	24	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
25	718,721	6,140,828	780	25	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
26	719,303	6,140,601	780	26	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
27	718,632	6,140,529	780	27	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
28	718,527	6,140,218	780	28	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
29	718,256	6,140,030	780	29	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
30	717,952	6,139,751	780	30	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
31	717,751	6,139,480	780	31	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
32	718,184	6,139,157	783	32	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
33	718,539	6,139,389	780	33	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
34	719,192	6,139,375	777	34	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
35	718,149	6,138,894	791	35	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
36	717,986	6,138,660	800	36	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
37	718,135	6,138,349	800	37	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
38	718,725	6,138,734	780	38	Yes	VESTAS	V112	3,000	112.0	94.0	12.8

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SHADOW - Main Result

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	UTM WGS84 S Zone: 55					WTG type						
	East	North	Z [m]	Row data/Description	Valid	Manufact.	Type	Power [kW]	Diam. [m]	Height [m]	RPM [RPM]
39	719,054	6,138,902	774	39	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
40	717,678	6,137,581	820	40	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
41	717,952	6,137,867	800	41	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
42	717,564	6,137,136	820	42	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
43	717,954	6,137,251	820	43	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
44	717,848	6,136,663	840	44	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
45	719,633	6,138,534	764	45	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
46	719,531	6,138,241	780	46	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
47	719,325	6,137,942	787	47	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
48	719,170	6,137,671	799	48	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
49	718,708	6,137,467	800	49	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
50	718,574	6,137,092	820	50	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
51	718,443	6,136,785	840	51	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
52	718,448	6,136,312	860	52	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
53	718,277	6,136,058	843	53	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
54	718,233	6,135,757	860	54	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
55	718,042	6,135,504	865	55	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
56	717,976	6,135,216	880	56	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
57	717,905	6,134,890	878	57	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
58	717,877	6,134,568	880	58	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
59	717,815	6,134,260	880	59	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
60	717,758	6,133,946	880	60	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
61	719,646	6,136,708	800	61	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
62	719,793	6,137,054	782	62	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
63	719,612	6,137,380	776	63	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
64	720,847	6,140,638	760	65	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
65	721,081	6,140,856	760	66	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
66	721,100	6,141,132	776	67	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
67	721,245	6,141,392	761	68	Yes	VESTAS	V112	3,000	112.0	94.0	12.8
68	720,925	6,141,697	740	69	Yes	VESTAS	V112	3,000	112.0	94.0	12.8

Shadow receptor-Input

		UTM WGS84 S Zone: 55							
No.	Name	East	North	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
A	A	716,166	6,126,500	840	1.0	1.0	2.0	0.0	90.0	"Green house mode"
B	B	716,366	6,126,247	847	1.0	1.0	2.0	0.0	90.0	"Green house mode"
C	C	717,211	6,128,373	862	1.0	1.0	2.0	0.0	90.0	"Green house mode"
D	D	716,571	6,129,490	830	1.0	1.0	2.0	0.0	90.0	"Green house mode"
E	E	716,897	6,129,714	840	1.0	1.0	2.0	0.0	90.0	"Green house mode"
F	F	719,761	6,131,405	705	1.0	1.0	2.0	0.0	90.0	"Green house mode"
G	G	716,686	6,133,417	866	1.0	1.0	2.0	0.0	90.0	"Green house mode"
H	H	719,839	6,132,819	714	1.0	1.0	2.0	0.0	90.0	"Green house mode"
I	I	721,120	6,132,680	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
J	J	720,081	6,133,755	724	1.0	1.0	2.0	0.0	90.0	"Green house mode"
K	L	714,476	6,135,604	813	1.0	1.0	2.0	0.0	90.0	"Green house mode"
L	K	714,263	6,137,536	772	1.0	1.0	2.0	0.0	90.0	"Green house mode"
M	M	715,919	6,137,699	764	1.0	1.0	2.0	0.0	90.0	"Green house mode"
N	N	717,810	6,140,502	774	1.0	1.0	2.0	0.0	90.0	"Green house mode"
O	O	715,025	6,134,872	820	1.0	1.0	2.0	0.0	90.0	"Green house mode"
P	P	711,956	6,138,527	673	1.0	1.0	2.0	0.0	90.0	"Green house mode"
Q	Q	713,019	6,140,846	694	1.0	1.0	2.0	0.0	90.0	"Green house mode"
R	R	713,357	6,142,531	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
S	S	716,282	6,138,352	780	1.0	1.0	2.0	0.0	90.0	"Green house mode"
T	T	716,186	6,138,745	760	1.0	1.0	2.0	0.0	90.0	"Green house mode"
U	U	719,285	6,130,253	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
V	V	715,744	6,133,809	849	1.0	1.0	2.0	0.0	90.0	"Green house mode"
W	W	722,766	6,134,658	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"

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SHADOW - Main Result

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UTM WGS84 S Zone: 55

No.	Name	East	North	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
X	X	723,865	6,136,136	717	1.0	1.0	2.0	0.0	90.0	"Green house mode"
Y	Y	713,396	6,137,919	734	1.0	1.0	2.0	0.0	90.0	"Green house mode"
Z	Z	715,180	6,138,036	760	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AA	AA	722,062	6,137,959	717	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AB	BB	723,156	6,141,476	720	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AC	CC	723,831	6,143,954	740	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AD	DD	717,150	6,146,019	720	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AE	EE	721,052	6,146,502	720	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AF	FF	721,605	6,139,345	760	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AG	Collector Town 1	721,613	6,133,614	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AH	Collector Town 2	721,868	6,133,898	700	1.0	1.0	2.0	0.0	90.0	"Green house mode"
AI	GG	713,009	6,141,552	680	1.0	1.0	2.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

Shadow, worst case

No.	Name	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
A	A	0:00	0	0:00
B	B	0:00	0	0:00
C	C	0:00	0	0:00
D	D	0:00	0	0:00
E	E	0:00	0	0:00
F	F	0:00	0	0:00
G	G	13:33	50	0:23
H	H	0:00	0	0:00
I	I	0:00	0	0:00
J	J	0:00	0	0:00
K	L	0:00	0	0:00
L	K	0:00	0	0:00
M	M	9:01	47	0:16
N	N	189:46	289	1:14
O	O	0:00	0	0:00
P	P	0:00	0	0:00
Q	Q	0:00	0	0:00
R	R	0:00	0	0:00
S	S	12:18	94	0:13
T	T	21:18	136	0:14
U	U	0:00	0	0:00
V	V	0:00	0	0:00
W	W	0:00	0	0:00
X	X	0:00	0	0:00
Y	Y	0:00	0	0:00
Z	Z	0:00	0	0:00
AA	AA	0:00	0	0:00
AB	BB	2:32	17	0:12
AC	CC	0:00	0	0:00
AD	DD	0:00	0	0:00
AE	EE	0:00	0	0:00
AF	FF	0:00	0	0:00
AG	Collector Town 1	0:00	0	0:00
AH	Collector Town 2	0:00	0	0:00
AI	GG	0:00	0	0:00

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SHADOW - Main Result

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

No.	Name	Worst case [h/year]
1	1	0:00
2	2	0:00
3	3	0:00
4	4	0:00
5	5	0:00
6	6	0:00
7	7	0:00
8	8	0:00
9	9	0:00
10	10	0:00
11	11	41:32
12	12	46:31
13	13	2:33
14	14	2:05
15	15	2:30
16	16	0:00
17	17	0:00
18	18	0:00
19	19	0:00
20	20	0:00
21	21	0:00
22	22	0:00
23	23	0:00
24	24	19:13
25	25	14:28
26	26	3:33
27	27	16:18
28	28	43:46
29	29	0:00
30	30	0:00
31	31	4:55
32	32	0:00
33	33	0:00
34	34	0:00
35	35	3:50
36	36	5:57
37	37	4:43
38	38	0:00
39	39	0:00
40	40	5:38
41	41	12:11
42	42	5:23
43	43	0:00
44	44	0:00
45	45	0:00
46	46	0:00
47	47	0:00
48	48	0:00
49	49	0:00
50	50	0:00
51	51	0:00
52	52	0:00
53	53	0:00
54	54	0:00
55	55	0:00
56	56	0:00
57	57	0:00
58	58	0:00
59	59	0:00
60	60	13:33
61	61	0:00

Continued on next page...

Project:
Collector

Printed/Page
6/02/2012 3:15 PM / 5

Licensed user:
Stanwell Corporation Limited
GPO Box 773
AU-BRISBANE Q 4001
+61 (0)7 3335 7444

Calculated:
6/02/2012 3:12 PM/2.5.4.70

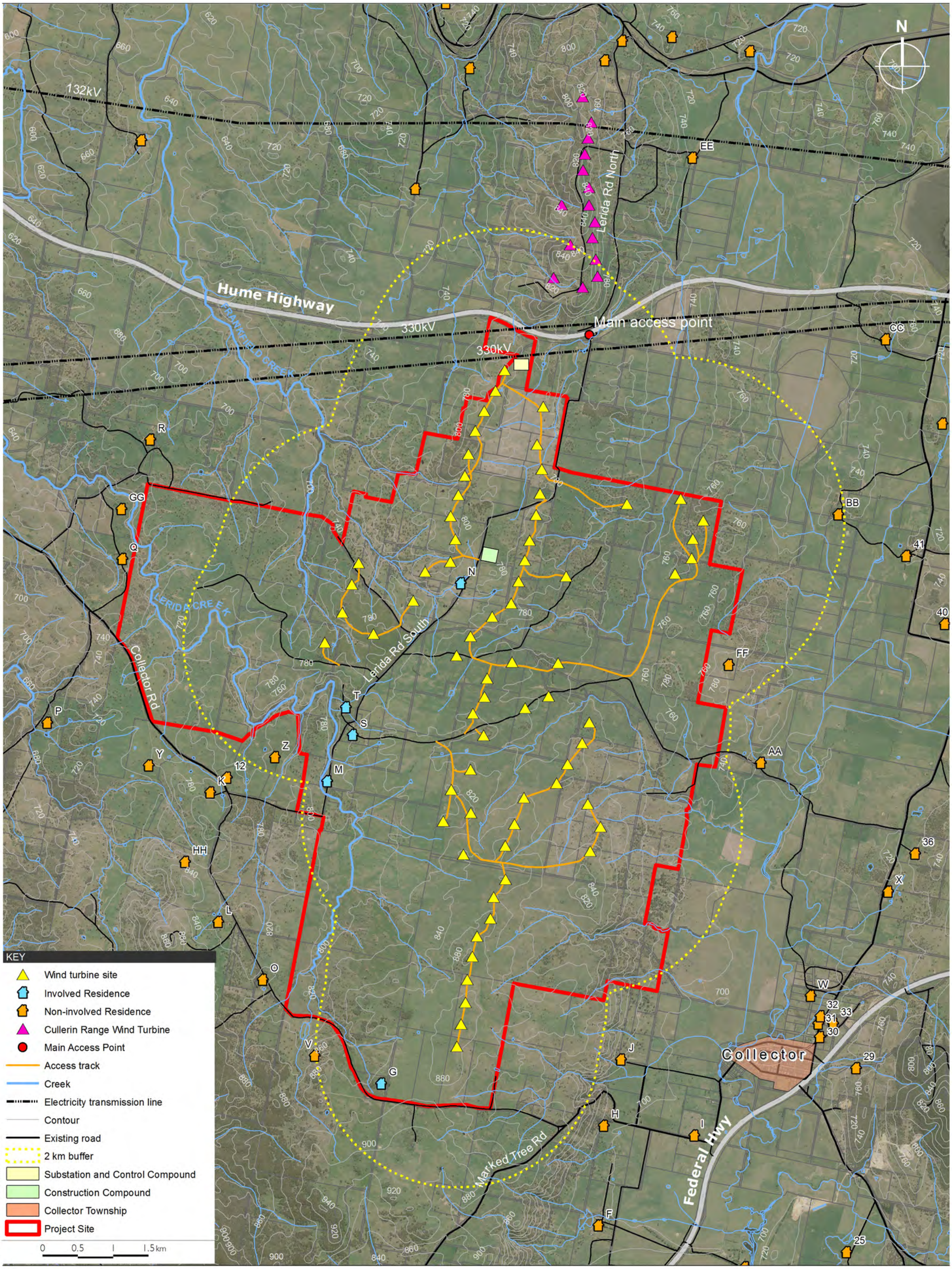
SHADOW - Main Result

...continued from previous page

No.	Name	Worst case [h/year]
62	62	0:00
63	63	0:00
64	65	0:00
65	66	0:00
66	67	0:00
67	68	2:32
68	69	0:00

APPENDIX B – RESIDENCE LOCATIONS AND DISTANCES

Dwelling Label	Minimum distance to WTG (m)	Nearest WTG	Dwelling Label	Minimum distance to WTG (m)	Nearest WTG
A	7,614	60	Q	3,100	16
B	7,824	60	R	3,478	13
C	5,600	60	S	1,372	16
D	4,611	60	T	968	16
E	4,319	60	U	3,996	60
F	3,236	60	V	2,019	60
G	1,195	60	W	3,733	61
H	2,367	60	X	4,174	62
I	3,592	60	Y	3,040	16
J	2,322	59	Z	1,775	16
K	2,676	16	AA	2,443	62
L	3,447	42	BB	1,913	67
M	1,739	42	CC	3,640	67
N	339	10	DD	2,807	1
O	2,856	59	EE	3,967	1
P	4,090	16	FF	1,499	64


N
132kV
330kV
330kV
Hume Highway
Main access point
Lerida Rd North
Lerida Rd South
Collector Rd
FRANKFIELD CREEK
LERIDA CREEK
Marked Tree Rd
Federal Hwy
Collector
EE
CC
BB
FF
AA
GG
HH
R
Q
P
Y
Z
12
K
L
M
N
O
S
T
V
G
W
X
41
40
36
29
25
KEY
Wind turbine site
Involved Residence
Non-involved Residence
Cullerin Range Wind Turbine
Main Access Point
Access track
Creek
Electricity transmission line
Contour
Existing road
2 km buffer
Substation and Control Compound
Construction Compound
Collector Township
Project Site
0 0.5 1 1.5 km
F:\GIS\APP\Collector Windfarm\December 2011 Focus GIS