



**MOUNT EMERALD 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 that 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 shadows decreases with distance.

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 Mount Emerald Wind Farm is expected to comprise up to 75 wind turbines with a nameplate rating of approximately 3MW. The turbines will have a hub height of around 80-90m and blade length of 40-50m. At the time of this report; the most likely configuration of the wind farm is a 75 wind turbine configuration.

Two alternative turbines will be investigated in this document;

1. 75 x Enercon E82 wind turbines with an overall height of 126m (85m hub and 41m blade).
2. 70 x Siemens SWT 3.0-101 wind turbines with an overall height of 131m (80m hub height and 51m blade).

The site is located on the Atherton Tablelands in Queensland, approximately 20km to the south of the town of Mareeba and 15km north-west of the town of Atherton.

The proposed MEWF development is situated on a single land title (Lot 7 SP235244) owned by the partners in the project Port Bajool Pty Ltd (PBJ). The title covers an area of approximately 2400ha, and is comprised of largely sparse natural scrub land with some rocky outcrops.

The site land is a rough plateau (el. 900m) elevated some 300m above the surrounding plains. The property is currently not used for any particular farming activity. The surrounding land is predominantly used for grazing and agriculture. The local landmark, Mount Emerald (el. 1122m) is located roughly 2km from the southern boundary of the site.

A review of the general area has identified 78 residences within the vicinity of the wind farm. The relative proximity of these residences to the wind turbines is shown in the table below.

Distance from WTG (m)	No. of Residences
500	0
1000	0
2000	10
3000	44
4000	69
5000	78

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

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 turbine 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 dwelling 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 as this is the methodology that 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 always facing perpendicular to the WTG. 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 dwelling is found to be experiencing an impact in excess of the recommended limit then a detailed assessment of the dwelling 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 is facing changes so to does the geometry of the turbine in respect to the dwelling and as such so to does 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 Mount Emerald site the annual hours in each direction are provided below using the data collected from monitoring tower 9530 (329088E 8100271N Z55 MGA94) which has been operating since May 2010.

	Wind Direction Statistics – Monitoring Tower 9530											
	N 0°	NNE 30°	ENE 60°	E 90°	ESE 120°	SSE 150°	S 180°	SSW 210°	WSW 240°	W 270°	WNW 300°	NNW 330°
Percentage Data	1.2	4.2	4.9	48.2	30.5	3.3	0.6	0.7	1.8	2.8	1.2	0.7
Annual Operating Hours	108	368	428	4224	2674	285	49	59	158	241	109	58

WIND TURBINE ROTOR

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.

The Environment Protection and Heritage Council *Draft National Wind Farm Guidelines – July 2010* recommend that only in instances where more than 20% of the sun disc is blocked by the blade should it be considered to cause shadow flicker.

To assess this condition, details of the wind turbine blade design need to be available with this data provided by the wind turbine manufacturer.

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 Mount Emerald wind farm site is based on data from the Bureau of Meteorology station at Mareeba Airport located approximately 13km to the northeast of the site and collected since 1971 to current day. A second BoM site at Atherton (15km away) was also investigated with data similar for both sites, but the Mareeba 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 – MAREEBA AIRPORT											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Clear Days	2.4	0.7	4.3	3.5	6.7	9.3	12.2	10.4	13.4	10.5	7	5.8
Cloudy Days	11.5	15.3	11.8	8.5	7	6.3	6.5	5.9	2.9	2.8	5.3	11.1
Other Days	17.1	12	14.9	18	17.3	14.4	12.3	14.7	13.7	17.7	17.7	14.1
Sunshine Probability	0.353	0.239	0.379	0.417	0.495	0.550	0.592	0.573	0.675	0.624	0.528	0.415

3.6. OBSTACLES

In a worst case evaluation no account has been made for the protection that vegetation or surrounding buildings 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
- Rotor – calculate only when more than 20% of sun is covered by the blade
- 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 within 2000m of a wind turbine are shown.

	WORST CASE - Shadow hours / year			
	Enercon E82 wind turbines		Siemens SWT 3.0-101 wind turbines	
Dwelling	Estimated hours - Worst Case	Allowable	Estimated hours - Worst Case	Allowable
R05	3:00	30:00	4:30	30:00
R26	0:00	30:00	0:00	30:00
R27	0:00	30:00	0:00	30:00
R30	0:00	30:00	0:00	30:00
R32	0:00	30:00	0:00	30:00
R35	0:00	30:00	0:00	30:00
R36	0:00	30:00	0:00	30:00
R49	5:06	30:00	7:43	30:00
R60	2:37	30:00	3:43	30:00
R78	2:36	30:00	5:37	30:00

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

As can be seen from these results there are three dwellings which it is predicted will experience shadow flicker. Even under the worst case scenario the annual amount of time shadow flicker experienced at these receptors is well below the recommended allowable limit.

The results also show the maximum amount of time a shadow flicker experience would occur for would be 13 minutes.

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 – 2000m
- Receptor – Greenhouse Effect
- Direction – from wind data records collected on-site
- Rotor – calculates only when more than 20% of sun is blocked by blade
- 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 that can be made to

move closer to the actual situation, such as exact locations and dimensions of windows rather than “greenhouse” and the inclusion of vegetation screening.

Dwelling	EXPECTED CASE - Shadow hours / year			
	Enercon E82 wind turbines		Siemens SWT 3.0-101 wind turbines	
	Estimated hours	Allowable	Estimated hours	Allowable
R05	1:23	30:00	2:05	30:00
R26	0:00	30:00	0:00	30:00
R27	0:00	30:00	0:00	30:00
R30	0:00	30:00	0:00	30:00
R32	0:00	30:00	0:00	30:00
R35	0:00	30:00	0:00	30:00
R36	0:00	30:00	0:00	30:00
R49	2:14	30:00	3:22	30:00
R60	0:58	30:00	1:20	30:00
R78	0:55	30:00	1:58	30:00

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 they 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 Siemens SWT3.0-101 option for the “worst case” in the area of the Mount Emerald wind farm is shown below, with a resolution of 25m.

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.

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.

Thus, it is stated that the impact of Shadow Flicker on residences around the Mount Emerald 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:
Mt Emerald

Printed/Page
4/08/2011 1:10 PM / 1
Licensed user:
Stanwell Corporation Limited
GPO Box 773
AU-BRISBANE Q 4001
+61 (0)7 3335 7444

Calculated:
4/08/2011 12:53 PM/2.5.4.70

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

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
0.35	0.24	0.38	0.42	0.50	0.55	0.59	0.57	0.68	0.62	0.53	0.41

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
108	368	428	4,224	2,674	285	49	59	158	240	109	58	8,760

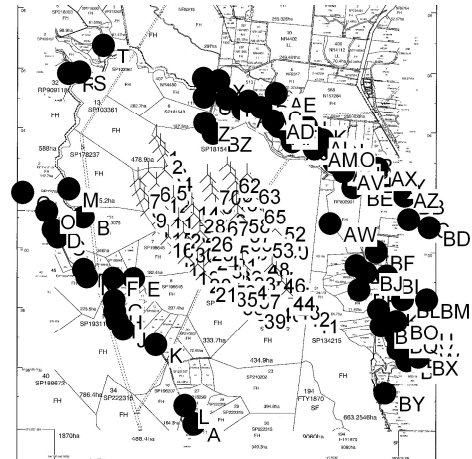
To avoid flicker from WTGs not visible a ZVI calculation is performed before the flicker calculation. The ZVI calculation is based on the following assumptions

Height contours used: Height Contours: Contours.map (1)

Obstacles used in calculation

Eye height: 1.5 m

Grid resolution: 100 m



Scale 1:250,000

^ New WTG

☞ Shadow receptor

WTGs

UTM WGS84 S Zone: 55

WTG type

	East	North	Z	Row data/Description	Valid	Manuf.	Type	Power	Diam.	Height	RPM
			[m]					[kW]	[m]	[m]	[RPM]
1	325,792	8,103,791	884	1	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
2	325,927	8,103,500	857	2	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
3	326,071	8,103,211	804	3	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
4	326,263	8,102,926	795	4	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
5	326,071	8,102,642	786	5	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
6	325,535	8,102,589	808	6	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
7	325,197	8,102,351	827	7	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
8	325,266	8,102,037	842	8	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
9	325,402	8,101,713	845	9	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
10	325,539	8,101,383	860	10	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
11	325,930	8,101,603	853	11	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
12	325,803	8,102,201	819	12	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
13	326,364	8,101,775	851	13	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
14	326,771	8,101,965	804	14	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
15	325,931	8,101,065	892	15	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
16	325,941	8,100,734	871	16	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
17	326,222	8,100,448	851	17	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
18	326,484	8,100,150	845	18	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
19	326,793	8,099,845	847	19	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
20	327,187	8,099,577	869	20	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
21	327,392	8,099,290	860	21	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
22	327,652	8,099,773	855	22	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
23	327,542	8,100,066	836	23	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
24	327,436	8,100,361	832	24	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
25	327,254	8,100,649	817	25	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
26	327,232	8,100,956	805	26	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
27	327,039	8,101,238	800	27	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
28	326,982	8,101,539	786	28	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
29	326,556	8,101,046	823	29	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
30	326,708	8,100,606	833	30	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
31	328,045	8,100,267	817	31	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
32	328,206	8,099,881	850	32	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
33	328,660	8,099,649	851	33	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
34	328,376	8,099,384	904	34	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
35	328,058	8,099,149	932	35	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
36	328,292	8,098,872	979	36	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
37	328,824	8,099,088	918	37	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0
38	328,726	8,098,695	1,014	38	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0

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Project:
Mt Emerald

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4/08/2011 1:10 PM / 2
Licensed user:
Stanwell Corporation Limited
GPO Box 773
AU-BRISBANE Q 4001
+61 (0)7 3335 7444

Calculated:
4/08/2011 12:53 PM/2.5.4.70

SHADOW - Main Result

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UTM WGS84 S Zone: 55				WTG type							
East	North	Z	Row data/Description	Valid	Manufact.	Type	Power [kW]	Diam. [m]	Height [m]	RPM [RPM]	
39	329,007	8,098,439	1,049 39	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
40	329,561	8,098,673	919 40	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
41	330,759	8,098,283	976 41	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
42	330,458	8,098,526	948 42	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
43	330,132	8,098,752	864 43	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
44	329,970	8,099,041	882 44	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
45	329,790	8,099,328	913 45	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
46	329,648	8,099,620	884 46	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
47	329,228	8,099,859	893 47	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
48	329,113	8,100,157	917 48	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
49	329,043	8,100,457	933 49	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
50	329,738	8,100,745	843 50	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
51	329,581	8,101,021	807 51	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
52	329,644	8,101,320	813 52	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
53	329,242	8,100,793	858 53	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
54	328,753	8,100,703	881 54	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
55	328,157	8,100,695	811 55	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
56	328,537	8,100,981	872 56	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
57	328,498	8,101,272	845 57	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
58	328,458	8,101,575	834 58	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
59	328,466	8,101,926	821 59	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
60	328,402	8,102,310	808 60	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
61	328,248	8,102,601	800 61	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
62	328,130	8,102,902	817 62	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
63	328,792	8,102,560	825 63	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
64	328,903	8,102,219	811 64	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
65	328,983	8,101,892	806 65	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
66	328,031	8,101,732	833 66	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
67	327,768	8,101,472	809 67	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
68	327,640	8,101,915	815 68	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
69	327,574	8,102,211	841 69	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	
70	327,496	8,102,505	799 70	Yes	Siemens	SWT-2.3-101	2,300	101.0	80.0	16.0	

Shadow receptor-Input

UTM WGS84 S Zone: 55										
No.	Name	East	North	Z	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
A	R01	327,108	8,094,240	586	1.0	1.0	1.0	0.0	90.0	"Green house mode"
B	R02	323,399	8,101,041	574	1.0	1.0	1.0	0.0	90.0	"Green house mode"
C	R03	322,551	8,100,377	524	1.0	1.0	1.0	0.0	90.0	"Green house mode"
D	R04	322,401	8,100,614	522	1.0	1.0	1.0	0.0	90.0	"Green house mode"
E	R05	325,080	8,099,051	558	1.0	1.0	1.0	0.0	90.0	"Green house mode"
F	R06	324,402	8,099,053	536	1.0	1.0	1.0	0.0	90.0	"Green house mode"
G	R07	324,438	8,098,311	542	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H	R08	324,461	8,097,943	545	1.0	1.0	1.0	0.0	90.0	"Green house mode"
I	R09	324,552	8,097,638	546	1.0	1.0	1.0	0.0	90.0	"Green house mode"
J	R10	324,741	8,097,351	552	1.0	1.0	1.0	0.0	90.0	"Green house mode"
K	R11	325,824	8,096,858	556	1.0	1.0	1.0	0.0	90.0	"Green house mode"
L	R12	326,812	8,094,840	581	1.0	1.0	1.0	0.0	90.0	"Green house mode"
M	R13	322,913	8,101,970	538	1.0	1.0	1.0	0.0	90.0	"Green house mode"
N	R14	323,526	8,099,070	537	1.0	1.0	1.0	0.0	90.0	"Green house mode"
O	R15	322,190	8,101,228	519	1.0	1.0	1.0	0.0	90.0	"Green house mode"
P	R16	323,417	8,099,332	532	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Q	R17	321,385	8,101,835	515	1.0	1.0	1.0	0.0	90.0	"Green house mode"
R	R18	322,861	8,105,817	539	1.0	1.0	1.0	0.0	90.0	"Green house mode"
S	R19	323,237	8,105,869	529	1.0	1.0	1.0	0.0	90.0	"Green house mode"
T	R20	324,011	8,106,789	540	1.0	1.0	1.0	0.0	90.0	"Green house mode"
U	R21	327,346	8,105,105	545	1.0	1.0	1.0	0.0	90.0	"Green house mode"

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SHADOW - Main Result

...continued from previous page

UTM WGS84 S Zone: 55

No.	Name	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
V R22		327,532	8,105,458	537	1.0	1.0	1.0	0.0	90.0	"Green house mode"
W R23		327,320	8,105,720	528	1.0	1.0	1.0	0.0	90.0	"Green house mode"
X R24		327,836	8,105,651	547	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Y R25		328,105	8,105,059	546	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Z R26		327,385	8,104,239	577	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AA R27		328,640	8,104,706	555	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AB R28		328,814	8,104,996	556	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AC R29		329,227	8,104,783	565	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AD R30		329,632	8,104,345	580	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AE R31		329,738	8,105,254	560	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AF R32		329,821	8,104,154	580	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AG R33		329,870	8,104,536	596	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AH R34		330,044	8,104,444	596	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AI R35		330,166	8,103,957	586	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AJ R36		330,281	8,103,655	576	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AK R37		330,744	8,104,165	584	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AL R38		331,053	8,103,796	585	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AM R39		331,012	8,103,431	574	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AN R40		331,286	8,103,732	590	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AO R41		331,610	8,103,457	591	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AP R42		331,773	8,103,467	592	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AQ R43		331,900	8,103,216	595	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AR R44		332,241	8,103,249	598	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AS R45		332,142	8,103,035	595	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AT R46		331,667	8,102,969	579	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AU R47		331,836	8,102,949	577	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AV R48		331,981	8,102,675	585	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AW R49		331,555	8,100,953	639	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AX R50		333,099	8,102,820	617	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AY R51		333,372	8,102,564	619	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AZ R52		333,849	8,102,111	622	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BA R53		333,977	8,101,981	625	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BB R54		334,001	8,101,907	627	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BC R55		334,143	8,101,119	644	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BD R56		334,828	8,100,860	644	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BE R57		332,290	8,102,160	595	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BF R58		333,082	8,100,051	684	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BG R59		332,424	8,099,580	694	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BH R60		332,526	8,098,770	755	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BI R61		333,441	8,099,268	690	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BJ R62		332,750	8,099,348	695	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BK R63		333,180	8,098,115	712	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BL R64		333,966	8,098,486	701	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BM R65		334,769	8,098,473	711	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BN R66		333,273	8,097,584	741	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BO R67		333,769	8,097,741	720	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BP R68		333,818	8,097,418	738	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BQ R69		333,759	8,097,284	740	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BR R70		333,858	8,097,008	755	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BS R71		333,837	8,096,819	757	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BT R72		334,122	8,096,447	781	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BU R73		334,300	8,097,467	741	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BV R74		334,315	8,097,097	760	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BW R75		334,312	8,096,814	779	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BX R76		334,510	8,096,570	802	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BY R77		333,420	8,095,349	844	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BZ R78		327,662	8,103,902	575	1.0	1.0	1.0	0.0	90.0	"Green house mode"

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SHADOW - Main Result**Calculation Results**

Shadow receptor

No.	Name	Shadow, worst case		Max shadow hours per day [h/day]	Shadow, expected values
		Shadow hours per year [h/year]	Shadow days per year [days/year]		Shadow hours per year [h/year]
A	R01	0:00	0	0:00	0:00
B	R02	0:00	0	0:00	0:00
C	R03	0:00	0	0:00	0:00
D	R04	0:00	0	0:00	0:00
E	R05	4:30	27	0:13	2:05
F	R06	0:00	0	0:00	0:00
G	R07	0:00	0	0:00	0:00
H	R08	0:00	0	0:00	0:00
I	R09	0:00	0	0:00	0:00
J	R10	0:00	0	0:00	0:00
K	R11	0:00	0	0:00	0:00
L	R12	0:00	0	0:00	0:00
M	R13	0:00	0	0:00	0:00
N	R14	0:00	0	0:00	0:00
O	R15	0:00	0	0:00	0:00
P	R16	0:00	0	0:00	0:00
Q	R17	0:00	0	0:00	0:00
R	R18	0:00	0	0:00	0:00
S	R19	0:00	0	0:00	0:00
T	R20	0:00	0	0:00	0:00
U	R21	0:00	0	0:00	0:00
V	R22	0:00	0	0:00	0:00
W	R23	0:00	0	0:00	0:00
X	R24	0:00	0	0:00	0:00
Y	R25	0:00	0	0:00	0:00
Z	R26	0:00	0	0:00	0:00
AA	R27	0:00	0	0:00	0:00
AB	R28	0:00	0	0:00	0:00
AC	R29	0:00	0	0:00	0:00
AD	R30	0:00	0	0:00	0:00
AE	R31	0:00	0	0:00	0:00
AF	R32	0:00	0	0:00	0:00
AG	R33	0:00	0	0:00	0:00
AH	R34	0:00	0	0:00	0:00
AI	R35	0:00	0	0:00	0:00
AJ	R36	0:00	0	0:00	0:00
AK	R37	0:00	0	0:00	0:00
AL	R38	0:00	0	0:00	0:00
AM	R39	0:00	0	0:00	0:00
AN	R40	0:00	0	0:00	0:00
AO	R41	0:00	0	0:00	0:00
AP	R42	0:00	0	0:00	0:00
AQ	R43	0:00	0	0:00	0:00
AR	R44	0:00	0	0:00	0:00
AS	R45	0:00	0	0:00	0:00
AT	R46	0:00	0	0:00	0:00
AU	R47	0:00	0	0:00	0:00
AV	R48	0:00	0	0:00	0:00
AW	R49	7:43	48	0:13	3:22
AX	R50	0:00	0	0:00	0:00
AY	R51	0:00	0	0:00	0:00
AZ	R52	0:00	0	0:00	0:00
BA	R53	0:00	0	0:00	0:00
BB	R54	0:00	0	0:00	0:00
BC	R55	0:00	0	0:00	0:00
BD	R56	0:00	0	0:00	0:00
BE	R57	0:00	0	0:00	0:00

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SHADOW - Main Result

...continued from previous page

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]
BF	R58	0:00	0	0:00	0:00
BG	R59	0:00	0	0:00	0:00
BH	R60	3:43	23	0:13	1:20
BI	R61	0:00	0	0:00	0:00
BJ	R62	0:00	0	0:00	0:00
BK	R63	0:00	0	0:00	0:00
BL	R64	0:00	0	0:00	0:00
BM	R65	0:00	0	0:00	0:00
BN	R66	0:00	0	0:00	0:00
BO	R67	0:00	0	0:00	0:00
BP	R68	0:00	0	0:00	0:00
BQ	R69	0:00	0	0:00	0:00
BR	R70	0:00	0	0:00	0:00
BS	R71	0:00	0	0:00	0:00
BT	R72	0:00	0	0:00	0:00
BU	R73	0:00	0	0:00	0:00
BV	R74	0:00	0	0:00	0:00
BW	R75	0:00	0	0:00	0:00
BX	R76	0:00	0	0:00	0:00
BY	R77	0:00	0	0:00	0:00
BZ	R78	5:37	38	0:13	1:58

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

No.	Name	Worst case [h/year]
-----	------	------------------------

1	1	0:00
2	2	3:35
3	3	2:02
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	0:00
12	12	0:00
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	4:30
20	20	0:00
21	21	0:00
22	22	0:00
23	23	0:00
24	24	0:00
25	25	0:00
26	26	0:00
27	27	0:00
28	28	0:00
29	29	0:00
30	30	0:00
31	31	0:00
32	32	0:00
33	33	0:00

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SHADOW - Main Result*...continued from previous page*

No. Name Worst case

[h/year]

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	3:43
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	2:49
51	51	2:18
52	52	2:36
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
62	62	0:00
63	63	0:00
64	64	0:00
65	65	0:00
66	66	0:00
67	67	0:00
68	68	0:00
69	69	0:00
70	70	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

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

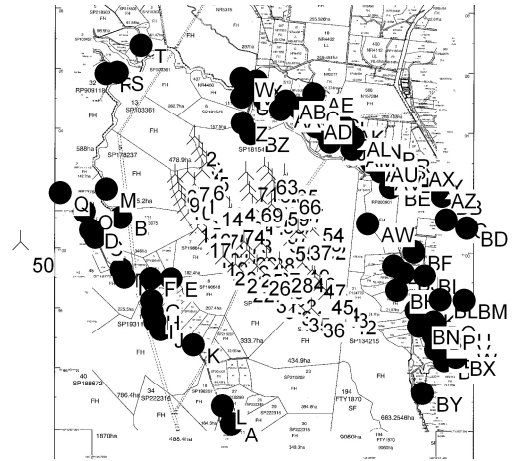
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.35	0.24	0.38	0.42	0.50	0.55	0.59	0.57	0.68	0.62	0.53	0.41

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
108	368	428	4,224	2,674	285	49	59	158	240	109	58	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: Contours.map (1)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 100 m



Scale 1:250,000

▲ 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	325,809	8,102,197	818	1	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
2	325,803	8,103,785	881	2	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
3	325,956	8,103,457	850	3	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
4	326,073	8,103,207	804	4	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
5	326,217	8,102,937	797	5	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
6	326,064	8,102,645	788	6	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
7	325,581	8,102,596	805	7	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
8	325,167	8,102,500	823	8	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
9	325,263	8,102,243	834	9	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
10	325,299	8,101,986	840	10	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
11	325,387	8,101,730	845	11	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
12	325,507	8,101,485	856	12	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
13	325,916	8,101,631	851	13	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
14	326,327	8,101,782	855	14	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
15	325,617	8,101,231	870	15	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
16	325,929	8,101,048	893	16	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
17	325,934	8,100,748	872	17	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
18	326,232	8,100,427	850	18	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
19	326,493	8,100,143	845	19	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
20	326,789	8,099,837	848	20	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
21	327,190	8,099,583	869	21	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
22	327,386	8,099,294	860	22	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
23	327,471	8,100,310	831	23	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
24	327,570	8,100,046	837	24	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
25	327,652	8,099,781	855	25	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
26	327,915	8,099,518	859	26	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
27	328,230	8,099,829	848	27	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
28	328,656	8,099,631	851	28	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
29	328,367	8,099,407	903	29	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
30	328,029	8,099,220	926	30	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
31	328,146	8,098,962	971	31	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
32	328,425	8,098,766	1,012	32	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
33	328,786	8,098,927	974	33	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
34	329,002	8,098,559	1,051	34	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
35	329,234	8,098,320	1,013	35	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
36	329,717	8,098,155	1,000	36	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
37	329,260	8,100,722	860	37	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
38	328,046	8,100,298	816	38	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5

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SHADOW - Main Result

...continued from previous page

UTM WGS84 S Zone: 55				WTG type						
East	North	Z	Row data/Description	Valid	Manufact.	Type	Power [kW]	Diam. [m]	Height [m]	RPM [RPM]
39	326,981	8,101,460	790 39	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
40	326,734	8,100,584	831 40	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
41	327,737	8,101,507	811 41	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
42	330,766	8,098,261	974 42	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
43	330,489	8,098,504	949 43	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
44	330,207	8,098,696	887 44	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
45	329,988	8,098,935	870 45	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
46	329,823	8,099,182	894 46	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
47	329,729	8,099,441	923 47	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
48	329,404	8,099,649	856 48	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
49	329,203	8,099,946	902 49	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
50	320,091	8,100,198	525 50	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
51	329,040	8,100,460	932 51	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
52	329,738	8,100,745	843 52	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
53	329,581	8,101,006	810 53	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
54	329,659	8,101,299	815 54	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
55	328,773	8,100,681	885 55	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
56	328,578	8,100,955	875 56	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
57	328,506	8,101,239	847 57	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
58	328,368	8,101,559	840 58	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
59	328,507	8,101,817	825 59	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
60	328,450	8,102,087	818 60	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
61	328,384	8,102,361	806 61	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
62	328,250	8,102,610	799 62	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
63	328,123	8,102,866	814 63	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
64	326,730	8,101,936	813 64	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
65	328,792	8,102,560	825 65	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
66	328,891	8,102,237	812 66	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
67	328,964	8,101,930	808 67	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
68	328,019	8,101,756	835 68	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
69	327,636	8,101,937	818 69	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
70	327,578	8,102,225	842 70	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
71	327,508	8,102,611	810 71	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
72	327,279	8,100,581	822 72	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
73	327,284	8,100,882	807 73	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
74	327,063	8,101,191	801 74	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5
75	326,543	8,101,038	824 75	Yes	ENERCON	E-82	2,300	82.0	78.3	19.5

Shadow receptor-Input

UTM WGS84 S Zone: 55										
No.	Name	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
		[m]	[m]	[m]	[m]	[m]	[m]	[°]	[°]	
A	R01	327,108	8,094,240	586	1.0	1.0	1.0	0.0	90.0	"Green house mode"
B	R02	323,399	8,101,041	574	1.0	1.0	1.0	0.0	90.0	"Green house mode"
C	R03	322,551	8,100,377	524	1.0	1.0	1.0	0.0	90.0	"Green house mode"
D	R04	322,401	8,100,614	522	1.0	1.0	1.0	0.0	90.0	"Green house mode"
E	R05	325,080	8,099,051	558	1.0	1.0	1.0	0.0	90.0	"Green house mode"
F	R06	324,402	8,099,053	536	1.0	1.0	1.0	0.0	90.0	"Green house mode"
G	R07	324,438	8,098,311	542	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H	R08	324,461	8,097,943	545	1.0	1.0	1.0	0.0	90.0	"Green house mode"
I	R09	324,552	8,097,638	546	1.0	1.0	1.0	0.0	90.0	"Green house mode"
J	R10	324,741	8,097,351	552	1.0	1.0	1.0	0.0	90.0	"Green house mode"
K	R11	325,824	8,096,858	556	1.0	1.0	1.0	0.0	90.0	"Green house mode"
L	R12	326,812	8,094,840	581	1.0	1.0	1.0	0.0	90.0	"Green house mode"
M	R13	322,913	8,101,970	538	1.0	1.0	1.0	0.0	90.0	"Green house mode"
N	R14	323,526	8,099,070	537	1.0	1.0	1.0	0.0	90.0	"Green house mode"
O	R15	322,190	8,101,228	519	1.0	1.0	1.0	0.0	90.0	"Green house mode"
P	R16	323,417	8,099,332	532	1.0	1.0	1.0	0.0	90.0	"Green house mode"

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SHADOW - Main Result

...continued from previous page

UTM WGS84 S Zone: 55

No.	Name	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
					[m]	[m]	[m]	[°]	[°]	
Q R17		321,385	8,101,835	515	1.0	1.0	1.0	0.0	90.0	"Green house mode"
R R18		322,861	8,105,817	539	1.0	1.0	1.0	0.0	90.0	"Green house mode"
S R19		323,237	8,105,869	529	1.0	1.0	1.0	0.0	90.0	"Green house mode"
T R20		324,011	8,106,789	540	1.0	1.0	1.0	0.0	90.0	"Green house mode"
U R21		327,346	8,105,105	545	1.0	1.0	1.0	0.0	90.0	"Green house mode"
V R22		327,532	8,105,458	537	1.0	1.0	1.0	0.0	90.0	"Green house mode"
W R23		327,320	8,105,720	528	1.0	1.0	1.0	0.0	90.0	"Green house mode"
X R24		327,836	8,105,651	547	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Y R25		328,105	8,105,059	546	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Z R26		327,385	8,104,239	577	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AA R27		328,640	8,104,706	555	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AB R28		328,814	8,104,996	556	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AC R29		329,227	8,104,783	565	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AD R30		329,632	8,104,345	580	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AE R31		329,738	8,105,254	560	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AF R32		329,821	8,104,154	580	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AG R33		329,870	8,104,536	596	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AH R34		330,044	8,104,444	596	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AI R35		330,166	8,103,957	586	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AJ R36		330,281	8,103,655	576	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AK R37		330,744	8,104,165	584	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AL R38		331,053	8,103,796	585	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AM R39		331,012	8,103,431	574	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AN R40		331,286	8,103,732	590	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AO R41		331,610	8,103,457	591	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AP R42		331,773	8,103,467	592	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AQ R43		331,900	8,103,216	595	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AR R44		332,241	8,103,249	598	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AS R45		332,142	8,103,035	595	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AT R46		331,667	8,102,969	579	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AU R47		331,836	8,102,949	577	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AV R48		331,981	8,102,675	585	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AW R49		331,555	8,100,953	639	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AX R50		333,099	8,102,820	617	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AY R51		333,372	8,102,564	619	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AZ R52		333,849	8,102,111	622	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BA R53		333,977	8,101,981	625	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BB R54		334,001	8,101,907	627	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BC R55		334,143	8,101,119	644	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BD R56		334,828	8,100,860	644	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BE R57		332,290	8,102,160	595	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BF R58		333,082	8,100,051	684	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BG R59		332,424	8,099,580	694	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BH R60		332,526	8,098,770	755	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BI R61		333,441	8,099,268	690	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BJ R62		332,750	8,099,348	695	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BK R63		333,180	8,098,115	712	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BL R64		333,966	8,098,486	701	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BM R65		334,769	8,098,473	711	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BN R66		333,273	8,097,584	741	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BO R67		333,769	8,097,741	720	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BP R68		333,818	8,097,418	738	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BQ R69		333,759	8,097,284	740	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BR R70		333,858	8,097,008	755	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BS R71		333,837	8,096,819	757	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BT R72		334,122	8,096,447	781	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BU R73		334,300	8,097,467	741	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BV R74		334,315	8,097,097	760	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BW R75		334,312	8,096,814	779	1.0	1.0	1.0	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	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
BX R76		334,510	8,096,570	802	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BY R77		333,420	8,095,349	844	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BZ R78		327,662	8,103,902	575	1.0	1.0	1.0	0.0	90.0	"Green house mode"

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	R01	0:00	0	0:00	0:00
B	R02	0:00	0	0:00	0:00
C	R03	0:00	0	0:00	0:00
D	R04	0:00	0	0:00	0:00
E	R05	3:00	22	0:11	1:23
F	R06	0:00	0	0:00	0:00
G	R07	0:00	0	0:00	0:00
H	R08	0:00	0	0:00	0:00
I	R09	0:00	0	0:00	0:00
J	R10	0:00	0	0:00	0:00
K	R11	0:00	0	0:00	0:00
L	R12	0:00	0	0:00	0:00
M	R13	0:00	0	0:00	0:00
N	R14	0:00	0	0:00	0:00
O	R15	0:00	0	0:00	0:00
P	R16	0:00	0	0:00	0:00
Q	R17	0:00	0	0:00	0:00
R	R18	0:00	0	0:00	0:00
S	R19	0:00	0	0:00	0:00
T	R20	0:00	0	0:00	0:00
U	R21	0:00	0	0:00	0:00
V	R22	0:00	0	0:00	0:00
W	R23	0:00	0	0:00	0:00
X	R24	0:00	0	0:00	0:00
Y	R25	0:00	0	0:00	0:00
Z	R26	0:00	0	0:00	0:00
AA	R27	0:00	0	0:00	0:00
AB	R28	0:00	0	0:00	0:00
AC	R29	0:00	0	0:00	0:00
AD	R30	0:00	0	0:00	0:00
AE	R31	0:00	0	0:00	0:00
AF	R32	0:00	0	0:00	0:00
AG	R33	0:00	0	0:00	0:00
AH	R34	0:00	0	0:00	0:00
AI	R35	0:00	0	0:00	0:00
AJ	R36	0:00	0	0:00	0:00
AK	R37	0:00	0	0:00	0:00
AL	R38	0:00	0	0:00	0:00
AM	R39	0:00	0	0:00	0:00
AN	R40	0:00	0	0:00	0:00
AO	R41	0:00	0	0:00	0:00
AP	R42	0:00	0	0:00	0:00
AQ	R43	0:00	0	0:00	0:00
AR	R44	0:00	0	0:00	0:00
AS	R45	0:00	0	0:00	0:00
AT	R46	0:00	0	0:00	0:00
AU	R47	0:00	0	0:00	0:00
AV	R48	0:00	0	0:00	0:00

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SHADOW - Main Result

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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]
AW	R49	5:06	39	0:11	2:14
AX	R50	0:00	0	0:00	0:00
AY	R51	0:00	0	0:00	0:00
AZ	R52	0:00	0	0:00	0:00
BA	R53	0:00	0	0:00	0:00
BB	R54	0:00	0	0:00	0:00
BC	R55	0:00	0	0:00	0:00
BD	R56	0:00	0	0:00	0:00
BE	R57	0:00	0	0:00	0:00
BF	R58	0:00	0	0:00	0:00
BG	R59	0:00	0	0:00	0:00
BH	R60	2:37	18	0:11	0:58
BI	R61	0:00	0	0:00	0:00
BJ	R62	0:00	0	0:00	0:00
BK	R63	0:00	0	0:00	0:00
BL	R64	0:00	0	0:00	0:00
BM	R65	0:00	0	0:00	0:00
BN	R66	0:00	0	0:00	0:00
BO	R67	0:00	0	0:00	0:00
BP	R68	0:00	0	0:00	0:00
BQ	R69	0:00	0	0:00	0:00
BR	R70	0:00	0	0:00	0:00
BS	R71	0:00	0	0:00	0:00
BT	R72	0:00	0	0:00	0:00
BU	R73	0:00	0	0:00	0:00
BV	R74	0:00	0	0:00	0:00
BW	R75	0:00	0	0:00	0:00
BX	R76	0:00	0	0:00	0:00
BY	R77	0:00	0	0:00	0:00
BZ	R78	2:36	19	0:11	0:55

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	2:36
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	0:00
12	12	0:00
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	3:00
21	21	0:00
22	22	0:00
23	23	0:00
24	24	0:00

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Project:

Mt Emerald

Printed/Page

4/08/2011 1:23 PM / 6

Licensed user:

Stanwell Corporation Limited

GPO Box 773

AU-BRISBANE Q 4001

+61 (0)7 3335 7444

Calculated:

4/08/2011 1:16 PM/2.5.4.70

SHADOW - Main Result

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No. Name Worst case

No.	Name	Worst case [h/year]
25	25	0:00
26	26	0:00
27	27	0:00
28	28	0:00
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	2:37
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	1:53
53	53	1:32
54	54	1:41
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
62	62	0:00
63	63	0:00
64	64	0:00
65	65	0:00
66	66	0:00
67	67	0:00
68	68	0:00
69	69	0:00
70	70	0:00
71	71	0:00
72	72	0:00
73	73	0:00
74	74	0:00
75	75	0:00