



A Conserve First Company



Cuyahoga County Fairgrounds Wind Turbine Project Turbine Visualization and Photo Analysis

Prepared for:
Cuyahoga County Commissioners
Cuyahoga County Fairgrounds Board

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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 be 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.

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.



Fairgrounds Visualizations

Set Number	Picture Number	Distance from Turbine (miles)	Site Description	Latitude	Longitude	Direction
1	1388	1.24	Berea Union Depot	41° 22' 51.12" N	81° 51' 15.93" W	140°
2	1418	0.40	Berea District 7 School	41° 22' 20.93" N	81° 50' 28.07" W	165°
3	1427	0.26	Nursing Home on Old Oak Blvd	41° 22' 06.09" N	81° 50' 05.06" W	246°
4	1434	0.39	Southwest General Hospital Parking Garage	41° 22' 08.65" N	81° 49' 56.40" W	247°
5	1441	0.41	Quadax	41° 21' 41.89" N	81° 50' 09.39" W	335°
6	1448	0.34	Corner of Austin & Andrew	41° 21' 43.62" N	81° 50' 22.86" W	4°
7	1480	0.27	352 Waverly	41° 21' 48.35" N	81° 50' 28.78" W	24°
8	1499	0.25	211 Eastland	41° 21' 59.93" N	81° 50' 38.87" W	84°
9	1516	0.15	University Drive	41° 22' 09.11" N	81° 50' 21.33" W	181°
10	1518	0.37	Bagley Road - Fairgrounds Entrance	41° 22' 19.22" N	81° 50' 11.77" W	202°
11	1733	0.67	Coe Lake	41° 21' 49.26" N	81° 51' 04.65" W	70°
12	1515	0.45	Corner of Eastland and Bagley	41° 22' 21.00" N	81° 50' 37.94" W	148°
13	1505	0.71	Corner of Front Street	41° 22' 01.11" N	81° 51' 10.85" W	90°

Proposed Site Panoramic Photos Looking Out

Looking North



Looking East



Looking South



Looking West



Turbine View Visualizations

FG-V-1

Berea Union Depot
Turbine not Visible



FG-V-2

Berea District 7 School
Turbine not Visible behind Trees



FG-V-3

Nursing Home on Old Oak Blvd



FG-V-4

Southwest General Hospital Parking Garage
Image taken from top of Parking Garage (49' off of Ground)



FG-V-5

Quadax off of Old Oak Blvd
Turbine not Visible behind Trees



FG-V-6

Corner of Austin & Andrews
Blades Visible between two homes





FG-V-7

South by Southwest, Typical Yard, Off of Waverly

FG-V-8

211 Eastland
Blades visible behind Trees



FG-V-9

University Drive



FG-V-10

Bagley Road Fairgrounds Entrance
Turbine not Visible behind Trees



FG-V-11

Coe Lake



FG-V-12

Corner of Eastland and Bagley
Turbine not Visible behind Trees and Built Structures



FG-V-13

Corner of Front Street
Turbine not Visible behind Trees



Downtown Berea



Example Images of Other Regional Tall Structures

Tower on Fairgrounds Property



Fairgrounds Grandstands



Baldwin Wallace Skystream Wind Turbine



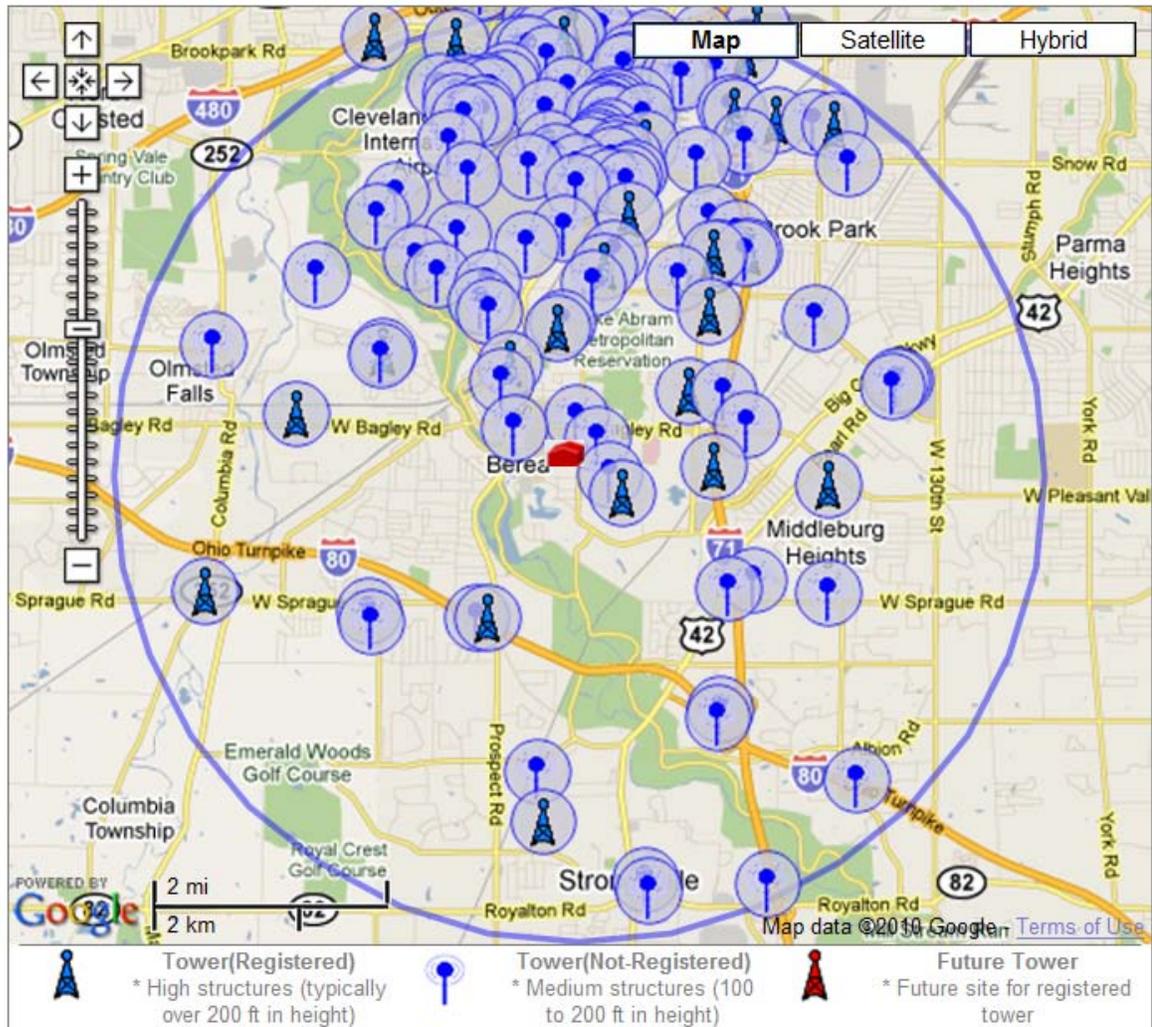
Other Local Towers



(Also See Tall Tower Tables Below)

Existing Tall Towers Within 4 Miles of The Proposed Turbine Site

- Tower Structures - (194 Eastland Rd, Berea, OH 44017)



Non-Registered Towers			
1	Mr. Jim Yates	200 feet	.30 miles
2	Blank	70 feet	.34 miles
3	Blank	70 feet	.45 miles
4	Ameritech Wireless Communiations, Inc.	113 feet	.77 miles
5	Northcoast Communications Llc	139 feet	1.10 miles
6	22218-ib-27	100 feet	1.20 miles
7	Sobota, James	80 feet	1.51 miles
8	Ohio Turnpike Commission	135 feet	1.54 miles
9	Blank	70 feet	1.59 miles
10	Gte Mobilnet Of Ohio	161 feet	1.61 miles
11	Blank	70 feet	1.69 miles
12	Northcoast Communications Llc	146 feet	1.75 miles
13	Voicestream Wireless	120 feet	1.76 miles
14	Ameritech New Media Enterprises	100 feet	1.76 miles
15	Medina Supply Company	65 feet	1.77 miles
16	Blank	70 feet	1.82 miles
17	Surenergy, Llc	317 feet	1.87 miles
18	Itt Corporation	30 feet	1.92 miles
19	Cellular One Technical Operations	150 feet	1.94 miles
20	Sprint Pcs	124 feet	2.14 miles
21	Cleveland Airport System	23 feet	2.24 miles
22	Brookpark, City Of	114 feet	2.25 miles
23	Brook Park Land Development Co	28 feet	2.25 miles
24	Blank	70 feet	2.26 miles
25	Cleveland Hopkins Intl Airport	49 feet	2.30 miles
26	Continental Airlines Inc.	64 feet	2.30 miles
27	Northern Ohio Cellular Telephone Co	195 feet	2.31 miles
28	Blank	105 feet	2.31 miles
29	At&t Wireless Services	200 feet	2.32 miles
30	Ameritech Wireless Comm Inc	185 feet	2.33 miles
31	Brookpark, City Of	80 feet	2.39 miles
32	Department Of Port Control	50 feet	2.40 miles
33	Itt Corporation	42 feet	2.40 miles
34	Blank	70 feet	2.41 miles
35	Tower Assets Newco Iv, Llc	165 feet	2.42 miles
36	Brookpark, City Of	215 feet	2.42 miles
37	American Tower-schaumburg, Il	166 feet	2.44 miles
38	National Weather Service	30 feet	2.46 miles
39	Department Of Port Control	45 feet	2.47 miles
40	Blank	70 feet	2.48 miles
41	Cleveland Hopkins International Airport (cle)	90 feet	2.49 miles
42	Department Of Port Control	45 feet	2.52 miles
43	Cleveland Hopkins International Airport	50 feet	2.53 miles
44	United Airlines - Trent Surlis	60 feet	2.53 miles
45	Department Of Port Control	45 feet	2.56 miles
46	Itt Corporation	56 feet	2.56 miles
47	City Of Cleveland Dpc	52 feet	2.59 miles
48	Department Of Port Control	45 feet	2.59 miles
49	Faa Ani-480	45 feet	2.60 miles
50	Department Of Port Control	45 feet	2.63 miles
51	Department Of Port Control	45 feet	2.69 miles
52	Nextel West Corp	94 feet	2.71 miles
53	Ford Motor Land Ser Corporation	125 feet	2.72 miles
54	Northcoast Communications	127 feet	2.72 miles
55	Department Of Port Control	45 feet	2.80 miles
56	Cleveland Airport System - Dept Of Port Control	100 feet	2.80 miles
57	Cleveland Airport System - Dept Of Port Control	100 feet	2.81 miles

58	Department Of Port Control	45 feet	2.82 miles
59	City Of Clev	792 feet	2.84 miles
60	Cingular Wireless-gd	190 feet	2.85 miles
61	Cleveland Airport System - Dept Of Port Control	65 feet	2.87 miles
62	Cleveland Airport System - Dept Of Port Control	65 feet	2.89 miles
63	Nextel West Corp	120 feet	2.90 miles
64	City Of Brookpark	40 feet	2.91 miles
65	Department Of Port Control	50 feet	2.91 miles
66	Cleveland Airport System - Dept Of Port Control	65 feet	2.91 miles
67	Cleveland Airport System - Dept Of Port Control	65 feet	2.93 miles
68	Itt Corporation	43 feet	2.97 miles
69	Paul Wolff	25 feet	2.97 miles
70	Faa Ani-480	45 feet	2.99 miles
71	Cleveland Airport System - Dept Of Port Control	150 feet	3.02 miles
72	Itt Corporation	66 feet	3.03 miles
73	Southwest Cab Co,	140 feet	3.10 miles
74	Itt Corporation	50 feet	3.13 miles
75	Sensis Corporation	60 feet	3.13 miles
76	Cleveland Hopkins	822 feet	3.14 miles
77	Ameritech Wireless Communications, Llc	96 feet	3.15 miles
78	National Aeronautics And Space Administo	101 feet	3.16 miles
79	Mr. Heinz L. Wimmer	72 feet	3.18 miles
80	At&t Wireless	260 feet	3.20 miles
81	City Of Cleveland Department Of Port Control	28 feet	3.20 miles
82	City Of Cleveland Department Of Port Control	25 feet	3.20 miles
83	Federal Aviaition Administration	786 feet	3.21 miles
84	Cleveland Airport System	21 feet	3.22 miles
85	Nasa Lewis Research Center	91 feet	3.22 miles
86	Cleveland Airport System	28 feet	3.23 miles
87	Blank	65 feet	3.23 miles
88	Nasa Lewis Research Center	100 feet	3.25 miles
89	Cleveland Airport System	34 feet	3.25 miles
90	Department Of Port Control	50 feet	3.26 miles
91	Sprint Pcs	150 feet	3.27 miles
92	Gte Mobilnet Of Ohio Limited Partnership	96 feet	3.28 miles
93	Department Of Port Control	50 feet	3.28 miles
94	Nasa Lewis Research Center	130 feet	3.34 miles
95	Nextel West Corp	64 feet	3.35 miles
96	Sensis Corporation	50 feet	3.35 miles
97	Nasa Lewis Research Center	50 feet	3.36 miles
98	Ms. Tracey Tilden	96 feet	3.38 miles
99	New Par	82 feet	3.43 miles
100	Cleveland Hopkins International Airport	30 feet	3.43 miles
101	Faa Central Service Area	108 feet	3.44 miles
102	Ohio Department Of Transportation	21 feet	3.44 miles
103	Dana Ryan	60 feet	3.47 miles
104	Dana Ryan	60 feet	3.58 miles
105	Ohio Department Of Transportation	42 feet	3.60 miles
106	Alltel Communications Inc Co Airspac	85 feet	3.62 miles
107	Blank	70 feet	3.63 miles
108	At&t Wireless Services	148 feet	3.66 miles
109	Sprintcom Inc	145 feet	3.70 miles
110	At&t Wireless Services Cl 165 06	199 feet	3.70 miles
111	Amsdell Construction, Inc.	80 feet	3.74 miles
112	Amsdell Construction Inc	57 feet	3.77 miles
113	Amsdell Construction Inc	57 feet	3.82 miles
114	Blank	70 feet	3.91 miles
115	New Par	112 feet	3.93 miles

Multiple Antennas on Listed Towers

1	Nextel License Holdings 4, Inc. Fehl	100 feet 1.00 miles	102 feet .99 miles
2	Nextel License Holdings 4, Inc. Fibertower Network Services Corp. Berea, City Of	137 feet 1.14 miles 137 feet 1.14 miles 151 feet 1.13 miles	
3	Middleburg Heights, City Of Fibertower Network Services Corp. Nextel License Holdings 4, Inc. Alltel Ohio Limited Partnership Berea, City Of	138 feet 1.33 miles 139 feet 1.32 miles 139 feet 1.32 miles NA 1.33 miles 138 feet 1.33 miles	
4	Nextel License Holdings 4, Inc. Nextel License Holdings 4, Inc. Nextel License Holdings 4, Inc.	102 feet 2.13 miles 102 feet 2.13 miles	
5	Ford Communications Inc Ford Communications Inc Ford Communications Inc Ford Communications Inc Ford Communications Inc	NA 2.37 miles NA 2.37 miles NA 2.37 miles 30 feet 2.37 miles 30 feet 2.37 miles	
6	Progressive Plastics Inc Rybicki & Son Funeral Home Aeronautical Radio Inc Cleveland Communications Inc Holiday Inn Of Middleburg Heights Fci 900, Inc. Fci 900, Inc. Gilcrest Electric Mercury Air Center Continental Airlines Inc Airport Communicatio Ns Dept United Airlines Inc Cardpak Incorporated Fci 900, Inc. Fci 900, Inc. Rak Contracting Inc Cairns Construction Inc Us Airways, Inc. Baldwin Wallace College Us Airways, Inc.	NA 2.82 miles NA 2.82 miles NA 2.83 miles NA 2.82 miles NA 2.82 miles 49 feet 2.83 miles NA 2.83 miles NA 2.82 miles 20 feet 2.82 miles 56 feet 2.83 miles NA 2.82 miles NA 2.82 miles 49 feet 2.83 miles NA 2.82 miles NA 2.82 miles 45 feet 2.83 miles NA 2.82 miles 45 feet 2.83 miles	
7	Nextel License Holdings 4, Inc. Fibertower Network Services Corp.	140 feet 2.99 miles 129 feet 2.99 miles	
8	Nextel License Holdings 4, Inc. Brook Park, City Of Nextel License Holdings 4, Inc. Nextel License Holdings 4, Inc.	171 feet 3.25 miles 171 feet 3.25 miles 171 feet 3.25 miles	
9	Ford Communications Inc Ford Communications Inc Ford Communications Inc	NA 3.26 miles 10 feet 3.26 miles 69 feet 3.26 miles	
10	Baldwin Wallace College Baldwin Wallace College Baldwin Wallace College	NA .30 miles NA .30 miles 49 feet .30 miles	
11	Berea, City Of Berea, City Of Berea, City Of	75 feet .61 miles 59 feet .61 miles 75 feet .61 miles	
12	Gregory J Norman Inc Gregory J Norman Inc	NA .64 miles 49 feet .64 miles	
13	Berea City Schools Berea Board Of Education Berea Board Of Education	89 feet .66 miles 89 feet .66 miles 89 feet .66 miles	

14	Berea, City Of Middleburg Heights, City Of Southwest General Health Care Center Southwest General Health Center Southwest General Hospital Berea Board Of Education Southwest General Health Center Southwest General Health Care Center Southwest General Health Care Center	92 feet .70 miles 92 feet .70 miles 49 feet .70 miles NA .69 miles 79 feet .70 miles NA .70 miles 49 feet .69 miles NA .70 miles 49 feet .70 miles	
15	Polaris Career Center Polaris Career Center	NA .70 miles NA .70 miles	
16	Middleburg Heights, City Of Southwest General Health Center	95 feet .81 miles 92 feet .81 miles	
17	Dearborn Inc Dearborn Inc Dearborn Inc	NA .84 miles NA .84 miles NA .84 miles	
18	Ohio Turnpike Commission Ohio Turnpike Commission	NA 1.33 miles NA 1.33 miles	
19	Elyria Auto Parts Incorporated Elyria Auto Parts Baldwin Wallace College Union	39 feet 1.50 miles 39 feet 1.51 miles NA 1.50 miles	
20	Oc-sma, Llc Quality Block And Supply Inc	79 feet 1.85 miles 79 feet 1.85 miles	
21	Cleveland Metropolitan Park District Cleveland Metropolitan Park District	49 feet 2.04 miles NA 2.04 miles	
22	Ici Paints Ici Paints	NA 2.11 miles 20 feet 2.11 miles	
23	Middleburg Heights, City Of Middleburg Heights, City Of	NA 2.21 miles 59 feet 2.21 miles	
24	Parking Co. Of America Brighton Best Socket Screw Manufacturing	15 feet 2.24 miles NA 2.24 miles	
25	Berea City Schools Berea Board Of Education	39 feet 2.28 miles 39 feet 2.28 miles	
26	Global Ground Service Air Services Of Cleveland Inc Mercury Air Center Secovsair Global Ground Service	20 feet 2.35 miles NA 2.35 miles 840 feet 2.35 miles 20 feet 2.35 miles NA 2.35 miles	
27	Fibertower Corporation Park Place Inc	128 feet 2.41 miles NA 2.40 miles	
28	Ppg Industries Inc Ppg Industries	NA 2.56 miles NA 2.56 miles	
29	Aero Mag - Contego Cle Llc Aero Mag - Contego Cle Llc	NA 2.58 miles 15 feet 2.58 miles	
30	Continental Airlines, Inc. Continental Airlines, Inc. Continental Airlines, Inc.	43 feet 2.61 miles NA 2.61 miles NA 2.61 miles	
31	Avis Rent A Car Systems Inc Avis Rent A Car Systems Inc	NA 2.64 miles NA 2.64 miles	
32	Hukill Chemical Corporation Hukill Chemical Corporation	NA 2.68 miles NA 2.68 miles	
33	Notre Dame, University Of Notre Dame, University Of Notre Dame, University Of Sheraton Hopkins Airport Hotel Notre Dame, University Of Sheraton Hopkins Airport Hotel	NA 2.88 miles NA 2.88 miles NA 2.88 miles NA 2.88 miles NA 2.88 miles NA 2.88 miles	

34	Cleveland, City Of Ohio, State Of Ohio, State Of Ohio, State Of Cleveland, city Of Cleveland, City Of	135 feet 2.91 miles 121 feet 2.91 miles 135 feet 2.91 miles 135 feet 2.91 miles 119 feet 2.89 miles 135 feet 2.91 miles	
35	United Airlines, Inc. United Air Lines, Inc., Debtor-in-possession	NA 2.94 miles 20 feet 2.94 miles	
36	Oc-sma, Llc Oc-sma, Llc Oc-sma, Llc	80 feet 2.96 miles NA 2.96 miles 66 feet 2.96 miles	
37	Hertz Corporation Hertz Corporation Hertz Corporation	7 feet 3.01 miles NA 2.99 miles 13 feet 2.99 miles	
38	Ford Communications Inc Ford Communications Inc	41 feet 3.03 miles NA 3.03 miles	
39	Aircraft Service International Inc Aircraft Service International Inc. Aircraft Service International Inc.	72 feet 3.06 miles NA 3.05 miles 15 feet 3.05 miles	
40	City Of Strongsville City Of Strongsville	36 feet 3.12 miles 36 feet 3.12 miles	
41	Arbys 201 Arbys Inc 201	NA 3.20 miles NA 3.18 miles	
42	Norfolk Southern Railway Company Penn Central Communications Company	10 feet 3.22 miles NA 3.22 miles	
43	Ford Communications Inc Ford Communications Inc	NA 3.27 miles 59 feet 3.27 miles	
44	United Parcel Service United Parcel Service	NA 3.36 miles 49 feet 3.36 miles	
45	Ford Communications Inc Ford Communications Inc Ford Communications Inc Ford Communications Inc Fci 900, Inc. Ford Communications Inc Ford Communications Inc Ford Communications Inc	82 feet 3.47 miles NA 3.47 miles NA 3.47 miles 69 feet 3.47 miles NA 3.47 miles NA 3.47 miles 49 feet 3.47 miles NA 3.47 miles	
46	Olmsted Falls, City Of Olmsted Falls, City Of Olmsted Falls, City Of Olmsted Falls, City Of	NA 3.61 miles 121 feet 3.61 miles 98 feet 3.61 miles NA 3.61 miles	
47	Richard E Jacobs Group Dba South Park Center Southpark Mall Security Southpark Mall Security	75 feet 3.70 miles 75 feet 3.70 miles NA 3.70 miles	
48	T-mobile License Llc Alltel Ohio Limited Partnership New Par	199 feet 2.30 miles NA 2.29 miles 195 feet 2.29 miles	
49	Ohio Turnpike Commission Ohio Turnpike Commission	140 feet 1.43 miles 140 feet 1.43 miles	
50	Cleveland, City Of Cleveland, City Of	70 feet 2.85 miles 66 feet 2.85 miles	

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

<http://www.antennasearch.com/>

Single Antennas on Area Towers

54	Norfolk Southern Railway Company	7 feet	1.26 miles	102	American Steel & Wire Corporation	NA	3.00 miles
52	Nextel License Holdings 4, Inc.	189 feet	2.66 miles	103	Fairview Park, City Of	NA	3.01 miles
53	Nextel License Holdings 4, Inc.	377 feet	3.02 miles	104	Van Dorn Demag Inc	20 feet	3.02 miles
54	Nextel License Holdings 4, Inc.	64 feet	3.36 miles	105	Strongsville Board Of Education	NA	3.05 miles
55	Ams Spectrum Holdings, Llc	154 feet	3.46 miles	106	Cuyahoga Concrete Inc	60 feet	3.06 miles
56	Nextel License Holdings 4, Inc.	39 feet	3.97 miles	107	Hamamey Inc	32 feet	3.12 miles
57	Cuyahoga County Agricultural Society	52 feet	.07 miles	108	Navco Ent Inc Dbmcdonalds	NA	3.13 miles
58	Southwest General Health Center	NA	.55 miles	109	Strongsville, City Of	141 feet	3.20 miles
59	Baldwin Wallace College	NA	.61 miles	110	Delta Air Lines Inc	NA	3.20 miles
60	Hexagram, Inc.	NA	.64 miles	111	Wendys	NA	3.24 miles
61	Mal Mac Enterprises Inc Dbmcdonald S	NA	.64 miles	112	Safety Sign Co.	NA	3.32 miles
62	Ohio Turnpike Commission	NA	.68 miles	113	Apcoa Inc Dbmcdonald S	13 feet	3.33 miles
63	Greater Cleveland Hospital Association	NA	.70 miles	114	Mal Mac Ii Enterprises Inc Dbmcdonald S	NA	3.34 miles
64	Ohio Turnpike Commission	66 feet	1.39 miles	115	Gap Inc	NA	3.38 miles
65	Ohio, State Of	13 feet	1.39 miles	116	Target Store T985	NA	3.39 miles
66	United Parcel Service	49 feet	1.44 miles	117	Albums Inc	NA	3.42 miles
67	Bridgestone Firestone Inc	NA	1.54 miles	118	Applied Construction Technologies Inc	NA	3.48 miles
68	Jims Leasing	79 feet	1.56 miles	119	Vitamix Corporation	17 feet	3.49 miles
69	Dontes Pizza Inc	NA	1.62 miles	120	Strongsville City Schools	NA	3.50 miles
70	Lagf Operating Associates-west Llc	NA	1.64 miles	121	Ohio, State Of	NA	3.51 miles
71	Ohio, State Of	49 feet	1.66 miles	122	B & O Auto Parts	NA	3.54 miles
72	Home Depot U.s.a., Inc.	NA	1.75 miles	123	Miami Computer Supply Corp Dbmcdonald S	NA	3.56 miles
73	Columbia Gas Of Ohio	NA	1.75 miles	124	Aja Restaurant Group, Llc	NA	3.56 miles
74	Fabrizi Trucking & Paving Company	NA	1.80 miles	125	General Electric Radio Services Corporation	20 feet	3.57 miles
75	Brook Park, City Of	20 feet	1.89 miles	126	Dollar Operations Inc	NA	3.63 miles
76	Krispy Kreme Corporation	NA	1.96 miles	127	Jcpenney Corp Inc.	NA	3.65 miles
77	I X Center Inc	NA	2.11 miles	128	Giant Eagle Inc	NA	3.67 miles
78	Middleburg Heights, City Of	NA	2.16 miles	129	Fawn Lake Apartments	NA	3.67 miles
79	Brook Park, City Of	105 feet	2.24 miles	130	Sysco Food Services Of Cleveland Inc	49 feet	3.67 miles
80	Varbros Corporation	NA	2.30 miles	131	Central Reserve Life	NA	3.74 miles
81	Cleveland Hopkins International Airport	49 feet	2.35 miles	132	Vallier, Walter G	NA	3.74 miles
82	Ohio Turnpike Commission	NA	2.42 miles	133	Aja Restaurant Group, Llc	NA	3.74 miles
83	Brook Park, City Of	NA	2.43 miles	134	Stahl Construction	NA	3.85 miles
84	Apcoa Inc	NA	2.44 miles	135	Home Depot U.s.a., Inc.	NA	3.87 miles
85	Van Dorn Demag Corp	49 feet	2.48 miles	136	Olmsted Falls, City Of	NA	3.92 miles
86	Park & Fly Of Ohio Inc	NA	2.50 miles	137	Olmsted Falls, City Of	197 feet	3.93 miles
87	Ohio Turnpike Commission	NA	2.53 miles	138	Alltel Ohio Limited Partnership	144 feet	2.30 miles
88	Federal Express Corporation	NA	2.58 miles	139	Usa Mobility Wireless, Inc.	90 feet	.84 miles
89	Hertz Corporation	20 feet	2.68 miles	140	Ams Spectrum Holdings, Llc	56 feet	2.73 miles
90	Avis Rent A Car Systems Inc	16 feet	2.68 miles	141	The Ohio Bell Telephone Company	NA	3.80 miles
91	K ii Inc	NA	2.69 miles	142	Usa Mobility Wireless, Inc.	88 feet	3.82 miles
92	Delta Air Lines, Inc.	33 feet	2.70 miles	143	Baldwin-wallace College	100 feet	.32 miles
93	Cleveland, City Of Hopkins Airport Fire Department	NA	2.75 miles	144	Fibertower Network Services Corp.	190 feet	.43 miles
94	Independence Air, Inc.	NA	2.81 miles	145	Metropolitan Area Networks, Inc.	168 feet	2.42 miles
95	Us Airways, Inc.	NA	2.83 miles	146	Itt Corporation	41 feet	2.46 miles
96	Southwest Airlines Company	32 feet	2.89 miles	147	Cleveland Electric Illuminating Company	98 feet	3.11 miles
97	Trans Airlines Inc.	NA	2.92 miles	148	Itt Corporation	46 feet	3.16 miles
98	Polaris Joint Vocational School District	NA	2.93 miles	149	Itt Corporation	46 feet	3.18 miles
99	Hertz Corporation	NA	2.96 miles	150	Metropolitan Area Networks, Inc.	54 feet	3.49 miles
100	Dymment Distribution	NA	2.96 miles	151	Spacenet Services License Sub, Inc.	31 feet	3.72 miles
101	American Airlines Inc.	36 feet	2.98 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/>

Horizon View Impact Calculator

Rotor Diameter 154.2 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	24.54%	100.00%
200	0.04	12.27%	73.63%
400	0.08	6.14%	36.81%
800	0.15	3.07%	18.41%
1,600	0.30	1.53%	9.20%
3,200	0.61	0.77%	4.60%
5,280	1.00	0.46%	2.79%
10,560	2.00	0.23%	1.39%
15,840	3.00	0.15%	0.93%
21,120	4.00	0.12%	0.70%
26,400	5.00	0.09%	0.56%
52,800	10.00	0.05%	0.28%

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	274 Feet
Turbine Height to Hub	197 Feet
Persons Eye Height	5.5 Feet
Based on Level Ground.	

Listed Obstruction Height (Feet)

Will Block Turbine View

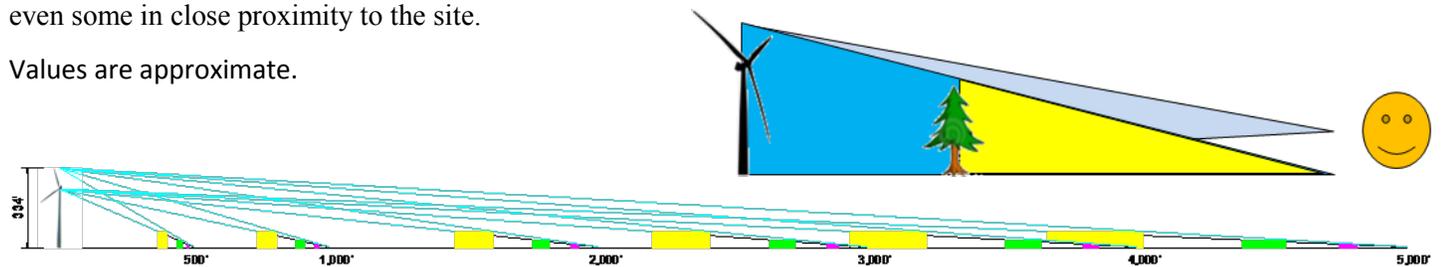
Within Listed Distance of Viewer (Feet)

Obstruction Height (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)
		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.

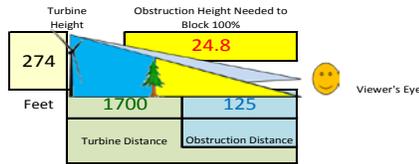
Values are approximate.



Sample Wind Turbine Visibility Over Obstructions Tables

Turbine Information:

	Feet	Meters
Tower Height	196.9	60.0
Rotor Diameter	154.2	47.0
Tip Height	274.0	83.5
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	31.9	26.5	22.9	20.4	18.4	14.0	11.7	10.4	9.5	8.8	8.4	8.0	7.7	7.4	7.2	7.1	6.9	6.8	6.7	6.6	6.5	6.4	6.3
20	58.8	48.0	40.9	35.7	31.9	22.9	18.4	15.8	14.0	12.7	11.7	11.0	10.4	9.9	9.5	9.1	8.8	8.6	8.4	8.2	8.0	7.8	7.7
30	85.7	69.5	58.8	51.1	45.3	31.9	25.2	21.1	18.4	16.5	15.1	14.0	13.1	12.3	11.7	11.2	10.8	10.4	10.0	9.7	9.5	9.2	9.0
40	112.6	91.1	76.7	66.5	58.8	40.9	31.9	26.5	22.9	20.4	18.4	17.0	15.8	14.8	14.0	13.3	12.7	12.2	11.7	11.3	11.0	10.7	10.4
50	139.5	112.6	94.7	81.8	72.2	49.8	38.6	31.9	27.4	24.2	21.8	19.9	18.4	17.2	16.2	15.3	14.6	14.0	13.4	12.9	12.5	12.1	11.7
60	166.4	134.1	112.6	97.2	85.7	58.8	45.3	37.3	31.9	28.1	25.2	22.9	21.1	19.7	18.4	17.4	16.5	15.8	15.1	14.5	14.0	13.5	13.1
70	193.3	155.6	130.5	112.6	99.1	67.8	52.1	42.7	36.4	31.9	28.5	25.9	23.8	22.1	20.7	19.5	18.4	17.6	16.8	16.1	15.5	14.9	14.4
80	220.2	177.1	148.4	127.9	112.6	76.7	58.8	48.0	40.9	35.7	31.9	28.9	26.5	24.6	22.9	21.6	20.4	19.3	18.4	17.7	17.0	16.3	15.8
90	247.1	198.6	166.4	143.3	126.0	85.7	65.5	53.4	45.3	39.6	35.3	31.9	29.2	27.0	25.2	23.6	22.3	21.1	20.1	19.2	18.4	17.7	17.1
100	274.0	220.2	184.3	158.7	139.5	94.7	72.2	58.8	49.8	43.4	38.6	34.9	31.9	29.5	27.4	25.7	24.2	22.9	21.8	20.8	19.9	19.2	18.4
125	NA	NA	229.1	197.1	173.1	117.1	89.0	72.2	61.0	53.0	47.0	42.4	38.6	35.6	33.0	30.9	29.0	27.4	26.0	24.8	23.7	22.7	21.8
150	NA	NA	274.0	235.5	206.7	139.5	105.9	85.7	72.2	62.6	55.4	49.8	45.3	41.7	38.6	36.0	33.8	31.9	30.2	28.7	27.4	26.2	25.2
175	NA	NA	NA	274.0	240.3	161.9	122.7	99.1	83.4	72.2	63.8	57.3	52.1	47.8	44.2	41.2	38.6	36.4	34.4	32.7	31.1	29.8	28.5
200	NA	NA	NA	NA	274.0	184.3	139.5	112.6	94.7	81.8	72.2	64.8	58.8	53.9	49.8	46.4	43.4	40.9	38.6	36.6	34.9	33.3	31.9
225	NA	NA	NA	NA	NA	206.7	156.3	126.0	105.9	91.4	80.6	72.2	65.5	60.0	55.4	51.5	48.2	45.3	42.8	40.6	38.6	36.8	35.3
250	NA	NA	NA	NA	NA	229.1	173.1	139.5	117.1	101.1	89.0	79.7	72.2	66.1	61.0	56.7	53.0	49.8	47.0	44.6	42.4	40.4	38.6
500	NA	NA	NA	NA	NA	NA	NA	274.0	229.1	197.1	173.1	154.4	139.5	127.3	117.1	108.4	101.1	94.7	89.0	84.1	79.7	75.8	72.2
1000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	274.0	249.5	229.1	211.9	197.1	184.3	173.1	163.2	154.4	146.6	139.5

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	6.3	6.2	7.1	6.9	6.8	6.7	6.6	6.5	6.4	6.3	6.3	6.2	6.2	6.1	6.1	6.0	6.0	6.0	5.9	5.9	5.9	5.8	5.8
20	7.6	7.4	9.1	8.8	8.6	8.4	8.2	8.0	7.8	7.7	7.6	7.4	7.3	7.2	7.2	7.1	7.0	6.9	6.9	6.8	6.7	6.7	6.6
30	8.8	8.7	11.2	10.8	10.4	10.0	9.7	9.5	9.2	9.0	8.8	8.7	8.5	8.4	8.2	8.1	8.0	7.9	7.8	7.7	7.6	7.5	7.4
40	10.1	9.9	13.3	12.7	12.2	11.7	11.3	11.0	10.7	10.4	10.1	9.9	9.7	9.5	9.3	9.1	9.0	8.8	8.7	8.6	8.5	8.4	8.3
50	11.4	11.1	15.3	14.6	14.0	13.4	12.9	12.5	12.1	11.7	11.4	11.1	10.8	10.6	10.4	10.2	10.0	9.8	9.6	9.5	9.3	9.2	9.1
60	12.7	12.3	17.4	16.5	15.8	15.1	14.5	14.0	13.5	13.1	12.7	12.3	12.0	11.7	11.5	11.2	11.0	10.8	10.6	10.4	10.2	10.0	9.9
70	14.0	13.6	19.5	18.4	17.6	16.8	16.1	15.5	14.9	14.4	14.0	13.6	13.2	12.8	12.5	12.2	12.0	11.7	11.5	11.3	11.1	10.9	10.7
80	15.2	14.8	21.6	20.4	19.3	18.4	17.7	17.0	16.3	15.8	15.2	14.8	14.4	14.0	13.6	13.3	13.0	12.7	12.4	12.2	11.9	11.7	11.5
90	16.5	16.0	23.6	22.3	21.1	20.1	19.2	18.4	17.7	17.1	16.5	16.0	15.5	15.1	14.7	14.3	14.0	13.6	13.3	13.1	12.8	12.6	12.3
100	17.8	17.2	25.7	24.2	22.9	21.8	20.8	19.9	19.2	18.4	17.8	17.2	16.7	16.2	15.8	15.3	15.0	14.6	14.3	14.0	13.7	13.4	13.2
125	21.0	20.3	30.9	29.0	27.4	26.0	24.8	23.7	22.7	21.8	21.0	20.3	19.6	19.0	18.4	17.9	17.5	17.0	16.6	16.2	15.8	15.5	15.2
150	24.2	23.3	36.0	33.8	31.9	30.2	28.7	27.4	26.2	25.2	24.2	23.3	22.5	21.8	21.1	20.5	19.9	19.4	18.9	18.4	18.0	17.6	17.2
175	27.4	26.4	41.2	38.6	36.4	34.4	32.7	31.1	29.8	28.5	27.4	26.4	25.5	24.6	23.8	23.1	22.4	21.8	21.2	20.7	20.2	19.7	19.3
200	30.6	29.5	46.4	43.4	40.9	38.6	36.6	34.9	33.3	31.9	30.6	29.5	28.4	27.4	26.5	25.7	24.9	24.2	23.5	22.9	22.4	21.8	21.3
225	33.8	32.5	51.5	48.2	45.3	42.8	40.6	38.6	36.8	35.3	33.8	32.5	31.3	30.2	29.2	28.3	27.4	26.6	25.9	25.2	24.5	23.9	23.3
250	37.0	35.6	56.7	53.0	49.8	47.0	44.6	42.4	40.4	38.6	37.0	35.6	34.2	33.0	31.9	30.9	29.9	29.0	28.2	27.4	26.7	26.0	25.4
500	69.0	66.1	108.4	101.1	94.7	89.0	84.1	79.7	75.8	72.2	69.0	66.1	63.2	61.0	58.8	56.7	54.8	53.0	51.4	49.8	48.4	47.0	45.8
1000	133.1	127.3	211.9	197.1	184.3	173.1	163.2	154.4	146.6	139.5	133.1	127.3	121.9	117.1	112.6	108.4	104.6	101.1	97.7	94.7	91.8	89.0	86.5

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	5.8	5.8	5.7	5.7	5.7	5.7	5.7	5.7	5.6	5.6	5.6	5.6	5.6	5.6	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
20	6.6	6.5	6.5	6.5	6.4	6.4	6.3	6.3	6.3	6.3	6.2	6.2	6.2	6.1	6.1	6.1	6.1	6.0	6.0	6.0	6.0	6.0	6.0
30	7.4	7.3	7.2	7.2	7.1	7.1	7.0	7.0	6.9	6.9	6.8	6.8	6.8	6.7	6.7	6.6	6.6	6.6	6.5	6.5	6.5	6.5	6.4
40	8.2	8.1	8.0	7.9	7.8	7.8	7.7	7.6	7.6	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.2	7.1	7.1	7.0	7.0	7.0	6.9
50	9.0	8.8	8.7	8.6	8.5	8.4	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
60	9.7	9.6	9.5	9.4	9.2	9.1	9.0	8.9	8.8	8.8	8.7	8.6	8.5	8.4	8.4	8.3	8.2	8.2	8.1	8.0	8.0	7.9	7.9
70	10.5	10.4	10.2	10.1	10.0	9.8	9.7	9.6	9.5	9.4	9.3	9.2	9.1	9.0	8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.4	8.4
80	11.3	11.1	11.0	10.8	10.7	10.5	10.4	10.2	10.1	10.0	9.9	9.8	9.7	9.6	9.5	9.4	9.3	9.2	9.1	9.1	9.0	8.9	8.8
90	12.1	11.9	11.7	11.5	11.4	11.2	11.1	10.9	10.8	10.6	10.5	10.4	10.3	10.2	10.0	9.9	9.8	9.7	9.6	9.5	9.4	9.3	9.2
100	12.9	12.7	12.5	12.3	12.1	11.9	11.7	11.6	11.4	11.3	11.1	11.0	10.8	10.7	10.6	10.5	10.4	10.3	10.2	10.1	10.0	9.9	9.8
125	14.9	14.6	14.3	14.1	13.8	13.6	13.4	13.2	13.0	12.8	12.6	12.5	12.3	12.2	12.0	11.9	11.7	11.6	11.5	11.3	11.2	11.1	11.0
150	16.9	16.5	16.2	15.9	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	12.3	12.2
175	18.8	18.4	18.1	17.7	17.4	17.1	16.8	16.5	16.2	15.9	15.7	15.5	15.2	15.0	14.8	14.6	14.4	14.2	14.1	13.9	13.7	13.6	13.4
200	20.8	20.4	19.9	19.5	19.2	18.8	18.4	18.1	17.8	17.5	17.2	17.0	16.7	16.4	16.2	16.0	15.8	15.5	15.3	15.1	15.0	14.8	14.6
225	22.8	22.3	21.8	21.4	20.9	20.5	20.1	19.8	19.4	19.1	18.8	18.4	18.2	17.9	17.6	17.3	17.1	16.9	16.6	16.4	16.2	16.0	15.8
250	24.8	24.2	23.7																				

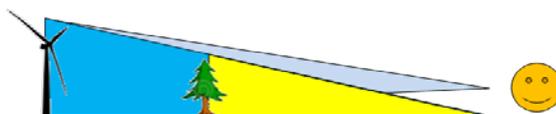
Sample Wind Turbine View Calculator

	Address	Longitude	Latitude
Project Turbine	Cuyahoga County Fairgrounds 194 Eastland Road Berea Ohio	81° 50' 21.10" W	41° 21' 59.50" N

Subject Viewpoint Property

Point of View

Sample



User Inputs	Calculations
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Turbine Information:

	Feet	Meters	Notes:
Tower Height	196.9	60.0	
Rotor Diameter	154.2	47.0	
Tip Height	274.0	83.5	
Turbine Location Elevation Above Sea-level	801.0	244.1	

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	1260.0	384.0	
Net Viewpoint Ground Elevation Above Sea-level	1265.5	385.7	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	1265.0	385.6	
Net Obstruction Height Above Sea-Level	1300.0	396.2	

Results:

	Feet	Meters	Notes:
Will The Turbine Be Visible?	Yes	78.9%	Percent of Total Turbine and Tower
Relative Visible Turbine Height at Obstruction Distance	129.3	39.4	Feet / Meters Usefull for landscape scale
Actual Portion of Turbine Showing	216.2	65.9	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	2.068	0.6	Feet / Meters
	24.8	63.0	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.



A Conserve First Company



Cuyahoga County Fairgrounds Wind Turbine Project Shadow Flicker Analysis

Prepared for:
Cuyahoga County and Cuyahoga County Fair Board

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

Introduction

Proposed Turbine Location: Cuyahoga County Fairgrounds
164 Eastland Road
Berea, Ohio 44017

Latitude: 41° 21' 59.50" N

Longitude: 81° 50' 21.10" 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 1542 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.

Results

See “Cuyahoga County Fairgrounds 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. In fact, off-property shadow impacts will be very limited with all such sites receiving less than 10 hours of moving shadow per year and most of this shadow being blocked by existing trees. Impacts to Fair buildings will also be very limited to their locations and the fact that almost no structures have windows. The northern part of the track that surrounds the turbine site will receive significant moving shadows year-round. Although current use of this track is very limited, if formal horse races or similar formal events were scheduled in periods of potential shadow, the Fair Board would have the option to temporarily turn off the turbine to avoid event distractions or annoyance. (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: 1000 Feet Away: LifeWorks Fitness to the Southeast, 7390 Old Oak Blvd: Shadows will not impact this receptor.
- Receptor B: 1150 Feet Away: 208 Eastland Road: Shadows will be highly diffuse, to completely blocked, as the receptor is substantially blocked by multiple trees, but possible during portions of mid-April and mid-August to early-September mornings with a total average of less than 5 hours of moving morning shadow per year.
- Receptor C: 650 Feet Away: Fair buildings to the Northwest: Shadows will be limited, but possible during portions of late-November to mid-January mornings with a total average of less than 4 hours of moving shadow per year.
- Receptor D: 1,270 Feet Away: 142 Eastland Road: Shadows will be highly diffuse, to completely blocked, as the receptor is substantially blocked by multiple trees, but possible during portions of mid-May through July with a total average of less than 11 hours of moving morning shadow per year.

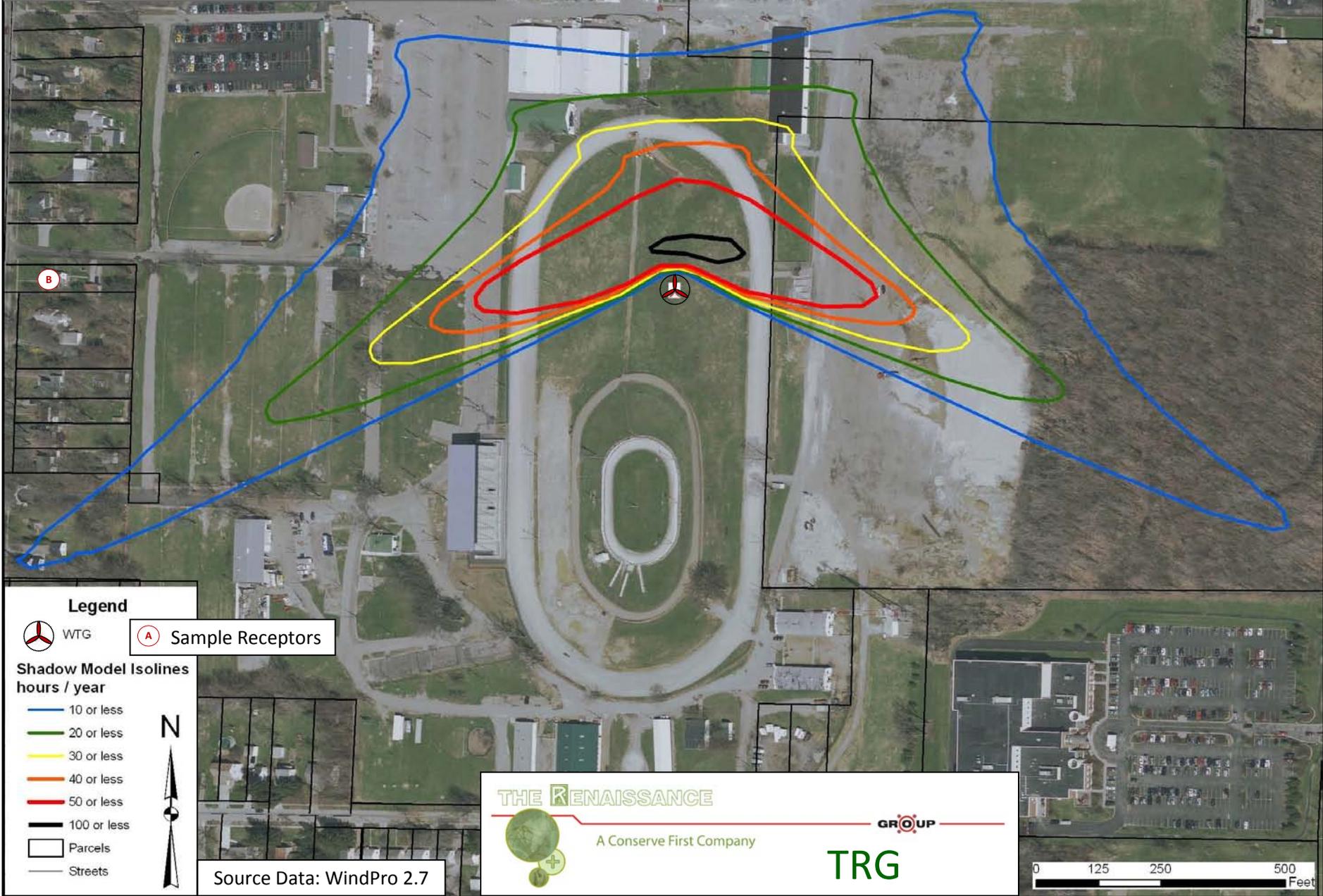
The duration of particular shadow events can vary from a minute to hours pending the receptor. See the following tables at the end of this report for precise dates and times where shadows could occur for each listed sample receptor.

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".

Cuyahoga County Fairgrounds WTG Shadow Flicker Analysis



Project: **CCFG** Shadow Receptor Potential Impacts Analysis, 2000 Meters

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 Calculated: 8/28/2010 8:11 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
 407 472 288 208 185 253 359 366 473 681 799 853

W WNW NW NNW Sum
 598 471 330 329 7,072

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: 2 ft contours
 Obstacles used in calculation
 Eye height: 1.5 m
 Grid resolution: 10 m



New WTG Scale 1:7,500 Shadow receptor

WTGs

UTM WGS84 Zone: 17				WTG type				Shadow data			
East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
UTM WGS84 Zone: 17 [m]											
1	429,822	4,579,772	243.2 VESTAS V47 660-200 47.0...	No	VESTAS	V47-660/200	660	47.0	60.0	2,000	26.0

Shadow receptor-Input

UTM WGS84 Zone: 17				Direction mode					
No.	East	North	Z	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
A	430,011	4,579,520	245.1	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
B	429,457	4,579,749	243.8	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
C	429,672	4,579,979	243.2	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
D	429,424	4,579,617	244.2	1.0	1.0	1.0	-180.0	90.0	"Green house mode"

Calculation Results

Shadow receptor
Shadow, expected values

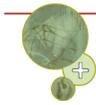
No.	Shadow hours per year [h/year]
A	0:00
B	4:46
C	3:13
D	10:35

WindPRO is developed by EMD International A/S, Niels Jernesvej 10, DK-9220 Aalborg Ø, Tlf. +45 96 35 44 44, Fax +45 96 35 44 46, e-mail: windpro@emd.dk

Project:

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THE RENAISSANCE



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Calculated:

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SHADOW - Main Result

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	VESTAS V47 660-200 47.0 !#! hub: 60.0 m (1)	74:31	18:35

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THE RENAISSANCE



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Calculated:

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SHADOW - Calendar

Shadow receptor: A - Shadow Receptor: 1.0 x 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
407 472 288 208 185 253 359 366 473 681 799 853 598 471 330 329 7,072
Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:54	07:40	07:04	07:12	06:26	05:57	05:58	06:22	06:53	07:24	06:59	07:34
	17:09	17:43	18:18	19:52	20:24	20:54	21:05	20:47	20:04	19:11	17:24	16:59
2	07:54	07:39	07:02	07:11	06:25	05:57	05:58	06:23	06:54	07:25	07:00	07:35
	17:10	17:45	18:19	19:53	20:25	20:54	21:05	20:46	20:02	19:09	17:23	16:59
3	07:54	07:38	07:00	07:09	06:24	05:56	05:59	06:24	06:55	07:26	07:01	07:36
	17:10	17:46	18:20	19:54	20:26	20:55	21:05	20:45	20:00	19:08	17:21	16:59
4	07:54	07:37	06:59	07:07	06:22	05:56	05:59	06:25	06:56	07:27	07:02	07:37
	17:11	17:47	18:21	19:56	20:27	20:56	21:05	20:43	19:57	19:06	17:20	16:59
5	07:54	07:36	06:57	07:06	06:21	05:56	06:00	06:26	06:57	07:28	07:03	07:38
	17:12	17:48	18:22	19:57	20:28	20:57	21:05	20:42	19:55	19:04	17:19	16:59
6	07:54	07:35	06:56	07:04	06:20	05:55	06:01	06:27	06:58	07:29	07:05	07:39
	17:13	17:50	18:24	19:58	20:29	20:57	21:04	20:41	19:54	19:03	17:18	16:58
7	07:54	07:34	06:54	07:02	06:19	05:55	06:01	06:28	06:59	07:30	07:06	07:40
	17:14	17:51	18:25	19:59	20:30	20:58	21:04	20:40	19:52	19:01	17:17	16:58
8	07:54	07:33	07:52	07:01	06:17	05:55	06:02	06:29	07:00	07:31	07:07	07:41
	17:15	17:52	19:26	20:00	20:31	20:59	21:04	20:39	19:50	18:59	17:16	16:58
9	07:54	07:31	07:51	06:59	06:16	05:54	06:03	06:30	07:01	07:32	07:08	07:42
	17:16	17:53	19:27	20:00	20:32	20:59	21:04	20:37	19:49	18:58	17:15	16:58
10	07:54	07:30	07:49	06:57	06:15	05:54	06:03	06:31	07:02	07:33	07:09	07:42
	17:17	17:55	19:28	20:01	20:33	21:00	21:03	20:36	19:47	18:56	17:14	16:58
11	07:53	07:29	07:48	06:56	06:14	05:54	06:04	06:32	07:03	07:34	07:11	07:43
	17:18	17:56	19:29	20:02	20:34	21:00	21:03	20:35	19:45	18:54	17:13	16:58
12	07:53	07:28	07:46	06:54	06:13	05:54	06:05	06:33	07:04	07:36	07:12	07:44
	17:19	17:57	19:30	20:03	20:35	21:01	21:02	20:34	19:44	18:53	17:12	16:59
13	07:53	07:26	07:44	06:53	06:12	05:54	06:05	06:34	07:05	07:37	07:13	07:45
	17:20	17:58	19:32	20:04	20:36	21:01	21:02	20:32	19:42	18:51	17:11	16:59
14	07:52	07:25	07:43	06:51	06:11	05:54	06:06	06:35	07:06	07:38	07:14	07:46
	17:22	18:00	19:33	20:05	20:37	21:02	21:01	20:31	19:40	18:50	17:10	16:59
15	07:52	07:24	07:41	06:49	06:10	05:54	06:07	06:36	07:07	07:39	07:15	07:46
	17:23	18:01	19:34	20:06	20:38	21:02	21:01	20:29	19:38	18:48	17:09	16:59
16	07:52	07:22	07:39	06:48	06:09	05:54	06:08	06:37	07:08	07:40	07:17	07:47
	17:24	18:02	19:35	20:07	20:39	21:03	21:00	20:28	19:37	18:47	17:08	16:59
17	07:51	07:21	07:38	06:46	06:08	05:54	06:09	06:38	07:09	07:41	07:18	07:48
	17:25	18:03	19:36	20:08	20:40	21:03	21:00	20:27	19:35	18:45	17:07	17:00
18	07:51	07:20	07:36	06:45	06:07	05:54	06:09	06:39	07:10	07:42	07:19	07:48
	17:26	18:05	19:37	20:10	20:41	21:03	20:59	20:25	19:33	18:43	17:07	17:00
19	07:50	07:18	07:34	06:43	06:06	05:54	06:10	06:40	07:11	07:43	07:20	07:49
	17:27	18:06	19:38	20:11	20:42	21:04	20:58	20:24	19:32	18:42	17:06	17:00
20	07:50	07:17	07:33	06:42	06:05	05:54	06:11	06:41	07:12	07:44	07:21	07:50
	17:29	18:07	19:39	20:12	20:43	21:04	20:58	20:22	19:30	18:40	17:05	17:01
21	07:49	07:16	07:31	06:40	06:04	05:54	06:12	06:42	07:14	07:46	07:23	07:50
	17:30	18:08	19:40	20:13	20:44	21:04	20:57	20:21	19:28	18:39	17:04	17:01
22	07:48	07:14	07:29	06:39	06:04	05:55	06:13	06:43	07:15	07:47	07:24	07:51
	17:31	18:10	19:41	20:14	20:45	21:05	20:56	20:19	19:26	18:38	17:04	17:02
23	07:48	07:13	07:27	06:37	06:03	05:55	06:14	06:44	07:16	07:48	07:25	07:51
	17:32	18:11	19:43	20:15	20:46	21:05	20:55	20:18	19:25	18:36	17:03	17:02
24	07:47	07:11	07:26	06:36	06:02	05:55	06:15	06:45	07:17	07:49	07:26	07:52
	17:33	18:12	19:44	20:16	20:47	21:05	20:54	20:16	19:23	18:35	17:02	17:03
25	07:46	07:10	07:24	06:34	06:01	05:55	06:15	06:46	07:18	07:50	07:27	07:52
	17:35	18:13	19:45	20:17	20:48	21:05	20:54	20:15	19:21	18:33	17:02	17:03
26	07:45	07:08	07:22	06:33	06:01	05:56	06:16	06:47	07:19	07:51	07:28	07:52
	17:36	18:14	19:46	20:18	20:49	21:05	20:53	20:13	19:19	18:32	17:01	17:04
27	07:45	07:07	07:21	06:32	06:00	05:56	06:17	06:48	07:20	07:53	07:29	07:53
	17:37	18:15	19:47	20:19	20:50	21:05	20:52	20:12	19:18	18:30	17:01	17:05
28	07:44	07:05	07:19	06:30	05:59	05:56	06:18	06:49	07:21	07:54	07:30	07:53
	17:38	18:17	19:48	20:20	20:50	21:05	20:51	20:10	19:16	18:29	17:01	17:05
29	07:43		07:17	06:29	05:59	05:57	06:19	06:50	07:22	07:55	07:32	07:53
	17:40		19:49	20:21	20:51	21:05	20:50	20:08	19:14	18:28	17:00	17:06
30	07:42		07:16	06:27	05:58	05:57	06:20	06:51	07:23	07:56	07:33	07:54
	17:41		19:50	20:22	20:52	21:05	20:49	20:07	19:13	18:26	17:00	17:07
31	07:41		07:14		05:58		06:21	06:52		07:57		07:54
	17:42		19:51		20:53		20:48	20:05		18:25		17:08
Potential sun hours	297	297	370	399	449	453	460	429	375	345	297	287
Total, worst case												
Sun reduction												
Oper. time red.												
Wind dir. red.												
Total reduction												
Total, real												

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:

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Calculated:

8/28/2010 8:11 PM/2.7.473

SHADOW - Calendar

Shadow receptor: B - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (2)

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
407	472	288	208	185	253	359	366	473	681	799	853	598	471	330	329	7,072

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

	January	February	March	April	May	June	July	August	September	October	November	December	
1	07:54	07:40	07:04	07:12	06:26	05:57	05:58	06:22	06:53	07:29 (1)	07:24	06:59	07:34
	17:09	17:43	18:18	19:52	20:24	20:54	21:05	20:47	20:04	29 07:58 (1)	19:11	17:24	16:59
2	07:54	07:39	07:02	07:11	06:25	05:57	05:58	06:23	06:54	07:29 (1)	07:25	07:00	07:35
	17:10	17:45	18:19	19:53	20:25	20:54	21:05	20:46	20:02	29 07:58 (1)	19:09	17:23	16:59
3	07:54	07:38	07:00	07:09	06:24	05:56	05:59	06:24	06:55	07:29 (1)	07:26	07:01	07:36
	17:10	17:46	18:20	19:55	20:26	20:55	21:05	20:45	20:00	28 07:57 (1)	19:08	17:22	16:59
4	07:54	07:37	06:59	07:07	06:22	05:56	05:59	06:25	06:56	07:30 (1)	07:27	07:02	07:37
	17:11	17:47	18:21	19:56	13 07:40 (1)	20:27	20:56	21:05	20:43	26 07:56 (1)	19:06	17:20	16:59
5	07:54	07:36	06:57	07:06	06:21	05:56	06:00	06:26	06:57	07:30 (1)	07:28	07:03	07:38
	17:12	17:48	18:23	19:57	17 07:55 (1)	20:28	20:57	21:05	20:42	24 07:54 (1)	19:04	17:19	16:59
6	07:54	07:35	06:56	07:04	06:20	05:55	06:01	06:27	06:58	07:31 (1)	07:29	07:05	07:39
	17:13	17:50	18:24	19:58	22 07:57 (1)	20:29	20:57	21:04	20:41	22 07:53 (1)	19:03	17:18	16:58
7	07:54	07:34	06:54	07:02	06:19	05:55	06:01	06:28	06:59	07:33 (1)	07:30	07:06	07:40
	17:14	17:51	18:25	19:59	24 07:57 (1)	20:30	20:58	21:04	20:40	18 07:51 (1)	19:01	17:17	16:58
8	07:54	07:33	06:52	07:01	06:17	05:55	06:02	06:29	07:00	07:35 (1)	07:31	07:07	07:41
	17:15	17:52	19:26	20:00	26 07:59 (1)	20:31	20:59	21:04	20:39	13 07:48 (1)	18:59	17:16	16:58
9	07:54	07:31	06:51	06:59	06:16	05:54	06:03	06:30	07:01	07:40 (1)	07:32	07:08	07:42
	17:16	17:53	19:27	20:00	28 07:59 (1)	20:32	20:59	21:04	20:37	2 07:42 (1)	18:58	17:15	16:58
10	07:54	07:30	06:49	06:57	06:15	05:54	06:03	06:31	07:02	07:33	07:09	07:42	
	17:17	17:55	19:28	20:01	29 08:00 (1)	20:33	21:00	21:03	20:36	19:47	18:56	17:14	16:58
11	07:53	07:29	06:48	06:56	06:14	05:54	06:04	06:32	07:03	07:35	07:11	07:43	
	17:18	17:56	19:29	20:02	29 07:59 (1)	20:34	21:00	21:03	20:35	19:45	18:54	17:13	16:58
12	07:53	07:28	06:46	06:54	06:13	05:54	06:05	06:33	07:04	07:36	07:12	07:44	
	17:19	17:57	19:30	20:03	30 07:59 (1)	20:35	21:01	21:02	20:34	19:44	18:53	17:12	16:59
13	07:53	07:26	06:44	06:53	06:12	05:54	06:05	06:34	07:05	07:37	07:13	07:45	
	17:20	17:58	19:32	20:04	30 07:59 (1)	20:36	21:01	21:02	20:32	19:42	18:51	17:11	16:59
14	07:52	07:25	06:43	06:51	06:11	05:54	06:06	06:35	07:06	07:38	07:14	07:46	
	17:22	18:00	19:33	20:05	30 07:58 (1)	20:37	21:02	21:01	20:31	19:40	18:50	17:10	16:59
15	07:52	07:24	06:41	06:50	06:10	05:54	06:07	06:36	07:07	07:39	07:15	07:46	
	17:23	18:01	19:34	20:06	29 07:58 (1)	20:38	21:02	21:01	20:29	19:38	18:48	17:09	16:59
16	07:52	07:23	06:39	06:48	06:09	05:54	06:08	06:37	07:08	07:40	07:17	07:47	
	17:24	18:02	19:35	20:07	29 07:57 (1)	20:39	21:03	21:00	20:28	19:37	18:47	17:08	16:59
17	07:51	07:21	06:38	06:46	06:08	05:54	06:09	06:38	07:09	07:41	07:18	07:48	
	17:25	18:03	19:36	20:09	28 07:57 (1)	20:40	21:03	21:00	20:27	19:35	18:45	17:07	17:00
18	07:51	07:20	06:36	06:45	06:07	05:54	06:09	06:39	07:10	07:42	07:19	07:48	
	17:26	18:05	19:37	20:10	26 07:55 (1)	20:41	21:04	20:59	20:25	19:33	18:43	17:07	17:00
19	07:50	07:18	06:34	06:43	06:06	05:54	06:10	06:40	07:12	07:43	07:20	07:49	
	17:27	18:06	19:38	20:11	25 07:55 (1)	20:42	21:04	20:58	20:24	19:32	18:42	17:06	17:00
20	07:50	07:17	06:33	06:42	06:05	05:54	06:11	06:41	07:13	07:45	07:21	07:50	
	17:29	18:07	19:39	20:12	22 07:53 (1)	20:43	21:04	20:58	20:22	12 07:52 (1)	19:30	18:40	17:05
21	07:49	07:16	06:31	06:40	06:04	05:54	06:12	06:42	07:14	07:46	07:23	07:50	
	17:30	18:08	19:40	20:13	20 07:52 (1)	20:44	21:04	20:57	20:21	16 07:54 (1)	19:28	18:39	17:04
22	07:48	07:14	06:29	06:39	06:04	05:55	06:13	06:43	07:15	07:47	07:24	07:51	
	17:31	18:10	19:42	20:14	16 07:49 (1)	20:45	21:05	20:56	20:19	20 07:56 (1)	19:26	18:38	17:04
23	07:48	07:13	06:27	06:37	06:03	05:55	06:14	06:44	07:16	07:48	07:25	07:51	
	17:32	18:11	19:43	20:15	11 07:47 (1)	20:46	21:05	20:55	20:18	23 07:57 (1)	19:25	18:36	17:03
24	07:47	07:11	06:26	06:36	06:02	05:55	06:15	06:45	07:17	07:49	07:26	07:52	
	17:33	18:12	19:44	20:16	20:47	21:05	20:54	20:16	25 07:58 (1)	19:23	18:35	17:03	17:03
25	07:46	07:10	06:24	06:34	06:01	05:55	06:16	06:46	07:18	07:50	07:27	07:52	
	17:35	18:13	19:45	20:17	20:48	21:05	20:54	20:15	26 07:58 (1)	19:21	18:33	17:02	17:03
26	07:45	07:08	06:22	06:33	06:01	05:56	06:16	06:47	07:19	07:51	07:28	07:52	
	17:36	18:14	19:46	20:18	20:49	21:05	20:53	20:13	28 07:59 (1)	19:19	18:32	17:01	17:04
27	07:45	07:07	06:21	06:32	06:00	05:56	06:17	06:48	07:20	07:53	07:29	07:53	
	17:37	18:15	19:47	20:19	20:50	21:05	20:52	20:12	29 07:59 (1)	19:18	18:31	17:01	17:05
28	07:44	07:05	06:19	06:30	05:59	05:57	06:18	06:49	07:21	07:54	07:31	07:53	
	17:38	18:17	19:48	20:20	20:50	21:05	20:51	20:10	29 07:59 (1)	19:16	18:29	17:01	17:05
29	07:43	07:07	06:17	06:29	05:59	05:57	06:19	06:50	07:22	07:55	07:32	07:53	
	17:40	18:19	19:49	20:21	20:51	21:05	20:50	20:08	30 07:59 (1)	19:14	18:28	17:00	17:06
30	07:42	07:16	06:28	06:38	05:58	05:57	06:20	06:51	07:23	07:56	07:33	07:54	
	17:41	18:20	19:50	20:23	20:52	21:05	20:49	20:07	30 07:59 (1)	19:13	18:27	17:00	17:07
31	07:41	07:14	06:28	06:38	05:58	05:57	06:21	06:52	07:24	07:57	07:34	07:54	
	17:42	18:21	19:51	20:24	20:53	21:06	20:48	20:05	30 07:59 (1)	18:25	17:00	17:08	
Potential sun hours	297	297	370	399	449	453	460	429	375	345	297	287	
Total, worst case				484					298		191		
Sun reduction				0.57					0.65		0.55		
Oper. time red.				0.81					0.81		0.81		
Wind dir. red.				0.62					0.62		0.62		
Total reduction				0.28					0.32		0.27		
Total, real				137					97		52		

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

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

Project:

CCFG3



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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
 AAaron Godwin / AAaron@ConserveFirst.com
 Calculated:
 8/28/2010 8:11 PM/2.7.473

SHADOW - Calendar

Shadow receptor: C - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (3)

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
 407 472 288 208 185 253 359 366 473 681 799 853 598 471 330 329 7,072
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June	July	August	September	October	November	December		
1	07:54 17:09	09:30 (1) 10:07 (1)	07:40 17:43	07:04 18:18	07:12 19:52	06:26 20:24	05:57 20:54	05:58 21:05	06:22 20:47	06:53 20:04	07:24 19:11	06:59 17:24	07:34 16:59	09:21 (1) 25 08:46 (1)
2	07:54 17:10	09:31 (1) 10:07 (1)	07:39 17:45	07:02 18:19	07:11 19:53	06:25 20:25	05:57 20:54	05:58 21:05	06:23 20:46	06:54 20:02	07:25 19:09	07:00 17:23	07:35 16:59	09:20 (1) 27 09:47 (1)
3	07:54 17:10	09:31 (1) 10:07 (1)	07:38 17:46	07:00 18:20	07:09 19:55	06:24 20:26	05:56 20:55	05:59 21:05	06:24 20:45	06:55 20:00	07:26 19:08	07:01 17:21	07:36 16:59	09:20 (1) 29 09:49 (1)
4	07:54 17:11	09:32 (1) 10:07 (1)	07:37 17:47	06:59 18:21	07:07 19:56	06:22 20:27	05:56 20:56	05:59 21:05	06:25 20:43	06:56 19:57	07:27 19:06	07:02 17:20	07:37 16:59	09:19 (1) 31 09:50 (1)
5	07:54 17:12	09:33 (1) 10:07 (1)	07:36 17:48	06:57 18:22	07:06 19:57	06:21 20:28	05:56 20:57	06:00 21:05	06:26 20:42	06:57 19:55	07:28 19:04	07:03 17:19	07:38 16:59	09:19 (1) 32 09:51 (1)
6	07:54 17:13	09:33 (1) 10:06 (1)	07:35 17:50	06:56 18:24	07:04 19:58	06:20 20:29	05:55 20:57	06:01 21:04	06:27 20:41	06:58 19:54	07:29 19:03	07:05 17:18	07:39 16:58	09:19 (1) 33 09:52 (1)
7	07:54 17:14	09:34 (1) 10:06 (1)	07:34 17:51	06:54 18:25	07:02 19:59	06:19 20:30	05:55 20:58	06:01 21:04	06:28 20:40	06:59 19:52	07:30 19:01	07:06 17:17	07:40 16:58	09:19 (1) 34 09:53 (1)
8	07:54 17:15	09:35 (1) 10:06 (1)	07:33 17:52	06:52 19:26	07:01 20:00	06:17 20:31	05:55 20:59	06:02 21:04	06:29 20:39	07:00 19:50	07:31 18:59	07:07 17:16	07:41 16:58	09:19 (1) 35 09:54 (1)
9	07:54 17:16	09:37 (1) 10:06 (1)	07:31 17:53	06:51 19:27	06:59 20:00	06:16 20:32	05:54 20:59	06:03 21:04	06:30 20:37	07:01 19:49	07:32 18:58	07:08 17:15	07:42 16:58	09:19 (1) 36 09:55 (1)
10	07:54 17:17	09:38 (1) 10:05 (1)	07:30 17:55	06:49 19:28	06:57 20:01	06:15 20:33	05:54 21:00	06:03 21:03	06:31 20:36	07:02 19:47	07:33 18:56	07:09 17:14	07:42 16:58	09:20 (1) 36 09:56 (1)
11	07:53 17:18	09:39 (1) 10:04 (1)	07:29 17:56	06:48 19:29	06:56 20:02	06:14 20:34	05:54 21:00	06:04 21:03	06:32 20:35	07:03 19:45	07:34 18:54	07:11 17:13	07:43 16:58	09:20 (1) 37 09:57 (1)
12	07:53 17:19	09:41 (1) 10:04 (1)	07:28 17:57	06:46 19:30	06:54 20:03	06:13 20:35	05:54 21:01	06:05 21:02	06:33 20:34	07:04 19:44	07:36 18:53	07:12 17:12	07:44 16:59	09:20 (1) 38 09:58 (1)
13	07:53 17:20	09:42 (1) 10:02 (1)	07:26 17:58	06:44 19:32	06:53 20:04	06:12 20:36	05:54 21:01	06:05 21:02	06:34 20:32	07:05 19:42	07:37 18:51	07:13 17:11	07:45 16:59	09:20 (1) 38 09:58 (1)
14	07:52 17:22	09:44 (1) 10:01 (1)	07:25 18:00	06:43 19:33	06:51 20:05	06:11 20:37	05:54 21:02	06:06 21:01	06:35 20:31	07:06 19:40	07:38 18:50	07:14 17:10	07:46 16:59	09:20 (1) 38 09:58 (1)
15	07:52 17:23	09:47 (1) 10:00 (1)	07:24 18:01	06:41 19:34	06:49 20:06	06:10 20:38	05:54 21:02	06:07 21:01	06:36 20:29	07:07 19:38	07:39 18:48	07:15 17:09	07:46 16:59	09:21 (1) 38 09:59 (1)
16	07:52 17:24	09:51 (1) 09:55 (1)	07:23 18:02	06:39 19:35	06:48 20:07	06:09 20:39	05:54 21:03	06:08 21:00	06:37 20:28	07:08 19:37	07:40 18:47	07:17 17:08	07:47 16:59	09:21 (1) 39 10:00 (1)
17	07:51 17:25	09:55 (1) 18:03	07:21 19:36	06:38 19:36	06:46 20:09	06:08 20:40	05:54 21:03	06:09 21:00	06:38 20:27	07:09 19:35	07:41 18:45	07:18 17:07	07:48 17:00	09:21 (1) 39 10:00 (1)
18	07:51 17:26	07:20 18:05	07:36 19:37	06:45 20:10	06:07 20:41	06:09 20:41	05:54 21:03	06:09 20:59	06:39 20:25	07:10 19:33	07:42 18:43	07:19 17:07	07:48 17:00	09:22 (1) 39 10:01 (1)
19	07:50 17:27	07:18 18:06	07:34 19:38	06:43 20:11	06:06 20:42	06:06 20:42	05:54 21:04	06:10 20:58	06:40 20:24	07:11 19:32	07:43 18:42	07:20 17:06	07:49 17:00	09:23 (1) 39 10:02 (1)
20	07:50 17:29	07:17 18:07	07:33 19:39	06:42 20:12	06:05 20:43	06:05 20:43	05:54 21:04	06:11 20:58	06:41 20:22	07:13 19:30	07:45 18:40	07:21 17:05	07:50 17:01	09:23 (1) 39 10:02 (1)
21	07:49 17:30	07:16 18:08	07:31 19:40	06:40 20:13	06:04 20:44	06:04 20:44	05:54 21:04	06:12 20:57	06:42 20:21	07:14 19:28	07:46 18:39	07:23 17:04	07:50 17:01	09:24 (1) 39 10:03 (1)
22	07:48 17:31	07:14 18:10	07:29 19:42	06:39 20:14	06:04 20:45	06:04 20:45	05:55 21:05	06:13 20:56	06:43 20:19	07:15 19:26	07:47 18:38	07:24 17:04	07:51 17:02	09:24 (1) 39 10:03 (1)
23	07:48 17:32	07:13 18:11	07:27 19:43	06:37 20:15	06:03 20:46	06:03 20:46	05:55 21:05	06:14 20:55	06:44 20:18	07:16 19:25	07:48 18:36	07:25 17:03	07:51 17:02	09:24 (1) 39 10:03 (1)
24	07:47 17:33	07:11 18:12	07:26 19:44	06:36 20:16	06:02 20:47	06:02 20:47	05:55 21:05	06:15 20:54	06:45 20:16	07:17 19:23	07:49 18:35	07:26 17:03	07:52 17:03	09:25 (1) 39 10:04 (1)
25	07:46 17:35	07:10 18:13	07:24 19:45	06:34 20:17	06:01 20:48	06:01 20:48	05:55 21:05	06:15 20:54	06:46 20:15	07:18 19:21	07:50 18:33	07:27 17:02	07:52 17:03	09:25 (1) 39 10:04 (1)
26	07:45 17:36	07:08 18:14	07:22 19:46	06:33 20:18	06:01 20:49	06:01 20:49	05:56 21:05	06:16 20:53	06:47 20:13	07:19 19:19	07:51 18:32	07:28 17:01	07:52 17:04	09:26 (1) 39 10:05 (1)
27	07:45 17:37	07:07 18:15	07:21 19:47	06:32 20:19	06:00 20:50	06:00 20:50	05:56 21:05	06:17 20:52	06:48 20:12	07:20 19:18	07:53 18:30	07:29 17:01	07:53 17:05	09:26 (1) 39 10:05 (1)
28	07:44 17:38	07:05 18:17	07:19 19:48	06:30 20:20	05:59 20:50	05:59 20:50	05:56 21:05	06:18 20:51	06:49 20:10	07:21 19:16	07:54 18:29	07:31 17:01	07:53 17:05	09:27 (1) 38 10:05 (1)
29	07:43 17:40	07:04 19:49	07:17 19:49	06:29 20:21	05:59 20:51	05:57 20:50	05:57 21:05	06:19 20:50	06:50 20:08	07:22 19:14	07:55 18:28	07:32 17:00	07:53 17:06	09:27 (1) 38 10:05 (1)
30	07:42 17:41	07:03 19:50	07:16 20:22	06:27 20:23	05:58 20:52	05:57 20:52	05:57 21:05	06:20 20:49	06:51 20:07	07:23 19:13	07:56 18:27	07:33 17:00	07:54 17:07	09:28 (1) 37 10:05 (1)
31	07:41 17:42	07:04 19:51	07:14 20:53	06:26 20:53	05:58 20:53	05:58 20:48	05:58 20:48	06:21 20:05	06:52 20:05	07:24 18:25	07:57 17:08	07:34 17:08	07:54 17:08	09:29 (1) 38 10:07 (1)
Potential sun hours	297	297	370	399	449	453	460	429	375	345	297	287		
Total, worst case		432									74		1126	
Sun reduction		0.36									0.27		0.20	
Oper. time red.		0.81									0.81		0.81	
Wind dir. red.		0.59									0.59		0.59	
Total reduction		0.17									0.13		0.10	
Total, real		75									10		109	

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

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

Project:

CCFG3



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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 8:11 PM/2.7.473

SHADOW - Calendar

Shadow receptor: D - Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (4)

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
 407 472 288 208 185 253 359 366 473 681 799 853 598 471 330 329 7,072
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:54	07:40	07:04	07:12	06:26	05:57	06:35 (1) 05:58	06:43 (1) 06:22	06:53	07:24	06:59	07:34
	17:09	17:43	18:18	19:52	20:24	20:54	27 07:02 (1) 21:05	23 07:06 (1) 20:47	20:04	19:11	17:24	17:00
2	07:54	07:39	07:02	07:11	06:25	05:57	06:36 (1) 05:58	06:43 (1) 06:23	06:54	07:25	07:00	07:35
	17:10	17:45	18:19	19:53	20:25	20:54	27 07:03 (1) 21:05	24 07:07 (1) 20:46	20:02	19:09	17:23	16:59
3	07:54	07:38	07:00	07:09	06:24	05:56	06:36 (1) 05:59	06:44 (1) 06:24	06:55	07:26	07:01	07:36
	17:10	17:46	18:20	19:55	20:26	20:55	26 07:02 (1) 21:05	24 07:08 (1) 20:45	20:00	19:08	17:22	16:59
4	07:54	07:37	06:59	07:07	06:22	05:56	06:36 (1) 05:59	06:43 (1) 06:25	06:56	07:27	07:02	07:37
	17:11	17:47	18:21	19:56	20:27	20:56	26 07:02 (1) 21:05	24 07:07 (1) 20:43	19:57	19:06	17:20	16:59
5	07:54	07:36	06:57	07:06	06:21	05:56	06:36 (1) 06:00	06:43 (1) 06:26	06:57	07:28	07:03	07:38
	17:12	17:48	18:23	19:57	20:28	20:57	26 07:02 (1) 21:05	25 07:08 (1) 20:42	19:55	19:04	17:19	16:59
6	07:54	07:35	06:56	07:04	06:20	05:55	06:37 (1) 06:01	06:43 (1) 06:27	06:58	07:29	07:05	07:39
	17:13	17:50	18:24	19:58	20:29	20:57	25 07:02 (1) 21:04	25 07:08 (1) 20:41	19:54	19:03	17:18	16:58
7	07:54	07:34	06:54	07:02	06:19	05:55	06:37 (1) 06:01	06:43 (1) 06:28	06:59	07:30	07:06	07:40
	17:14	17:51	18:25	19:59	20:30	20:58	25 07:02 (1) 21:04	26 07:09 (1) 20:40	19:52	19:01	17:17	16:58
8	07:54	07:33	07:52	07:01	06:17	05:55	06:38 (1) 06:02	06:43 (1) 06:29	07:00	07:31	07:07	07:41
	17:15	17:52	19:26	20:00	20:31	20:59	24 07:02 (1) 21:04	25 07:08 (1) 20:39	19:50	18:59	17:16	16:58
9	07:54	07:31	07:51	06:59	06:16	05:54	06:38 (1) 06:03	06:43 (1) 06:30	07:01	07:32	07:08	07:42
	17:16	17:53	19:27	20:00	20:32	20:59	24 07:02 (1) 21:04	26 07:09 (1) 20:37	19:49	18:58	17:15	16:58
10	07:54	07:30	07:49	06:57	06:15	05:54	06:38 (1) 06:03	06:43 (1) 06:31	07:02	07:33	07:09	07:42
	17:17	17:55	19:28	20:01	20:33	21:00	24 07:02 (1) 21:03	27 07:10 (1) 20:36	19:47	18:56	17:14	16:58
11	07:53	07:29	07:48	06:56	06:14	05:54	06:38 (1) 06:04	06:43 (1) 06:32	07:03	07:35	07:11	07:43
	17:18	17:56	19:29	20:02	20:34	21:00	24 07:02 (1) 21:03	26 07:09 (1) 20:35	19:45	18:54	17:13	16:58
12	07:53	07:28	07:46	06:54	06:13	05:54	06:39 (1) 06:05	06:43 (1) 06:33	07:04	07:36	07:12	07:44
	17:19	17:57	19:30	20:03	20:35	21:01	23 07:02 (1) 21:02	27 07:10 (1) 20:34	19:44	18:53	17:12	16:59
13	07:53	07:26	07:44	06:53	06:12	06:43 (1) 05:54	06:39 (1) 06:05	06:43 (1) 06:34	07:05	07:37	07:13	07:45
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14	07:52	07:25	07:43	06:51	06:11	06:40 (1) 05:54	06:40 (1) 06:06	06:44 (1) 06:35	07:06	07:38	07:14	07:46
	17:22	18:00	19:33	20:05	20:37	14 06:54 (1) 21:02	22 07:02 (1) 21:01	27 07:11 (1) 20:31	19:40	18:50	17:10	16:59
15	07:52	07:24	07:41	06:50	06:10	06:39 (1) 05:54	06:40 (1) 06:07	06:43 (1) 06:36	07:07	07:39	07:15	07:46
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	17:35	18:13	19:45	20:17	20:48	27 07:02 (1) 21:05	21 07:04 (1) 20:54	23 07:10 (1) 20:15	19:21	18:33	17:02	17:03
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27	07:45	07:07	07:21	06:32	06:00	06:34 (1) 05:56	06:43 (1) 06:17	06:49 (1) 06:48	07:20	07:53	07:29	07:53
	17:37	18:15	19:47	20:19	20:50	27 07:01 (1) 21:05	22 07:05 (1) 20:52	19 07:08 (1) 20:12	19:18	18:31	17:01	17:05
28	07:44	07:05	07:19	06:30	05:59	06:35 (1) 05:57	06:43 (1) 06:18	06:49 (1) 06:49	07:21	07:54	07:31	07:53
	17:38	18:17	19:48	20:20	20:50	27 07:02 (1) 21:05	22 07:05 (1) 20:51	17 07:06 (1) 20:10	19:16	18:29	17:01	17:05
29	07:43	07:07	07:17	06:29	05:59	06:34 (1) 05:57	06:43 (1) 06:19	06:50 (1) 06:50	07:22	07:55	07:32	07:53
	17:40	18:19	19:49	20:21	20:51	28 07:02 (1) 21:05	23 07:06 (1) 20:50	15 07:05 (1) 20:08	19:14	18:28	17:00	17:06
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	17:42	18:21	19:51	20:24	20:53	27 07:02 (1) 21:05	23 07:06 (1) 20:49	6 07:01 (1) 20:05	18:25	18:25	17:08	17:08
Potential sun hours	297	297	370	399	449	453	460	429	375	345	297	287
Total, worst case					441	692	733					
Sun reduction					0.62	0.62	0.69					
Oper. time red.					0.81	0.81	0.81					
Wind dir. red.					0.65	0.65	0.65					
Total reduction					0.32	0.33	0.36					
Total, real					143	226	266					

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)
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Project:

CCFG3

THE RENAISSANCE



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8/28/2010 8:12 PM / 7

Licensed user:

Conserve First LLC, d/b/a The Renaissance Group, Renewables

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US-44094 Kirtland, Ohio

4717

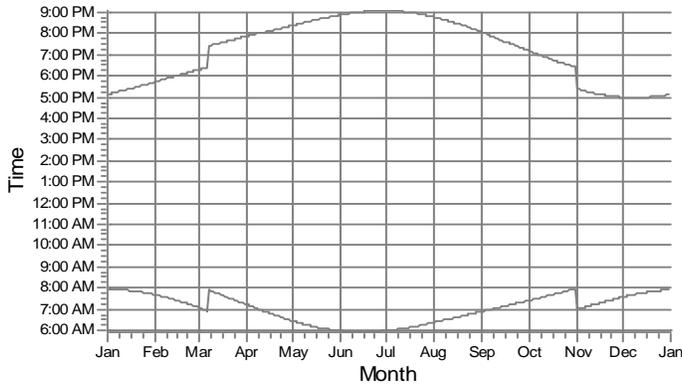
AAaron Godwin / AAaron@ConserveFirst.com

Calculated:

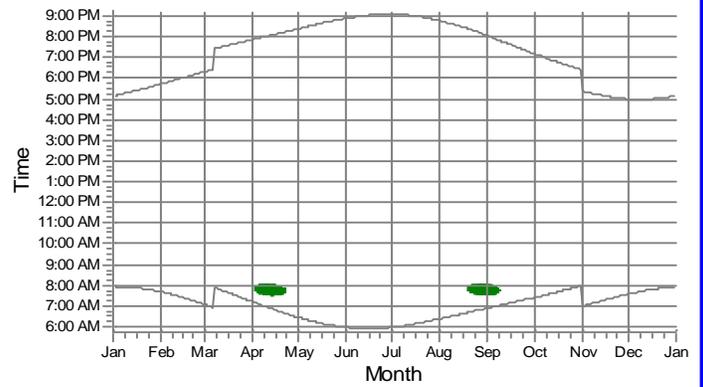
8/28/2010 8:11 PM/2.7.473

SHADOW - Calendar, graphical

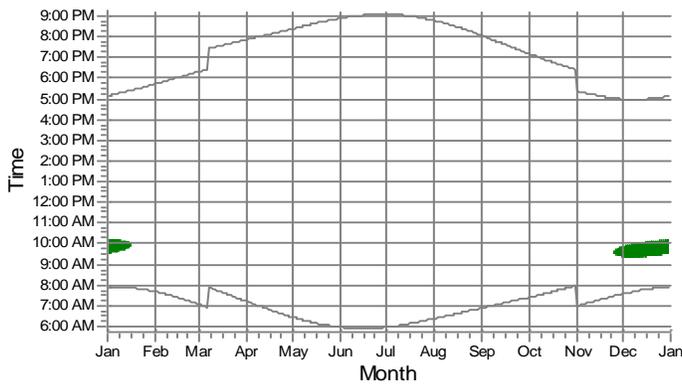
A: Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (1)



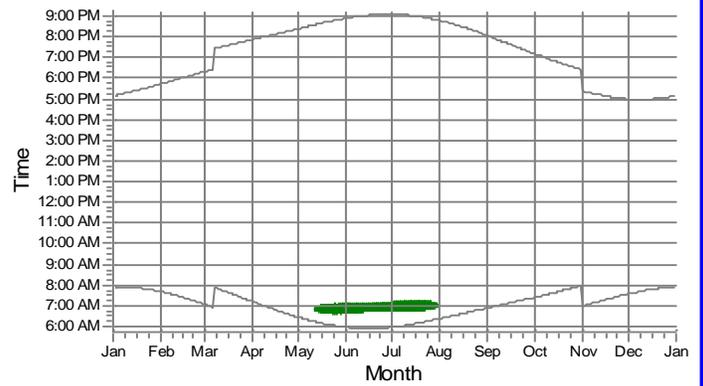
B: Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (2)



C: Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (3)



D: Shadow Receptor: 1.0 x 1.0 Azimuth: -180.0° Slope: 90.0° (4)



WTGs

1: VESTAS V47 660-200 47.0 !#! hub: 60.0 m (1)

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, Dobsch 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.