APPENDIX B:

VISUALIZATION, PHOTO ANALYSIS & SHADOW FLICKER ANALYSIS

THE RENAISSANCE GROUP

A Conserve First Company

Archbold Area Schools
Wind Turbine Project
Turbine Visualization and Photo Analysis

Prepared for:
Archbold Area Schools

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Thank You for Choosing The Renaissance Group, a Conserve First LLC Company

Introduction

Although the visual impact of wind turbine installations is highly subjective, some people consider them a tremendous asset to their landscape and community and others say “not in my backyard”. This said, it is often beneficial to get a sense of what an installation will look like before it is installed. The actual visibility of a turbine installation is affected by many factors: the size of the machine, the number of machines, tower and blade tip heights, turbine color, distance to the viewer, obstructions such as trees, hills and buildings, atmospheric conditions, Sun angle and even the curvature of the Earth. All things considered, the overall height of a turbine, obstructions in the sightline between the viewer and the turbine and the distance between the machine and the viewer has the greatest impact. Even in open unobstructed ground very tall towers become very small in the distance and even the largest of machines can be blocked by relatively short obstructions close to the viewer. All this said, when in an open sightline in close proximity, a modern wind turbine can be an imposing or an awe inspiring presence in the view-shed pending ones point of view. In all such cases, few would argue that the turbine was not a significant element of the said view-shed. (Further understanding concerning the relative view-shed size of turbines at distance and their visibility in relation to obstructions can be viewed on the following addendums at the end of this report: Horizon View Impact Calculator, Example Turbine View Calculator, Wind Turbine Visibility Over Obstruction Tables and Sample Wind Turbine View Calculator.)

Methods

Using field surveys, mathematical modeling and stake holder interests, the study team identified representative sightline locations for actual turbine visualization studies. At these sites, precise location logs were taken with accompanying photographs toward the turbine site. Camera bearings were confirmed using detailed maps and compass bearings. The camera height above ground was approximately 68” and the tilt was maintained at zero degrees/level. The camera’s focal length was maintained at 28 mm which was entered into the rendering software and which approximates a typical person’s field of view for the camera used, or approximately 65%. WindPro 2.7, an internationally accepted wind project modeling software, was used to create the visualizations. The software uses the input data such as turbine location, viewer location, topographical baselines maps, turbine model and height, camera bearing, camera tilt and camera focal length to calculate the distance of the turbine, its perspective height, differential ground levels and Sun angles to correctly locate, scale and shade the turbine onto the base sightline photograph. The technician then verifies for scale and location using secondary plots. The technician also manually removes the portions of the turbine overlay that would be blocked by the obstruction shown in the photo that would between the viewer and the turbine.

Special consideration was given to identifying potentially historically or culturally significant view-sheds for historic buildings, sites and landscapes. This review was done in conjunction with the local Historical Society and utilizing the Ohio Historic Preservation Office database.

Panoramic photos were also taken at sample locations including the turbine installation site.

A Sony DSC-HX1 camera was used for all source imagery.

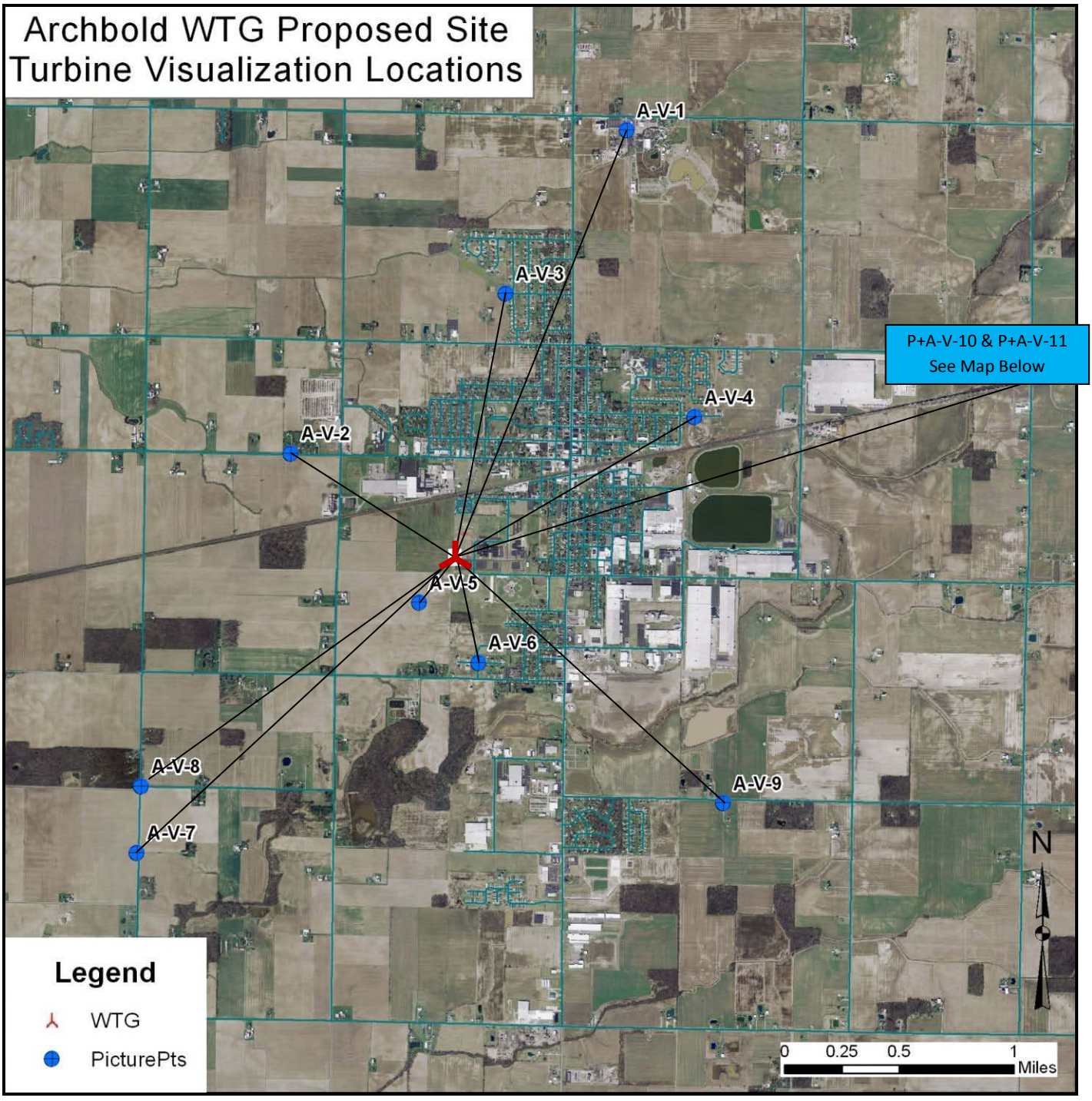
Results

See the following pages for representative turbine visualizations. Due to local obstruction proximities and densities to typical sightlines such as trees and buildings, much of the community will not be able to see the

turbine. This said much of the surrounding farms will be able to see the turbine due to the general openness of the regions farming landscape and its overall flat terrain that surrounds the Village. This said, due to perspective, the turbine will appear as a very small element of the skyline for most locations similar to the regions existing communication towers and granaries.

No historical or cultural site view-sheds were found that would be significantly impacted by the turbines installation.

For sites not modeled, the Report's included "Visualization Tables" can be used to determine approximate turbine visibility in relationship to viewer obstructions. A "Sample Wind Turbine View Calculator" has also been developed to mathematically model locations of concern upon community request, a sample of which is included in this report.



In addition to the above visualization, two visualizations were done from sample locations between Archbold and Pettisville where the turbines of both locations might be seen on the horizon, P+A-V-10 and P+A-V-11 (See map and the visualization photo log below).

Archbold and Pettisville Turbine Projects Visualization Locations Map

Archbold Visualizations

Set Number	Picture Number	Distance from Turbine (miles)	Site Description	Latitude	Longitude	Direction
A-V-1	2093	2.00	Sauder Village Parking Lot	41° 32' 32.83" N	84° 18' 07.67" W	202°
A-V-2	2096	0.80	24218 County Road D	41° 31' 17.72" N	84° 19' 47.31" W	120°
A-V-3	2123	1.10	Playground off St. Anne and Primrose	41° 31' 55.08" N	84° 18' 43.40" W	180°
A-V-4	2125	1.20	Between Tracks and Murbach	41° 31' 27.84" N	84° 17' 45.41" W	250°
A-V-5	2127	0.40	Archbold Evangelical Church	41° 30' 44.34" N	84° 18' 07.61" W	41°
A-V-6	2130	0.50	Corner Sylvanus & Lawrence	41° 30' 30.98" N	84° 18' 49.26" W	345°
A-V-7	2133	1.90	County Road 25 (Between County Road E.50 and County Road B)	41° 29' 46.15" N	84° 20' 31.38" W	48°
A-V-8	2135	1.70	Corner of County Road 25 & County Road B	41° 30' 01.29" N	84° 20' 30.48" W	50°
A-V-9	2137	1.60	22291 County Road B	41° 30' 00.20" N	84° 17' 34.26" W	318°
A-V-10	2340	2.70	Corner of County Road 21 & County Road D	41° 31' 43.98" N	84° 16' 04.57" W	252°
A-V-11	2352	3.70	Historic Home - 4208 County Road 20	41° 31' 55.22" N	84° 14' 52.04" W	254°

Proposed Site Panoramic Photos Looking Out

Looking East

Looking South

Looking West

Looking North

Turbine View Visualizations

A-V-1

Sauder Village Parking Lot
Barely Visible Behind Trees

A-V-2

24218 County Road D

A-V-3

Playground off Saint Anne and Primrose

A-V-4

Between Tracks and Murbach
Barely Visible Behind Houses, Next to Radio Tower

A-V-5

Archbold Evangelical Church

A-V-6

Corner of Sylvanus and Lawrence

A-V-7

County Road 25, Between E.50 and County Road B
Blocked by Corn

A-V-8

Corner of County Road 25 and County Road B
Turbine Blocked By Trees, But Would Be Visible 100’ North on Road

A-V-9

22291 County Road B
Blocked by Trees and Farm

A-V-10

Corner of County Road 21 and County Road D
Turbine Barely Visible to the West of the Granary

A-V-11

4208 County Road 21
Turbine View Blocked by Bushes

Example Images of Other Regional Tall Structures

Archbold Water Tower

Area Granaries

Area Farm Silos

Local Industrial Facilities

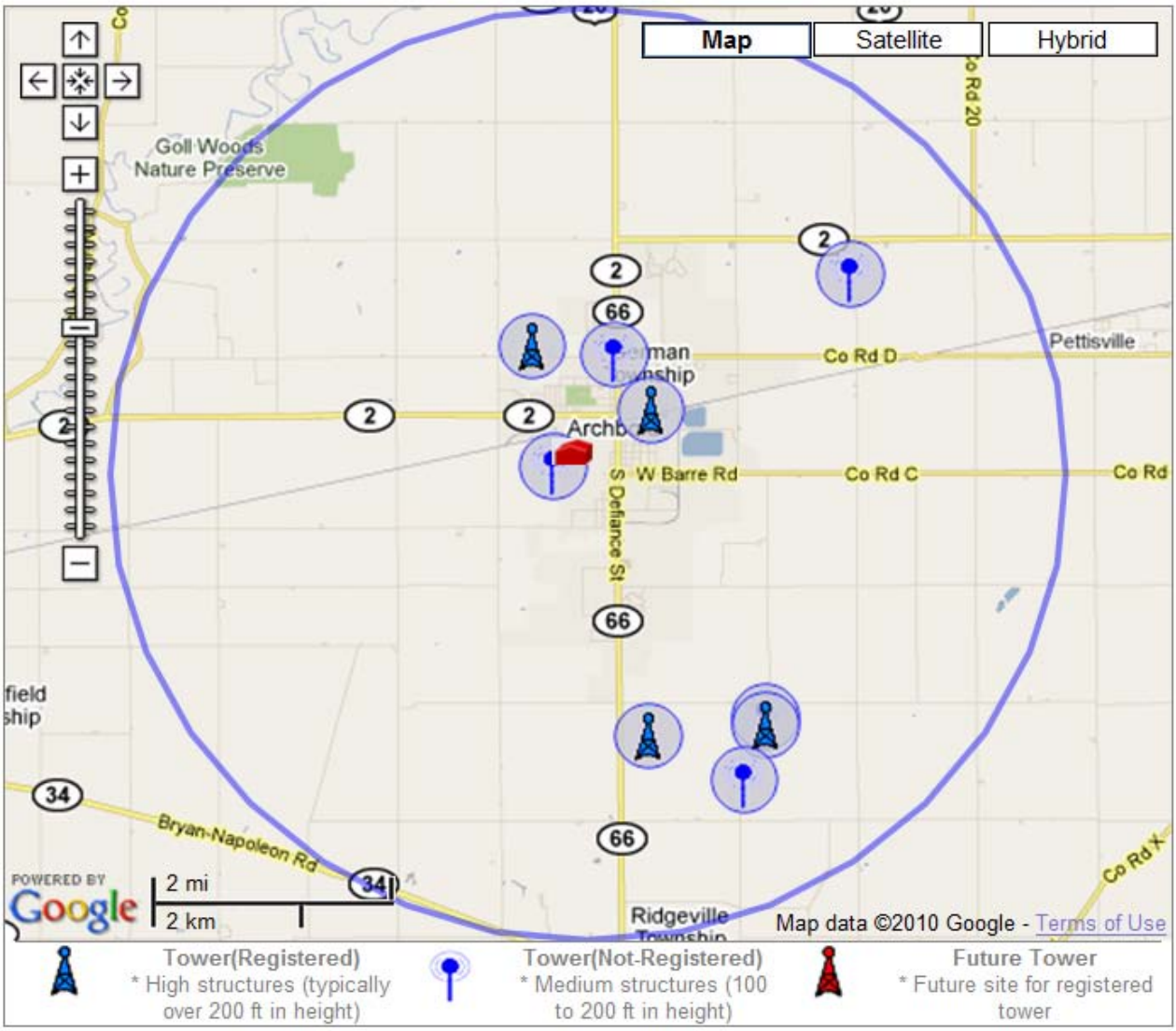
Downtown Archbold

Area Power Poles

Samples of Area Communication Towers

(Also See Tall Tower Map and Tables Below)

Existing Tall Towers Within 4 Miles of The Proposed Turbine Site



Registered Towers			
1	Felhc	315 feet	.80 miles
2	Towerco Assets Llc	200 feet	1.16 miles
3	Sba Towers, Inc.	290 feet	2.10 miles
4	Taylor University Broadcasting Inc Dba = Wbcl Radio	335 feet	2.63 miles

Non-Registered Towers			
1	Usa Mobile Communications, Inc. Ii	119 feet	.97 miles
2	Summit Christian College	335 feet	2.58 miles
3	360 Communications Company	199 feet	2.83 miles
4	Roger Arnos	328 feet	3.07 miles

Antennas on Listed Towers

1	Ams Spectrum Holdings, Llc	328 feet	3.07 miles
	Nofziger Door Sales Inc	NA	3.07 miles
	Ams Spectrum Holdings, Llc	109 feet	3.07 miles
	Futronics Paging Inc.	NA	3.07 miles
	Pearl Gas Co	NA	3.07 miles
	Nextel License Holdings 4, Inc	98 feet	3.07 miles
	Quadco Rehabilitation Center Inc	NA	3.07 miles
	Snows Fire Protection Service Inc	NA	3.07 miles
	Beck, Kevin J	328 feet	3.07 miles
	Laidlaw Waste Systems Inc	328 feet	3.07 miles
	Overnite Transportation Company	312 feet	3.07 miles
	Mohre Electronics Company	328 feet	3.06 miles
2	Sauder Woodworking Co	NA	.57 miles
	Sauder Woodworking Co	NA	.57 miles
	Sauder Woodworking Co	NA	.57 miles
	Sauder Woodworking Co	121 feet	.57 miles
3	A G B Inc	69 feet	.65 miles
	Archbold, Village Of	79 feet	.65 miles
	Archbold, Village Of	NA	.65 miles
	Archbold, Village Of	79 feet	.65 miles
	Archbold, Village Of	79 feet	.65 miles
4	Felhc, Inc.	94 feet	.81 miles
	Felhc, Inc.	20 feet	.81 miles
	Felhc	299 feet	.81 miles
5	Tri Flo Inc	NA	.93 miles
	Bil Jax Inc	NA	.93 miles
6	Sauder Woodworking Co	121 feet	1.11 miles
	Sauder Woodworking Co	20 feet	1.11 miles
	Sauder Woodworking Co	121 feet	1.11 miles
	Sauder Manufacturing	121 feet	1.11 miles
	Sauder Woodworking Co	121 feet	1.11 miles
	Sauder Woodworking Co	98 feet	1.11 miles
	Sauder Woodworking Co	121 feet	1.11 miles
	Sauder Woodworking Co	121 feet	1.11 miles
	Sauder Woodworking Company	121 feet	1.11 miles
7	Napoleon Spring Works Inc	NA	1.54 miles
	Napoleon Spring Works Inc.	164 feet	1.54 miles
8	S W Mills Inc	NA	1.63 miles
	Aeschliman, John	NA	1.63 miles
	S W Mills Inc	NA	1.63 miles
9	Roadway Express	98 feet	2.11 miles
	Roadway Express	NA	2.11 miles
	Archbold Lawn Service	20 feet	2.11 miles
10	Taylor University Broadcasting, Inc.	335 feet	2.58 miles
	T & M Supply	335 feet	2.58 miles

See the Website below for full details on these sites including precise locations, heights and frequencies.

http://www.antennasearch.com/

Single Antennas

11	Nextel License Holdings 4, Inc.	289 feet	2.10 miles
12	Archbold Area Schools	35 feet	.17 miles
13	Con Agra Grocery Products	59 feet	.47 miles
14	Sauders Tv & Appliance Inc	NA	.51 miles
15	Archbold Area Schools	NA	.62 miles
16	Fulton, County Of	NA	.64 miles
17	Hunt Foods Inc	NA	.72 miles
18	Bentley Enterprises	200 feet	.73 miles
19	Bil-jax, Inc	NA	.78 miles
20	Ohio Gas Company	39 feet	.78 miles
21	Campbell Soup Supply Company	NA	.81 miles
22	Hunt Weson	49 feet	.95 miles
23	Fairlawn Haven	39 feet	1.08 miles
24	Fry, Carl	NA	1.09 miles
25	Community Hospitals Of Williams County, Inc.	49 feet	1.10 miles
26	Rupp, Dexter	NA	1.50 miles
27	Sauder Farm Woodworking Company	66 feet	1.89 miles
28	Stuckey, Michael D	39 feet	1.91 miles
29	Nofzinger Electric Inc	NA	2.08 miles
30	Archbold Equipment Co Inc	NA	2.17 miles
31	Djm Llc	NA	3.52 miles
32	Four County Joint Vocational School	NA	3.82 miles
33	Heer Excavating Inc	98 feet	3.84 miles
34	Nobco, Inc.	85 feet	.68 miles
35	Fibertower Spectrum Holdings Llc	20 feet	3.92 miles

See the Website below for full details on these sites including but not limited to: precise locations, heights, frequencies and owners.

http://www.antennasearch.com/

Sample Horizon View Impact Calculator

Rotor Diameter	187	Feet

Viewer Distance From Turbine		Percent of Total Horizon View-shed Affected	Percent of Total Average Persons Field of View Affected
Feet	Miles		
100	0.02	29.76%	100.00%
200	0.04	14.88%	89.29%
400	0.08	7.44%	44.64%
800	0.15	3.72%	22.32%
1,600	0.30	1.86%	11.16%
3,200	0.61	0.93%	5.58%
5,280	1.00	0.56%	3.38%
10,560	2.00	0.28%	1.69%
15,840	3.00	0.19%	1.13%
21,120	4.00	0.14%	0.85%
26,400	5.00	0.11%	0.68%
52,800	10.00	0.06%	0.34%

Assumptions:

Model assumes absolute worst case for all variables.

Viewer is stationary, focused and looking directly at and centered on the turbine.

Viewer's field of view is 60 degrees.

Model assumes no sightline obstructions, crystal clear atmospheric visibility and 100% of the turbine is visible.

Model assumes the largest rotor diameter under consideration for the site.

Model assumes the turbine rotor is perpendicular to and fully visible to the viewer.

Model assumes worst case as if the turbine rotor diameter influences the entire column of the horizon as if the turbine was a solid plane covering the entire portion of the horizon at a width of the turbine's rotor.

Sample Turbine View Calculations

Baselines For Calculations

Turbine Height to Blade Tip	334	Feet
Turbine Height to Hub	246	Feet
Persons Eye Height Based on Level Ground.	5.5	Feet

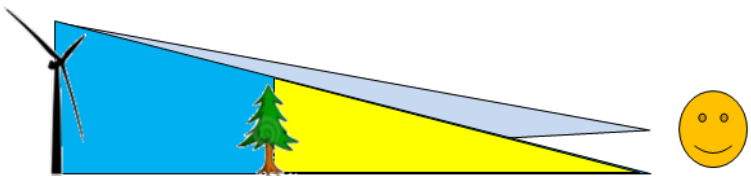
Listed Obstruction Height (Feet) Will Block Turbine View Within Listed Distance of Viewer (Feet)

		Typical One Story House or Short Tree		Typical Two Story House or Tree		Typical Tall Tree or Tall Building		Apparent Height of Turbine at 3' Arm's Length (Inches Tall) (If You Could See the Entire Turbine)
Obstruction Height (Feet)		17.5		35		70		
Minimum Visible Target to be Blocked		Hub Up	Blade Tip	Hub Up	Blade Tip	Hub Up	Blade Tip	
Viewer Distance From Turbine (Feet)	500	23	18	57	44	126	97	23.9
	1000	47	36	115	88	251	193	11.9
	1500	70	54	172	133	377	290	8.0
	2000	93	72	230	177	502	387	6.0
	2500	117	90	287	221	628	483	4.8
	3000	140	108	344	265	753	580	4.0
	3500	163	126	402	310	879	677	3.4
	4000	187	144	459	354	1004	774	3.0
	4500	210	162	517	398	1130	870	2.7
	5000	234	180	574	442	1255	967	2.4

Example: At a distance of 2,500 feet from the turbine your view of the turbine would be blocked by any 17.5 foot structure or tree if it was less than 90 feet from you. The apparent height of an unobstructed turbine view at this distance would 4.8 inches tall at a 3 foot arms length from your eye.

Typical community and natural obstructions will block the view of the turbine for many residences and businesses, even some in close proximity to the site.

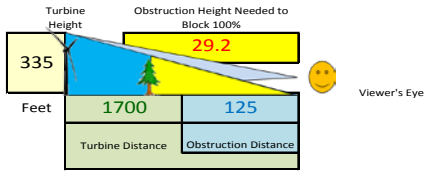
Values are approximate.



Sample Wind Turbine Visibility Over Obstructions Tables

Turbine Information:

	Feet	Meters
Tower Height	246.1	75.0
Rotor Diameter	177.2	54.0
Tip Height	334.6	102.0
Eye Height	5.0	1.5



Example: Using the tables below, a wind turbine 1700 feet away from you would be blocked by any obstruction over 24.8 feet tall 125 feet or less away from you. Based on flat ground and provided eye height. As can be seen, relatively low obstructions close to the viewer typical of many residential, urban or wooded areas will completely obstruct your view of a wind turbine.

Obstruction Height \ Turbine Distance	100	125	150	175	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000
10	38.0	31.4	27.0	23.8	21.5	16.0	13.2	11.6	10.5	9.7	9.1	8.7	8.3	8.0	7.7	7.5	7.4	7.2	7.1	6.9	6.8	6.7	6.6
20	70.9	57.7	49.0	42.7	38.0	27.0	21.5	18.2	16.0	14.4	13.2	12.3	11.6	11.0	10.5	10.1	9.7	9.4	9.1	8.9	8.7	8.5	8.3
30	103.9	84.1	70.9	61.5	54.4	38.0	29.7	24.8	21.5	19.1	17.4	16.0	14.9	14.0	13.2	12.6	12.1	11.6	11.2	10.8	10.5	10.2	9.9
40	136.9	110.5	92.9	80.3	70.9	49.0	38.0	31.4	27.0	23.8	21.5	19.7	18.2	17.0	16.0	15.1	14.4	13.8	13.2	12.8	12.3	11.9	11.6
50	169.8	136.9	114.9	99.2	87.4	59.9	46.2	38.0	32.5	28.5	25.6	23.3	21.5	20.0	18.7	17.7	16.8	16.0	15.3	14.7	14.2	13.7	13.2
60	202.8	163.2	136.9	118.0	103.9	70.9	54.4	44.6	38.0	33.3	29.7	27.0	24.8	23.0	21.5	20.2	19.1	18.2	17.4	16.6	16.0	15.4	14.9
70	235.8	189.6	158.8	136.9	120.4	81.9	62.7	51.2	43.5	38.0	33.8	30.6	28.1	26.0	24.2	22.8	21.5	20.4	19.4	18.6	17.8	17.1	16.5
80	268.7	216.0	180.8	155.7	136.9	92.9	70.9	57.7	49.0	42.7	38.0	34.3	31.4	29.0	27.0	25.3	23.8	22.6	21.5	20.5	19.7	18.9	18.2
90	301.7	242.3	202.8	174.5	153.3	103.9	79.2	64.3	54.4	47.4	42.1	38.0	34.7	32.0	29.7	27.8	26.2	24.8	23.5	22.5	21.5	20.6	19.8
100	334.6	268.7	224.8	193.4	169.8	114.9	87.4	70.9	59.9	52.1	46.2	41.6	38.0	35.0	32.5	30.4	28.5	27.0	25.6	24.4	23.3	22.3	21.5
125	NA	334.6	279.7	240.5	211.0	142.4	108.0	87.4	73.7	63.9	56.5	50.8	46.2	42.5	39.3	36.7	34.4	32.5	30.8	29.2	27.9	26.7	25.6
150	NA	NA	334.6	287.6	252.2	169.8	128.6	103.9	87.4	75.6	66.8	59.9	54.4	50.0	46.2	43.0	40.3	38.0	35.9	34.1	32.5	31.0	29.7
175	NA	NA	NA	334.6	293.4	197.3	149.2	120.4	101.1	87.4	77.1	69.1	62.7	57.4	53.1	49.4	46.2	43.5	41.1	38.9	37.0	35.4	33.8
200	NA	NA	NA	NA	334.6	224.8	169.8	136.9	114.9	99.2	87.4	78.3	70.9	64.9	59.9	55.7	52.1	49.0	46.2	43.8	41.6	39.7	38.0
225	NA	NA	NA	NA	NA	252.2	190.4	153.3	128.6	111.0	97.7	87.4	79.2	72.4	66.8	62.1	58.0	54.4	51.4	48.6	46.2	44.0	42.1
250	NA	NA	NA	NA	NA	279.7	211.0	169.8	142.4	122.7	108.0	96.6	87.4	79.9	73.7	68.4	63.9	59.9	56.5	53.5	50.8	48.4	46.2
500	NA	NA	NA	NA	NA	NA	NA	334.6	279.7	240.5	211.0	188.1	169.8	154.8	142.4	131.8	122.7	114.9	108.0	102.0	96.6	91.7	87.4
1000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	334.6	304.7	279.7	258.6	240.5	224.8	211.0	198.9	188.1	178.5	169.8

Obstruction Height \ Turbine Distance	2100	2200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300
10	6.6	6.5	7.5	7.4	7.2	7.1	6.9	6.8	6.7	6.6	6.6	6.5	6.4	6.4	6.3	6.3	6.2	6.2	6.1	6.1	6.1	6.0	6.0
20	8.1	8.0	10.1	9.7	9.4	9.1	8.9	8.7	8.5	8.3	8.1	8.0	7.9	7.7	7.6	7.5	7.4	7.4	7.3	7.2	7.1	7.1	7.0
30	9.7	9.5	12.6	12.1	11.6	11.2	10.8	10.5	10.2	9.9	9.7	9.5	9.3	9.1	9.0	8.8	8.7	8.5	8.4	8.3	8.2	8.1	8.0
40	11.3	11.0	15.1	14.4	13.8	13.2	12.8	12.3	11.9	11.6	11.3	11.0	10.7	10.5	10.3	10.1	9.9	9.7	9.5	9.4	9.3	9.1	9.0
50	12.8	12.5	17.7	16.8	16.0	15.3	14.7	14.2	13.7	13.2	12.8	12.5	12.2	11.9	11.6	11.3	11.1	10.9	10.7	10.5	10.3	10.2	10.0
60	14.4	14.0	20.2	19.1	18.2	17.4	16.6	16.0	15.4	14.9	14.4	14.0	13.6	13.2	12.9	12.6	12.3	12.1	11.8	11.6	11.4	11.2	11.0
70	16.0	15.5	22.8	21.5	20.4	19.4	18.6	17.8	17.1	16.5	16.0	15.5	15.0	14.6	14.2	13.9	13.5	13.2	13.0	12.7	12.4	12.2	12.0
80	17.6	17.0	25.3	23.8	22.6	21.5	20.5	19.7	18.9	18.2	17.6	17.0	16.5	16.0	15.5	15.1	14.8	14.4	14.1	13.8	13.5	13.2	13.0
90	19.1	18.5	27.8	26.2	24.8	23.5	22.5	21.5	20.6	19.8	19.1	18.5	17.9	17.4	16.9	16.4	16.0	15.6	15.2	14.9	14.6	14.3	14.0
100	20.7	20.0	30.4	28.5	27.0	25.6	24.4	23.3	22.3	21.5	20.7	20.0	19.3	18.7	18.2	17.7	17.2	16.8	16.4	16.0	15.6	15.3	15.0
125	24.6	23.7	36.7	34.4	32.5	30.8	29.2	27.9	26.7	25.6	24.6	23.7	22.9	22.2	21.5	20.8	20.3	19.7	19.2	18.7	18.3	17.9	17.5
150	28.5	27.5	43.0	40.3	38.0	35.9	34.1	32.5	31.0	29.7	28.5	27.5	26.5	25.6	24.8	24.0	23.3	22.7	22.1	21.5	21.0	20.5	20.0
175	32.5	31.2	49.4	46.2	43.5	41.1	38.9	37.0	35.4	33.8	32.5	31.2	30.1	29.0	28.1	27.2	26.4	25.6	24.9	24.2	23.6	23.0	22.5
200	36.4	35.0	55.7	52.1	49.0	46.2	43.8	41.6	39.7	38.0	36.4	35.0	33.7	32.5	31.4	30.4	29.4	28.5	27.7	27.0	26.3	25.6	25.0
225	40.3	38.7	62.1	58.0	54.4	51.4	48.6	46.2	44.0	42.1	40.3	38.7	37.2	35.9	34.7	33.5	32.5	31.5	30.6	29.7	28.9	28.2	27.5
250	44.2	42.5	68.4	63.9	59.9	56.5	53.5	50.8	48.4	46.2	44.2	42.5	40.8	39.3	38.0	36.7	35.5	34.4	33.4	32.5	31.6	30.8	30.0
500	83.5	79.9	131.8	122.7	114.9	108.0	102.0	96.6	91.7	87.4	83.5	79.9	76.7	73.7	70.9	68.4	66.0	63.9	61.8	59.9	58.2	56.5	54.9
1000	162.0	154.8	258.6	240.5	224.8	211.0	198.9	188.1	178.5	169.8	162.0	154.8	148.3	142.4	136.9	131.8	127.1	122.7	118.7	114.9	111.3	108.0	104.9

Obstruction Height \ Turbine Distance	3400	3500	3600	3700	3800	3900	4000	4100	4200	4300	4400	4500	4600	4700	4800	4900	5000	5100	5200	5300	5400	5500	5600
10	6.0	5.9	5.9	5.9	5.9	5.8	5.8	5.8	5.8	5.8	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.6	5.6	5.6	5.6	5.6	5.6
20	6.9	6.9	6.8	6.8	6.7	6.7	6.6	6.6	6.6	6.5	6.5	6.5	6.4	6.4	6.4	6.3	6.3	6.3	6.3	6.2	6.2	6.2	6.2
30	7.9	7.8	7.7	7.7	7.6	7.5	7.5	7.4	7.4	7.3	7.2	7.2	7.1	7.1	7.1	7.0	7.0	6.9	6.9	6.9	6.8	6.8	6.8
40	8.9	8.8	8.7	8.6	8.5	8.4	8.3	8.2	8.1	8.1	8.0	7.9	7.9	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.4
50	9.8	9.7	9.6	9.5	9.3	9.2	9.1	9.0	8.9	8.8	8.7	8.7	8.6	8.5	8.4	8.4	8.3	8.2	8.2	8.1	8.1	8.0	7.9
60	10.8	10.7	10.5	10.3	10.2	10.1	9.9	9.8	9.7	9.6	9.5	9.4	9.3	9.2	9.1	9.0	9.0	8.9	8.8	8.7	8.7	8.6	8.5
70	11.8	11.6	11.4	11.2	11.1	10.9	10.8	10.6	10.5	10.4	10.2	10.1	10.0	9.9	9.8	9.7	9.6	9.5	9.4	9.4	9.3	9.2	9.1
80	12.8	12.5	12.3	12.1	11.9	11.8	11.6	11.4	11.3	11.1	11.0	10.9	10.7	10.6	10.5	10.4	10.3	10.2	10.1	10.0	9.9	9.8	9.7
90	13.7	13.5	13.2	13.0	12.8	12.6	12.4	12.2	12.1	11.9	11.7	11.6	11.4	11.3	11.2	11.1	10.9	10.8	10.7	10.6	10.5	10.4	10.3
100	14.7	14.4	14.2	13.9	13.7	13.5	13.2	13.0	12.8	12.7	12.5	12.3	12.2	12.0	11.9	11.7	11.6	11.5	11.3	11.2	11.1	11.0	10.9
125	17.1	16.8	16.4	16.1	15.8	15.6	15.3	15.1	14.8	14.6	14.4	14.2	14.0	13.8	13.6	13.4	13.2	13.1	12.9	12.8	12.6	12.5	12.4
150	19.5	19.1	18.7	18.4	18.0	17.7	17.4	17.1	16.8	16.5	16.2	16.0	15.7	15.5	15.3	15.1	14.9	14.7	14.5	14.3	14.2	14.0	13.8
175	22.0	21.5	21.0	20.6	20.2	19.8	19.4	19.1	18.7	18.4	18.1	17.8	17.5	17.3	17.0	16.8	16.5	16.3	16.1	15.9	15.7	15.5	15.3
200	24.4	23.8	23.3	22.8	22.3	21.9	21.5	21.1	20.7	20.3	20.0	19.7	19.3	19.0	18.7	18.5	18.2	17.9	17.7	17.4	17.2	17.0	16.8
225	26.8	26.2	25.6	25.0	24.5	24.0	23.5	23.1	22.7	22.2	21.9	21.5	21.1	20.8	20.5	20.1	19.8	19.5	19.3	19.0	18.7	18.5	18.2
250	29.2	28.5	27.9	27.3	26.7	26.1	25.6	25.1	24.6	24.2	23.7	23.3	22.9	22.5	22.2	21.8	21.5	21.2	20.8	20.5	20.3	20.0	19.7
500	53.5	52.1	50.8	49.5	48.4	47.3	46.2	45.2	44.2	43.3	42.5	41.6	40.8	40.1	39.3	38.6	38.0	37.3	36.7	36.1	35.5	35.0	34.4
1000	102.0	99.2	96.6	94.1	91.7	89.5	87.4	85.4	83.5	81.7	79.9	78.3	76.7	75.1	73.7	72.3	70.9	69.6	68.4	67.2	66.0	64.9	63.9

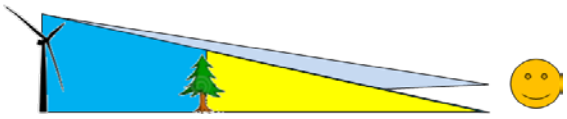
Obstruction Height \ Turbine Distance	5700	5800	5900	6000	6100	6200	6300	6400	6500	6600	6700	6800	6900	7000	7100	7200	7300	7400	7500	7600	7700	7800	7900
10	5.6	5.6	5.6	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.4	5.4	5.4	5.4	5.4	5.4
20	6.2	6.1	6.1	6.1	6.1	6.1	6.0	6.0	6.0	6.0	6.0	6.0	6.0	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.8	5.8
30	6.7	6.7	6.7	6.6	6.6	6.6	6.6	6.5	6.5	6.5	6.5	6.5	6.4	6.4	6.4	6.4	6.4	6.3	6.3	6.3	6.3	6.3	6.3
40	7.3	7.3	7.2	7.2	7.2	7.1	7.1	7.1	7.0	7.0	7.0	6.9	6.9	6.9	6.9	6.8	6.8	6.8	6.8	6.7	6.7	6.7	6.7
50	7.9	7.8	7.8	7.7	7.7	7.7	7.6	7.6	7.5	7.5	7.5	7.4	7.4	7.4	7.3	7.3	7.3	7.2	7.2	7.2	7.1	7.1	7.1
60	8.5	8.4	8.4	8.3	8.2	8.2	8.1	8.1	8.0	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.7	7.6	7.6	7.6	7.5	7.5
70	9.0	9.0	8.9	8.8	8.8	8.7	8.7	8.6	8.6	8.5	8.4	8.4	8.3	8.3	8.3	8.2	8.2	8.1	8.1	8.0	8.0	8.0	7.9
80	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.8	8.7	8.7	8.6	8.6	8.5	8.5	8.4	8.4	8.3
90	10.2	10.1	10.0	9.9	9.9	9.8	9.7	9.6	9.6	9.5	9.4	9.4	9.3	9.2	9.2	9.1	9.1	9.0	9.0	8.9	8.9	8.8	8.8
100	10.8	10.7	10.6	10.5	10.4	10.3	10.2	10.2	10.1	10.0	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.2
125	12.2	12.1	12.0	11.9	11.8	11.6	11.5	11.4	11.3	11.2	11.2	11.1	11.0	10.9	10.8	10.7	10.6	10.6	10.5	10.4	10.4	10.3	10.2
150	13.7	13.5	13.4	13.2	13.1	13.0	12.8	12.7	12.6	12.5	12.4	12.3	12.2	12.1	12.0	11.9	11.8	11.7	11.6	11.5	11.4	11.3	11.3
175	15.1	14.9	14.8	14.6	14.5	14.3	14.2	14.0	13.9	13.7	13.6	13.5	13.4	13.2	13.1	13.0	12.9	12.8	12.7	12.6	12.5	12.4	12.3
200	16.6	16.4	16.2	16.0	15.8	15.6	15.5	15.3	15.1	15.0	14.8	14.7	14.6	14.4	14.3	14.2	14.0	13.9	13.8	13.7	13.6	13.5	13.3
225	18.0	17.8	17.6	17.4	17.2	17.0	16.8	16.6	16.4	16.2	16.1	15.9	15.7	15.6	15.4	15.3	15.2	15.0	14.9	14.8	14.6	14.5	14.4
250	19.5	19.2	19.0	18.7	18.5	18.3	18.1	17.9	17.7	17.5	17.3	17.1	16.9	16.8	16.6	16.4	16.3	16.1	16.0	15.8	15.7	15.6	15.4
500	33.9	33.4	32.9	32.5	32.0	31.6	31.2	30.8	30.4	30.0	29.6	29.2	28.9	28.5	28.2	27.9	27.6	27.3	27.0	26.7	26.4	26.1	25.9
1000	62.8	61.8	60.9	59.9	59.0	58.2	57.3	56.5	55.7	54.9	54.2	53.5	52.8	52.1	51.4	50.8	50.2	49.5	49.0	48.4	47.8	47.3	46.7

Sample Wind Turbine View Calculator

		Address	Longitude	Latitutude
Project Turbine	Archbold Area Schools	600 Lafayette Street Archbold Ohio	84°18'57.24"W	41°30'54.65"N

Suject Viewpoint Property

Point of View Sample



	User Inputs	Calculations	
Turbine Information:	Feet	Meters	Notes:
Tower Height	213.3	65.0	
Rotor Diameter	177.2	54.0	
Tip Height	301.8	92.0	
Turbine Location Elevation Above Sea-level	727.0	221.6	
Viewpoint Information:	Feet	Meters	Notes:
Viewpoint Distance From Turbine	500.0	152.4	
Viewpoint Eye Height Above Ground	5.5	1.7	
Viewpoint Ground Elevation Above Sea-level	730.0	222.5	
Net Viewpoint Ground Elevation Above Sea-level	735.5	224.2	Eye height + ground elevation above sea-level (Level Line For Calculations)
Obstruction Information:	Feet	Meters	Notes:
Obstruction Distance From Viewpoint	125.0	38.1	
Obstruction Height Above Ground	35.0	10.7	
Obstruction Ground Elevation Above Sea-level	729.0	222.2	
Net Obstruction Height Above Sea-Level	764.0	232.9	
Results:			Notes:
Will The Turbine Be Visible?	Yes	62.2%	Percent of Total Turbine and Tower
Relative Visible Turbine Height at Obstruction Distance	47.0	14.3	Feet / Meters Usefull for landscape scale
Actual Portion of Turbine Showing	187.8	57.3	Feet / Meters
Will Blades Be Visible?	Yes	100%	Percent Rotor Diameter
Will Hub Be Visible?	Yes		
Apparent Height of Visible Portion of Turbine, at Distance From Eye Below	0.751	0.2	Feet / Meters
	9.0	22.9	Inches / Centimeters
Distance From Eye	2	0.61	Feet / Meters

Although this calculator does take into account relative topography, it does not take into account the width of obstructions or their shape. It calculates on a single vertical plane at a time. Although a good guide, it should only be used as a rough indicator of the magnitude of potential turbine visibility from a particular viewpoint.

THE RENAISSANCE GROUP

A Conserve First Company

Archbold Area Schools
Wind Turbine Project
Shadow Flicker Analysis

Prepared for:
Archbold Area Schools

Prepared by:
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Submitted September 2, 2010

Thank You for Choosing The Renaissance Group, a Conserve First LLC Company

Introduction

Proposed Turbine Location: Archbold Schools, NW Corner of Stadium Parking Lot
600 Lafayette Street
Archbold, Ohio 43502

Latitude: 41° 30' 54.65" N
Longitude: 84° 18' 57.24" W

While all tall objects cast shadows, wind turbines, due to their spinning blades, can cause moving/flickering shadows which can become an annoyance, especially in residential areas when they pass over windows. Fortunately, while the adverse effects of shadows can be subjective, the shadows themselves can be precisely modeled for location and duration. While modeling shadows for location knowing the latitude of site, the topography and the height and rotor diameter of a wind turbine is a precise science, quantifying the frequency of the shadow's actual occurrence is more difficult due to changing weather patterns affecting the actual Sun's intensity and presence. Further, weather patterns affect the orientation of the wind turbines blades as they follow the wind and hence their orientation to the Sun and the site. In short, on a cloudy day, there will be no shadows, and similarly, when the blades are parallel or close to parallel to the observer, none to limited moving shadow will be visible, and of course, if the wind is not sufficiently blowing to rotate the blades of the turbine, you will not have any moving shadow. Further, it is important to note the higher the angle of the Sun, the shorter the reach of the shadow and the smaller the area of potential impact. Further yet, it also important to note, due to the diffusion of light over distance, shadow intensity drops off significantly with distance. The thickness of the obstruction to the Sun, in this case the blades, also plays significantly into the actual apparent intensity and realized length of shadows. It is for these reasons that shadow distances over ten rotor diameters away from the turbine are considered insignificant. For shadow receptor sites within a turbine's shadow's reach, not all will receive shadow due to existing obstructions that block the shadows path such as other buildings, hills or trees. While evergreen trees will fairly consistently block shadows year-round, deciduous trees will have a lesser impact in the winter months when they have no leaves. Pending the density of the tree stand, single tree to an entire wooded area, winter shadows in these situations can go from being just slightly diffused to still totally obstructed. To properly model the true impacts of shadow flicker, all these considerations must be taken into account. Unobstructed shadows in latitudes similar to this study site will typically have a bow tie or flatten cross shape. In the winter, the sun rises lower on the horizon in the Southeast and sets in the Southwest and in the Summer, the Sun rises in the Northeast and sets in the Northwest all creating a path or area of potential shadow. The southern portion of the bowtie typically is larger due to there being more sunny days in the Summer although Winter shadows will be longer overall and tend to last for longer periods due to the lower angle of the Sun's rays. You will typically see more impacts in alignment with the site's predominate wind direction due to the corresponding predominate turbine blade orientation perpendicular to this direction and thus more visible moving shadows in this direction.

Although no official US policy has been adopted, international standards appear to be in consensus that flickering shadows in excess of thirty hours per year impacting a particular location

are considered a potential nuisance.[i] This said, the qualitative impacts of the shadows are subjective.

When considering potential health impacts from wind turbine shadows/flicker, photosensitivity triggered epilepsy is the only issue that is discussed and has been dismissed for mid to large scale modern wind turbines such as the one being considered by the site due to turbine operating frequencies being too low to trigger seizures. According to the British Epilepsy Association, approximately five percent of individuals with epilepsy have sensitivity to light, and most people with photosensitive epilepsy are sensitive to flickering around 16-25Hz (Hertz or Hz = 1 flash per second), although some people may be sensitive to rates as low as 3Hz and as high as 60Hz (British Epilepsy Association, 2007). Specific to wind power projects, the British Epilepsy Association (2007) states that there is no evidence that wind turbines can trigger seizures, and newer wind commercial scale turbines are built to operate at a frequency of 1Hz or less. This conclusion is also supported by the epilepsy thresholds published by the American Epilepsy Foundation.[ii] Therefore, health effects due to projected shadow flicker are not anticipated or further evaluated. The primary concern with shadow flicker is the annoyance it could cause for adjacent home and business owners.

Methods

WindPro 2.7, an internationally accepted software modeling tool, was used to generate the areas of potential shadow flicker impact around the proposed turbine installation site. The software imports historic weather variable averages from the nearest national weather station to obtain average numbers of days with sunshine and the average wind direction distributions. Local Latitude drives the solar path models. Local topographical information is input to determine if there are any natural geographic influences such as hills or valleys. The turbine information including tower height and rotor diameter are input as variables to the location's shadow source models. Rotor diameter is also used to determine the study area of influence, a ten rotor diameters radius around the turbine or 1870 feet for the largest rotor diameter being considered for this site, based on internationally accepted standards.[iii] Wind turbine operational variables for the site are also input which correspond to the turbine's overall percentage of operational time such as percentage of time when the wind speed is too low to rotate the blades and industry norms for availability driven from scheduled and unscheduled maintenance downtime. Wind speed Weibull distributions are from The Renaissance Group and State of Ohio wind data sets and models. Trees and other local obstructions are not considered in the base model (although can be added if desired) and thus the model can be considered a worst case, as if no obstructions existed. If a particular shadow receptor is found to be of potential concern, a receptor specific analysis of potential shadow flicker hours and occurrence periods/times is conducted, otherwise, the results are plotted for the area as a whole as average not-to-exceed threshold iso-lines on the map. Models were run at a two thousand meter hyper-conservative distance well beyond the likely observable shadows for this location and the turbines under consideration. For the stadium and playing field locations, extra-wide and tall receptor windows were used of 100' x 100' to better insure potential impact recording. With this in mind, it is important to note that the model records all potential impacts as if

they impacted the entire receptor, while in reality, they will only impact a relatively small portion of these large receptors at a given time.

Results

See "Archbold WTG Shadow Flicker Analysis" map for a visualization of the results. No homes or occupied business structures outside the owner's property within the turbines shadow influence will receive significant flickering shadows of over 30 hours per year. While some of the school's buildings will receive shadows, there are no windows on the turbine side of the buildings. While the stadium will receive significant shadows, the majority of these shadow events will occur when the facility is not in use in the winter (See WindPro Receptor Analysis for detailed data for this receptor location). For the periods when shadowing events will overlap scheduled sporting or other use events, the school has adopted a policy that will temporarily shut down the turbine during the shadows impact on the stadium. To a far lesser extent, less than 10 hours per year, diffuse shadows may reach the public ball fields to the southeast (See WindPro Receptor Analysis for detailed data for this receptor location). Similar to the stadium policy, the turbine may be shut down during these overlapping events if they prove to be a nuisance. The financial loss to the school district from this policy will be minimal due to the short duration of the shadow events and the fact the sporting events typically only last a few hours, and further, the shutdowns will only need to occur during sunny weather. (See below for further information and recommendations for the potentially impacted receptor sites.) (Also see "Turbine Use, Safety Policies and General Background" document for information on the Schools Turbine policies relating to shadow flicker.)

Models were run using a hyper-conservative two thousand meters, a distance well beyond the industry norm of ten rotor diameters, to insure full reporting of potential impacts. The models show the same iso-lines contour results for general shadow hour thresholds based on the actual average site conditions, but the tabular information shows worse case shadow hours and the potential hours of impact for particular receptor locations, as if it was always sunny. Also, note the further away from the turbine a receptor is the less intense the shadow will be. Beyond ten rotor diameters, shadows will be diffuse and difficult to see.

Overview of Tabular Results for Particular Sample Receptors:

- Receptor A: Closest House to the Southwest, 2780+ Feet Away: 2822 County Road 24; Shadows will be highly diffuse, if visible at all, as the receptor is well outside ten rotor diameters and likely substantially blocked by the farms outbuildings, but possible during portions of May, June, July and August mornings with a total average of 3 hours of moving shadow per year.

- Receptor B: South End of Archbold High School Stadium, as close as 110 Feet Away: Blue Streak Drive; Shadows will be distinct on southern portion of the stadium grounds during afternoons and sunsets throughout the year likely requiring the turbine to be turned off during sunny evening sporting events to avoid player distraction with a total average of about 210 hours of moving shadow per year. (Note study indicates impact at the receptor, even it shadow only touches a small portion of the receptor.)

- Receptor C: Archbold Public Ball Fields, As Close As 1200 Feet Away: Lafayette Street; Shadows will be diffuse, as the receptor is at the outer reaches of ten rotor diameters, but possible during portions of late April through mid August late evenings (after 7:30PM) with a total average of about 28 hours of moving shadow per year impacting some portion of the fields possibly requiring the turbine to be turned off during sunny sunset sporting events to avoid player distraction. (Note study indicates impact at the receptor, even it shadow only touches a small portion of the receptor.)

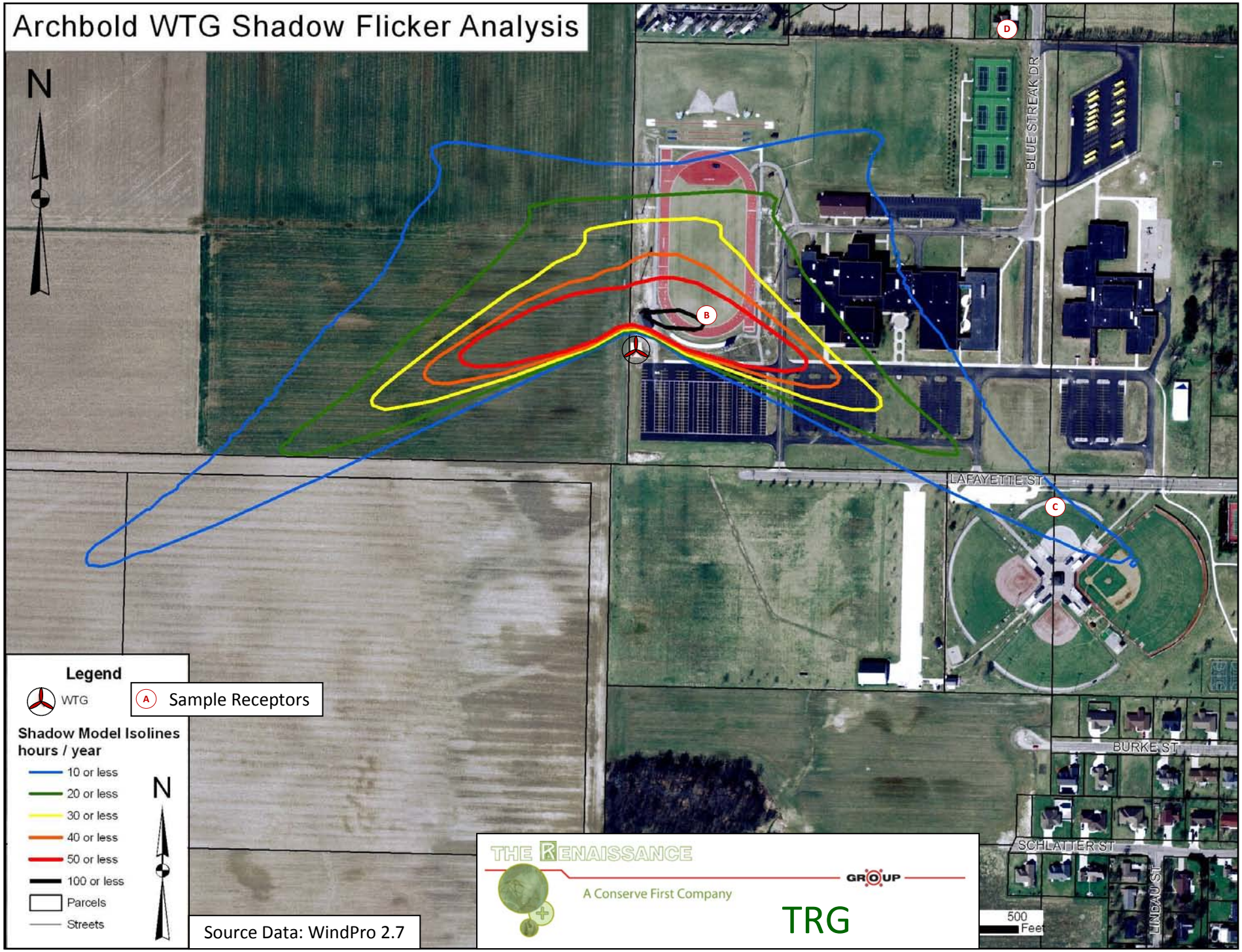
- Receptor D: Closest House to the Northeast, As Close As 1465 Feet Away: 101 Parkview Court; Shadows will be diffuse, as the receptor is at the outer reaches of ten rotor diameters and may be blocked by existing evergreen trees, but possible during portions of late November through mid January evenings with a total average of about 3 hours of moving shadow per year. (Note study indicates impact at the receptor, even it shadow only touches a small portion of the receptor.)

The duration of particular shadow events can vary from a minute to hours pending the receptor. See the following tables at the end of this report for precise dates and times where shadows could occur for each listed sample receptor.

Note the iso-line diagram on the following page shows hour thresholds of shadow impact based on average site conditions with results being referenced to one meter squares of potential impact, i.e. a meter square area within an iso-line area will receive up to the threshold of shadow hours per year. As the tabular information represents larger areas and adds up the entire receptor as if it was one location, its cumulative hour results may be higher. This equates to watching if a shadow will enter a window to watching if it will enter any portion of an entire ball field or yard. Although impacts can be subjective, shadows impacting a specific receptor window are considered significantly more severe than those that impact a yard.

Recommendations

Based on the study findings, no occupied structure will receive over 30 hours of moving shadow per year, the currently accepted consensus on nuisance thresholds for moving shadows/flickering. No local, State or Federal policy or regulation exists to govern shadow flicker thresholds. This said, some receptors will receive some shadow which the affect of will be subjective to the receptor owners' views on the project and their sensitivity. With this in mind, the study authors would recommend that the project site owner follow the guidelines and mediation strategies outlined in "Turbine Use, Safety Policies and General Background".



Project:
Archbold

Description:
Shadow Receptor Potential Impacts Analysis, 2000 Meters

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Printed/Page
8/28/2010 6:51 PM / 1
Licensed user:
Conserve First LLC, d/b/a The Renaissance Group, Renewables
8281 Euclid Chardon Road, Suite E
US-44094 Kirtland, Ohio
4717
AAron Godwin / AAron@ConserveFirst.com
Calculated:
8/28/2010 6:51 PM/2.7.473

SHADOW - Main Result

Assumptions for shadow calculations

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

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

Sunshine probability S (Average daily sunshine hours) [CLEVELAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.47	4.37	4.90	7.57	8.91	9.33	10.21	9.01	6.89	5.70	2.71	1.87

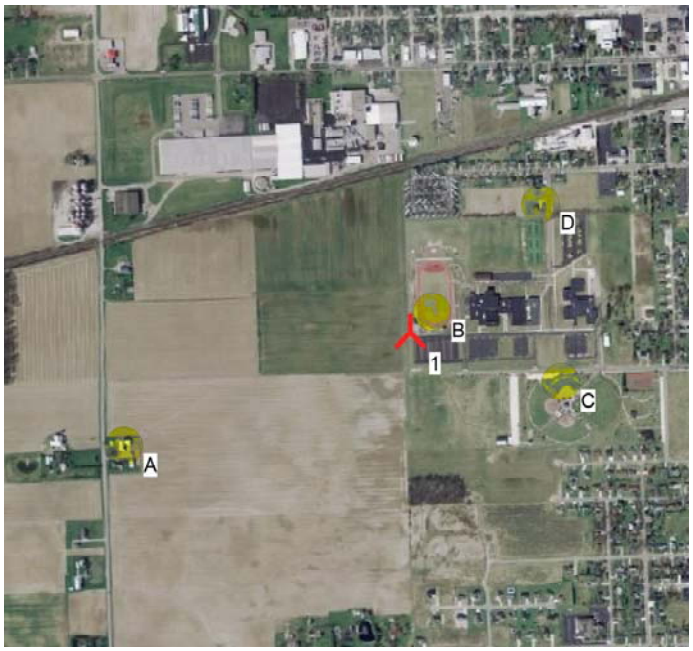
Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
227	217	324	570	498	353	263	290	423	680	776	830

W	WNW	NW	NNW	Sum
755	671	460	318	7,655

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

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Height Contours: FultonXYZ.wpo (1)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10 m



Scale 1:20,000
New WTG
Shadow receptor

WTGs

	UTM WGS84 Zone: 16				WTG type						Shadow data	
	East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Calculation distance	RPM
	UTM WGS84 Zone: 16		[m]					[kW]	[m]	[m]	[m]	[RPM]
1	723,980	4,599,428	221.5	Unison U54-750kW 750 5...	Yes	Unison	U54-750kW-750	750	54.0	75.0	1,088	25.0

Shadow receptor-Input

No.	UTM WGS84 Zone: 16 East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
A	723,221	4,599,127	220.7	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
B	724,038	4,599,484	222.3	30.0	30.0	0.2	-180.0	90.0	"Green house mode"
C	724,380	4,599,298	222.1	30.0	30.0	0.2	-180.0	90.0	"Green house mode"
D	724,326	4,599,770	221.2	1.0	1.0	1.0	-180.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Shadow, expected values Shadow hours per year [h/year]
A	2:41
B	209:08
C	28:13
D	3:16

Project:
Archbold

Description:
The Renaissance Group

THE RENAISSANCE GROUP
A Conserve First Company

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8/28/2010 6:51 PM / 2
Licensed user:
Conserve First LLC, d/b/a The Renaissance Group, Renewables
8281 Euclid Chardon Road, Suite E
US-44094 Kirtland, Ohio
4717
AAron Godwin / AAron@ConserveFirst.com
Calculated:
8/28/2010 6:51 PM/2.7.473

SHADOW - Main Result

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	Unison U54-750kW 750 54.0 !O! hub: 75.0 m (2)	853:59	243:19

Project:
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8/28/2010 6:51 PM / 3
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8281 Euclid Chardon Road, Suite E
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4717
AAron Godwin / AAron@ConserveFirst.com
Calculated:
8/28/2010 6:51 PM/2.7.473

SHADOW - Calendar

Shadow receptor: A - Shadow Receptor: 1.0 × 1.0 Azimuth: -180.0° Slope: 90.0° (1)

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

Sunshine probability S (Average daily sunshine hours) [CLEVELAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.47	4.37	4.90	7.57	8.91	9.33	10.21	9.01	6.89	5.70	2.71	1.87

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
227	217	324	570	498	353	263	290	423	680	776	830	755	671	460	318	7,655

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	08:04	07:50	07:14	07:22	06:36	06:07	06:07	06:32	07:03	07:34	07:09	07:44
	17:18	17:53	18:28	20:01	20:34	21:04	21:16	20:57	20:14	19:21	17:34	17:09
2	08:05	07:49	07:12	07:20	06:34	06:06	06:08	06:33	07:04	07:35	07:10	07:45
	17:19	17:54	18:29	20:02	20:35	21:05	21:16	20:56	20:12	19:19	17:32	17:09
3	08:05	07:48	07:11	07:19	06:33	06:06	06:08	06:34	07:05	07:36	07:11	07:46
	17:20	17:56	18:30	20:03	20:36	21:06	21:15	20:55	20:10	19:17	17:31	17:08
4	08:05	07:47	07:09	07:17	06:32	06:05	06:09	06:35	07:06	07:37	07:12	07:47
	17:21	17:57	18:31	20:05	20:37	21:06	21:15	20:54	20:09	19:16	17:30	17:08
5	08:05	07:46	07:07	07:15	06:31	06:05	06:09	06:36	07:07	07:38	07:14	07:48
	17:22	17:58	18:32	20:06	20:38	21:07	21:15	20:53	20:07	19:14	17:29	17:08
6	08:05	07:45	07:06	07:14	06:29	06:51 (1) 06:05	06:10	06:37	07:08	07:39	07:15	07:49
	17:23	17:59	18:33	20:07	20:39	7 06:58 (1) 21:08	21:15	20:51	20:05	19:12	17:28	17:08
7	08:04	07:44	07:04	07:12	06:28	06:50 (1) 06:04	06:11	06:38	07:09	07:40	07:16	07:50
	17:24	18:01	18:35	20:08	20:40	10 07:00 (1) 21:08	21:15	20:50	20:04	19:11	17:27	17:08
8	08:04	07:43	08:02	07:11	06:27	06:49 (1) 06:04	06:11	06:39	07:10	07:41	07:17	07:51
	17:25	18:02	19:36	20:09	20:41	12 07:01 (1) 21:09	21:14	20:49	20:02	19:09	17:25	17:08
9	08:04	07:42	08:01	07:09	06:26	06:48 (1) 06:04	06:12	06:40	07:11	07:42	07:18	07:52
	17:26	18:03	19:37	20:10	20:42	14 07:02 (1) 21:10	21:14	20:48	20:00	19:07	17:24	17:08
10	08:04	07:40	07:59	07:07	06:25	06:47 (1) 06:04	06:13	06:41	07:12	07:43	07:20	07:53
	17:27	18:04	19:38	20:11	20:43	16 07:03 (1) 21:10	21:14	20:46	19:57	19:06	17:23	17:08
11	08:04	07:39	07:58	07:06	06:24	06:47 (1) 06:04	06:13	06:42	07:13	07:45	07:21	07:54
	17:28	18:06	19:39	20:12	20:44	16 07:03 (1) 21:11	21:13	20:45	19:55	19:04	17:22	17:08
12	08:03	07:38	07:56	07:04	06:23	06:47 (1) 06:03	06:14	06:43	07:14	07:46	07:22	07:54
	17:29	18:07	19:40	20:13	20:45	16 07:03 (1) 21:11	21:13	20:44	19:54	19:03	17:21	17:08
13	08:03	07:37	07:54	07:02	06:21	06:47 (1) 06:03	06:15	06:44	07:15	07:47	07:23	07:55
	17:30	18:08	19:41	20:14	20:47	16 07:03 (1) 21:12	21:12	20:42	19:52	19:01	17:20	17:08
14	08:03	07:35	07:53	07:01	06:20	06:47 (1) 06:03	06:16	06:45	07:16	07:48	07:25	07:56
	17:31	18:09	19:43	20:15	20:48	16 07:03 (1) 21:12	21:12	20:41	19:50	18:59	17:19	17:08
15	08:02	07:34	07:51	06:59	06:19	06:47 (1) 06:03	06:16	06:46	07:17	07:49	07:26	07:57
	17:32	18:11	19:44	20:16	20:49	16 07:03 (1) 21:13	21:11	20:40	19:48	18:58	17:19	17:09
16	08:02	07:33	07:49	06:58	06:18	06:48 (1) 06:03	06:17	06:47	07:18	07:50	07:27	07:57
	17:33	18:12	19:45	20:18	20:50	14 07:02 (1) 21:13	21:11	20:38	19:47	18:56	17:18	17:09
17	08:01	07:31	07:48	06:56	06:17	06:48 (1) 06:03	06:18	06:48	07:19	07:51	07:28	07:58
	17:35	18:13	19:46	20:19	20:51	13 07:01 (1) 21:14	21:10	20:37	19:45	18:55	17:17	17:09
18	08:01	07:30	07:46	06:55	06:17	06:49 (1) 06:03	06:19	06:49	07:20	07:52	07:29	07:59
	17:36	18:14	19:47	20:20	20:52	12 07:01 (1) 21:14	21:09	20:35	19:43	18:53	17:16	17:09
19	08:00	07:29	07:44	06:53	06:16	06:50 (1) 06:04	06:20	06:50	07:21	07:53	07:31	07:59
	17:37	18:16	19:48	20:21	20:53	11 07:01 (1) 21:14	21:09	20:34	19:41	18:52	17:15	17:10
20	08:00	07:27	07:42	06:51	06:15	06:52 (1) 06:04	06:21	06:51	07:22	07:55	07:32	08:00
	17:38	18:17	19:49	20:22	20:53	7 06:59 (1) 21:15	21:08	20:32	19:40	18:50	17:15	17:10
21	07:59	07:26	07:41	06:50	06:14	06:54 (1) 06:04	06:21	06:52	07:23	07:56	07:33	08:01
	17:39	18:18	19:50	20:23	20:54	2 06:56 (1) 21:15	21:07	20:31	19:38	18:49	17:14	17:11
22	07:59	07:24	07:39	06:48	06:13	06:04	06:22	06:53	07:24	07:57	07:34	08:01
	17:41	18:19	19:51	20:24	20:55	21:15	21:06	20:29	19:36	18:47	17:13	17:11
23	07:58	07:23	07:37	06:47	06:12	06:04	06:23	07:03 (1) 06:54	07:25	07:58	07:35	08:02
	17:42	18:20	19:53	20:25	20:56	21:15	21:06 5	07:08 (1) 20:28	19:35	18:46	17:13	17:12
24	07:57	07:21	07:36	06:46	06:12	06:05	06:24	07:01 (1) 06:55	07:27	07:59	07:36	08:02
	17:43	18:22	19:54	20:26	20:57	21:15	21:05 8	07:09 (1) 20:26	19:33	18:44	17:12	17:12
25	07:56	07:20	07:34	06:44	06:11	06:05	06:25	07:00 (1) 06:56	07:28	08:00	07:38	08:02
	17:44	18:23	19:55	20:27	20:58	21:16	21:04 11	07:11 (1) 20:25	19:31	18:43	17:11	17:13
26	07:56	07:18	07:32	06:43	06:10	06:05	06:26	06:59 (1) 06:57	07:29	08:02	07:39	08:03
	17:45	18:24	19:56	20:28	20:59	21:16	21:03 13	07:12 (1) 20:23	19:29	18:42	17:11	17:14
27	07:55	07:17	07:31	06:41	06:09	06:06	06:27	06:58 (1) 06:58	07:30	08:03	07:40	08:03
	17:47	18:25	19:57	20:29	21:00	21:16	21:02 14	07:12 (1) 20:22	19:28	18:40	17:11	17:14
28	07:54	07:15	07:29	06:40	06:09	06:06	06:28	06:58 (1) 06:59	07:31	08:04	07:41	08:03
	17:48	18:26	19:58	20:31	21:01	21:16	21:01 15	07:13 (1) 20:20	19:26	18:39	17:10	17:15
29	07:53		07:27	06:38	06:08	06:06	06:29	06:58 (1) 07:00	07:32	08:05	07:42	08:04
	17:49		19:59	20:32	21:02	21:16	21:00 15	07:13 (1) 20:19	19:24	18:37	17:10	17:16
30	07:52		07:26	06:37	06:08	06:07	06:30	06:58 (1) 07:01	07:33	08:06	07:43	08:04
	17:50		20:00	20:33	21:02	21:16	20:59 16	07:14 (1) 20:17	19:23	18:36	17:09	17:16
31	07:51		07:24		06:07		06:31	06:57 (1) 07:02		08:08		08:04
	17:52		20:00		21:03		20:58 17	07:14 (1) 20:15		18:35		17:17
Potential sun hours	296	297	370	399	449	454	461	429	375	344	297	286
Total, worst case					98	1	14	1 7		8		
Sun reduction					0.61		0.69	0.65				
Oper. time red.					0.87		0.87	0.87				
Wind dir. red.					0.72		0.72	0.72				
Total reduction					0.39		0.43	0.41				
Total, real					7	7	9	6 4		3		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
Archbold

Description:
The Renaissance Group

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Licensed user:
Conserve First LLC, d/b/a The Renaissance Group, Renewables
8281 Euclid Chardon Road, Suite E
US-44094 Kirtland, Ohio
4717
AAron Godwin / AAron@ConserveFirst.com

Calculated:
8/28/2010 6:51 PM/2.7.473

SHADOW - Calendar

Shadow receptor: B - Shadow Receptor: 30.0 × 30.0 Azimuth: -180.0° Slope: 90.0° (7)

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

Sunshine probability S (Average daily sunshine hours) [CLEVELAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.47	4.37	4.90	7.57	8.91	9.33	10.21	9.01	6.89	5.70	2.71	1.87

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
227	217	324	570	498	353	263	290	423	680	776	830	755	671	460	318	7,655

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

	January		February		March		April		May		June	
1	08:04		13:57 (1)	07:50	13:55 (1)	07:14	13:45 (1)	07:22	14:47 (1)	06:36	15:45 (1)	06:07
	17:18	113	15:50 (1)	17:53 159	16:34 (1)	18:28 201	17:06 (1)	20:01 190	17:57 (1)	20:34 89	17:14 (1)	21:04
2	08:05		13:58 (1)	07:49	13:55 (1)	07:12	13:45 (1)	07:20	14:49 (1)	06:34	15:46 (1)	06:06
	17:19	113	15:51 (1)	17:54 161	16:36 (1)	18:29 202	17:07 (1)	20:02 187	17:56 (1)	20:35 85	17:11 (1)	21:05
3	08:05		13:58 (1)	07:48	13:55 (1)	07:10	13:44 (1)	07:19	14:51 (1)	06:33	15:48 (1)	06:06
	17:20	114	15:52 (1)	17:55 163	16:38 (1)	18:30 203	17:07 (1)	20:03 184	17:55 (1)	20:36 82	17:10 (1)	21:06
4	08:05		13:58 (1)	07:47	13:54 (1)	07:09	13:43 (1)	07:17	14:53 (1)	06:32	15:49 (1)	06:05
	17:21	115	15:53 (1)	17:57 165	16:39 (1)	18:31 204	17:07 (1)	20:05 181	17:54 (1)	20:37 80	17:09 (1)	21:06
5	08:05		13:58 (1)	07:46	13:53 (1)	07:07	13:43 (1)	07:15	14:55 (1)	06:31	15:51 (1)	06:05
	17:22	116	15:54 (1)	17:58 167	16:40 (1)	18:32 204	17:07 (1)	20:06 178	17:53 (1)	20:38 76	17:07 (1)	21:07
6	08:05		13:58 (1)	07:45	13:53 (1)	07:06	13:42 (1)	07:14	14:58 (1)	06:29	15:52 (1)	06:05
	17:23	117	15:55 (1)	17:59 169	16:42 (1)	18:33 205	17:07 (1)	20:07 174	17:52 (1)	20:39 73	17:05 (1)	21:08
7	08:04		13:58 (1)	07:44	13:53 (1)	07:04	13:41 (1)	07:12	15:00 (1)	06:28	15:53 (1)	06:04
	17:24	119	15:57 (1)	18:01 171	16:44 (1)	18:35 206	17:07 (1)	20:08 171	17:51 (1)	20:40 71	17:04 (1)	21:08
8	08:04		13:57 (1)	07:43	13:53 (1)	08:02	14:41 (1)	07:10	15:02 (1)	06:27	15:55 (1)	06:04
	17:25	120	15:57 (1)	18:02 173	16:46 (1)	19:36 207	18:08 (1)	20:09 168	17:50 (1)	20:41 67	17:02 (1)	21:09
9	08:04		13:58 (1)	07:42	13:53 (1)	08:01	14:40 (1)	07:09	15:04 (1)	06:26	15:57 (1)	06:04
	17:26	121	15:59 (1)	18:03 175	16:48 (1)	19:37 207	18:07 (1)	20:10 165	17:49 (1)	20:42 64	17:01 (1)	21:10
10	08:04		13:58 (1)	07:40	13:52 (1)	07:59	14:40 (1)	07:07	15:06 (1)	06:25	15:58 (1)	06:04
	17:27	122	16:00 (1)	18:04 177	16:49 (1)	19:38 208	18:08 (1)	20:11 161	17:47 (1)	20:43 62	17:00 (1)	21:10
11	08:04		13:58 (1)	07:39	13:52 (1)	07:58	14:39 (1)	07:06	15:09 (1)	06:24	16:00 (1)	06:04
	17:28	124	16:02 (1)	18:06 178	16:50 (1)	19:39 209	18:08 (1)	20:12 158	17:47 (1)	20:44 59	16:59 (1)	21:11
12	08:03		13:57 (1)	07:38	13:52 (1)	07:56	14:38 (1)	07:04	15:10 (1)	06:22	16:01 (1)	06:03
	17:29	125	16:02 (1)	18:07 180	16:52 (1)	19:40 209	18:07 (1)	20:13 155	17:45 (1)	20:45 56	16:57 (1)	21:11
13	08:03		13:58 (1)	07:37	13:52 (1)	07:54	14:37 (1)	07:02	15:13 (1)	06:21	16:02 (1)	06:03
	17:30	126	16:04 (1)	18:08 182	16:54 (1)	19:41 210	18:07 (1)	20:14 151	17:44 (1)	20:46 54	16:56 (1)	21:12
14	08:03		13:57 (1)	07:35	13:51 (1)	07:53	14:37 (1)	07:01	15:15 (1)	06:20	16:04 (1)	06:03
	17:31	128	16:05 (1)	18:09 183	16:54 (1)	19:43 210	18:07 (1)	20:15 147	17:42 (1)	20:47 51	16:55 (1)	21:12
15	08:02		13:57 (1)	07:34	13:51 (1)	07:51	14:37 (1)	06:59	15:16 (1)	06:19	16:05 (1)	06:03
	17:32	130	16:07 (1)	18:11 185	16:56 (1)	19:44 210	18:07 (1)	20:16 144	17:40 (1)	20:49 48	16:53 (1)	21:13
16	08:02		13:57 (1)	07:33	13:51 (1)	07:49	14:36 (1)	06:58	15:19 (1)	06:18	16:06 (1)	06:03
	17:33	131	16:08 (1)	18:12 186	16:57 (1)	19:45 210	18:06 (1)	20:18 140	17:39 (1)	20:50 46	16:52 (1)	21:13
17	08:01		13:57 (1)	07:31	13:50 (1)	07:47	14:36 (1)	06:56	15:20 (1)	06:17	16:08 (1)	06:03
	17:35	133	16:10 (1)	18:13 188	16:58 (1)	19:46 210	18:06 (1)	20:19 137	17:37 (1)	20:51 43	16:51 (1)	21:14
18	08:01		13:57 (1)	07:30	13:50 (1)	07:46	14:36 (1)	06:55	15:22 (1)	06:16	16:09 (1)	06:03
	17:36	134	16:11 (1)	18:14 189	16:59 (1)	19:47 210	18:06 (1)	20:20 134	17:36 (1)	20:52 41	16:50 (1)	21:14
19	08:00		13:57 (1)	07:28	13:49 (1)	07:44	14:36 (1)	06:53	15:24 (1)	06:16	16:10 (1)	06:03
	17:37	136	16:13 (1)	18:16 191	17:00 (1)	19:48 209	18:05 (1)	20:21 129	17:33 (1)	20:52 38	16:48 (1)	21:14
20	08:00		13:57 (1)	07:27	13:49 (1)	07:42	14:36 (1)	06:51	15:26 (1)	06:15	16:13 (1)	06:04
	17:38	137	16:14 (1)	18:17 192	17:01 (1)	19:49 209	18:05 (1)	20:22 126	17:32 (1)	20:53 35	16:48 (1)	21:15
21	07:59		13:56 (1)	07:26	13:48 (1)	07:41	14:36 (1)	06:50	15:27 (1)	06:14	16:14 (1)	06:04
	17:39	139	16:15 (1)	18:18 193	17:01 (1)	19:50 209	18:05 (1)	20:23 123	17:30 (1)	20:54 33	16:47 (1)	21:15
22	07:59		13:57 (1)	07:24	13:48 (1)	07:39	14:36 (1)	06:48	15:30 (1)	06:13	16:15 (1)	06:04
	17:40	141	16:18 (1)	18:19 194	17:02 (1)	19:51 208	18:04 (1)	20:24 118	17:28 (1)	20:55 30	16:45 (1)	21:15
23	07:58		13:56 (1)	07:23	13:47 (1)	07:37	14:36 (1)	06:47	15:31 (1)	06:12	16:17 (1)	06:04
	17:42	143	16:19 (1)	18:20 196	17:03 (1)	19:53 207	18:03 (1)	20:25 115	17:26 (1)	20:56 27	16:44 (1)	21:15
24	07:57		13:56 (1)	07:21	13:47 (1)	07:36	14:38 (1)	06:46	15:33 (1)	06:11	16:19 (1)	06:05
	17:43	144	16:20 (1)	18:22 197	17:04 (1)	19:54 205	18:03 (1)	20:26 112	17:25 (1)	20:57 24	16:43 (1)	21:15
25	07:56		13:55 (1)	07:20	13:46 (1)	07:34	14:38 (1)	06:44	15:35 (1)	06:11	16:21 (1)	06:05
	17:44	147	16:22 (1)	18:23 198	17:04 (1)	19:55 204	18:02 (1)	20:27 109	17:24 (1)	20:58 20	16:41 (1)	21:16
26	07:56		13:55 (1)	07:18	13:47 (1)	07:32	14:38 (1)	06:43	15:36 (1)	06:10	16:23 (1)	06:05
	17:45	148	16:23 (1)	18:24 198	17:05 (1)	19:56 203	18:01 (1)	20:28 105	17:21 (1)	20:59 16	16:39 (1)	21:16
27	07:55		13:56 (1)	07:17	13:46 (1)	07:31	14:40 (1)	06:41	15:38 (1)	06:09	16:27 (1)	06:05
	17:47	150	16:26 (1)	18:25 199	17:05 (1)	19:57 201	18:01 (1)	20:29 102	17:20 (1)	21:00 10	16:37 (1)	21:16
28	07:54		13:55 (1)	07:15	13:46 (1)	07:29	14:41 (1)	06:40	15:39 (1)	06:09		06:06
	17:48	152	16:27 (1)	18:26 200	17:06 (1)	19:58 199	18:00 (1)	20:31 99	17:18 (1)	21:01		21:16
29	07:53		13:55 (1)			07:27	14:42 (1)	06:38	15:41 (1)	06:08		06:06
	17:49	154	16:29 (1)			19:59 197	17:59 (1)	20:32 95	17:16 (1)	21:02		21:16
30	07:52		13:55 (1)			07:25	14:44 (1)	06:37	15:43 (1)	06:08		06:07
	17:50	156	16:31 (1)			20:00 195	17:59 (1)	20:33 92	17:15 (1)	21:02		21:16
31	07:51		13:55 (1)			07:24	14:46 (1)			06:07		
	17:52	157	16:32 (1)			20:00 192	17:58 (1)			21:03		
Potential sun hours	296		297		370		399		449		454	
Total, worst case		4105		5109		6363		4250		1380		
Sun reduction		0.36		0.41		0.41		0.57		0.61		
Oper. time red.		0.87		0.87		0.87		0.87		0.87		
Wind dir. red.		0.71		0.71		0.71		0.71		0.71		
Total reduction		0.23		0.26		0.26		0.35		0.38		
Total, real		925		1308		1623		1502		527		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
Archbold

Description:
The Renaissance Group

Printed/Page
8/28/2010 6:51 PM / 5
Licensed user:
Conserve First LLC, d/b/a The Renaissance Group, Renewables
8281 Euclid Chardon Road, Suite E
US-44094 Kirtland, Ohio
4717
AAron Godwin / AAron@ConserveFirst.com
Calculated:
8/28/2010 6:51 PM/2.7.473

SHADOW - Calendar

Shadow receptor: B - Shadow Receptor: 30.0 × 30.0 Azimuth: -180.0° Slope: 90.0° (7)

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

Sunshine probability S (Average daily sunshine hours) [CLEVELAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.47	4.37	4.90	7.57	8.91	9.33	10.21	9.01	6.89	5.70	2.71	1.87

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
227	217	324	570	498	353	263	290	423	680	776	830	755	671	460	318	7,655

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

	July		August		September		October		November		December	
1	06:07		06:32		16:11 (1)	07:03	15:08 (1)	07:34	14:18 (1)	07:09	13:22 (1)	07:44	13:40 (1)
	21:16		20:57	57	17:08 (1)	20:14 158	17:46 (1)	19:21 209	17:47 (1)	17:34 176	16:18 (1)	17:09 124	15:44 (1)
2	06:08		06:33		16:10 (1)	07:04	15:05 (1)	07:35	14:18 (1)	07:10	13:22 (1)	07:45	13:41 (1)
	21:16		20:56	60	17:10 (1)	20:12 161	17:46 (1)	19:19 208	17:46 (1)	17:32 174	16:16 (1)	17:09 122	15:43 (1)
3	06:08		06:34		16:08 (1)	07:05	15:02 (1)	07:36	14:18 (1)	07:11	13:23 (1)	07:46	13:42 (1)
	21:15		20:55	63	17:11 (1)	20:10 165	17:47 (1)	19:17 208	17:46 (1)	17:31 172	16:15 (1)	17:08 121	15:43 (1)
4	06:09		06:35		16:07 (1)	07:06	15:00 (1)	07:37	14:18 (1)	07:12	13:23 (1)	07:47	13:42 (1)
	21:15		20:54	65	17:12 (1)	20:09 167	17:47 (1)	19:16 207	17:45 (1)	17:30 171	16:14 (1)	17:08 120	15:42 (1)
5	06:09		06:36		16:05 (1)	07:07	14:57 (1)	07:38	14:17 (1)	07:14	13:23 (1)	07:48	13:43 (1)
	21:15		20:53	69	17:14 (1)	20:07 171	17:48 (1)	19:14 207	17:44 (1)	17:29 169	16:12 (1)	17:08 119	15:42 (1)
6	06:10		06:37		16:02 (1)	07:08	14:54 (1)	07:39	14:17 (1)	07:15	13:24 (1)	07:49	13:44 (1)
	21:15		20:51	72	17:14 (1)	20:05 174	17:48 (1)	19:12 207	17:44 (1)	17:28 167	16:11 (1)	17:08 117	15:41 (1)
7	06:11		06:38		16:01 (1)	07:09	14:51 (1)	07:40	14:17 (1)	07:16	13:24 (1)	07:50	13:45 (1)
	21:15		20:50	74	17:15 (1)	20:04 178	17:49 (1)	19:11 206	17:43 (1)	17:26 165	16:09 (1)	17:08 116	15:41 (1)
8	06:11		06:39		15:59 (1)	07:10	14:48 (1)	07:41	14:17 (1)	07:17	13:24 (1)	07:51	13:46 (1)
	21:14		20:49	78	17:17 (1)	20:02 181	17:49 (1)	19:09 205	17:42 (1)	17:25 163	16:07 (1)	17:08 115	15:41 (1)
9	06:12		06:40		15:58 (1)	07:11	14:46 (1)	07:42	14:17 (1)	07:18	13:25 (1)	07:52	13:47 (1)
	21:14		20:48	80	17:18 (1)	20:00 183	17:49 (1)	19:07 205	17:42 (1)	17:24 162	16:07 (1)	17:08 114	15:41 (1)
10	06:13		06:41		15:56 (1)	07:12	14:43 (1)	07:43	14:18 (1)	07:20	13:26 (1)	07:53	13:47 (1)
	21:14		20:46	83	17:19 (1)	19:57 187	17:50 (1)	19:06 204	17:42 (1)	17:23 159	16:05 (1)	17:08 113	15:40 (1)
11	06:13		06:42		15:54 (1)	07:13	14:40 (1)	07:45	14:18 (1)	07:21	13:26 (1)	07:54	13:47 (1)
	21:13		20:45	86	17:20 (1)	19:55 190	17:50 (1)	19:04 203	17:41 (1)	17:22 157	16:03 (1)	17:08 113	15:40 (1)
12	06:14		06:43		15:52 (1)	07:14	14:37 (1)	07:46	14:18 (1)	07:22	13:26 (1)	07:54	13:48 (1)
	21:13		20:44	90	17:22 (1)	19:54 192	17:49 (1)	19:03 202	17:40 (1)	17:21 155	16:01 (1)	17:08 112	15:40 (1)
13	06:15		06:44		15:50 (1)	07:15	14:35 (1)	07:47	14:18 (1)	07:23	13:27 (1)	07:55	13:49 (1)
	21:12		20:42	93	17:23 (1)	19:52 194	17:49 (1)	19:01 201	17:39 (1)	17:20 154	16:01 (1)	17:08 111	15:40 (1)
14	06:16		06:45		15:48 (1)	07:16	14:33 (1)	07:48	14:18 (1)	07:24	13:27 (1)	07:56	13:50 (1)
	21:12		20:41	96	17:24 (1)	19:50 196	17:49 (1)	18:59 200	17:38 (1)	17:19 152	15:59 (1)	17:08 110	15:40 (1)
15	06:16		06:46		15:47 (1)	07:17	14:31 (1)	07:49	14:18 (1)	07:26	13:28 (1)	07:57	13:50 (1)
	21:11		20:40	99	17:26 (1)	19:48 198	17:49 (1)	18:58 199	17:37 (1)	17:19 150	15:58 (1)	17:09 110	15:40 (1)
16	06:17		16:38 (1)	06:47	15:45 (1)	07:18	14:29 (1)	07:50	14:18 (1)	07:27	13:29 (1)	07:57	13:51 (1)
	21:11	7	16:45 (1)	20:38 102	17:27 (1)	19:47 201	17:50 (1)	18:56 198	17:36 (1)	17:18 148	15:57 (1)	17:09 109	15:40 (1)
17	06:18		16:34 (1)	06:48	15:43 (1)	07:19	14:27 (1)	07:51	14:19 (1)	07:28	13:29 (1)	07:58	13:52 (1)
	21:10	13	16:47 (1)	20:37 105	17:28 (1)	19:45 203	17:50 (1)	18:55 197	17:36 (1)	17:17 147	15:56 (1)	17:09 109	15:41 (1)
18	06:19		16:32 (1)	06:49	15:41 (1)	07:20	14:25 (1)	07:52	14:19 (1)	07:29	13:30 (1)	07:59	13:52 (1)
	21:09	18	16:50 (1)	20:35 109	17:30 (1)	19:43 204	17:49 (1)	18:53 196	17:35 (1)	17:16 144	15:54 (1)	17:09 109	15:41 (1)
19	06:20		16:30 (1)	06:50	15:38 (1)	07:21	14:24 (1)	07:53	14:19 (1)	07:30	13:30 (1)	07:59	13:53 (1)
	21:09	22	16:52 (1)	20:34 113	17:31 (1)	19:41 205	17:49 (1)	18:52 195	17:34 (1)	17:15 143	15:53 (1)	17:10 108	15:41 (1)
20	06:20		16:28 (1)	06:51	15:36 (1)	07:22	14:23 (1)	07:55	14:19 (1)	07:32	13:32 (1)	08:00	13:54 (1)
	21:08	26	16:54 (1)	20:32 116	17:32 (1)	19:40 206	17:49 (1)	18:50 194	17:33 (1)	17:15 141	15:53 (1)	17:10 108	15:42 (1)
21	06:21		16:27 (1)	06:52	15:34 (1)	07:23	14:22 (1)	07:56	14:19 (1)	07:33	13:32 (1)	08:01	13:54 (1)
	21:07	28	16:55 (1)	20:31 120	17:34 (1)	19:38 207	17:49 (1)	18:49 192	17:31 (1)	17:14 140	15:52 (1)	17:11 108	15:42 (1)
22	06:22		16:25 (1)	06:53	15:32 (1)	07:24	14:21 (1)	07:57	14:20 (1)	07:34	13:33 (1)	08:01	13:54 (1)
	21:06	32	16:57 (1)	20:29 123	17:35 (1)	19:36 208	17:49 (1)	18:47 191	17:31 (1)	17:13 137	15:50 (1)	17:11 108	15:42 (1)
23	06:23		16:23 (1)	06:54	15:30 (1)	07:25	14:20 (1)	07:58	14:20 (1)	07:35	13:33 (1)	08:02	13:55 (1)
	21:06	34	16:57 (1)	20:28 126	17:36 (1)	19:35 209	17:49 (1)	18:46 190	17:30 (1)	17:13 136	15:49 (1)	17:12 108	15:43 (1)
24	06:24		16:22 (1)	06:55	15:27 (1)	07:26	14:19 (1)	07:59	14:20 (1)	07:36	13:35 (1)	08:02	13:55 (1)
	21:05	36	16:58 (1)	20:26 130	17:37 (1)	19:33 210	17:49 (1)	18:44 189	17:29 (1)	17:12 134	15:49 (1)	17:12 108	15:43 (1)
25	06:25		16:20 (1)	06:56	15:25 (1)	07:28	14:18 (1)	08:00	14:20 (1)	07:37	13:35 (1)	08:02	13:56 (1)
	21:04	39	16:59 (1)	20:25 134	17:39 (1)	19:31 210	17:48 (1)	18:43 187	17:27 (1)	17:11 133	15:48 (1)	17:13 108	15:44 (1)
26	06:26		16:19 (1)	06:57	15:23 (1)	07:29	14:18 (1)	08:02	14:21 (1)	07:39	13:36 (1)	08:03	13:56 (1)
	21:03	42	17:01 (1)	20:23 137	17:40 (1)	19:29 210	17:48 (1)	18:42 186	17:27 (1)	17:11 131	15:47 (1)	17:13 109	15:45 (1)
27	06:27		16:18 (1)	06:58	15:20 (1)	07:30	14:18 (1)	08:03	14:21 (1)	07:40	13:36 (1)	08:03	13:56 (1)
	21:02	44	17:02 (1)	20:22 141	17:41 (1)	19:28 211	17:49 (1)	18:40 184	17:25 (1)	17:10 130	15:46 (1)	17:14 109	15:45 (1)
28	06:28		16:16 (1)	06:59	15:18 (1)	07:31	14:18 (1)	08:04	14:21 (1)	07:41	13:37 (1)	08:03	13:57 (1)
	21:01	47	17:03 (1)	20:20 144	17:42 (1)	19:26 210	17:48 (1)	18:39 183	17:24 (1)	17:10 128	15:45 (1)	17:15 110	15:47 (1)
29	06:29		16:15 (1)	07:00	15:15 (1)	07:32	14:18 (1)	08:05	14:21 (1)	07:42	13:38 (1)	08:04	13:57 (1)
	21:00	50	17:05 (1)	20:19 148	17:43 (1)	19:24 210	17:48 (1)	18:37 181	17:22 (1)	17:10 126	15:44 (1)	17:16 110	15:47 (1)
30	06:30		16:14 (1)	07:01	15:13 (1)	07:33	14:18 (1)	08:06	14:22 (1)	07:43	13:39 (1)	08:04	13:57 (1)
	20:59	52	17:06 (1)	20:17 151	17:44 (1)	19:23 209	17:47 (1)	18:36 180	17:22 (1)	17:09 125	15:44 (1)	17:16 111	15:48 (1)
31	06:31		16:12 (1)	07:02	15:10 (1)			08:08	14:22 (1)			08:04	13:57 (1)
	20:58	55	17:07 (1)	20:15 155	17:45 (1)			18:35 178	17:20 (1)			17:17 112	15:49 (1)
Potential sun hours	461			429		375		344		297		286	
Total, worst case		545		3219		5808		6092		4489		3481	
Sun reduction		0.69		0.65		0.55		0.51		0.27		0.20	
Oper. time red.		0.87		0.87		0.87		0.87		0.87		0.87	
Wind dir. red.		0.71		0.71		0.71		0.71		0.71		0.71	
Total reduction		0.43		0.40		0.34		0.32		0.17		0.13	
Total, real		233		1301		1988		1941		764		438	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
Archbold

Description:
The Renaissance Group

THE RENAISSANCE GROUP
A Conserve First Company

Printed/Page
8/28/2010 6:51 PM / 6
Licensed user:
Conserve First LLC, d/b/a The Renaissance Group, Renewables
8281 Euclid Chardon Road, Suite E
US-44094 Kirtland, Ohio
4717
AAron Godwin / AAron@ConserveFirst.com
Calculated:
8/28/2010 6:51 PM/2.7.473

SHADOW - Calendar

Shadow receptor: C - Shadow Receptor: 30.0 × 30.0 Azimuth: -180.0° Slope: 90.0° (10)

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

Sunshine probability S (Average daily sunshine hours) [CLEVELAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.47	4.37	4.90	7.57	8.91	9.33	10.21	9.01	6.89	5.70	2.71	1.87

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
227	217	324	570	498	353	263	290	423	680	776	830	755	671	460	318	7,655

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

	January	February	March	April		May		June		July		August		September	October	November	December
1	08:04	07:50	07:14	07:22		06:36		19:51 (1)	06:07		19:39 (1)	06:07		19:49 (1)	06:32		19:47 (1)	07:03	07:34	07:09	07:44
	17:18	17:53	18:28	20:01		20:34	21	20:12 (1)	21:04	49	20:28 (1)	21:16	42	20:31 (1)	20:57	46	20:33 (1)	20:14	19:21	17:34	17:09
2	08:04	07:49	07:12	07:20		06:34		19:48 (1)	06:06		19:40 (1)	06:08		19:48 (1)	06:33		19:48 (1)	07:04	07:35	07:10	07:45
	17:19	17:54	18:29	20:02		20:35	24	20:12 (1)	21:05	49	20:29 (1)	21:16	43	20:31 (1)	20:56	44	20:32 (1)	20:12	19:19	17:32	17:09
3	08:05	07:48	07:10	07:19		06:33		19:47 (1)	06:06		19:41 (1)	06:08		19:49 (1)	06:34		19:49 (1)	07:05	07:36	07:11	07:46
	17:20	17:55	18:30	20:03		20:36	26	20:13 (1)	21:06	48	20:29 (1)	21:15	43	20:32 (1)	20:55	42	20:31 (1)	20:10	19:17	17:31	17:08
4	08:05	07:47	07:09	07:17		06:32		19:46 (1)	06:05		19:41 (1)	06:09		19:48 (1)	06:35		19:50 (1)	07:06	07:37	07:12	07:47
	17:21	17:57	18:31	20:04		20:37	29	20:15 (1)	21:06	47	20:28 (1)	21:15	44	20:32 (1)	20:54	40	20:30 (1)	20:09	19:16	17:30	17:08
5	08:05	07:46	07:07	07:15		06:31		19:44 (1)	06:05		19:42 (1)	06:09		19:48 (1)	06:36		19:51 (1)	07:07	07:38	07:14	07:48
	17:22	17:58	18:32	20:06		20:38	32	20:16 (1)	21:07	46	20:28 (1)	21:15	45	20:33 (1)	20:53	38	20:29 (1)	20:07	19:14	17:29	17:08
6	08:05	07:45	07:06	07:14		06:29		19:42 (1)	06:05		19:42 (1)	06:10		19:49 (1)	06:37		19:51 (1)	07:08	07:39	07:15	07:49
	17:23	17:59	18:33	20:07		20:39	34	20:16 (1)	21:08	46	20:28 (1)	21:15	45	20:34 (1)	20:51	35	20:26 (1)	20:05	19:12	17:28	17:08
7	08:04	07:44	07:04	07:12		06:28		19:41 (1)	06:04		19:42 (1)	06:11		19:48 (1)	06:38		19:52 (1)	07:09	07:40	07:16	07:50
	17:24	18:01	18:35	20:08		20:40	36	20:17 (1)	21:08	45	20:27 (1)	21:15	46	20:34 (1)	20:50	33	20:25 (1)	20:04	19:11	17:26	17:08
8	08:04	07:43	08:02	07:10		06:27		19:40 (1)	06:04		19:43 (1)	06:11		19:48 (1)	06:39		19:54 (1)	07:10	07:41	07:17	07:51
	17:25	18:02	19:36	20:09		20:41	38	20:18 (1)	21:09	44	20:27 (1)	21:14	47	20:35 (1)	20:49	30	20:24 (1)	20:02	19:09	17:25	17:08
9	08:04	07:42	08:01	07:09		06:26		19:38 (1)	06:04		19:44 (1)	06:12		19:48 (1)	06:40		19:55 (1)	07:11	07:42	07:18	07:52
	17:26	18:03	19:37	20:10		20:42	41	20:19 (1)	21:10	43	20:27 (1)	21:14	48	20:36 (1)	20:48	28	20:23 (1)	20:00	19:07	17:24	17:08
10	08:04	07:40	07:59	07:07		06:25		19:38 (1)	06:04		19:44 (1)	06:13		19:47 (1)	06:41		19:56 (1)	07:12	07:43	07:20	07:53
	17:27	18:04	19:38	20:11		20:43	42	20:20 (1)	21:10	43	20:27 (1)	21:14	49	20:36 (1)	20:46	26	20:22 (1)	19:57	19:06	17:23	17:08
11	08:04	07:39	07:58	07:06		06:24		19:37 (1)	06:04		19:45 (1)	06:13		19:47 (1)	06:42		19:57 (1)	07:13	07:45	07:21	07:54
	17:28	18:06	19:39	20:12		20:44	44	20:21 (1)	21:11	42	20:27 (1)	21:13	49	20:36 (1)	20:45	24	20:21 (1)	19:55	19:04	17:22	17:08
12	08:03	07:38	07:56	07:04		06:22		19:36 (1)	06:03		19:45 (1)	06:14		19:47 (1)	06:43		19:59 (1)	07:14	07:46	07:22	07:54
	17:29	18:07	19:40	20:13		20:45	46	20:22 (1)	21:11	42	20:27 (1)	21:13	50	20:37 (1)	20:44	20	20:19 (1)	19:54	19:03	17:21	17:08
13	08:03	07:37	07:54	07:02		06:21		19:36 (1)	06:03		19:46 (1)	06:15		19:46 (1)	06:44		20:00 (1)	07:15	07:47	07:23	07:55
	17:30	18:08	19:41	20:14		20:46	47	20:23 (1)	21:12	41	20:27 (1)	21:12	51	20:37 (1)	20:42	18	20:18 (1)	19:52	19:01	17:20	17:08
14	08:03	07:35	07:53	07:01		06:20		19:35 (1)	06:03		19:46 (1)	06:16		19:46 (1)	06:45		20:01 (1)	07:16	07:48	07:24	07:56
	17:31	18:09	19:43	20:15		20:47	49	20:24 (1)	21:12	41	20:27 (1)	21:12	52	20:38 (1)	20:41	16	20:17 (1)	19:50	18:59	17:19	17:08
15	08:02	07:34	07:51	06:59		06:19		19:35 (1)	06:03		19:47 (1)	06:16		19:46 (1)	06:46		20:03 (1)	07:17	07:49	07:26	07:57
	17:32	18:11	19:44	20:16		20:48	50	20:25 (1)	21:13	40	20:27 (1)	21:11	52	20:38 (1)	20:40	12	20:15 (1)	19:48	18:58	17:18	17:09
16	08:02	07:33	07:49	06:58		06:18		19:35 (1)	06:03		19:47 (1)	06:17		19:46 (1)	06:47		20:06 (1)	07:18	07:50	07:27	07:57
	17:33	18:12	19:45	20:18		20:49	51	20:26 (1)	21:13	40	20:27 (1)	21:11	53	20:39 (1)	20:38	8	20:14 (1)	19:47	18:56	17:18	17:09
17	08:01	07:31	07:47	06:56		06:17		19:34 (1)	06:03		19:47 (1)	06:18		19:45 (1)	06:48			07:19	07:51	07:28	07:58
	17:34	18:13	19:46	20:19		20:50	53	20:27 (1)	21:14	40	20:27 (1)	21:10	53	20:38 (1)	20:37			19:45	18:55	17:17	17:09
18	08:01	07:30	07:46	06:54		06:16		19:34 (1)	06:03		19:47 (1)	06:19		19:45 (1)	06:49			07:20	07:52	07:29	07:59
	17:36	18:14	19:47	20:20		20:51	54	20:28 (1)	21:14	40	20:27 (1)	21:09	54	20:39 (1)	20:35			19:43	18:53	17:16	17:09
19	08:00	07:28	07:44	06:53		06:16		19:34 (1)	06:03		19:47 (1)	06:20		19:45 (1)	06:50			07:21	07:53	07:30	07:59
	17:37	18:16	19:48	20:21		20:52	54	20:28 (1)	21:14	40	20:27 (1)	21:09	54	20:39 (1)	20:34			19:41	18:52	17:15	17:10
20	08:00	07:27	07:42	06:51		06:15		19:35 (1)	06:04		19:48 (1)	06:20		19:45 (1)	06:51			07:22	07:55	07:32	08:00
	17:38	18:17	19:49	20:22		20:53	55	20:30 (1)	21:15	39	20:27 (1)	21:08	55	20:40 (1)	20:32			19:40	18:50	17:15	17:10
21	07:59	07:26	07:41	06:50		06:14		19:35 (1)	06:04		19:48 (1)	06:21		19:45 (1)	06:52			07:23	07:56	07:33	08:01
	17:39	18:18	19:50	20:23		20:54	55	20:30 (1)	21:15	39	20:27 (1)	21:07	55	20:40 (1)	20:31			19:38	18:49	17:14	17:11
22	07:59	07:24	07:39	06:48		06:13		19:35 (1)	06:04		19:49 (1)	06:22		19:45 (1)	06:53			07:24	07:57	07:34	08:01
	17:40	18:19	19:51	20:24		20:55	54	20:29 (1)	21:15	39	20:28 (1)	21:06	55	20:40 (1)	20:29			19:36	18:47	17:13	17:11
23	07:58	07:23	07:37	06:47		06:12		19:35 (1)	06:04		19:48 (1)	06:23		19:44 (1)	06:54			07:25	07:58	07:35	08:02
	17:42	18:20	19:53	20:25		20:56	54	20:29 (1)	21:15	40	20:28 (1)	21:06	55	20:39 (1)	20:28			19:35	18:46	17:13	17:12
24	07:57	07:21	07:36	06:45		06:11		19:36 (1)	06:04		19:48 (1)	06:24		19:44 (1)	06:55			07:26	07:59	07:36	08:02
	17:43	18:22	19:54	20:26		20:57	54	20:30 (1)	21:15	40	20:28 (1)	21:05	55	20:39 (1)	20:26			19:33	18:44	17:12	17:12
25	07:56	07:20	07:34	06:44		06:11		19:36 (1)	06:05		19:48 (1)	06:25		19:45 (1)	06:56			07:27	08:00	07:37	08:02
	17:44	18:23	19:55	20:27		20:58	53	20:29 (1)	21:16	40	20:28 (1)	21:04	54	20:39 (1)	20:25			19:31	18:43	17:11	17:13
26	07:56	07:18	07:32	06:43		06:10		19:36 (1)	06:05		19:49 (1)	06:26		19:45 (1)	06:57			07:29	08:02	07:39	08:03
	17:45	18:24	19:56	20:28		20:59	53	20:29 (1)	21:16	40	20:29 (1)	21:03	53	20:38 (1)	20:23			19:29	18:42	17:11	17:13
27	07:55	07:17	07:31	06:41	19:58 (1)	06:09		19:37 (1)	06:05		19:49 (1)	06:27		19:45 (1)	06:58			07:30	08:03	07:40	08:03
	17:47	18:25	19:57	20:29	10 20:08 (1)	21:00	53	20:30 (1)	21:16	40	20:29 (1)	21:02	52	20:37 (1)	20:22			19:28	18:40	17:10	17:14
28	07:54	07:15	07:29	06:40	19:55 (1)	06:09		19:37 (1)	06:06		19:49 (1)	06:28		19:45 (1)	06:59			07:31	08:04	07:41	08:03
	17:48	18:26	19:58	20:31	13 20:08 (1)	21:01	52	20:29 (1)	21:16	41	20:30 (1)	21:01	51	20:36 (1)	20:20			19:26	18:39	17:10	17:15
29	07:53		07:27	06:38	19:53 (1)	06:08		19:38 (1)	06:06		19:49 (1)	06:29		19:46 (1)	07:00			07:32	08:05	07:42	08:04
	17:49		19:59	20:32	16 20:09 (1)	21:02	51	20:29 (1)	21:16	41	20:30 (1)	21:00	49	20:35 (1)	20:19			19:24	18:37	17:10	17:16
30	07:52		07:25	06:37	19:52 (1)	06:08		19:38 (1)	06:07		19:48 (1)	06:30		19:46 (1)	07:01			07:33	08:06	07:43	08:04
	17:50		20:00	20:33	19 20:11 (1)	21:02	51	20:29 (1)	21:16	42	20:30 (1)	20:59	49	20:35 (1)	20:17			19:22	18:36	17:09	17:16
31	07:51		07:24			06:07		19:39 (1)				06:31		19:46 (1)	07:02				08:07		08:04
	17:52		20:00			21:03	50	20:29 (1)				20:58	48	20:34 (1)	20:15				18:35		17:17
Potential sun hours	296	297	370	399		449			454			461			429			375	344	297	286
Total, worst case					58		1406			1267			1551			460					
Sun reduction					0.57		0.61			0.62			0.69			0.65					
Oper. time red.					0.87		0.87			0.87			0.87			0.87					
Wind dir. red.					0.64		0.64			0.64			0.64			0.64					
Total reduction					0.32		0.34			0.34			0.38			0.36					
Total, real					18		481			435			593			167					

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

Project:
Archbold

Description:
The Renaissance Group

THE RENAISSANCE GROUP
A Conserve First Company

Printed/Page
8/28/2010 6:51 PM / 7

Licensed user:
Conserve First LLC, d/b/a The Renaissance Group, Renewables
8281 Euclid Chardon Road, Suite E
US-44094 Kirtland, Ohio
4717
AAron Godwin / AAron@ConserveFirst.com

Calculated:
8/28/2010 6:51 PM/2.7.473

SHADOW - Calendar

Shadow receptor: D - Shadow Receptor: 1.0 × 1.0 Azimuth: -180.0° Slope: 90.0° (11)

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

Sunshine probability S (Average daily sunshine hours) [CLEVELAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.47	4.37	4.90	7.57	8.91	9.33	10.21	9.01	6.89	5.70	2.71	1.87

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
227	217	324	570	498	353	263	290	423	680	776	830	755	671	460	318	7,655

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

	January		February	March	April	May	June	July	August	September	October	November		December	
1	08:04	15:56 (1)	07:50	07:14	07:22	06:36	06:07	06:07	06:32	07:03	07:34	07:09		07:44	15:45 (1)
	17:18	26 16:22 (1)	17:53	18:28	20:01	20:34	21:04	21:16	20:57	20:14	19:21	17:34		17:09	21 16:06 (1)
2	08:04	15:56 (1)	07:49	07:12	07:20	06:34	06:06	06:08	06:33	07:04	07:35	07:10		07:45	15:45 (1)
	17:19	27 16:23 (1)	17:54	18:29	20:02	20:35	21:05	21:16	20:56	20:12	19:19	17:32		17:09	22 16:07 (1)
3	08:05	15:57 (1)	07:48	07:10	07:19	06:33	06:06	06:08	06:34	07:05	07:36	07:11		07:46	15:45 (1)
	17:20	26 16:23 (1)	17:55	18:30	20:03	20:36	21:06	21:15	20:55	20:10	19:17	17:31		17:08	23 16:08 (1)
4	08:05	15:57 (1)	07:47	07:09	07:17	06:32	06:05	06:09	06:35	07:06	07:37	07:12		07:47	15:45 (1)
	17:21	26 16:23 (1)	17:57	18:31	20:05	20:37	21:06	21:15	20:54	20:09	19:16	17:30		17:08	24 16:09 (1)
5	08:05	15:58 (1)	07:46	07:07	07:15	06:31	06:05	06:09	06:36	07:07	07:38	07:14		07:48	15:45 (1)
	17:22	26 16:24 (1)	17:58	18:32	20:06	20:38	21:07	21:15	20:53	20:07	19:14	17:29		17:08	24 16:09 (1)
6	08:05	15:59 (1)	07:45	07:06	07:14	06:29	06:05	06:10	06:37	07:08	07:39	07:15		07:49	15:45 (1)
	17:23	25 16:24 (1)	17:59	18:33	20:07	20:39	21:08	21:15	20:51	20:05	19:12	17:28		17:08	25 16:10 (1)
7	08:04	16:00 (1)	07:44	07:04	07:12	06:28	06:04	06:11	06:38	07:09	07:40	07:16		07:50	15:45 (1)
	17:24	24 16:24 (1)	18:01	18:35	20:08	20:40	21:08	21:15	20:50	20:04	19:11	17:26		17:08	26 16:11 (1)
8	08:04	16:00 (1)	07:43	08:02	07:10	06:27	06:04	06:11	06:39	07:10	07:41	07:17		07:51	15:45 (1)
	17:25	24 16:24 (1)	18:02	19:36	20:09	20:41	21:09	21:14	20:49	20:02	19:09	17:25		17:08	26 16:11 (1)
9	08:04	16:01 (1)	07:42	08:01	07:09	06:26	06:04	06:12	06:40	07:11	07:42	07:18		07:52	15:46 (1)
	17:26	23 16:24 (1)	18:03	19:37	20:10	20:42	21:10	21:14	20:48	20:00	19:07	17:24		17:08	26 16:12 (1)
10	08:04	16:02 (1)	07:40	07:59	07:07	06:25	06:04	06:13	06:41	07:12	07:43	07:20		07:53	15:45 (1)
	17:27	22 16:24 (1)	18:04	19:38	20:11	20:43	21:10	21:14	20:46	19:57	19:06	17:23		17:08	27 16:12 (1)
11	08:04	16:03 (1)	07:39	07:58	07:06	06:24	06:03	06:13	06:42	07:13	07:45	07:21		07:54	15:46 (1)
	17:28	21 16:24 (1)	18:06	19:39	20:12	20:44	21:11	21:13	20:45	19:55	19:04	17:22		17:08	26 16:12 (1)
12	08:03	16:04 (1)	07:38	07:56	07:04	06:22	06:03	06:14	06:43	07:14	07:46	07:22		07:54	15:46 (1)
	17:29	19 16:23 (1)	18:07	19:40	20:13	20:45	21:11	21:13	20:44	19:54	19:03	17:21		17:08	27 16:13 (1)
13	08:03	16:05 (1)	07:37	07:54	07:02	06:21	06:03	06:15	06:44	07:15	07:47	07:23		07:55	15:47 (1)
	17:30	18 16:23 (1)	18:08	19:41	20:14	20:46	21:12	21:12	20:42	19:52	19:01	17:20		17:08	27 16:14 (1)
14	08:03	16:06 (1)	07:35	07:53	07:01	06:20	06:03	06:16	06:45	07:16	07:48	07:24		07:56	15:47 (1)
	17:31	16 16:22 (1)	18:09	19:43	20:15	20:47	21:12	21:12	20:41	19:50	18:59	17:19		17:08	28 16:15 (1)
15	08:02	16:08 (1)	07:34	07:51	06:59	06:19	06:03	06:16	06:46	07:17	07:49	07:26		07:57	15:47 (1)
	17:32	14 16:22 (1)	18:11	19:44	20:16	20:49	21:13	21:11	20:40	19:48	18:58	17:18		17:08	27 16:14 (1)
16	08:02	16:10 (1)	07:33	07:49	06:58	06:18	06:03	06:17	06:47	07:18	07:50	07:27		07:57	15:48 (1)
	17:33	10 16:20 (1)	18:12	19:45	20:18	20:50	21:13	21:11	20:38	19:47	18:56	17:18		17:09	27 16:15 (1)
17	08:01	16:13 (1)	07:31	07:47	06:56	06:17	06:03	06:18	06:48	07:19	07:51	07:28		07:58	15:48 (1)
	17:34	6 16:19 (1)	18:13	19:46	20:19	20:51	21:14	21:10	20:37	19:45	18:55	17:17		17:09	28 16:16 (1)
18	08:01		07:30	07:46	06:54	06:16	06:03	06:19	06:49	07:20	07:52	07:29		07:59	15:48 (1)
	17:36		18:14	19:47	20:20	20:51	21:14	21:09	20:35	19:43	18:53	17:16		17:09	28 16:16 (1)
19	08:00		07:28	07:44	06:53	06:16	06:03	06:20	06:50	07:21	07:53	07:30		07:59	15:49 (1)
	17:37		18:16	19:48	20:21	20:52	21:14	21:09	20:34	19:41	18:52	17:15		17:10	28 16:17 (1)
20	08:00		07:27	07:42	06:51	06:15	06:04	06:20	06:51	07:22	07:55	07:32		08:00	15:50 (1)
	17:38		18:17	19:49	20:22	20:53	21:15	21:08	20:32	19:40	18:50	17:15		17:10	28 16:18 (1)
21	07:59		07:26	07:41	06:50	06:14	06:04	06:21	06:52	07:23	07:56	07:33		08:01	15:50 (1)
	17:39		18:18	19:50	20:23	20:54	21:15	21:07	20:31	19:38	18:49	17:14		17:11	28 16:18 (1)
22	07:59		07:24	07:39	06:48	06:13	06:04	06:22	06:53	07:24	07:57	07:34		08:01	15:50 (1)
	17:40		18:19	19:51	20:24	20:55	21:15	21:06	20:29	19:36	18:47	17:13		17:11	28 16:18 (1)
23	07:58		07:23	07:37	06:47	06:12	06:04	06:23	06:54	07:25	07:58	07:35		08:02	15:51 (1)
	17:42		18:20	19:53	20:25	20:56	21:15	21:06	20:28	19:35	18:46	17:13		17:12	28 16:19 (1)
24	07:57		07:21	07:36	06:45	06:11	06:04	06:24	06:55	07:26	07:59	07:36		08:02	15:51 (1)
	17:43		18:22	19:54	20:26	20:57	21:15	21:05	20:26	19:33	18:44	17:12		17:12	28 16:19 (1)
25	07:56		07:20	07:34	06:44	06:11	06:05	06:25	06:56	07:27	08:00	07:37	15:51 (1)	08:02	15:52 (1)
	17:44		18:23	19:55	20:27	20:58	21:16	21:04	20:25	19:31	18:43	17:11	5 15:56 (1)	17:13	28 16:20 (1)
26	07:56		07:18	07:32	06:43	06:10	06:05	06:26	06:57	07:29	08:02	07:39	15:49 (1)	08:03	15:52 (1)
	17:45		18:24	19:56	20:28	20:59	21:16	21:03	20:23	19:29	18:42	17:11	10 15:59 (1)	17:13	28 16:20 (1)
27	07:55		07:17	07:31	06:41	06:09	06:05	06:27	06:58	07:30	08:03	07:40	15:47 (1)	08:03	15:53 (1)
	17:47		18:25	19:57	20:29	21:00	21:16	21:02	20:22	19:28	18:40	17:10	14 16:01 (1)	17:14	27 16:20 (1)
28	07:54		07:15	07:29	06:40	06:09	06:06	06:28	06:59	07:31	08:04	07:41	15:46 (1)	08:03	15:54 (1)
	17:48		18:26	19:58	20:31	21:01	21:16	21:01	20:20	19:26	18:39	17:10	16 16:02 (1)	17:15	27 16:21 (1)
29	07:53			07:27	06:38	06:08	06:06	06:29	07:00	07:32	08:05	07:42	15:45 (1)	08:04	15:54 (1)
	17:49			19:59	20:32	21:02	21:16	21:00	20:19	19:24	18:37	17:10	18 16:03 (1)	17:16	28 16:22 (1)
30	07:52			07:25	06:37	06:08	06:07	06:30	07:01	07:33	08:06	07:43	15:46 (1)	08:04	15:55 (1)
	17:50			20:00	20:33	21:02	21:16	20:59	20:17	19:22	18:36	17:09	19 16:05 (1)	17:16	27 16:22 (1)
31	07:51			07:24		06:07		06:31	07:02		08:08			08:04	15:55 (1)
	17:52			20:00		21:03		20:58	20:15		18:35			17:17	27 16:22 (1)
Potential sun hours	296		297	370	399	449	454	461	429	375	344	297		286	
Total, worst case		353											82		822
Sun reduction		0.36											0.27		0.20
Oper. time red.		0.87											0.87		0.87
Wind dir. red.		0.71											0.71		0.71
Total reduction		0.23											0.17		0.13
Total, real		79											14		103

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

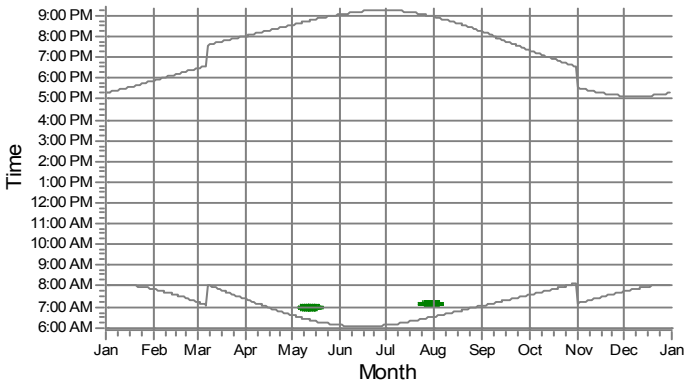
Project:
Archbold

Description:
The Renaissance Group

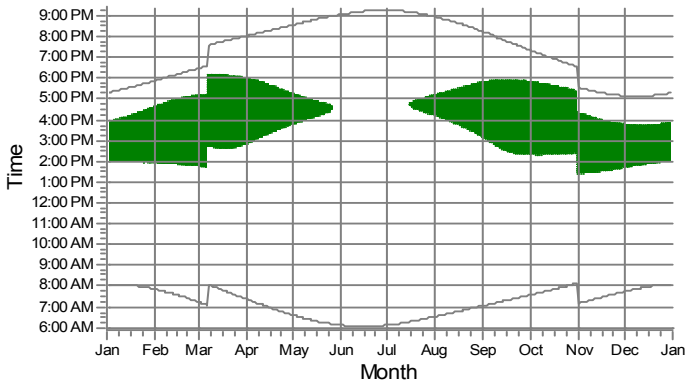
Printed/Page
8/28/2010 6:51 PM / 8
Licensed user:
Conserve First LLC, d/b/a The Renaissance Group, Renewables
8281 Euclid Chardon Road, Suite E
US-44094 Kirtland, Ohio
4717
AAron Godwin / AAron@ConserveFirst.com
Calculated:
8/28/2010 6:51 PM/2.7.473

SHADOW - Calendar, graphical

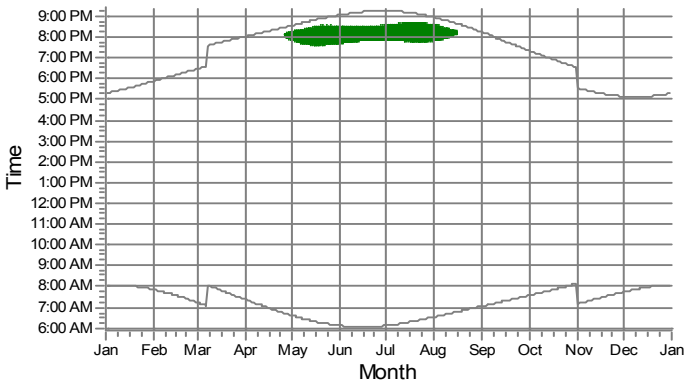
A: Shadow Receptor: 1.0 × 1.0 Azimuth: -180.0° Slope: 90.0° (1)



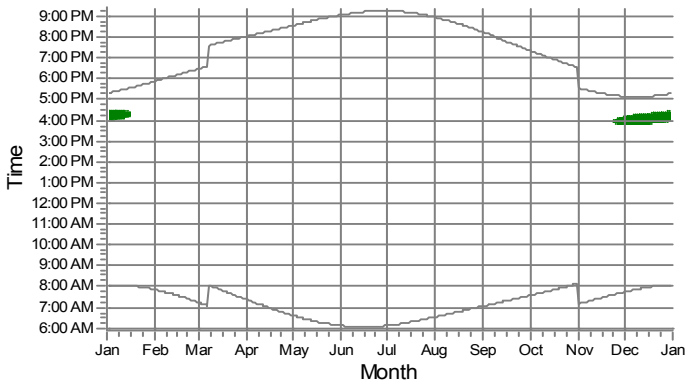
B: Shadow Receptor: 30.0 × 30.0 Azimuth: -180.0° Slope: 90.0° (7)



C: Shadow Receptor: 30.0 × 30.0 Azimuth: -180.0° Slope: 90.0° (10)



D: Shadow Receptor: 1.0 × 1.0 Azimuth: -180.0° Slope: 90.0° (11)



WTGs

1: Unison U54-750kW 750 54.0 !O! hub: 75.0 m (2)

Turbine Use, Safety Policies and General Background

Security:

- Tower Climbing: The wind turbine utilizes a smooth exterior monopole tower with no climbing surfaces or apparatus. Tower climbing is only achieved through the use of an internal ladder system. This system is only reachable through a locked plate steel door.
- Availability: Only preauthorized personnel will be given access to the internal tower and turbine systems.

Tower Climbing Safety:

- Safety Climb: For maintenance personnel climbing of the tower, an OSHA approved "safety climb" system is included in the tower climbing system. This system is comprised of a ladder, a steel cable for the safety climb device, a full body harness designed and approved for the purpose, a locking safety climb device, safety lanyards with self-locking clips and additional tie-in points throughout the turbine system where a cable system is not available.
- OSHA approved safety equipment such as hardhats will be worn by all maintenance personnel climbing or working on the turbine.
- No individual shall climb the tower without a partner.

Electrical Safety:

- All electrical components and their installations shall meet all Local, State and Federal applicable laws and regulations.
- The turbine system shall meet UL1741 and IEC requirements for Utility Grid Protection in case of Grid power failures or power quality abnormalities.
- All electrical supply/grid interconnect services to and from the turbine shall be in buried conduits.
- The turbine system will have a staff accessible emergency shut-offs.
    - Utility room
    - Tower base
    - Nacelle
    - Remote through "Web" interface.

- The turbine system will have an automated system fault shut-off triggered at a minimum by the following sensors: System temperature, power quality, vibration, over-speed, fire and icing.
    - This system will also automatically send fault codes to preauthorized personnel through a "Web" interface.
- All safety sensors and equipment shall fault to a turbine fault state in case of their own failure.

Fire:

- The turbine shall have fire detection devices at the tower base and within the nacelle that shall be linked to the Site's existing fire detection/alarm systems (if present).
- The local fire department shall be contacted and a fire/emergency response plan shall be adopted.
- Although formal fire suppression systems are extremely rare for wind turbines, the site shall investigate passive and active fire suppression systems for possible implementation in the turbine system.
- Local fire department approved fire extinguishers shall be located within the tower base and within the nacelle.
- The turbine system will have staff accessible emergency shut-offs.
    - Utility room
    - Tower base
    - Nacelle
    - Remote through "Web" interface.
- The turbine system will have an automated system fault shut-off triggered at a minimum by the following sensors: System temperature, power quality, vibration, over-speed, fire and icing.
    - This system will also automatically send fault codes to preauthorized personnel through a "Web" interface.
- Safety zones similar to any fire related incident will be utilized, if a fire should occur.

Lightening:

- The turbine system is equipped with a full grounding loop meeting or exceeding all Local, State and Federal regulations concerning grounding and lightening protection.
- Surge suppressing technology will be utilized to protect key electronics.
- See fire policies above.

Icing:

- Although icing of wind turbines is very rare and safety issues related to icing even rarer, it can occur, similar to any built structure (roofs, power lines, stadium lights, etc.).
- Although not an absolute brake, blade icing induced airfoil shape spoiling will naturally reduce the efficiency of the blades and thus reduce their rotational speed.
- Although formal icing detection systems are extremely rare for wind turbines, the site shall investigate active icing detection systems for possible implementation in the turbine system.
- The turbine system will have an automated system fault shut-off triggered at a minimum by the following sensors: System temperature, power quality, vibration, over-speed, fire and icing (vibration caused by blade icing induced imbalances will automatically shut down the turbine).
    - This system will also automatically send fault codes to preauthorized personnel through a "Web" interface.
- The turbine's nacelle will have a cold-weather package including nacelle heaters. These heaters are designed to maintain nacelle temperatures above the dew-point and well above freezing. This system will automatically melt snow and ice accumulation on top of the nacelle.
- The turbine system will have a staff accessible emergency shut-offs.
    - Utility room
    - Tower base
    - Nacelle
    - Remote through "Web" interface.
- All icing related turbine shut-downs will require a direct inspection and an on-site manual restart.
- The site personnel and the system maintenance personnel will shut down the turbine in the event of an icing condition.
- The site shall adopt an ice safety zone around the turbine for implementation during icing events, if they should occur.

High Wind:

- The turbine automatically shuts down in high winds and turns itself out of the wind.
- The turbine system will have an automated system fault shut-off triggered at a minimum by the following sensors: System temperature, power quality, vibration,

over-speed, fire and icing (vibration caused by blade icing induced imbalances will automatically shut down the turbine).
    - This system will also automatically send fault codes to preauthorized personnel through a "Web" interface.

Aviation Safety:

- The project has been review by both FAA and ODOT and "No Hazard to Aviation" determinations were issued.
- An FAA approved red obstruction marking light will be located on top of the nacelle.

Shadow Flicker:

- Although all structures cast shadows, shadows from wind turbines that reach occupied structures or areas can be considered a nuisance due to the fact that they move or flicker as the blades rotate in front of the Sun.
- A formal shadow flicker study has been conducted for the site based on the turbine's rotor diameter and height, the site latitude and longitude, weather records, existing site topography and the existing area obstructions.
- Per international standards, shadow flicker impacting a particular location above 30 hours per year is considered a potential nuisance. While the turbine's shadow will reach some of the area properties, no residential or business property locations will receive more than 30 hours of shadow per year. Other factors that mitigate the shadows' impact include:
    - Shadow intensity drops off with distance. Shadow edges soften and shadow bodies become more muted. Shadows beyond ten rotor diameters from the tower base are considered insignificant with shadows within five rotor diameters being the most significant.
    - Shadows move and do not remain in one spot for extended periods of time.
    - The longest extended period shadows occur in the winter when there are fewer sunny days.
    - Many local natural and built environmental elements such as trees will block or significantly diffuse shadows.
- If extended adverse shadows should impact a particular dwelling, the wind turbine site owner will take one or more of the following mitigating measures:
    - Plant evergreen trees to block the shadow.
    - Provide blinds for the dwelling.
    - Turn off the turbine during the shadowing periods that excessively affect the dwelling.

Sound:

- Wind turbines of the size to be installed are inherently quite devices, especially over distance, and are typically very hard to hear over the wind itself and the existing ambient area noise levels.
    - Sound from a single wind turbines typically comes from the following areas:
        - Wind noise off of the blades as they are driven by the wind (swooshing that drops off over distance and typically competes with the area's natural wind noise).
        - Drive-train noise (mechanical sound typically not heard outside the immediate vicinity of the turbine).
        - Yaw system noise (mechanical sound typically not heard outside the immediate vicinity of the turbine and that is only present when the turbine turns into the wind).
        - Electrical noise from the turbine's electrical equipment and transformer (buzz, typically not heard outside the immediate vicinity of the turbine).
- Sound modeling for the proposed wind turbine supports that turbine produced audio levels will not exceed any local code or ordinance at the site's property lines. To be conservative, this modeling was done at an 8 mps/17.9 mph wind speed, well above site averages.
- Sound measurement of existing ambient sound levels for both day and evening periods at multiple locations surrounding the site show existing ambient sound levels above what the wind turbine will produce.

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[i] The only known shadow flicker regulation to date was enacted in Germany, where a court ruled that the maximum allowable flicker would be 30 hours per year (Klepinger, 2007). In addition, Dobesch and Kury (2001) recommended that shadow flicker should not exceed 30 hours per year, and the guidelines for wind power development in the State of Victoria, Australia state that shadow flicker may not exceed 30 hours per year at any dwelling in the surrounding area (Sustainable Energy Authority Victoria, 2003). Since there are no known national or local regulations that govern shadow flicker in the United States, New York State, or Steuben County, the 30-hour per year threshold is used in this analysis to determine potentially impacted structures.
http://www.eon.com/en/downloads/Appendix_M_Shadow_Flicker_Modeling_Report.pdf

[ii] Epilepsy Foundation. (n.d.). Photosensitivity and Epilepsy.
http://www.epilepsyfoundation.org/about/photosensitivity/

[iii] As there is a possibility of a turbine model change on the project, the worst case largest model under consideration was used for the shadow flicker models.