

Border Winds Wind Energy Project

Shadow Flicker Assessment



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Executive Summary

The Border Winds project is a 150MW wind energy project proposed by Sequoia Energy US Inc., consisting of 66 wind turbines and located north and east of Rolla, North Dakota. On November 3rd, 2009 the North Dakota Public Service Commission held a public hearing to discuss the human and environmental impacts of the proposed wind energy project. During this hearing the Commission requested that Sequoia submit a shadow flicker assessment for the project as a late-filed exhibit.

There are many conditions that have to be met in a particular combination in order for shadow flicker to occur, including time of day, time of year, turbine operation and sky conditions. Also there are a number of factors which determine the intensity of any shadow flicker on a receptor, such as distance from the turbine, turbine rotor speed, and obstacles surrounding the shadow receptor.

This assessment was based on two scenarios: (1) worst case (sun always shining in daytime, turbine always rotating and wind direction "worst case"), and (2) real-case (includes monthly sunshine probabilities and on site meteorological data). Neither scenario takes into account the obstacles (trees, buildings, etc.) that surround most shadow receptors. Obstacles such as trees and buildings cast shadows and help mitigate predicted effect of shadow flicker.

The results show the following receptors experiencing the most shadow flicker:

- The worst case maximum shadow flicker (minutes per day) is 47 minutes at shadow receptor M.
- The real-case maximum shadow flicker (hours per year) is 16:44 at shadow receptor M.
- The worst case maximum shadow flicker (hours per year) is 47:24 at shadow receptor M.

In the event that shadow flicker is a concern, placing shutters on windows, planting trees in strategic locations and turbine curtailment for specific wind directions and time of day are all effective mitigation techniques. To date, there are no proven health impacts caused by shadow flicker.

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1.0 Introduction

The Border Winds project is a 150MW wind energy project proposed by Sequoia Energy US Inc. (Sequoia), consisting of 66 wind turbines and located north and east of Rolla, North Dakota (see Appendix A). On November 3rd, 2009 the North Dakota Public Service Commission held a public hearing to discuss the human and environmental impacts of the proposed wind energy project.

During the hearing proceedings the Commission requested that Sequoia prepare a late-filed exhibit regarding the potential impacts of wind turbine shadow flicker to residences within the project area. To address this request, a detailed analysis has been performed to quantify the amount of shadow flicker from the proposed turbines on the surrounding residences. Shadow flicker is generally quantified in modeled shadow hours per year and shadow minutes per day.

This report will give a brief overview of shadow flicker, the methods that were used to assess this project, and the corresponding results.

2.0 Shadow Flicker Overview

Wind turbine shadow flicker is defined as alternating changes in light intensity caused by shadows cast from moving turbine blades. For this study, shadow receptors were defined as residences within the project area.

In order for shadow flicker to occur a certain set of conditions must occur in a specific combination, such as:

- Location
- Time of day (generally at sun rise and sun set)
- Time of year (elevation of the sun changes throughout the year)
- Turbine operation
- Sky conditions (must be clear)

There are also a number of factors that determine the intensity and duration of shadow flicker at a shadow receptor, such as:

- Distance from the turbine to the shadow receptor (greater than 10 rotor diameters, or approximately 1000m, the changing light intensity is low enough that a person does not perceive the turbine rotor as “chopping” through the sun, but rather as an object with the sun behind it)
- The rotor speed and number of blades on the turbine
- Obstacles in and around the shadow receptor
- Light intensity level of perception of the human eye
- Plane angle of the turbine rotor
- Ambient lighting conditions
- Aerosols in the atmosphere

Most North American jurisdictions do not have established shadow flicker regulations. However, some European countries such as Denmark and Germany have developed recommendations and guidelines suggesting acceptable hours of shadow per year at residences. Some guidelines suggest that less than 30 hours per year of modeled shadow flicker is generally not considered to be a serious concern.

In the event that shadow flicker is a concern, placing shutters on windows, planting trees in specific locations and turbine curtailment for specific wind directions and time of day are all effective mitigation techniques. To date, there are no proven health impacts caused by shadow flicker.

3.0 Border Winds Shadow Flicker Assessment

The shadow flicker assessment for the Border Winds project was completed using the EMD WindPRO software. WindPRO is the world's most comprehensive software package for design and planning of wind farm projects.

The SHADOW module of WindPRO calculates shadow flicker in terms of hours per year during which a shadow receptor would be exposed to flickering from nearby turbine rotors. Also, maximum minutes per day are calculated. For this project the SHADOW module calculated both worst case results (sun always shining in daytime, turbine always rotating and wind direction "worst case"), and expected values based on sunshine probabilities and turbine operation estimates.

This assessment identified 54 shadow receptors within the project area (see Appendix A), and assigned the following characteristics to each receptor:

- Window type = Green House (since the direction of the residence windows was not known the shadow receptor was considered to be perpendicular to all turbines)
- Bottom line height above ground = 1 meter
- Slope of window = 90 degrees vertical

The following inputs were used in the calculation:

- Turbine Locations (66 - Siemens 2.3MW)
- Turbine geometry (80m hub height, 101m rotor diameter, 3.5m blade width and 16 rpm)
- Digital Elevation model
- Calculate flicker only when 20% of sun is covered by the blade. According to German guidelines flickering is only an issue when at least 20% of the sun disk is covered by the turbine blade.
- Angle above horizon with no shadow influence = 3.0 degrees
- Resolution for Zones of Visual Influence (ZVI) grid in shadow receptor calculation = 10 meters
- Eye height = 1.5 meters
- Turbine operational hours calculated from on site met tower data
- The sunshine probabilities shown in Table 1 (part of time from sun rise to sun set with sun shine), from www.city-data.com

Table 1: Sunshine Probabilities for Rolla, ND

Month	Probability
January	0.51
February	0.55
March	0.57
April	0.59
May	0.61
June	0.65
July	0.71
August	0.71
September	0.65
October	0.56
November	0.45
December	0.46

- The yaw system of the wind turbine changes the orientation of the rotor according to the wind direction, thus the shadow produced by a turbine will change according to the wind direction. Figure 1 is the wind rose representing the wind direction distribution at the Border Winds project.

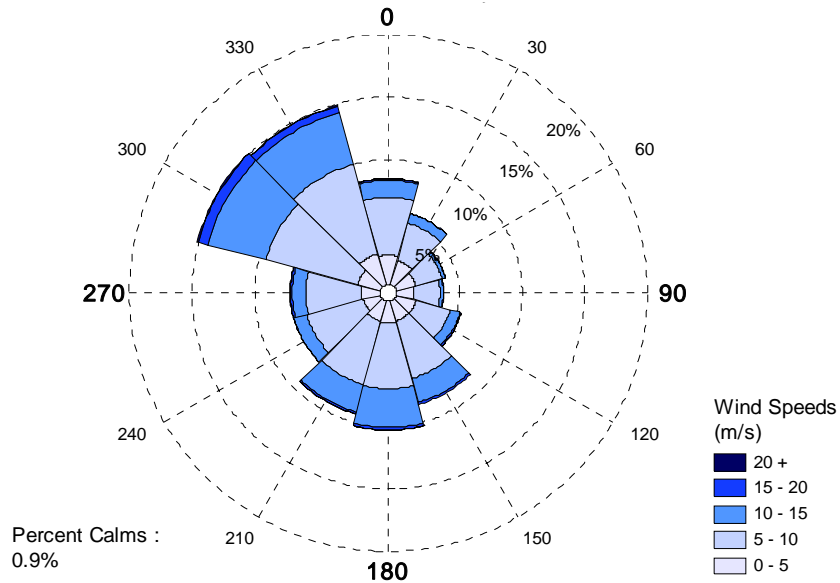


Figure 1: Wind

Direction Distribution at Border Winds, Rolette County, ND

4.0 Assessment Results

The Border Winds project consists of 66 Siemens 2.3MW wind turbines. Worst case and real case shadow flicker results for each receptor are presented in Table 2. Receptors experiencing the most shadow flicker are mentioned below:

- The worst case maximum shadow flicker (minutes per day) is 47 minutes at shadow receptor M.
- The real-case maximum shadow flicker (hours per year) is 16:44 at shadow receptor M.
- The worst case maximum shadow flicker (hours per year) is 47:24 at shadow receptor M.

Table 2: Worst-case and Real-case Shadow Flicker for Each Receptor

Receptor No.	Shadow days per year (Worst Case)	Max Shadow hours per day (Worst Case)	Shadow hours per year (Worst Case)	Shadow hours per year (Real-Case)
A	46	0:16	6:46	2:08
B	0	0:00	0:00	0:00
C	0	0:00	0:00	0:00
D	18	0:13	2:34	0:52
E	112	0:30	38:53	12:35
F	108	0:34	41:55	10:26
G	68	0:34	21:19	6:11
H	84	0:32	26:31	8:55
I	0	0:00	0:00	0:00
J	0	0:00	0:00	0:00
K	53	0:24	12:07	4:13
L	0	0:00	0:00	0:00
M	102	0:47	47:24	16:44
N	98	0:36	36:02	12:42
O	45	0:15	7:07	2:18
P	118	0:43	46:10	16:28
Q	73	0:15	9:59	3:27
R	0	0:00	0:00	0:00
S	82	0:28	21:25	5:14
T	0	0:00	0:00	0:00
U	79	0:20	14:31	4:43
V	0	0:00	0:00	0:00
W	26	0:17	4:38	1:53
X	0	0:00	0:00	0:00

Receptor No.	Shadow days per year (Worst Case)	Max Shadow hours per day (Worst Case)	Shadow hours per year (Worst Case)	Shadow hours per year (Real-Case)
Y	0	0:00	0:00	0:00
Z	0	0:00	0:00	0:00
AA	34	0:15	5:34	1:54
AB	0	0:00	0:00	0:00
AC	0	0:00	0:00	0:00
AD	0	0:00	0:00	0:00
AE	21	0:15	3:24	1:10
AF	51	0:24	11:17	3:59
AG	20	0:15	3:25	0:59
AH	90	0:32	33:03	13:52
AI	0	0:00	0:00	0:00
AJ	0	0:00	0:00	0:00
AK	0	0:00	0:00	0:00
AL	0	0:00	0:00	0:00
AM	0	0:00	0:00	0:00
AN	0	0:00	0:00	0:00
AO	0	0:00	0:00	0:00
AP	0	0:00	0:00	0:00
AQ	0	0:00	0:00	0:00
AR	0	0:00	0:00	0:00
AS	0	0:00	0:00	0:00
AT	0	0:00	0:00	0:00
AU	0	0:00	0:00	0:00
AV	0	0:00	0:00	0:00
AW	0	0:00	0:00	0:00
AX	0	0:00	0:00	0:00
AY	0	0:00	0:00	0:00
AZ	0	0:00	0:00	0:00
BA	0	0:00	0:00	0:00
BB	0	0:00	0:00	0:00

All of the numeric and graphic results of the shadow flicker calculation are in Appendices B and C.

5.0 References

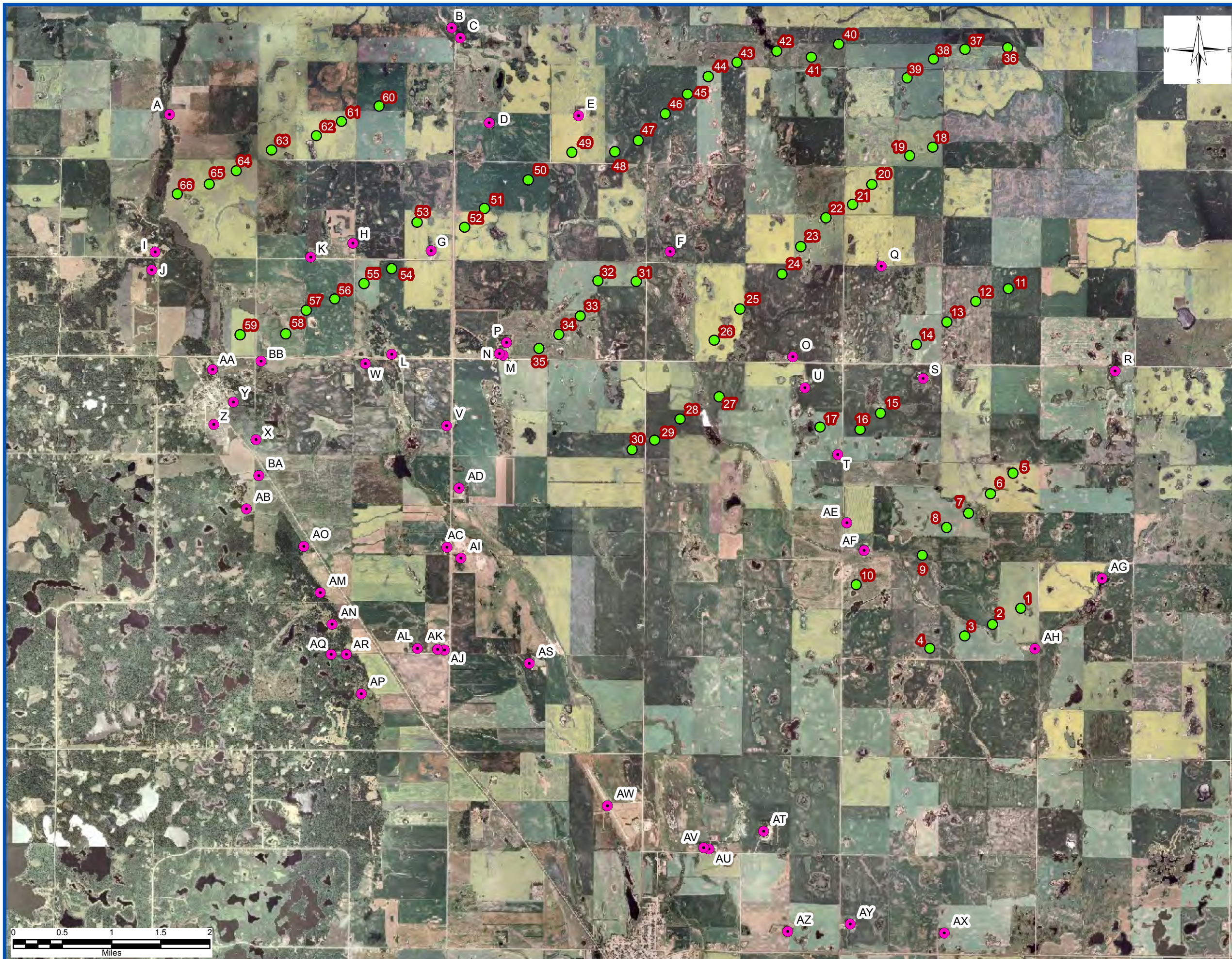
EMD WindPRO User Guide, EMD International A/S, Denmark, January 2006

Higgins Mountain II Wind Plant: Analysis of Shadow Flicker on Ski Wentworth, Frontier Power Systems Inc, Alberton, PE, December 2007

<http://www.city-data.com/city/Rolla-North-Dakota.html>

Bornish Wind Power Project Shadow Flicker Assessment GENIVAR, Calgary, AB, October 2009

Appendix A – Project Layout with Shadow Receptors



Border Winds Wind Energy Project

Appendix A: Project Layout with Shadow Receptors

- PROPOSED TURBINES
- SHADOW RECEPTORS

03 / 2010 1:60,000

Source(s):



Appendix B – WindPRO Analysis Numeric Results

Project:

Border Winds Feb 09 10 Layout Options

Description:

Shadow Flicker calculation for 54 receptors without Obstacles - Feb 09 10 150MW Layout - Using Sunshine statistics for Rolla ND and operational data from tower 1509

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Calculated:

3/3/2010 11:35 PM/2.6.1.252

SHADOW - Main Result

Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

Assumptions for shadow calculations

Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence 3 °
Day step for calculation 1 days
Time step for calculation 1 minutes

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
0.51	0.55	0.57	0.59	0.61	0.65	0.71	0.71	0.65	0.56	0.45	0.46

Operational hours are calculated from WTGs in calculation and wind distribution:
Validation Tower 1509

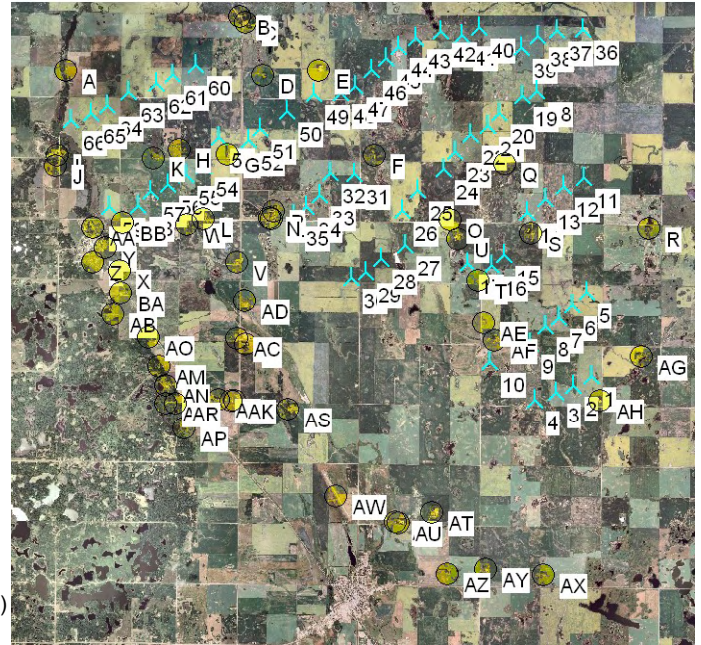
Operational time

0	1	2	3	4	5	6	7	8	9	10	11	
349	310	244	176	167	161	158	144	196	316	344	430	
12	13	14	15	16	17	18	19	20	21	22	23	Sum
400	406	384	333	291	256	305	349	616	856	612	399	8,201

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: Border Winds 5m Contours.WPO (1)
Obstacles not used in calculation

Eye height: 1.5 m
Grid resolution: 10 m



Scale 1:200,000
New WTG (red triangle)
Shadow receptor (yellow circle)

WTGs

UTM NAD83 Zone: 14				Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
East	North	Z	Valid		Manufact.	Type-generator	Calculation distance [m]				RPM [RPM]	
UTM NAD83 Zone: 14			[m]									
1	461,209	5,418,024	543.1	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
2	460,745	5,417,760	545.0	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
3	460,286	5,417,572	545.5	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
4	459,719	5,417,370	545.4	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
5	461,082	5,420,240	542.1	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
6	460,712	5,419,898	544.9	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
7	460,355	5,419,584	545.0	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
8	459,992	5,419,352	547.9	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
9	459,597	5,418,893	550.0	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
10	458,516	5,418,412	550.0	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
11	461,006	5,423,257	540.0	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
12	460,469	5,423,047	541.7	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
13	460,000	5,422,713	546.2	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
14	459,500	5,422,348	550.0	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
15	458,909	5,421,220	550.0	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
16	458,574	5,420,951	551.9	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
17	457,921	5,420,990	555.0	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
18	459,764	5,425,573	541.4	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
19	459,389	5,425,435	544.9	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
20	458,769	5,424,966	548.0	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
21	458,453	5,424,641	550.0	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
22	458,017	5,424,421	550.0	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
23	457,607	5,423,946	551.9	Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0

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Project: Border Winds Feb 09 10 Layout Options	Description: Shadow Flicker calculation for 54 receptors without Obstacles - Feb 09 10 150MW Layout - Using Sunshine statistics for Rolla ND and operational data from tower 1509	Printed/Page: 3/4/2010 9:40 AM / 2 Licensed user: Sequoia Energy Inc. 210 - 259 Portage Ave. CA-WINNIPEG, MB R3B 2A9 (204)927 0290 Calculated: 3/3/2010 11:35 PM/2.6.1.252
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SHADOW - Main Result

Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

...continued from previous page

UTM NAD83 Zone: 14			WTG type				Shadow data				
East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
UTM NAD83 Zone: 14		[m]									
24	457,302	5,423,497	555.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
25	456,609	5,422,926	557.5 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
26	456,186	5,422,414	555.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
27	456,269	5,421,489	555.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
28	455,628	5,421,122	555.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
29	455,215	5,420,778	556.4 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
30	454,847	5,420,625	560.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
31	454,912	5,423,378	556.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
32	454,289	5,423,386	560.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
33	454,000	5,422,810	560.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
34	453,647	5,422,510	560.5 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
35	453,321	5,422,282	563.2 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
36	460,991	5,427,202	527.3 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
37	460,293	5,427,179	535.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
38	459,780	5,427,018	536.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
39	459,349	5,426,709	540.3 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
40	458,225	5,427,257	544.8 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
41	457,776	5,427,048	550.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
42	457,215	5,427,150	550.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
43	456,562	5,426,965	552.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
44	456,090	5,426,732	555.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
45	455,750	5,426,442	555.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
46	455,392	5,426,122	555.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
47	454,946	5,425,687	555.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
48	454,564	5,425,501	555.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
49	453,860	5,425,494	560.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
50	453,148	5,425,042	560.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
51	452,431	5,424,572	560.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
52	452,105	5,424,264	561.7 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
53	451,326	5,424,342	564.9 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
54	450,909	5,423,587	567.9 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
55	450,457	5,423,345	570.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
56	449,978	5,423,089	570.6 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
57	449,512	5,422,906	575.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
58	449,177	5,422,518	578.1 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
59	448,430	5,422,504	583.5 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
60	450,705	5,426,250	560.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
61	450,094	5,425,995	564.1 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
62	449,681	5,425,759	570.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
63	448,942	5,425,527	570.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
64	448,372	5,425,189	574.1 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
65	447,926	5,424,971	575.0 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0
66	447,407	5,424,809	578.1 Siemens SWT-2.3-10...	Yes	Siemens	SWT-2.3-101 1.19-2,300	2,300	100.6	80.0	1,463	16.0

Shadow receptor-Input

UTM NAD83 Zone: 14									
No.	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	447,274	5,426,112	570.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
B	451,890	5,427,531	555.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
C	452,035	5,427,369	555.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
D	452,504	5,425,972	560.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
E	453,966	5,426,091	555.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"

Continued on next page...

Project:
Border Winds Feb 09 10 Layout Options

Description:
 Shadow Flicker calculation for 54 receptors without
 Obstacles - Feb 09 10 150MW Layout - Using Sunshine
 statistics for Rolla ND and operational data from tower 1509

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SHADOW - Main Result

Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

...continued from previous page

UTM NAD83 Zone: 14

No.	East	North	Z	Width	Height	Height	Degrees from	Slope of	Direction mode
				[m]	[m]	a.g.l.	south cw	window	
				[m]	[m]	[m]	[°]	[°]	
F	455,465	5,423,866	555.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
G	451,557	5,423,882	565.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H	450,273	5,424,003	570.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
I	447,039	5,423,860	583.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
J	446,984	5,423,569	586.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
K	449,582	5,423,777	570.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
L	450,912	5,422,185	568.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
M	452,734	5,422,168	565.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
N	452,675	5,422,194	565.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
O	457,474	5,422,142	555.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
P	452,788	5,422,379	564.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Q	458,919	5,423,625	550.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
R	462,746	5,421,912	532.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
S	459,607	5,421,788	550.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
T	458,208	5,420,544	555.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
U	457,670	5,421,638	555.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
V	451,809	5,421,016	565.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
W	450,477	5,422,030	566.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
X	448,691	5,420,787	588.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Y	448,322	5,421,404	589.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Z	447,997	5,421,038	594.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AA	447,979	5,421,937	585.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AB	448,534	5,419,657	606.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AC	451,816	5,419,024	565.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AD	452,012	5,419,994	562.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AE	458,355	5,419,429	550.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AF	458,640	5,418,974	550.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AG	462,531	5,418,515	530.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AH	461,437	5,417,362	535.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AI	452,043	5,418,848	565.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AJ	451,772	5,417,345	570.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AK	451,662	5,417,353	571.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AL	451,329	5,417,370	575.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AM	449,740	5,418,284	598.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AN	449,933	5,417,764	602.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AO	449,472	5,419,039	590.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AP	450,412	5,416,626	598.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AQ	449,918	5,417,273	605.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AR	450,169	5,417,273	594.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AS	453,163	5,417,128	560.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AT	456,998	5,414,378	555.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AU	456,102	5,414,086	553.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AV	456,014	5,414,106	552.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AW	454,441	5,414,794	555.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AX	459,950	5,412,708	540.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AY	458,412	5,412,856	550.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AZ	457,391	5,412,736	552.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BA	448,736	5,420,201	590.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
BB	448,770	5,422,074	580.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"

Project: Border Winds Feb 09 10 Layout Options	Description: Shadow Flicker calculation for 54 receptors without Obstacles - Feb 09 10 150MW Layout - Using Sunshine statistics for Rolla ND and operational data from tower 1509	Printed/Page 3/4/2010 9:40 AM / 4 Licensed user: Sequoia Energy Inc. 210 - 259 Portage Ave. CA-WINNIPEG, MB R3B 2A9 (204)927 0290 Calculated: 3/3/2010 11:35 PM/2.6.1.252
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SHADOW - Main Result

Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

Calculation Results

Shadow receptor

No.	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	6:46	46	0:16	2:08
B	0:00	0	0:00	0:00
C	0:00	0	0:00	0:00
D	2:34	18	0:13	0:52
E	38:53	112	0:30	12:35
F	41:55	108	0:34	10:26
G	21:19	68	0:34	6:11
H	26:31	84	0:32	8:55
I	0:00	0	0:00	0:00
J	0:00	0	0:00	0:00
K	12:07	53	0:24	4:13
L	0:00	0	0:00	0:00
M	47:24	102	0:47	16:44
N	36:02	98	0:36	12:42
O	7:07	45	0:15	2:18
P	46:10	118	0:43	16:28
Q	9:59	73	0:15	3:27
R	0:00	0	0:00	0:00
S	21:25	82	0:28	5:14
T	0:00	0	0:00	0:00
U	14:31	79	0:20	4:43
V	0:00	0	0:00	0:00
W	4:38	26	0:17	1:53
X	0:00	0	0:00	0:00
Y	0:00	0	0:00	0:00
Z	0:00	0	0:00	0:00
AA	5:34	34	0:15	1:54
AB	0:00	0	0:00	0:00
AC	0:00	0	0:00	0:00
AD	0:00	0	0:00	0:00
AE	3:24	21	0:15	1:10
AF	11:17	51	0:24	3:59
AG	3:25	20	0:15	0:59
AH	33:03	90	0:32	13:52
AI	0:00	0	0:00	0:00
AJ	0:00	0	0:00	0:00
AK	0:00	0	0:00	0:00
AL	0:00	0	0:00	0:00
AM	0:00	0	0:00	0:00
AN	0:00	0	0:00	0:00
AO	0:00	0	0:00	0:00
AP	0:00	0	0:00	0:00
AQ	0:00	0	0:00	0:00
AR	0:00	0	0:00	0:00
AS	0:00	0	0:00	0:00
AT	0:00	0	0:00	0:00
AU	0:00	0	0:00	0:00
AV	0:00	0	0:00	0:00
AW	0:00	0	0:00	0:00
AX	0:00	0	0:00	0:00
AY	0:00	0	0:00	0:00
AZ	0:00	0	0:00	0:00
BA	0:00	0	0:00	0:00

Continued on next page...

Project: Border Winds Feb 09 10 Layout Options	Description: Shadow Flicker calculation for 54 receptors without Obstacles - Feb 09 10 150MW Layout - Using Sunshine statistics for Rolla ND and operational data from tower 1509	Printed/Page: 3/4/2010 9:40 AM / 5 Licensed user: Sequoia Energy Inc. 210 - 259 Portage Ave. CA-WINNIPEG, MB R3B 2A9 (204)927 0290 Calculated: 3/3/2010 11:35 PM/2.6.1.252
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SHADOW - Main Result

Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

...continued from previous page

No.	Shadow, worst case		Shadow, expected values	
	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
BB	0:00	0	0:00	0:00

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

No.	Name	Worst case [h/year]
1	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1134)	3:25
2	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1135)	26:59
3	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1136)	6:04
4	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1137)	0:00
5	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1138)	0:00
6	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1139)	0:00
7	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1140)	0:00
8	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1141)	3:08
9	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1142)	11:33
10	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1143)	0:00
11	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1144)	0:00
12	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1145)	0:00
13	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1146)	6:30
14	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1147)	0:00
15	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1148)	24:34
16	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1149)	16:41
17	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1150)	0:00
18	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1151)	0:00
19	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1152)	0:00
20	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1153)	0:00
21	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1154)	0:00
22	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1155)	0:00
23	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1156)	3:29
24	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1157)	0:00
25	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1158)	0:00
26	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1159)	3:36
27	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1160)	5:56
28	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1161)	0:00
29	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1162)	0:00
30	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1163)	0:00
31	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1164)	37:31
32	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1165)	4:24
33	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1166)	11:39
34	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1167)	27:09
35	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1168)	69:07
36	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1169)	0:00
37	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1170)	0:00
38	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1171)	0:00
39	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1172)	0:00
40	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1173)	0:00
41	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1174)	0:00
42	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1175)	0:00
43	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1176)	0:00
44	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1177)	0:00
45	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1178)	0:00
46	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1179)	2:30
47	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1180)	6:49
48	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1181)	29:34

Continued on next page...

Project:

Border Winds Feb 09 10 Layout Options

Description:

Shadow Flicker calculation for 54 receptors without
Obstacles - Feb 09 10 150MW Layout - Using Sunshine
statistics for Rolla ND and operational data from tower 1509

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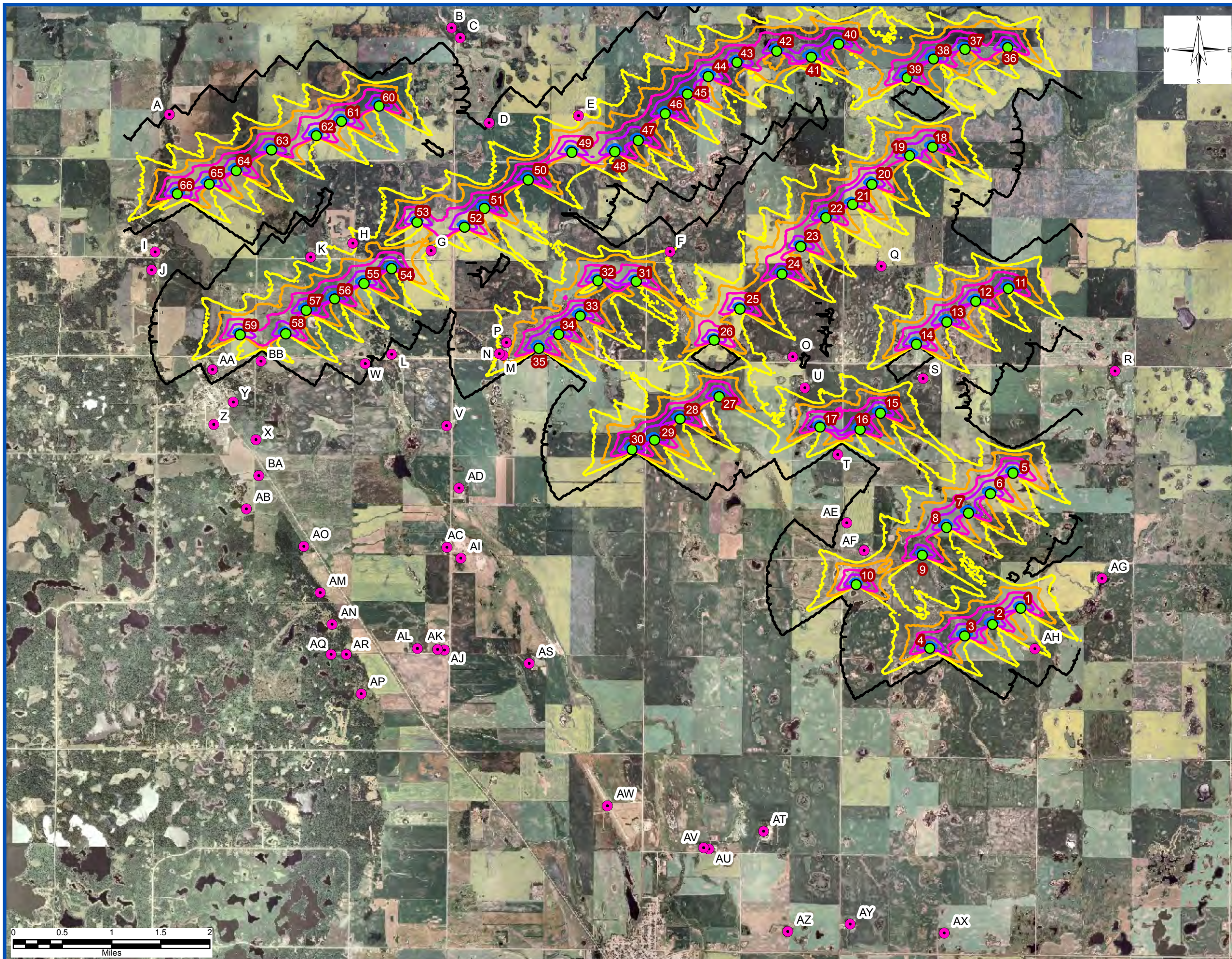
SHADOW - Main Result

Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

...continued from previous page

No.	Name	Worst case [h/year]
49	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1182)	2:34
50	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1183)	0:00
51	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1184)	0:00
52	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1185)	1:34
53	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1186)	7:02
54	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1187)	41:36
55	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1188)	14:26
56	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1189)	0:00
57	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1190)	0:00
58	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1191)	10:12
59	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1192)	0:00
60	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1193)	0:00
61	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1194)	0:00
62	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1195)	0:00
63	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1196)	0:00
64	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1197)	6:46
65	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1198)	0:00
66	Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1199)	0:00

Appendix C – WindPRO Analysis Graphic Results



Border Winds Wind Energy Project

Appendix C: Graphic Results

- PROPOSED TURBINES
- SHADOW RECEPTORS

Shadow Hours Per Year (Real Case)

- 0.015
- 0.016 - 10.000
- 10.001 - 25.000
- 25.001 - 50.000
- 50.001 - 100.000
- 100.001 - 200.000

03 / 2010

1:60,000

Source(s):



Project:
Border Winds Feb 09 10 Layout Options

Description:
 Shadow Flicker calculation for 54 receptors without
 Obstacles - Feb 09 10 150MW Layout - Using Sunshine
 statistics for Rolla ND and operational data from tower 1509

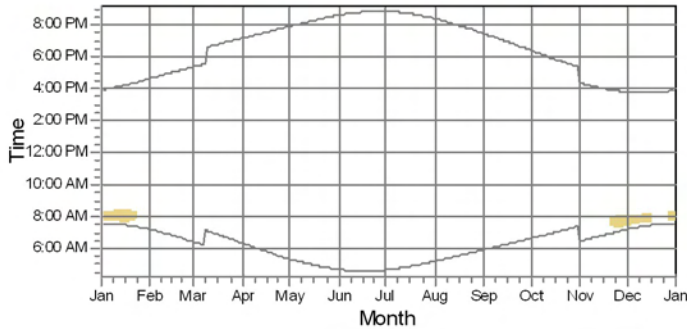
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Sequoia Energy Inc.
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 (204)927 0290

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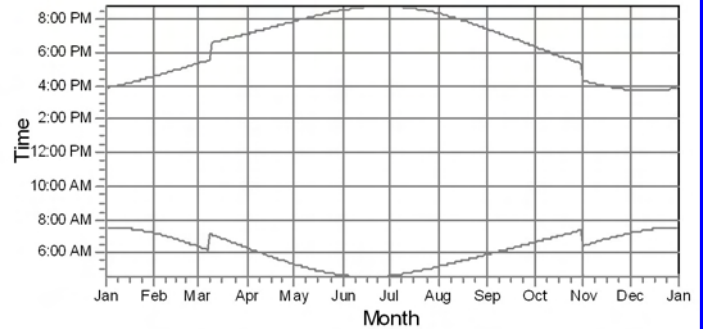
SHADOW - Calendar, graphical

Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

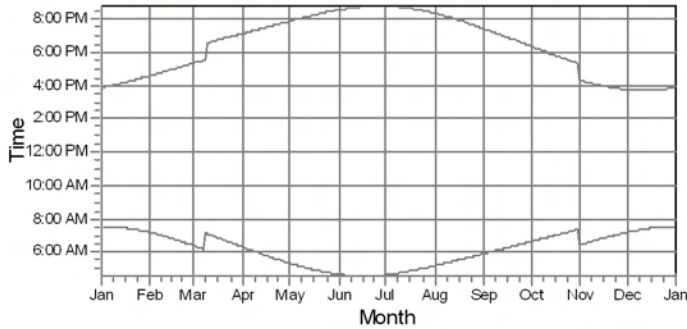
A: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (1)



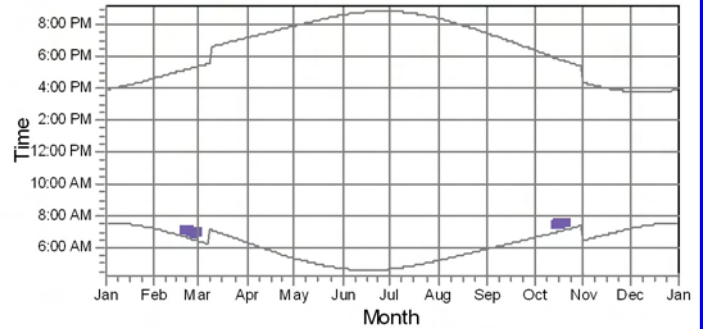
B: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (2)



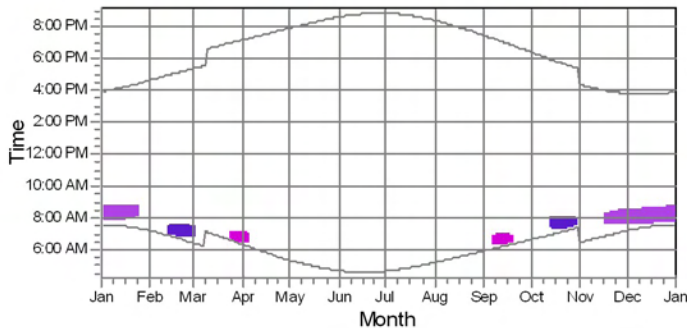
C: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (3)



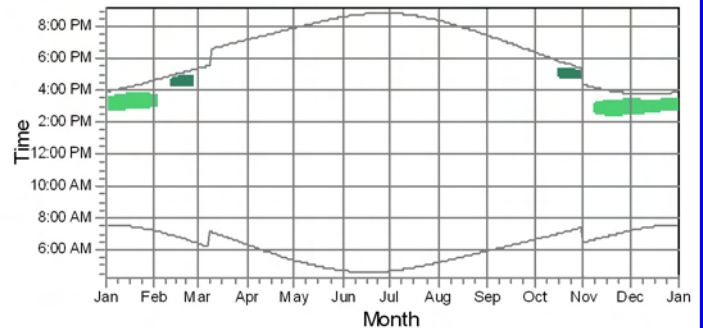
D: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (4)



E: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (5)



F: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (6)



WTGs

- | | |
|--|--|
| <ul style="list-style-type: none"> 31: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1164) 32: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1165) 46: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1179) 47: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1180) | <ul style="list-style-type: none"> 48: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1181) 49: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1182) 64: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1197) |
|--|--|

Project:
Border Winds Feb 09 10 Layout Options

Description:
 Shadow Flicker calculation for 54 receptors without
 Obstacles - Feb 09 10 150MW Layout - Using Sunshine
 statistics for Rolla ND and operational data from tower 1509

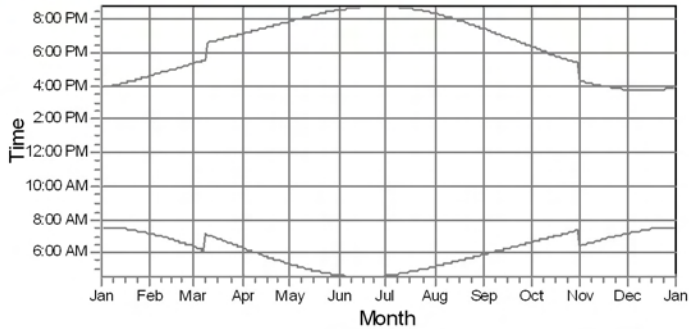
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Calculated:
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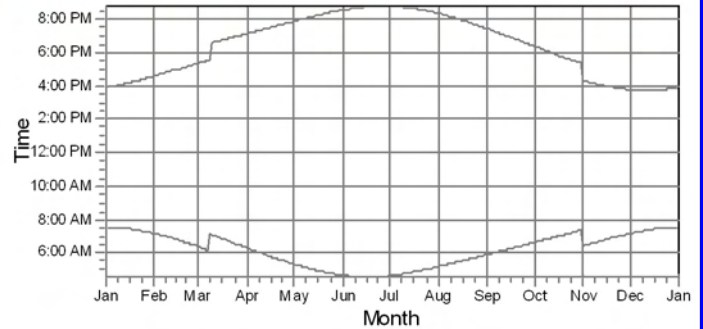
SHADOW - Calendar, graphical

Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

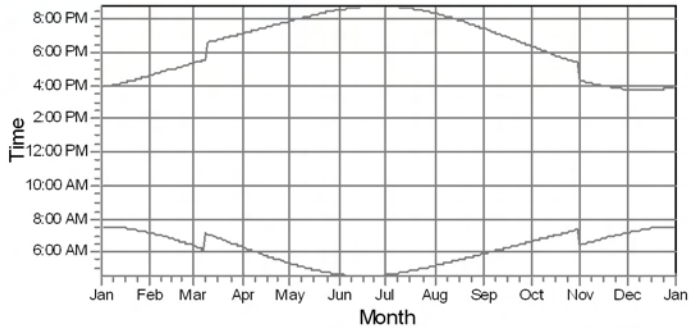
AW: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (49)



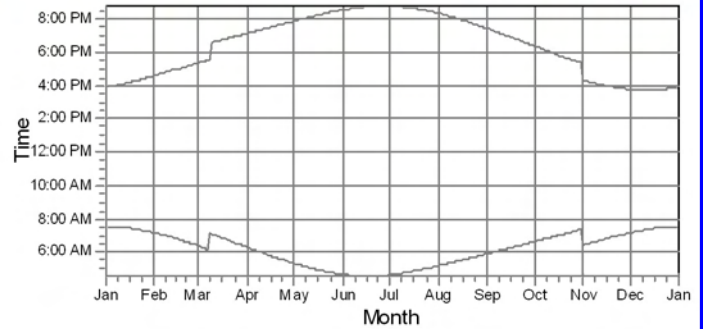
AX: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (50)



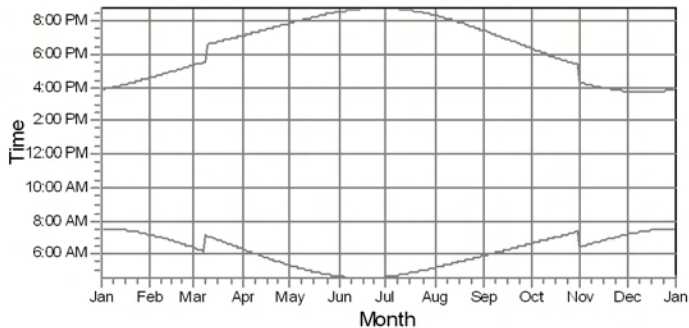
AY: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (51)



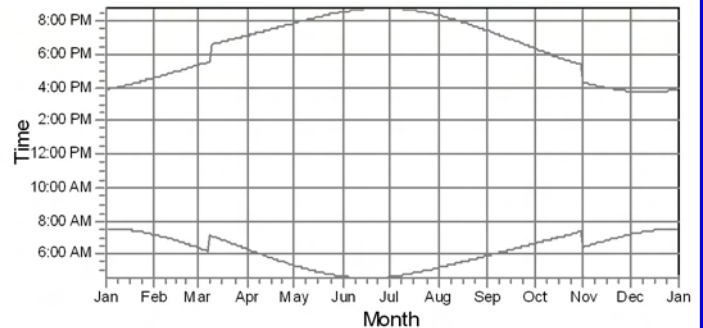
AZ: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (52)



BA: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (53)



BB: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (54)



WTGs

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Border Winds Feb 09 10 Layout Options

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 Shadow Flicker calculation for 54 receptors without
 Obstacles - Feb 09 10 150MW Layout - Using Sunshine
 statistics for Rolla ND and operational data from tower 1509

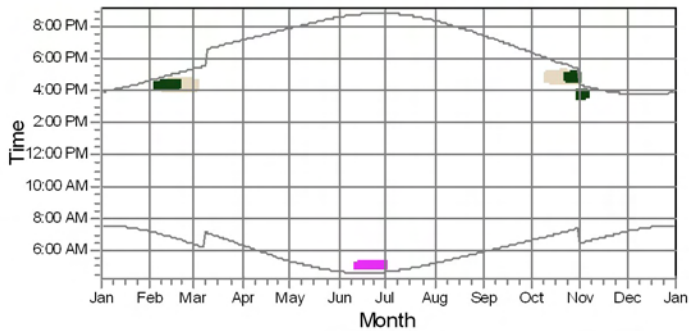
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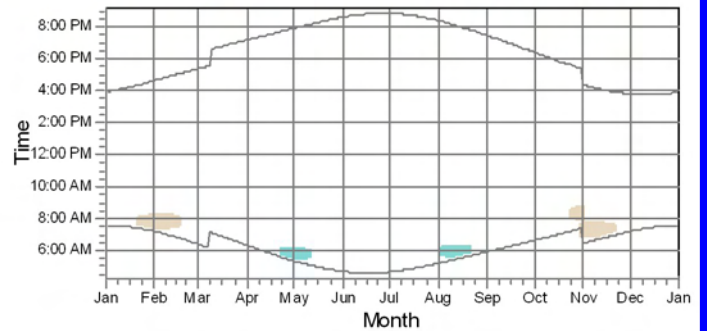
SHADOW - Calendar, graphical

Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

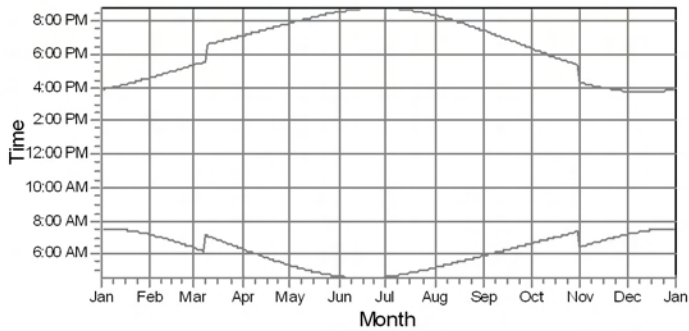
G: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (7)



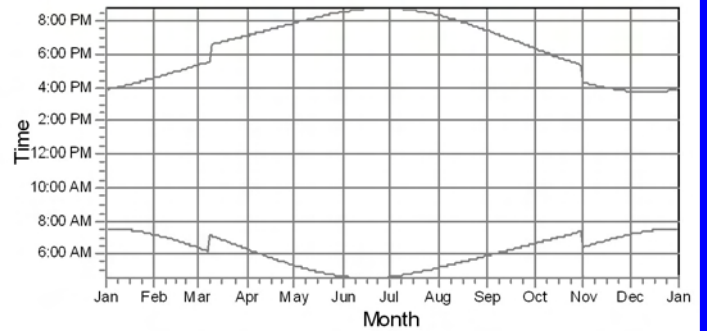
H: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (8)



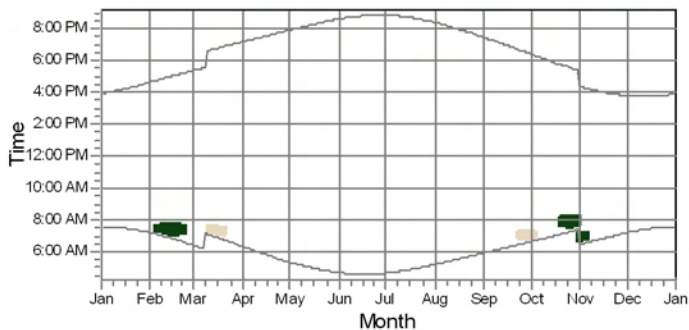
I: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (9)



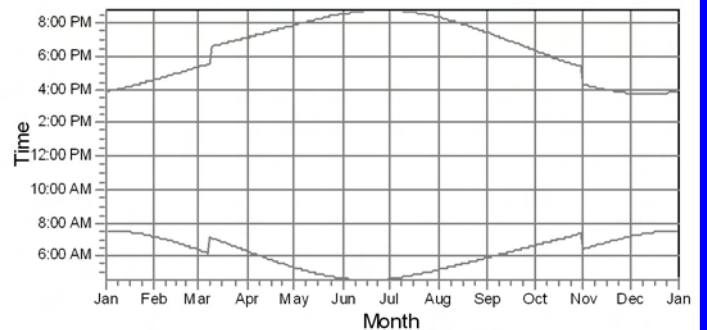
J: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (10)



K: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (11)



L: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (12)



WTGs

- 52: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1185)
- 53: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1186)
- 54: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1187)
- 55: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1188)

Project:
Border Winds Feb 09 10 Layout Options

Description:
 Shadow Flicker calculation for 54 receptors without
 Obstacles - Feb 09 10 150MW Layout - Using Sunshine
 statistics for Rolla ND and operational data from tower 1509

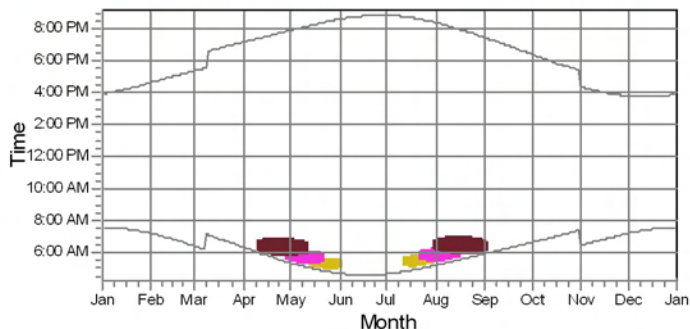
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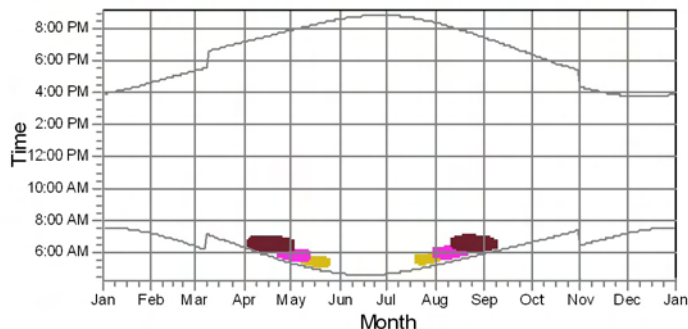
SHADOW - Calendar, graphical

Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

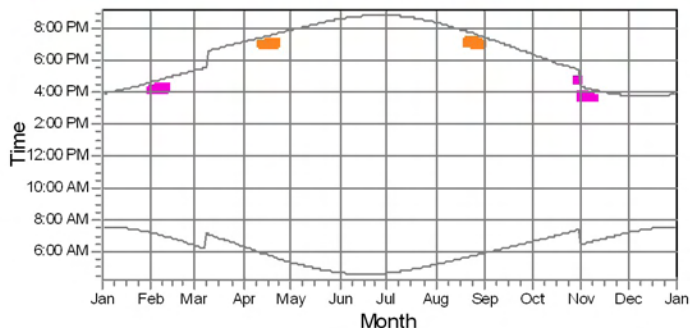
M: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (13)



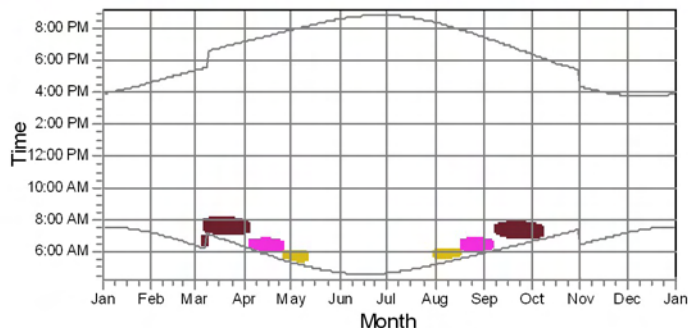
N: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (14)



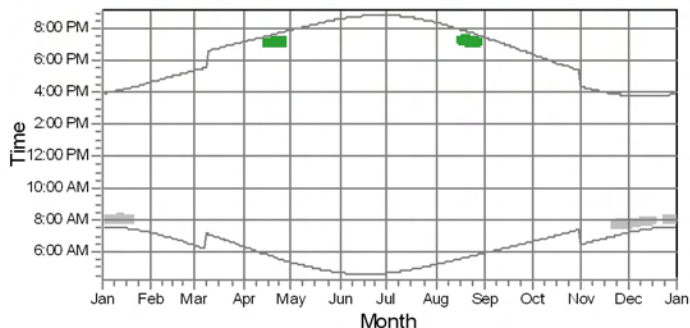
O: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (15)



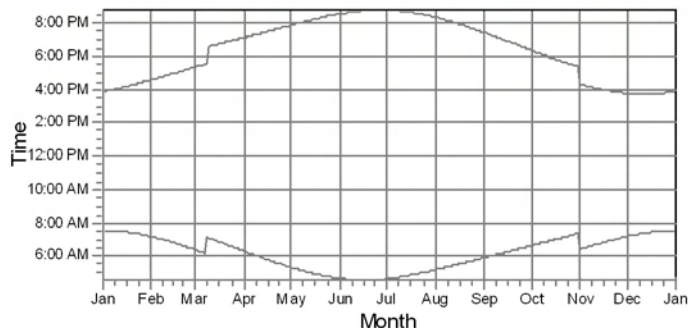
P: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (16)



Q: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (17)



R: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (18)



WTGs

- 13: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1146)
- 23: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1156)
- 26: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1159)
- 27: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1160)

- 33: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1166)
- 34: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1167)
- 35: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1168)

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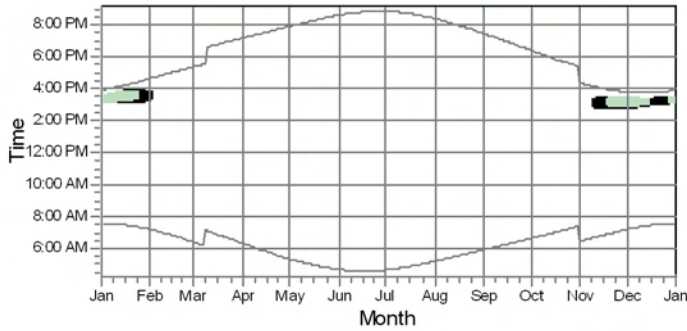
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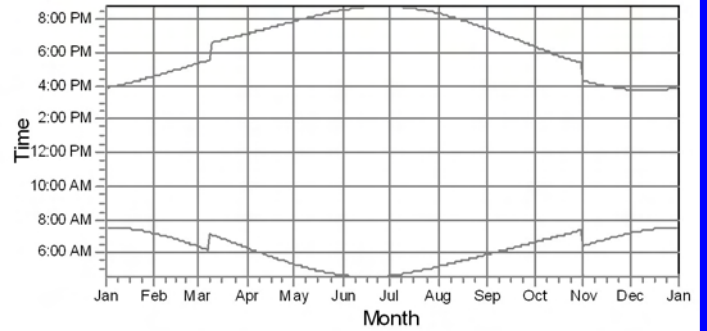
SHADOW - Calendar, graphical

Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

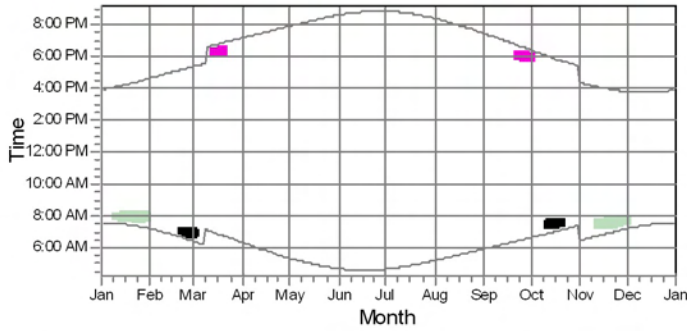
S: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (19)



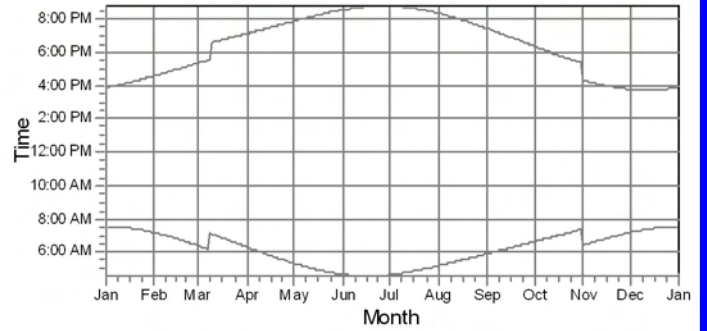
T: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (20)



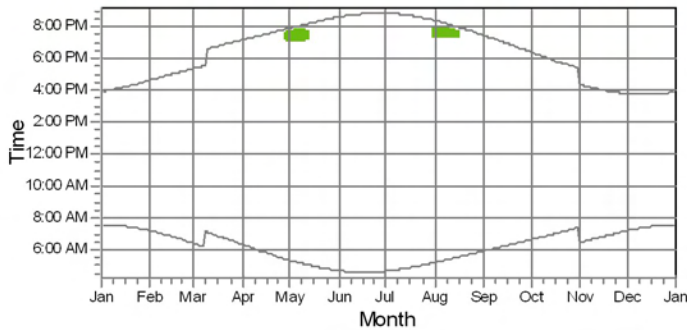
U: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (21)



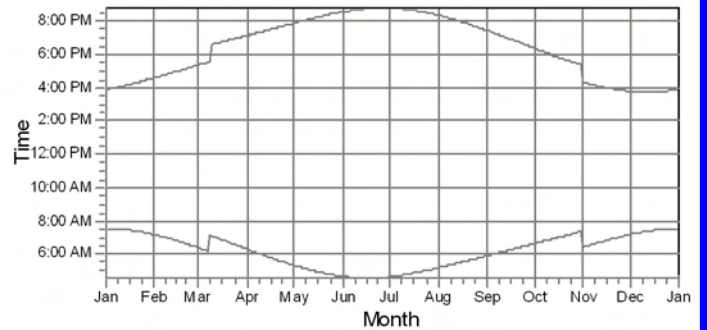
V: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (22)







W: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (23)



X: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (24)



WTGs

-  15: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1148)
-  16: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1149)
-  27: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1160)
-  58: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1191)

Project:
Border Winds Feb 09 10 Layout Options

Description:
 Shadow Flicker calculation for 54 receptors without
 Obstacles - Feb 09 10 150MW Layout - Using Sunshine
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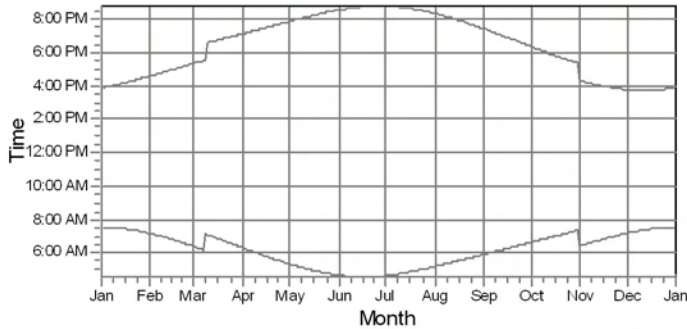
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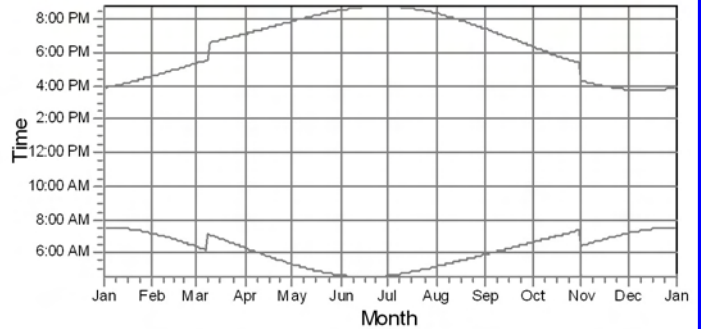
SHADOW - Calendar, graphical

Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

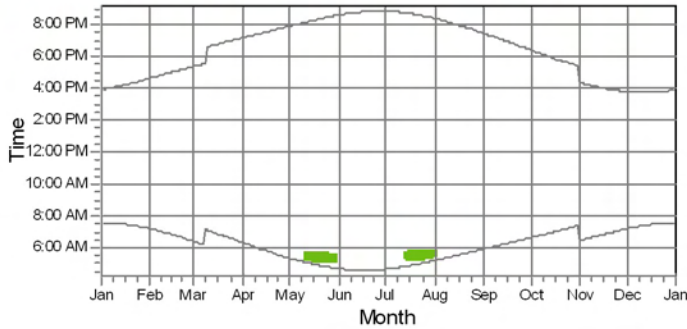
Y: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (25)



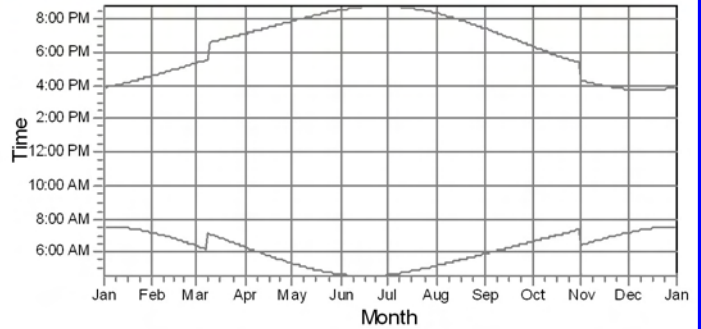
Z: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (26)



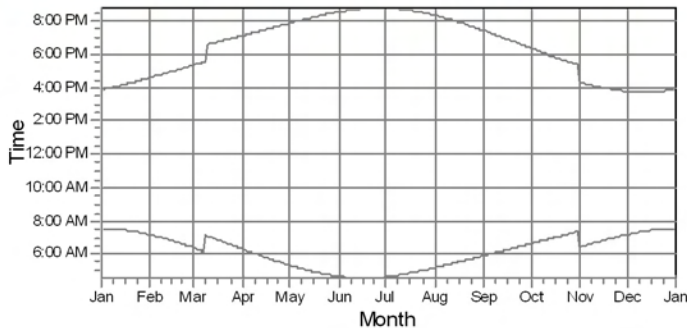
AA: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (27)



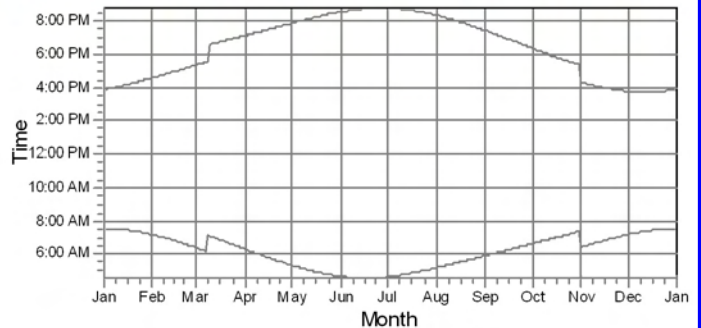
AB: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (28)



AC: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (29)



AD: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (30)



WTGs

58: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1191)

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Border Winds Feb 09 10 Layout Options

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 Shadow Flicker calculation for 54 receptors without
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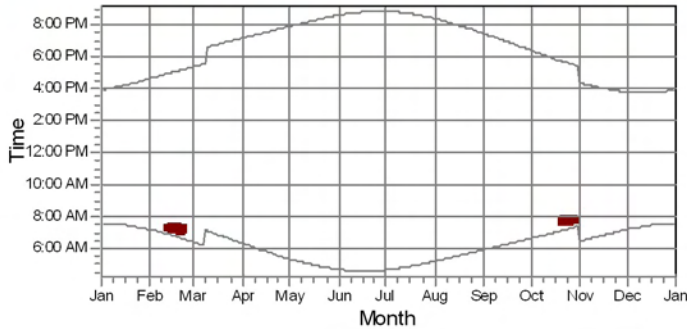
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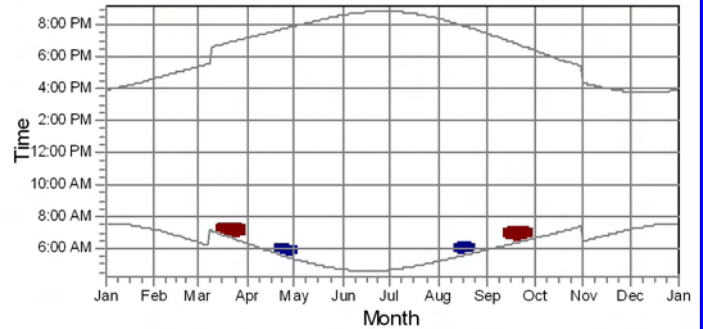
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Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

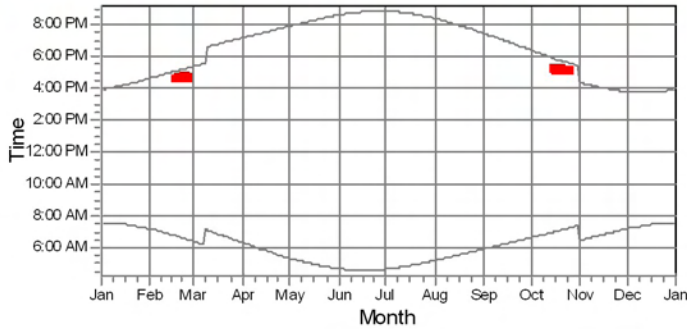
AE: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (31)



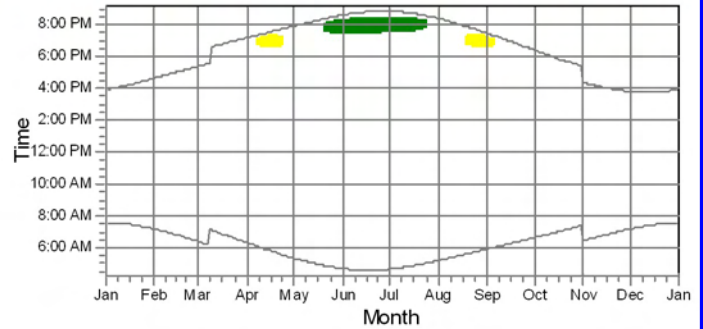
AF: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (32)



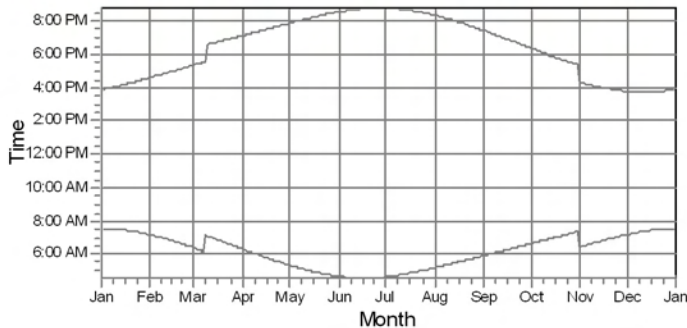
AG: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (33)



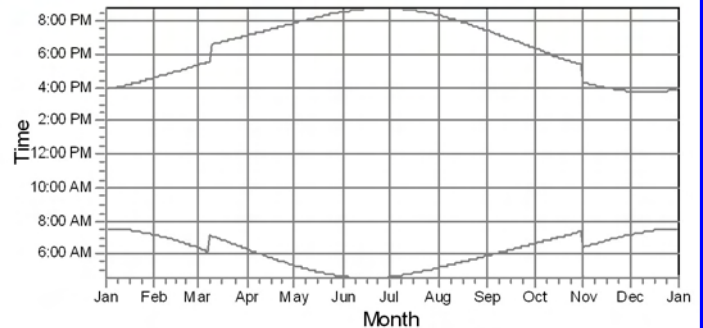
AH: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (34)



AI: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (35)



AJ: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (36)



WTGs

- 1: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1134)
- 2: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1135)
- 3: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1136)
- 8: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1141)
- 9: Siemens SWT-2.3-101 1.19 2300 100.6 !O! hub: 80.0 m (1142)

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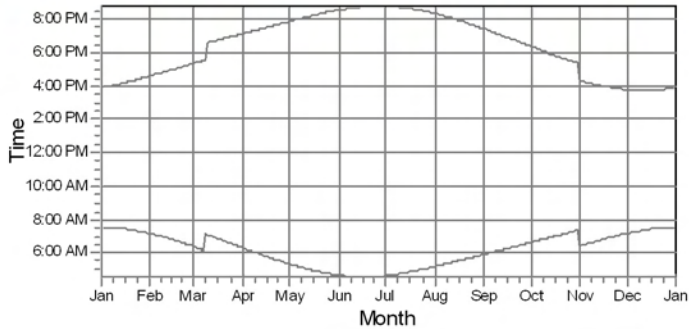
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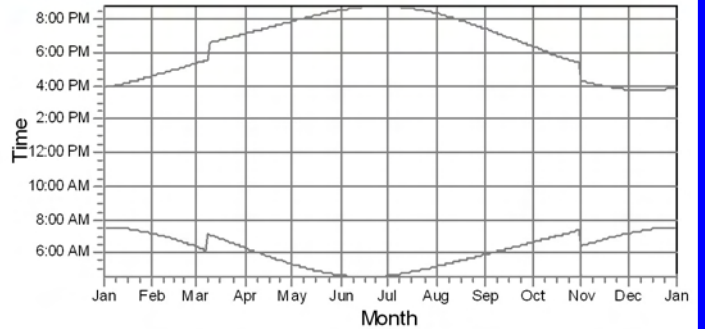
SHADOW - Calendar, graphical

Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

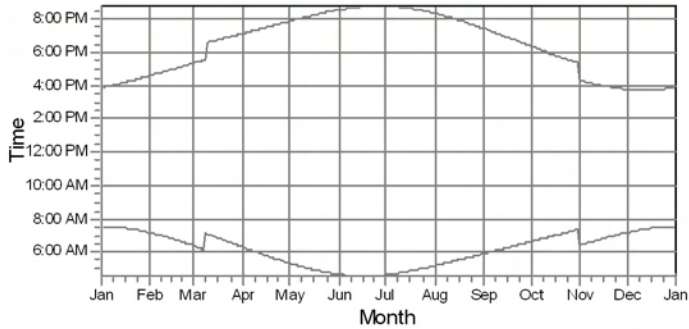
AK: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (37)



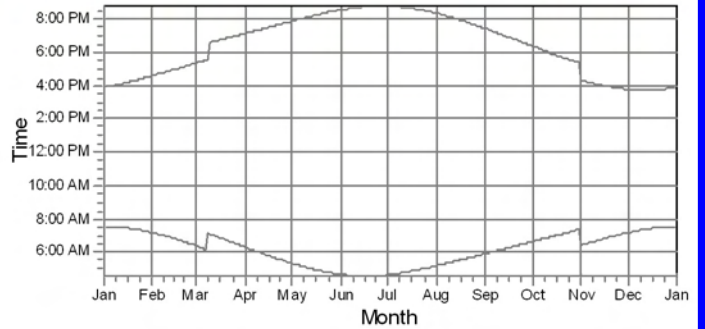
AL: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (38)



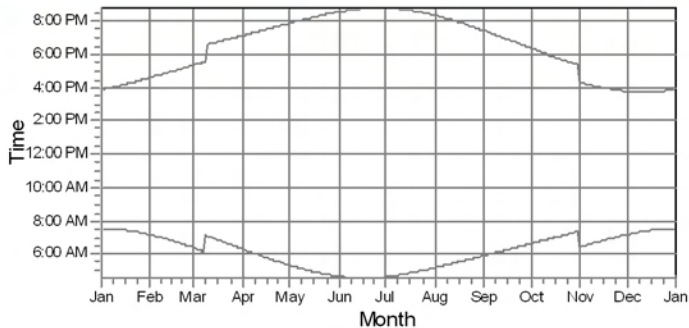
AM: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (39)



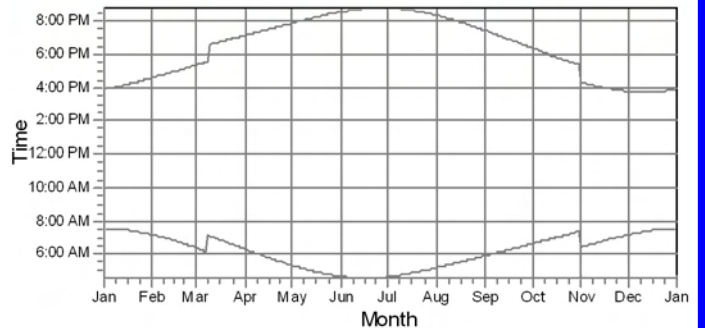
AN: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (40)



AO: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (41)



AP: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (42)



WTGs

Project: **Border Winds Feb 09 10 Layout Options**

Description: Shadow Flicker calculation for 54 receptors without Obstacles - Feb 09 10 150MW Layout - Using Sunshine statistics for Rolla ND and operational data from tower 1509

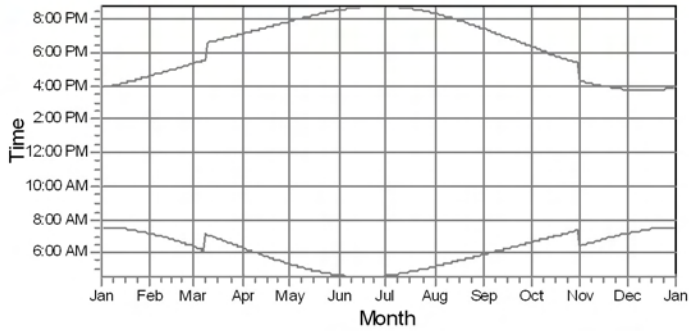
Printed/Page: 3/4/2010 9:44 AM / 8
Licensed user: **Sequoia Energy Inc.**
210 - 259 Portage Ave.
CA-WINNIPEG, MB R3B 2A9
(204)927 0290

Calculated: 3/3/2010 11:35 PM/2.6.1.252

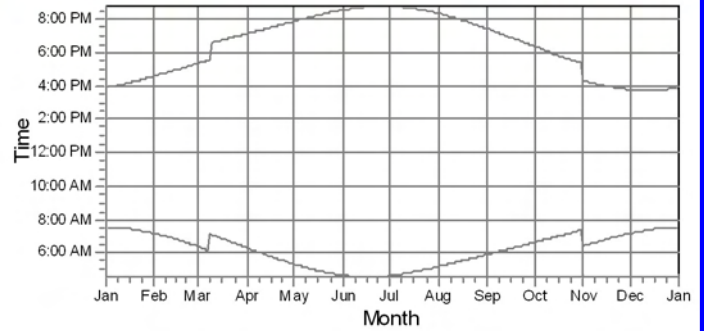
SHADOW - Calendar, graphical

Calculation: Shadow Flicker - 54 receptors w/o Obstacles - Feb 09 10 150MW Layout - Using Solar and Turbine Operation D

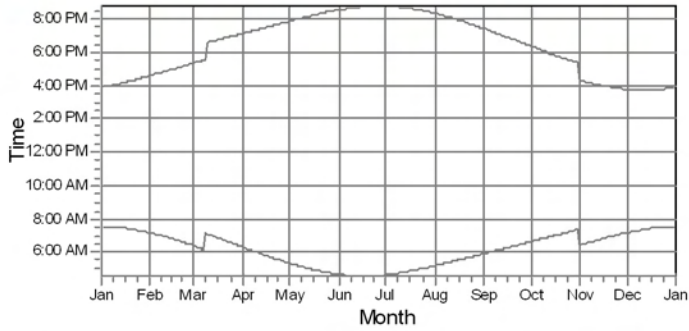
AQ: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (43)



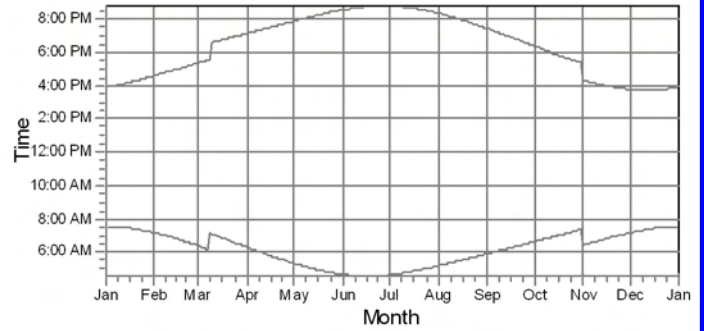
AR: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (44)



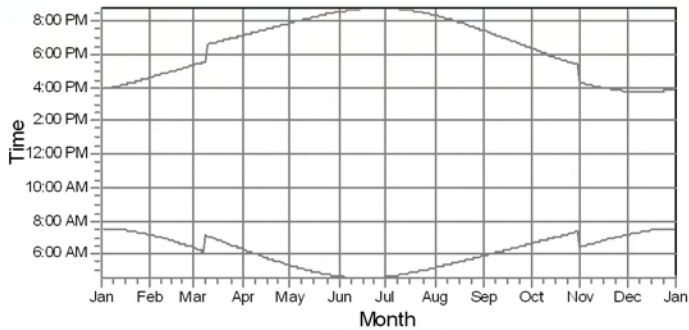
AS: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (45)



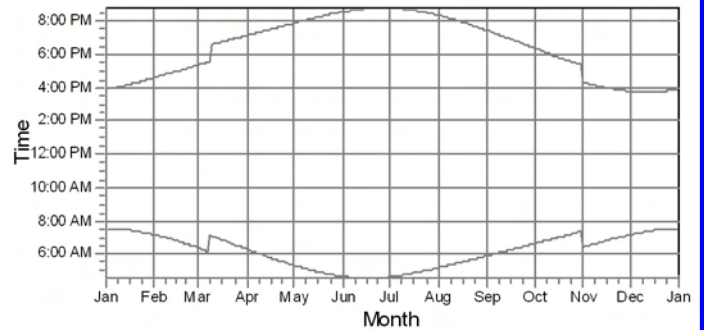
AT: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (46)



AU: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (47)



AV: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 90.0° (48)



WTGs