FINAL
Wind Turbine Generator Feasibility Study





Prepared for:
Commonwealth Wind Incentive Program
Community Scale
Massachusetts Clean Energy Center
55 Summer Street, 9th Floor
Boston, MA 02110

Submitted by:
City of Salem Renewable Energy Task Force
93 Washington Street
Salem, MA 01970

In Partnership with:
Meridian Associates, Inc.
500 Cummings Center, Suite 5950
Beverly, MA 01915

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MERIDIAN ASSOCIATES

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List of Abbreviations

ACEC	Area of Critical Environmental Concern
AGL	Above Grade Level
ASTM	American Society for Testing and Materials
AWEA	American Wind Energy Association
CEC	Massachusetts Clean Energy Center
CMR	Code of Massachusetts Regulations
dB	Decibels
DEP	Massachusetts Department of Environmental Protection
DES	New Hampshire Department of Environmental Services
FERC	Federal Energy Regulatory Commission
Ft	Feet
GIS	Geographical Information Systems
GWh	Giga Watt Hours
km	Kilometers
kV	Kilovolts
kVA	Kilovolts Amperes
kW	Kilowatts
kWh	Kilowatt Hours
m	Meters
MassCEC	Massachusetts Clean Energy Center
MEPA	Massachusetts Environmental Policy Act
MHC	Massachusetts Historical Commission
MHD	Massachusetts Highway Department
mph	Miles per Hour
m/s	Meters per Second
MTC	Massachusetts Technology Collaborative
MW	Megawatt
NHESP	Natural Heritage and Endangered Species Program
PPA	Power Purchase Agreement
RPS	Renewable Portfolio Standards
rpm	Revolutions per Minute
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
V	Volt
WECs	Wind Energy Conversion System
WTG	Wind Turbine Generator

EXECUTIVE SUMMARY AND RECOMMENDATIONS

1. Executive Summary

a. Summary

Winter Island is a Marine Recreational Park owned and maintained by the City of Salem. The park is in operation year round providing campsites for recreational vehicles, a boat launch, picnic areas, a bath house and a small beach.

The site is located in the northeast portion of the City of Salem, just past the Salem Willows Park and the Salem Power Plant, in the Salem Harbor. The land is classified as Residential One Family (R1) per the City of Salem Zoning Code with an approximate area of 27± acres. The buildings on the site are for municipal use.

The City of Salem is quickly emerging in the region as a clean energy & environmental leader, and is committed in its efforts to promote wind energy which will help to decrease energy costs and set a strong community example regarding renewable energy. To accomplish this task the city is considering the construction of a Wind Turbine Generator. The site selected for this feasibility study appeared to have sufficient wind to be considered a financially feasible on-site wind generation project. This finding is based upon modeled wind velocities in the Commonwealth of Massachusetts from the Massachusetts Geographical Information System website (MassGIS) and the Commonwealth Wind Evaluation and Siting Tool developed by The Cadmus Group under directives from the Massachusetts Clean Energy Center and onsite wind data collected from a MET Tower.

Based on the aforementioned findings the recommended wind turbine generator for this site is a 1.5 MW, which has been evaluated in this report for a hub height of 80 m. In addition, Federal Aviation Administration (FAA) turbine height restrictions have been evaluated, as well as siting and environmental constraints.

Pro-Forma Economic Analysis

The economic analysis for the installation of a 1.5 MW wind turbine at the site as Identified above was based on a set of reasonable assumptions for numerous vital economic factors. Employing the maximum Massachusetts Clean Energy Center (MASSCEC) Commonwealth Wind Incentive Program funding amount of $400,000, simple financing, and an annual inflation of electricity rate equal to 2.5% the economic return for this project is as follows:

Multiple financial scenarios have been considered for the proposed project. These scenarios evaluated each of the three size turbines under financed, non-financed and PPA conditions with and without maximum contributions from MassCEC for turbine erection. The best financial scenario for a municipally owned and operated wind turbine is for a 1.5 MW turbine at an 80 m hub height at the Winter Island. This scenario yields a twelve (12) year payback under financed conditions and eight (8) year payback under cash conditions, with maximum contribution from MassCEC and under P50 wind speeds.

Cost Analysis Assumptions for Wind Turbine Generators installed at Winter Island, Salem, MA

	Elecon T600 Annual Production = 1,226,891 kWh			Mitsubishi MWT62/1.0 Annual Production = 1,672,389 kWh			GE 1.5sle Annual Production = 3,607,026 kWh		
	without MassCEC Funding	with MassCEC Funding	PPA	without MassCEC Funding	with MassCEC Funding	PPA	without MassCEC Funding	with MassCEC Funding	PPA
Total Installed Cost ($)	2,500,000	2,500,000	0	3,400,000	3,400,000	0	4,500,000	4,500,000	0
Electricity Cost ($/kWh)	0.13	0.13	0.01	0.13	0.13	0.01	0.13	0.13	0.01
Electricity Inflation Rate (%)	2.5	2.5	-	2.5	2.5	-	2.5	2.5	-
Bond Interest Rate (%)	5.0	5.0	0	5.0	5.0	0	5.0	5.0	0
Loan Term (yrs.)	20	20	0	20	20	0	20	20	0
REC Revenue ($/kWh)	0.030	0.030	0	0.030	0.030	0	0.030	0.030	0
MassCEC Funding ($)	0	320,500	0	0	364,820	0	0	400,000	0

P50 Financial Pro-Forma Summary at Winter Island, Salem, MA

		Elecon T600	Mitsubishi MWT62/1.0	GE 1.5sle
Hub Height (m)		60	70	80
Average Wind Speed (m/s)		6.05	6.28	6.48
Simple Cash (Yrs. To Positive Return/NPV @ Yr. 20)	without MassCEC Grant	14 -$419,648	13 -$564,249	9 $1,616,178
	with MassCEC Grant	12 -$99,148	12 -$199,429	8 $2,016,178
	PPA Agreement	0 $131,398	0 $179,110	0 $386,306
Financed (Yrs. To Positive Return/NPV @ Yr. 20)	without MassCEC Grant	20 -$201,747	20 -$267,903	13 $2,008,400
	with MassCEC Grant	18 $411,318	18 $429,939	12 $2,773,536

P90 Financial Pro-Forma Summary at Winter Island, Salem, MA

		Elecon T600	Mitsubishi MWT62/1.0	GE 1.5sle
Hub Height (m)		60	70	80
Average Wind Speed (m/s)		5.505	5.71	5.89
Simple Cash (Yrs. To Positive Return/NPV @ Yr. 20)	without MassCEC Grant	18 -$999,718	18 -$1,382,936	12 -$140,816
	with MassCEC Grant	16 -$679,218	16 -$1,018,116	11 $259,184
	PPA Agreement	0 $94,760	0 $127,400	0 $275,332
Financed (Yrs. To Positive Return/NPV @ Yr. 20)	without MassCEC Grant	26 -$781,816	26 -$1,086,590	17 $251,406
	with MassCEC Grant	23 -$168,751	24 -$388,748	16 $1,016,542

b. Recommendations:

- Based on the wind resources and economic analyses, the proposed wind turbine generator should be a 1.5 MW rated power turbine on an 80 m tower with IEC II.

- Preferably, the wind turbine generator should be located at the highest elevation on the site property which meets all applicable setbacks and pertinent rules and regulations. Per topographic maps from the Massachusetts Geographic System (MassGIS) this location is at an elevation of 6m (32 ft).

- Locate Wind Turbine Generator at least 300 feet from existing property line to meet City of Salem Zoning Code setbacks requirements.

2. Wind Resource Evaluation

The wind speed and turbulence was studied at the proposed site in order to provide the most accurate value of annual energy production possible. Identifying the true wind power in Winter Island allows for a more precise estimate of project feasibility and profitable returns for the proposed wind power project.

Figure 1 displays the mean wind speed at these specified heights. Wind Speeds at the proposed site range between 6.5 – 7.0 m/s (14.5 and 15.6 mph) at 70 meter height per MassGIS Wind Resources Map, which falls within the Massachusetts Clean Energy Center (MassCEC) Commonwealth Wind Initiative recommended minimum wind speed of 6.0 m/s. These wind speeds are as stated from MassGIS and have not been adjusted for ground cover.

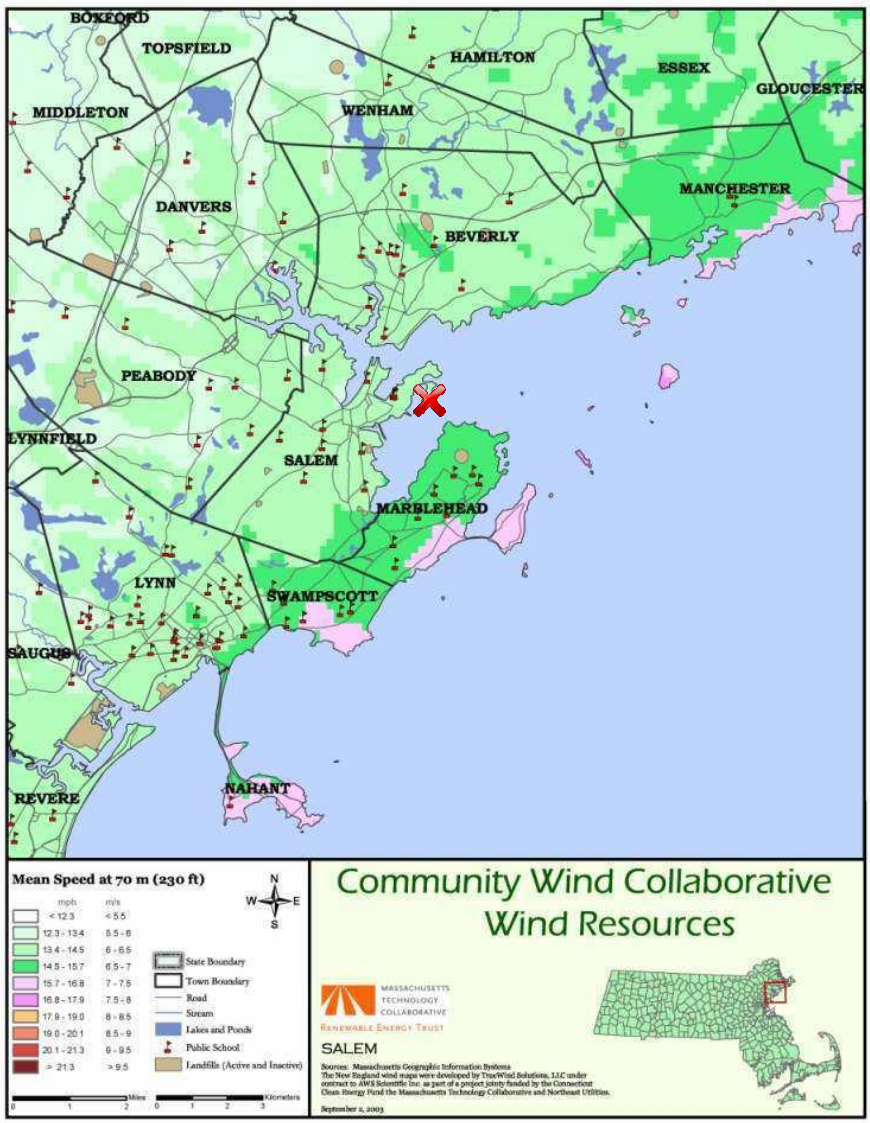
Figure 1: Mean Wind Speed at 70m

Source: MassGIS (www.mass.gov/mgis)

Location of proposed Wind Turbine Generator

MassCEC provides Wind Resource Maps, Figure 2, for each Town/City in the Commonwealth. This map was from 2003 and was used for initial screening. Analysis of this map revealed that at 70m the mean wind speed is approximately 6.6 to 7.0 m/s. MassCEC also provides a Commonwealth Wind Evaluation Siting Tool which adjusts for local tree cover and obstacles. This resource reported that wind speeds corrected for site factors at Winter Island are approximately 6.3 m/s at 70m corrected for site factors.

Figure 2: Community Wind Collaborative Wind Resources Map



Location of proposed Wind Turbine Generator

i. Site Wind Resource Profile

MET Tower Data Collection

Wind data apparatus was installed on December 31, 2009 at Winter Island, Salem, Massachusetts and began collecting wind speed and directional data on January 6, 2010. Data was collected through January 24, 2011, a time period greater than twelve (12) months. The meteorological (MET) tower was erected at an elevation approximately 6m (20') above sea level at a location of 42° 31' 46"N 70° 52' 12"W. This position, as depicted in Figure 3, is situated in the southwest portion of the Winter Island site and located in an open clearing away from property structures

Figure 3: Meteorological Tower Location

The wind monitoring equipment was mounted on 50m (164') tall tower that was held up by guy wires. This system rests directly on the ground as shown in Figure 4 and no foundation was necessary. The equipment installed was obtained from NRG Systems and consists of the following Items:

- Tower Kit: 50m NRG Tower
- Logger Kit: NRG Symphonie Logger
- 6 - #40 Anemometers, standard calibration (with variable scale factor and offset). A pair of anemometers are located at each a 50m (164'), 40m (131') and at 30m (98') heights.
- 2 - #200P Wind Direction Vanes. The vanes are located at 50m (164') and 40m (131')
- 1 - #110S Temperature Sensor.

Figure 4: Meteorological Tower

The data from the Symphonie logger was collected by Meridian Associates on a monthly basis. The logger sampled wind speeds and direction once every two seconds. The samples were combined into 10-minute averages and the standard deviation between these intervals was calculated. The NRG logger creates binary files which were converted to ASCII text files using NRG supplied software. These text files are imported into an Excel Software program where they were subjected to quality assurance tests prior to usage.

Data Quality Assurance Testing

All data collected from the Met Tower underwent a series of tests and control filters to expunge any data that was faulty. The data recovery and validation methods were obtained from the Renewable Energy Research Laboratory at the University of Massachusetts, Amherst as a means of quality control. These control filters were designed to automate the quality control process any data which was determined invalid was not included in the wind analysis. These tests were calculated as described below:

Percentage Data Recovered: The gross percentage of data recovered (ratio of raw data points received to data points expected) and net percentage (ratio of raw data points which passed all QA control tests to data points expected) are shown below

Gross Data Recovered (%) 100
Net Data Recovered (%) 93.6

Test Definitions

MinMax Test: All sensors are expected to report data values within a range specified by the sensor and logger manufacturers. If a value falls outside this range, it is flagged as invalid. A data value from the sensor listed in Test Field 1 (TF1) is flagged if it less than Fact 1 (F1) or greater than Factor 2. This test has been applied to the following sensors (as applicable): wind speed, wind speed standard deviation, wind direction, temperature and solar insulation.

$$F1 > TF1 > F2$$

MinMaxT Test: This is a MinMax Test for wind direction standard deviation with different ranges applied for high and low winds. A wind direction standard deviation data value (TF1) is flagged either if it is less than Factor 1, if the wind speed (TF2) is less than Factor 4 and the wind direction standard deviation is greater than Factor 2, or if the wind speed is greater than or equal to Factor 4 and the wind direction standard deviation is greater than Factor 3.

$$(TF1 < F1)$$
$$\text{Or } (TF2 < F4 \text{ and } TF1 > F2)$$
$$\text{Or } (TF2 \geq F4 \text{ and } TF1 > F3)$$

Icing Test: An icing event occurs when ice collects on a sensor and degrades it's performance. Icing events are characterized by the simultaneous measurements of near-zero standard deviation of wind direction, non-zero wind speed, and near or below freezing temperatures. Wind Speed, wind speed standard deviation, wind direction, and wind direction standard deviation data values are flagged if the wind direction standard deviation (CF1) is less than or equal or equal to

Factor 1 (F1), the wind speed (TF1) is greater than Factor 2 (F2), and the temperature (CF2) is less than Factor 3 (F3). To exit an icing event, the wind direction standard deviation must be greater than Factor 4 (F4).

$$CF\ 1 \leq F1 \text{ and } TF1 > F2 \text{ and } CF2 < F3 \text{ (w/ exit clause } CF1 > F4)$$

CompareSensors Test: Where primary and redundant sensors are used, it is possible to determine when one of the sensors is note performing properly. For anemometers, poor performance is characterized by low data values. Therefore, if one sensor of the pair reports values significantly below the other, the low values are flagged. At low wind speeds (Test Fields 1 and 2 less than or equal to Factor 3) wind speed data are flagged if the absolute difference between the two wind speeds in greater than Factor 1. At high wind speeds (test Fields 1 or 2 greater than Factor 3) wind speed data are flagged if the absolute value of the ratio of the two wind speeds is greater than Factor 2.

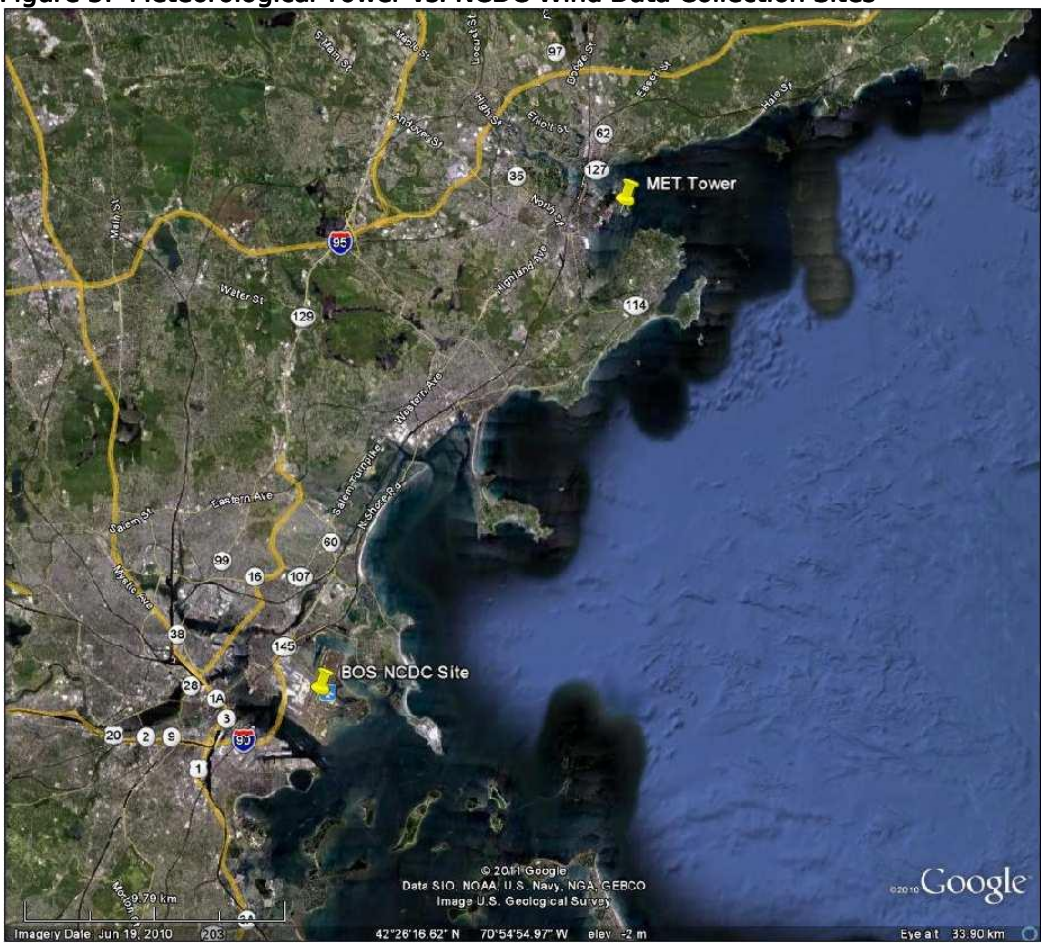
$$[\ TF1 \leq F3 \text{ and } TF2 \leq F3 \text{ and } abs(TF1 - TF2) > F1]$$
$$\text{Or } [\ TF1 > F3 \text{ or } TF2 > F3) \text{ and } (abs(1-TF1/TF2) > F2 \text{ or } abs(1-TF2/TF1) > F2)]$$

Site Correlation

Daily wind speed and wind direction data was purchased from the National Climatic Data Center (NCDC) for the Logan International Airport (BOS) in Boston, Massachusetts to conduct a site correlation wind speed analysis. The Quality Controlled Local Climatological Data was ordered for the time period equivalent to that of on-site met tower data collection (January 6, 2010 – January 5, 2011).

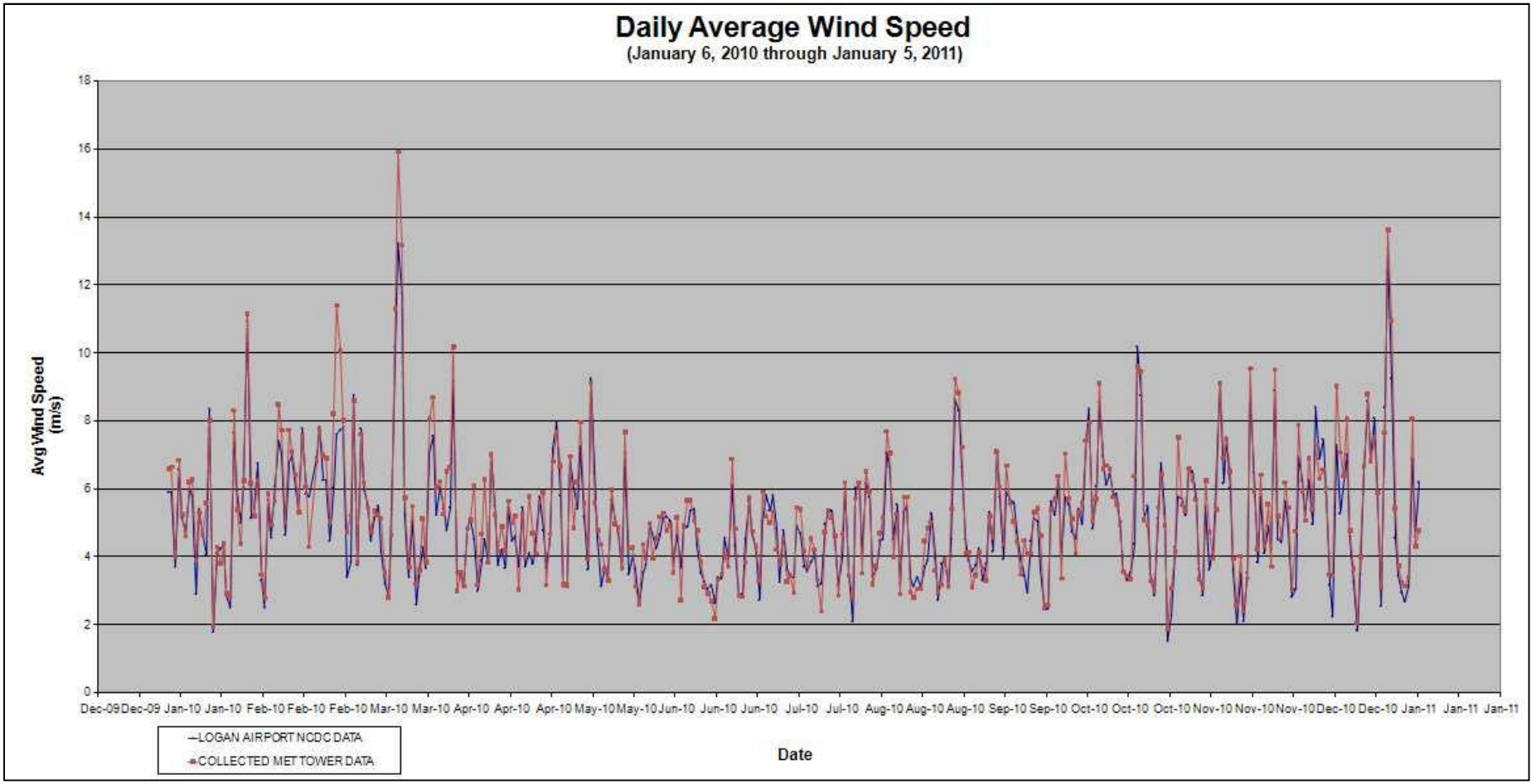
As shown in Figure 5, BOS lies approximately 13 miles southwest of the site with Boston Harbor and the Atlantic Ocean abutting the airport to the south and east. Densely developed urban areas surround the remainder of the site. The wind data collection apparatus sits at 42.361°N and 71.011°W at an elevation of 6m (19’). It is located approximately amidst Logan International Airport terminal runways in a very flat and wide open area. The Met Tower stands approximately 10m (33’) tall and makes hourly observations of wind speed and direction per NCDC.

Figure 5: Meteorological Tower vs. NCDC Wind Data Collection Sites



Concurrent daily average wind speed data from January 6, 2010 through January 5, 2011 for the collected Met Tower and the Logan International (BOS) NCDC wind data are plotted against the one another on the following page in Chart 1.

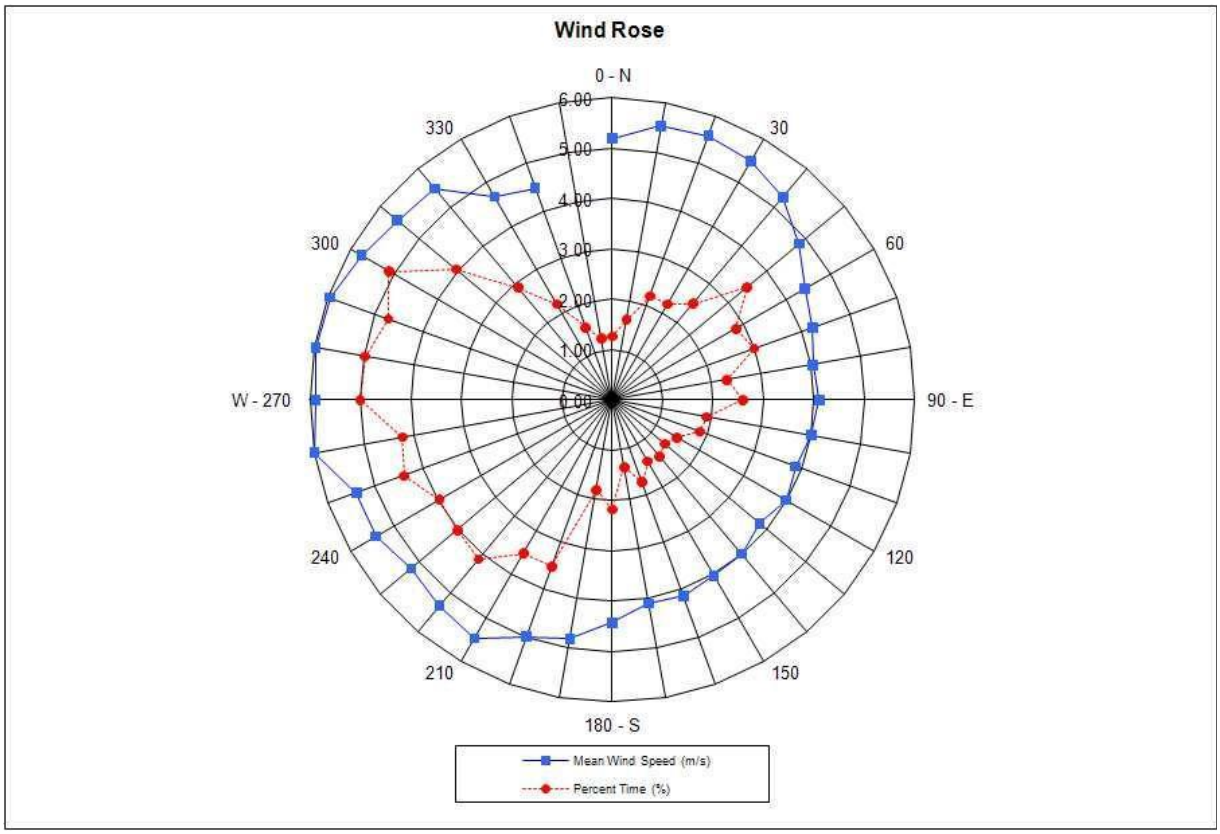
Chart 1: Daily Average Wind Speed



Wind Directional Data

In Figure 6, we provide a wind rose that contains the joint frequency distribution of site winds and the level of associated wind speeds at the met tower. The figure indicates that the predominant wind directions are fairly uniform – with the direction of west having the most energy-productive winds. However not a vast amount of wind-generated electricity is produced from the direct north or southwest directions.

Figure 6: Wind Rose

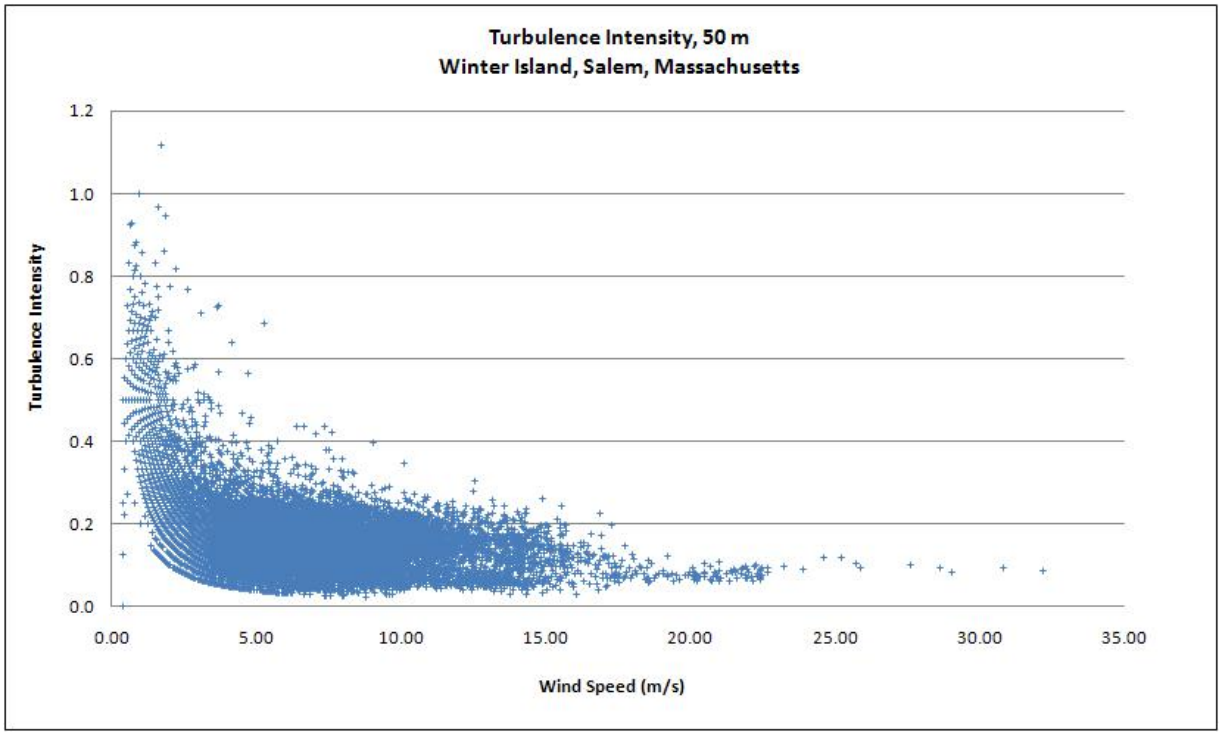


Turbulence Intensity

Turbine intensity is the measurement of the fluctuation of wind speed or gusts over the average wind speed over a measured period of time. Turbulence intensity is calculated as the standard deviation of the wind speed divided by the wind speed. Turbulence intensity decrease with height, therefore the actual turbulence intensity measured at 50m is plotted below in Chart 2.

The turbulence intensity average at @ 10 m/s for the 50m height is approximately 15%.

Chart 2: Turbulence Intensity



ii. Wind Resource at Hub Height

A Measure-Correlate-Predict (MCP) wind regression analysis was used to develop correlation factors between the collected MET tower data and the yearlong daily BOS data as obtained from NCDC. The MCP was use to estimate the long-term winds at the site for the most comparative anemometer level (30m anemometer height) at which winds were measured. We arrived at the following results for the regression analysis and curve fits for the 30m level:

30m Level = 1.0325 x BOS Data + 0.0435, R = 0.9480

Chart 3 shows Met Tower data vs. Logan International Airport (BOS) NCDC Data with the linear regression fit:

Chart 3: Linear Regression

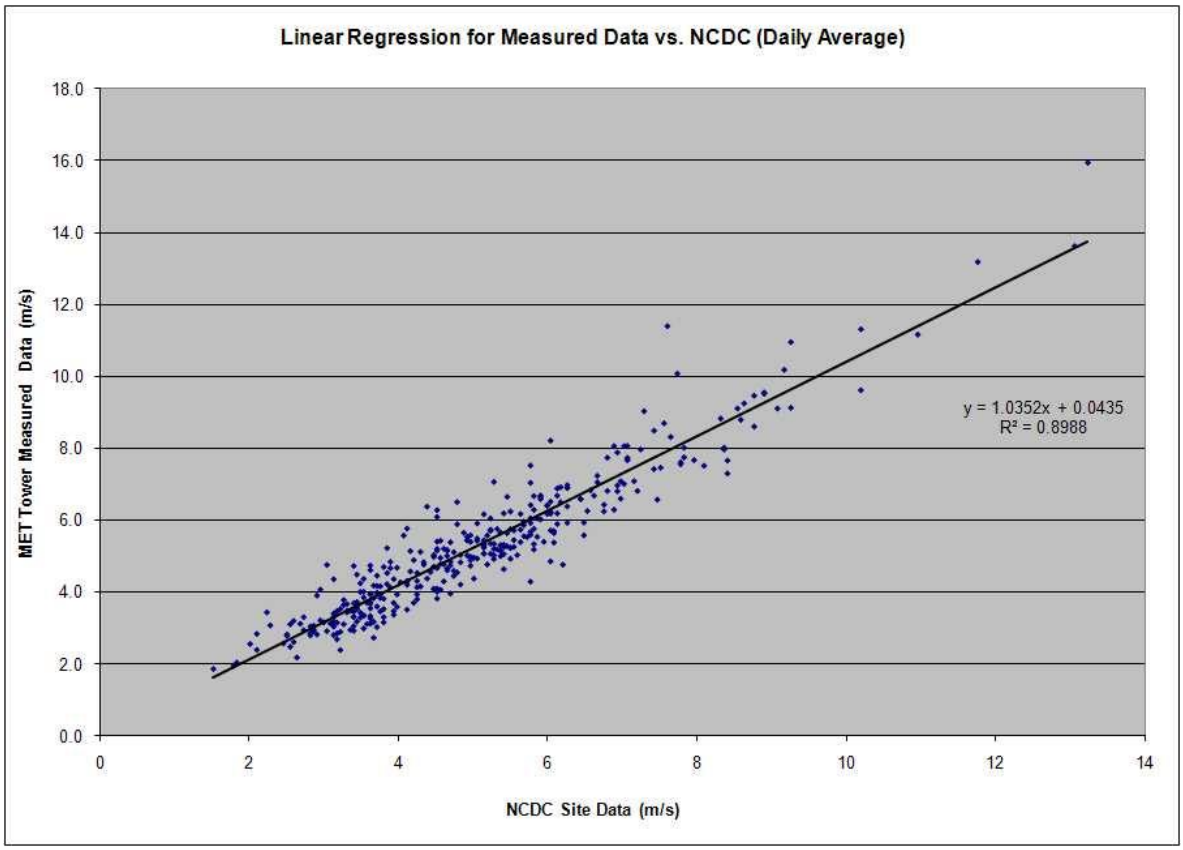


Table 1 provides a comparison of the average wind speed as measured on the site via the Met Tower at a 30m height, the Logan International Airport (BOS) wind data as provided by NCDC (the “direct” wind data) and the “corrected” wind speed (calculated by the applying the linear regression to the direct NCDC wind data).

Table 1: Average Wind Speeds (m/s)

Month	Average Wind Speed (m/s) at 30m Height		
	MET Tower	Direct NCDC	Corrected NCDC
January	5.42	5.19	5.42
February	6.51	5.93	6.19
March	6.28	5.79	6.04
April	4.97	4.66	4.87
May	4.87	4.75	4.96
June	4.24	4.24	4.43
July	4.36	4.34	4.54
August	4.66	4.57	4.77
September	5.00	4.84	5.05
October	5.59	5.47	5.71
November	5.24	4.92	5.14
December	6.15	6.00	6.25
Average	5.27	5.06	5.28

The average long term wind speed was determined to be 5.26 m/s, which is approximately 0.1% greater than the average collected wind speed of 5.27 m/s. (See section (iii) for details.)

Wind Shear

Wind shear (i.e., variation in the horizontal component of wind speed as a function of height (agl)) was examine based on the twelve (12) months (January 6, 2010, January 5, 2011) of data from the met tower on site. The variation of the horizontal component of wind speed with height above the ground is described by the following equation:

$$V_2/V_1 = (H_2/H_1)^{\alpha} \quad (1)$$

Where:

- V_2 and V_1 are the wind speeds at reference heights 2 and 1, respectively,
- H_2 and H_1 are the reference heights 2 and 1 in consistent units (i.e. meters or feet), and
- Alpha is the power-law wind shear coefficient.

Wind shear is a function of the frictional effects of the ground surface cover. The wind power law attempts to emulate this change in wind speed with height through use of the power law exponent, or alpha value. One of the major sources of error in wind project theoretical energy estimates is the extrapolation of wind speeds from the measurement level to the wind turbine hub height.

Wind speeds collected at the 40m and 50m anemometer heights were used in conjunction with the parameters set forth in Attachment 1 of MassCEC's Feasibility Study Requirements to calculate the seasonal wind shear.

The coefficients were calculated as stated on Table 2.

Table 2: Season Wind Shear Coefficient

Season	α Coefficient
Spring	0.242
Summer	0.230
Fall	0.224
Winter	0.257

Wind shear values at Winter Island are relatively low. Due to the low shear coefficient alpha, as hub height increases wind speed will gradually increase. Various manufacturers have different requirements for shear and turbulence intensity. Prior to selecting a turbine these parameters will have to be evaluated by the manufacturer.

iii. Long Term Wind Correlation

An additional ten (10) years of daily wind speed data was purchased from NCDC for the Logan International Airport Site. The linear regression fit was applied to these wind speeds to create ten (10) years of long term corrected site data at a 30m level (agl). To this long term corrected Met Tower data wind shear power law coefficients were applied seasonally to determine the average wind speeds at 60m, 70m, and 80m and hub heights. A summary by year of these calculated values are below in Table 3.

The ten (10) year period of the data that we analyzed was for the period January 2001 through December 2010.

Table 3: Long Term Corrected Wind Speeds

Year	Average Speed (m/s)	Corrected Wind Speed (m/s	Average Wind Speed (m/s)		
			60m	70m	80m
2001	4.82	5.04	5.94	6.17	6.36
2002	5.11	5.33	6.29	6.52	6.74
2003	4.87	5.08	6.00	6.22	6.43
2004	5.02	5.24	6.19	6.42	6.63
2005	4.93	5.14	6.07	6.30	6.50
2006	5.01	5.23	6.18	6.41	6.61
2007	4.83	5.04	5.95	6.18	6.37
2008	4.67	4.88	5.76	5.97	6.17
2009	4.81	5.02	5.93	6.14	6.35
2010	5.06	5.28	6.24	6.47	6.68
Average	4.91	5.13	6.05	6.28	6.48

Long Term Frequency Distribution

A long term frequency distribution was applied to each of the analyzed hub heights to which long term correction values were calculated. The frequency distributions are shown as Chart 4, 5, 6, and 7 for corresponding hub heights at 30m, 60m, 70m, and 80m.

Chart 4: Long Term Frequency @ 30m

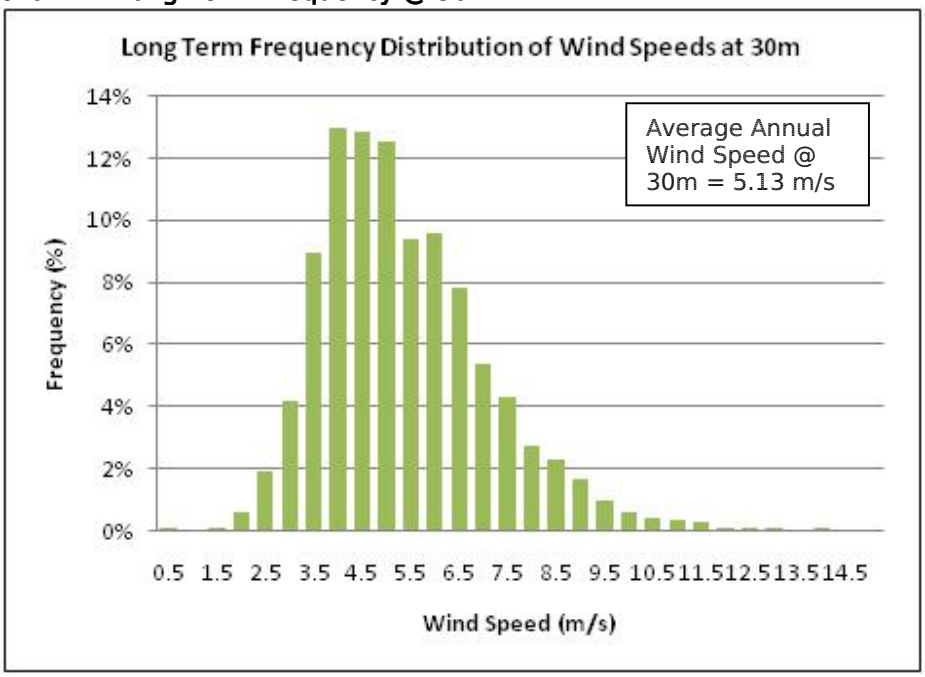


Chart 5: Frequency Distribution for 60m

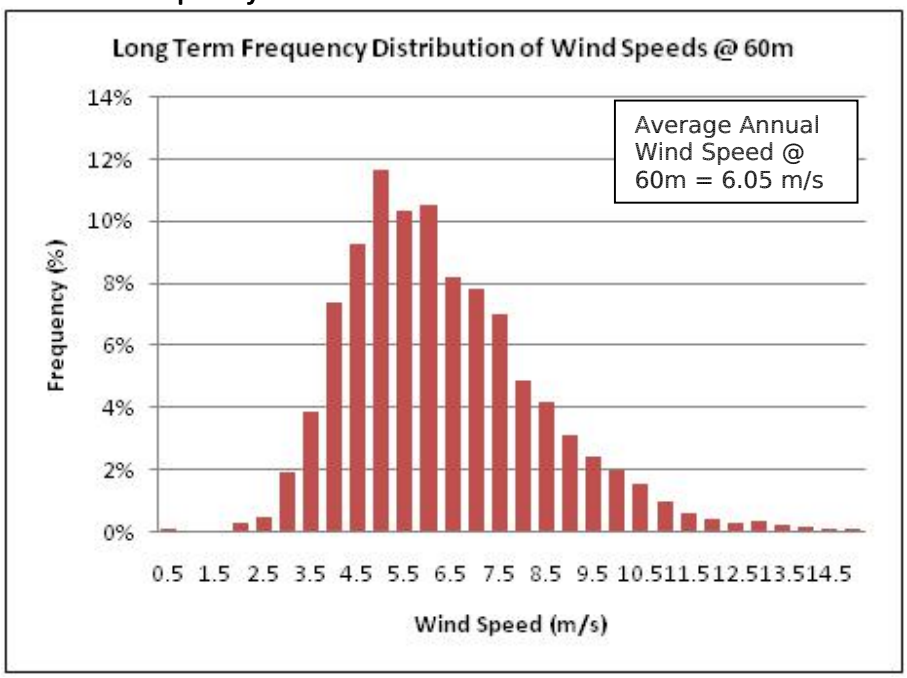


Chart 6: Frequency Distribution for 70m

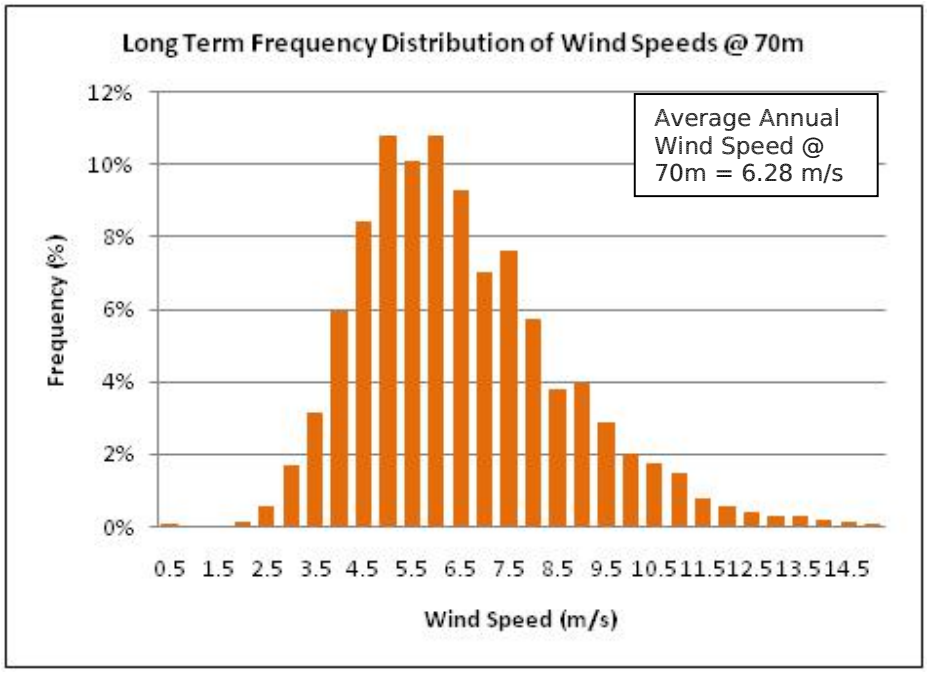
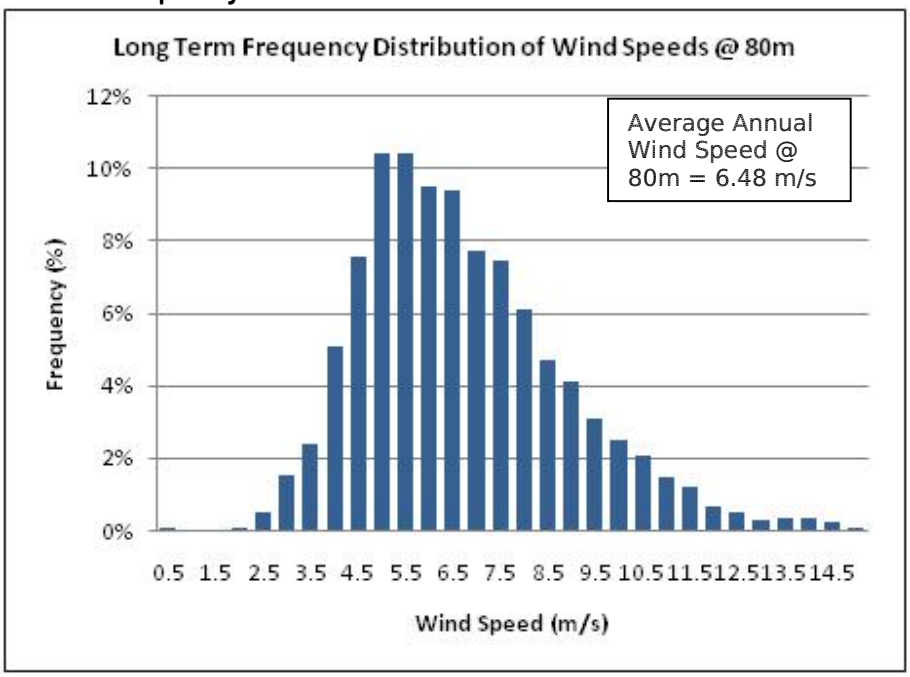


Chart 7: Frequency Distribution for 80m



iv. P50 and P90 Exceedance Levels

The average annual wind speed (Table 4) is derived from wind speed data collection and applied test and filters. To account for uncertainties due to inter-annual variability of wind speeds, cup anemometer, wind shear calculation, and MCP algorithm calculation that might impact the wind turbines performance the P50 and P90 Exceedance levels are calculated. The average annual wind speed values correspond to the P50 confidence value estimate, meaning that there is a 50 percent chance that the true long-term average wind speed is higher, and a 50 percent chance it is lower. The P90 level is the estimate of average annual wind speed that will be exceeded with a 90% probability.

Table 4: Average Annual Wind Speed at P50 and P90

Hub Height (m)	Average Annual Wind Speed (m/s)	
	at P50	at P90
60	6.05	5.50
70	6.28	5.71
80	6.48	5.89

Uncertainty Analysis

To determine the sensitivity of the production to variations in wind speed and to estimate the magnitude of variations possible, an analysis combining the following uncertainty and production loss factors (Table 5 and Table 6) was performed.

Table 5: Uncertainty Factors

Uncertainty Parameter	Standard Deviation in Wind Speed (%)
Inter-Annual Variability of Wind Speed	1.90
Anemometer Calibration(NRG #40)	1.48
Wind Shear Calculation	2.30
MCP Algorithm Calculation	1.43
Total Uncertainty	7.11

- **Inter- Annual Variability:** this is a measure of how well understood the long-term wind resource is, and is determined by the length of the long-term data set analyzed.

- **Anemometer Calibration:** this is the stated calibration of the primary anemometer used to measure the on-site wind resource. For uncalibrated instruments, the standard accuracy of the anemometer published by its manufacturer is used. For instruments left installed past their calibration period or for longer than one year for uncalibrated sensors, an increase in the calibration uncertainty may be applied for expected sensor degradation.

- **Wind Shear Calculation:** this value is a measure of extrapolation from met tower shear calculations to the projected tower height. Wind shear calculations are based on the difference in wind speed from 30m to 50m, and extrapolated to the turbine height of 80m.

- **MCP Algorithm Calcualtion:** this value is a measure of how well the collected site data fits the long term corrected data. As the test site is not located at the same site as the long term data set used for calculation, an uncertainty parameter must be used to describe the potential difference in long term correlation calculations.

Table 6: Production Losses

Production Losses	Loss (%)
Topographic Effects	0.0
Site Obstructions	0.0
Estimated additional losses	
WTGs Availability	2.0
Utility Grid Availability	0.25
Electrical Losses	2.5
Cold Temperature Shutdown	0.5
High-Wind Hysteresis	0.0
Blade Contamination	0.5
Wind Farm Waking Effects	0.0
Square Root Sum of Losses	2.40

- **Topographic Effect:** This is the loss (or gain) due to wind speed reductions (or increases) between the met tower and turbine caused by the site's topography. This value varies somewhat by turbine height and rotor diameter.

- **Site Obstruction:** This is the energy loss due to the effect one turbine will have on another, or the wake caused by any structure on the wind turbines. This effect varies by rotor diameter and speed.

- **Turbine Availability:** Wind turbine manufacturers will specify an availability level to be covered in a warranty. This value assumes the turbine's availability is only at the warranted value.

- **Grid Availability:** An estimate is made as to the amount of time that the utility will be available to receive power from the project. All grid systems are offline periodically for maintenance, and projects in more remote locations are generally connected to weaker grid systems that are more prone to failure. Losses for grid availability vary between 0.1 percent for very strong grid systems to as high as 5 percent for weak systems.

- **Electrical Losses:** Losses in the lines and electrical equipment prior to the plant's revenue meters are covered by this factor. Points of significant

electrical losses in a wind energy project usually include the underground and overhead distribution lines connecting the turbines to a substation, and the substation's primary transformer. Typical electrical loss values range from as low as 1 percent up to 10 percent or more, depending on the project layout and equipment used.

- **Cold Temperature Shut Down:** During winter storms, snow and ice will build on the wind turbine blades causing the same degradation as caused by dust and insects. While this contamination will build much faster than summer contamination, it is often cleared after a few hours of direct sunlight (even at continued subzero temperatures). Based on the climate in the project area, a loss of 0.5 percent was assumed for the lost energy due to icing.

- **High Wind Hysteresis:** When wind speeds exceed the operational range of a wind turbine, the turbine shuts down to protect itself. Such shutdowns normally require the turbine to remain offline for several minutes, even if the wind speed returns to the operational range in a shorter time. Sites with a significant number of these high wind events suffer lost energy due to this hysteresis effect, which is in addition to the amount of time the average wind speed remains above the cut-out wind speed. Because the project site does not have a significant number of high wind events on record, no losses due to hysteresis were applied.

- **Blade Contamination:** Wind turbine performance is sensitive to the cleanliness of the turbine's blades. In areas of high dust or insects, contamination can build up on the turbine blades that will limit the turbine's performance (causing losses of up to 5 percent or more). Often the blades are cleaned by occasional rainfall, but in some areas periodic blade washing is required. An annual loss of 0.5 percent was assumed for blade contamination.

v. Wind Turbine Output Potential

In addition to our more conservative wind speed estimate which is based on MCP wind data, Wind Pro Software was also used to determine the wind turbine output potential for the three turbines evaluated by entering the full year's worth of filtered met tower data. The calculation was based on the MET tower data, giving the Weibull distribution for the wind speeds on the site and the selected power curve. The METEO Module calculated that the mean wind speed for the Elecon T600, Mitsubishi MWT62/1.0 and GE 1.5sle Wind Turbines at 60m, 70m, and 80m hub heights is as follows:

- Elecon T600 at 60m – 6.26 m/s
- Mitsubishi MWT62/1.0 at 70m – 6.50 m/s
- GE 1.5sle at 80m – 6.71m/s

a. Site Obstructions

The topography of the site makes it an ideal location for the erection of a wind turbine. The elevation of the terrain and the proximity to the Salem Harbor and the Atlantic Ocean has been taken into consideration in the wind resource assessment.

The majority of wind influence from man-made structures will come from the 3 existing smoke stacks from the Salem Harbor Generating Station located approximately 1,500 feet to the East of the proposed turbine. Other small structures include buildings on the South Essex Sewerage District, located approx 1,300 feet to the ENE of the proposed turbine, as well as an abandoned 3 story building located on Winter Island approximately 150' to the north. A former aircraft hangar, now being used for general storage, lies on the site approximately 400' to the East.

The MET tower was erected at the most southern portion of the Winter Island property adjacent to the cul-de-sac drive on an open grassy area. The closest residential structure, the Plummer Home for Boys, is approximately 1300 feet directly to the north off Winter Island Road and the closest structure is approximately 100 feet to the south of the location of the MET tower's base.

b. Wind Resource Profile

Appendix A contains the full wind resource profile for the Elecon T600 at a 60m hub height, the Mitsubishi MWT62/1.0 at a 70m hub height and for the GE 1.5sle at an 80m hub height as produced by WindPro.

vi. Site Viability

The Winter Island Site has sufficient wind for overall viability of this project at the site for the construction of a commercial size wind turbine.

vii. Wind Resource Recommendations

Various manufacturers have different requirements for shear and turbulence intensity. Prior to selecting a turbine, these parameters will be to be evaluated by the manufacturer, however no additional wind resource monitoring or validation is recommended.

INSTALLATION SITE AND VICINITY

3. Characteristics of Site Vicinity

a. General Description

The proposed site is located on a peninsula located in the northeast portion of the City of Salem. The site is also home to Fort Pickering. The northeast side of the island contains ramparts, bunkers, and ammunition areas. The site is listed in the Massachusetts State Register and the National Register of Historic Places as the Winter Island Historic and Archaeological District. The 27± acres site is situated in the Salem Harbor, surrounded by the Salem Neck neighborhood, and walking distance from the Salem Willows Park; the site is characterized by lawns and sparsely wooded areas consisting of deciduous trees in its majority. Beverly Municipal Airport is approximately 4 miles northwest of the proposed location of the wind turbine generator. Refer to Figure 7, for MassGIS USGS Locus Map.

Figure 7: Locus Map

Source: MassGIS (www.mass.gov/mgis)

✕ Location of proposed Wind Turbine Generator

Winter Island is located in an electric utility capacity constrained area and opportunities for clean renewable distributed energy generation of this magnitude will aid the City of Salem in achieving energy sustainability.

b. Visual and Noise Receptors

i. Potential Visual Impacts

A photomontage has been prepared using WindPRO Software to simulate the view of the proposed turbine. See the attached photos for before and after pictures taken from various vantage points of a typical 1.5 MW turbine. Additional photomontages for each of the turbines studied are available in Appendix B.

Without Proposed Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Winter Island – Salem, MA
Before and After Photos
View from Naugus Beach, Marblehead

Without Proposed Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Winter Island – Salem, MA
Before and After Photos
View from Shetland Park, Salem

Without Proposed Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Winter Island – Salem, MA
Before and After Photos
View from Salem-Beverly Bridge, Salem

Without Proposed 1.5 MW Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Winter Island – Salem, MA
Before and After Photos
View from Beverly Port Marina, Beverly

Without Proposed Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Winter Island – Salem, MA
Before and After Photos
View from Columbus Avenue (Salem Willows), Salem

Without Proposed Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Winter Island – Salem, MA
Before and After Photos
View from Salem-Marblehead Causeway, Salem
(Note: Turbine is in red for visibility purposes)

Winter Island – Salem, MA
Before and After Photos
View from Ocean Avenue, Salem

Without Proposed Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Winter Island – Salem, MA
Before and After Photos
View from Independence Park, Beverly

Without Proposed Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Winter Island – Salem, MA
Before and After Photos
View from Cheval Road, Salem

Without Proposed Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Winter Island – Salem, MA
Before and After Photos
View from Collins Cove, Salem

Without Proposed Wind Turbine Generator

With Proposed 1.5 MW Wind Turbine Generator

Winter Island – Salem, MA
Before and After Photos
View from Winter Island Causeway, Salem

i. Potential Noise Impacts

Noise considerations should be taken into account for compliance with state regulatory and nuisance levels at nearby residences. Massachusetts state regulations do not allow a rise of 10 dB(A) or greater above background noise levels at a property boundary. The proposed 1.5 MW turbine siting location is approximately 1000 feet to the nearest property line and 1430 feet from the nearest residence. The nearest residence is the Plummer Home for Boys on Winter Island, followed by a residence to the north at a distance of approximately 1690 feet from the turbine.

Using WindPro Software five (5) residential receptors were analyzed to determine the effects on acoustics by the installation a 1.5 MW turbine; Receptors A and C located in in the neighborhoods situated to the west of the proposed turbine, adjacent to Fort Avenue. Receptors B and D are positioned in the inhabited areas north of the site. An additional receptor was positioned across Salem Harbor on Naugus Avenue in the Town of Marblehead, Massachusetts.

These locations were chosen for analysis for the reason that they represent areas that may be influenced the most by the installation of a wind turbine generator and any potential noise nuisance. A Complete WindPro Decibel results for the proposed 1.5 MW turbine are attached as Appendix C.

Howard Quin Consulting in association with HMMH was contracted by Meridian Associates to perform a noise study for the proposed wind turbine installations. In the report, applicable noise standards and criteria were reviewed, the modeling used to project noise emissions from the selected wind turbine was described, and an analysis of all the information to assess potential noise impacts from the project was completed.

Applicable noise standards for the proposed wind turbine are the Salem noise ordinance, and the Massachusetts Department of Environmental Protection (DEP) noise guidelines, which are identical. The Code of Massachusetts Regulations (title 310, Section 7.10, amended September 1, 1972) empowers the Division of Air Quality Control (DAQC) of the Department of Environmental Protection (DEP) to enforce its noise standards. According to DAQC Policy 90-001 (February 1, 1990), a source of sound will be considered to be violating the Department's noise regulations if the source (1) increases the broadband sound level by more than 10dBA above ambient, or (2) produces a "pure tone condition", when any octave-band center frequency sound pressure level exceeds the two adjacent frequency sound pressure levels by 3 decibels or more. Ambient is defined as the background A-weighted sound level that is exceeded 90 percent of the time (i.e. L90) measured during equipment operating hours. A wind turbine only operates when there is sufficient wind speed to run it, which is generally 4 meters per second (m/s) (9 mph) measured at a height of 10 meters (m). (This is the standard height at which wind is usually measured at airports and meteorological stations; it corresponds to a hub height wind of about 5 m/s). Therefore, it is appropriate to estimate likely background L90 when winds are blowing at speeds of 4 m/s or higher, for the purposes of comparison to the turbine noise emissions

According to the report in Appendix D, Winter Island Wind Turbine Noise Study by Howard Quin Consulting LLC, predictions to four (4) sensitive areas were evaluated using actual measured turbine noise levels. The analysis is listed below in Table 7.

Table 7: Predicted Noise Levels from proposed 1.5 MW Wind Turbine

Site Address	Predicted Turbine Leq dB(A)	*Estimated Background Leq dB(A)	Estimated Total Leq dB(A)	Estimated Difference dB(A)
Plummer Home for Boys	40	32	41	9
Four Closest Residence, on Winter Island Road	37	32	38	6
Yacht Club Building	39	32	40	8
Building Directly Beneath Turbine	53	32	53	21

*Ambient Noise Measurements will be taken and submitted as part of MassCEC's Business Planning Deliverables

Based on this study, the following was concluded:

- The Massachusetts Department of Environmental Protection (DEP) and City of Salem noise guideline of 10 dB(A) increase in noise levels will probably not be exceeded by the proposed wind turbine operation in any noise sensitive area at any time of day or night.

- The Project will be in compliance with the DEP noise guidance for a pure tone condition.

While the turbine operation may be audible at some of the nearest homes during nighttime hours with windows open, we believe that the noise level will not be considered intrusive.

c. Airports and Air Navigation Facilities

i. Proximity of Airports and Air Navigation Facilities

The closest active public airport is Beverly Municipal Airport which lies approximately 4.5 miles to the northwest of the site as depicted in Figure 8.

Figure 8: Local Airports

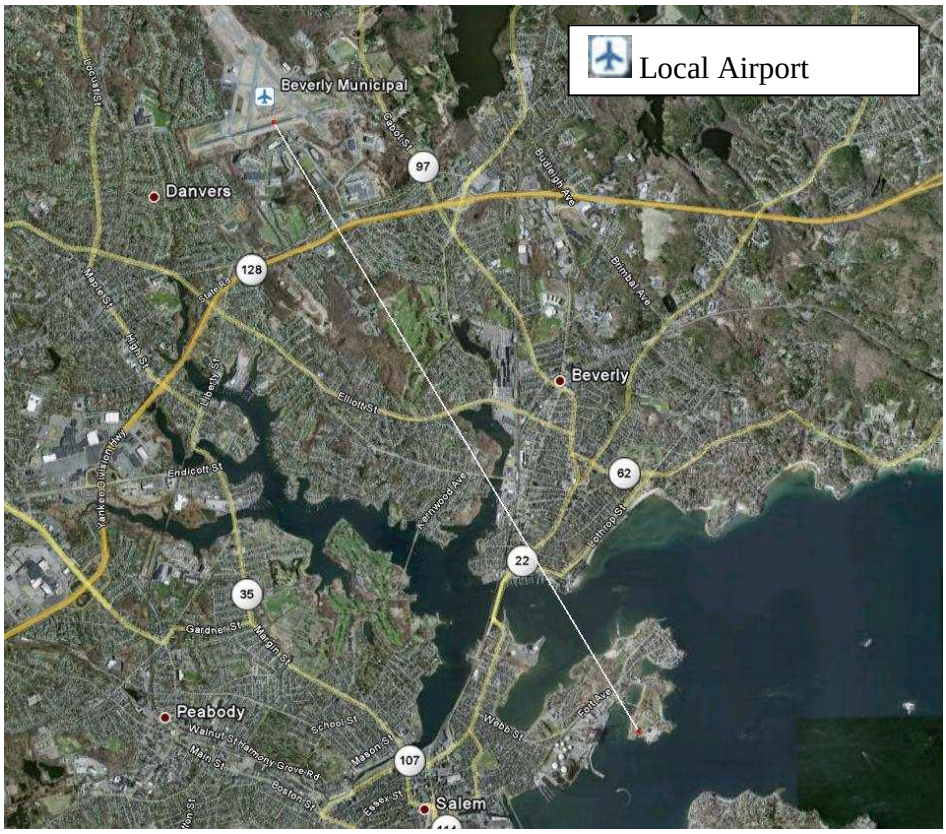


Image Source: Google Maps – April 2008

ii. Federal Aeronautics Administration

A Notice of Proposed Construction or Alteration is required by the FAA for any structure that is proposed to be 200 feet or above ground level. On October 10, 2009 Form 7640-1 was filed with the FAA for a 399 foot structure at the proposed site and was assigned the Aeronautical Study Number (ASN) 2009-WTE-10282-OE. The FAA has conducted their aeronautical study under the provisions of 49 U.S.C., Section 44718 and, if applicable, Title 14 of the Code of Federal Regulations, part 77. On November 12, 2009 a Determination of 'No Hazard to Air Navigation' was issued for a total height of 399' AGL. Appendix E contains a copy of FAA's favorable Determination.

d. Electronic Communications Facilities

All Federal Communications Commission (FCC) registered electronic communications facilities within a 3-mile radius of the project site have been identified. These positions were located using Mobiledia http://www.cellreception.com/towers) and City-Data (http://www.city-data.com/city/Massachusetts.html) websites. A summary of these findings is located in Appendix F. Although most communication signals are completely unaffected by wind turbines, in some instances AM radio signals could potentially be affected and microwave signals can be blocked by the wind turbine if it is in direct line between the microwave transmitter and receiver it.

e. Community Acceptance

While the Renewable Energy Task Force (RETF) monthly meetings are open to the public, additional public outreach has included public meetings in association with the SODAR study conducted at SESD and the MET tower installation, and newspaper articles regarding the process undertaken so far. More recently, as part of its Winter Island Master Plan development process (being undertaken by a professional consulting group), the City of Salem has conducted three public hearings (March, April & May 2011). At each of these hearings the possibility of a wind turbine at the park was actively discussed, and participants were shown a graphic depicting the proposed wind turbine location. Additional public information sessions are planned and the City will likely commission third party assistance in planning and delivering the sessions. Also, the City has made the feasibility study completed by Meridian Associates publicly available on its website, along with the wind data which had been posted monthly.

The RETF has provided information about the project at over 12 fairs/events in Salem over the past 2 years (including the local Farmers' Markets and Living Green Fairs). Furthermore, a member of the City's Renewable Energy Task Force has scheduled a visit to the City of Hull's two wind turbines with Administrators from the Plummer Home For Boy's, the nearest residential structure.

4. Installation Site Physical Characteristics

a. Site Physical Characteristics

Winter Island is a Marine Recreational Park owned and maintained by the City of Salem. The park is in operation year round providing campsites for recreational vehicles, a boat launch, picnic areas, a bath house and a small beach.

The site is located in the northeast portion of the City of Salem, just past the Salem Willows Park and the Salem Power Plant, in the Salem Harbor. The land is classified as Residential One Family (R1) per the City of Salem Zoning Code with an approximate area of 27± acres. The buildings on the site are for municipal use.

Figure 9 defines perimeter of the City of Salem property and the approximate location of the wind turbine within the property boundaries.

Figure 9: Property Characteristics

Source: MassGIS (www.mass.gov/mgis) **Scale: 1" = 400'**

Location of proposed Wind Turbine Generator

b. Current and Anticipated Uses

Winter Island is currently and anticipated to remain a Marine Recreational Park. The park is in operation year round providing campsites for recreational vehicles, a boat launch, picnic areas, a bath house and a small beach.

c. Site Infrastructure

The Winter Island peninsula is connected to mainland through a causeway built in the late 1600's. Winter Island Road is the only mean of access to the site. The property has extensive buried infrastructure, and is home to Fort Pickering so underground tunnels and structures could be potentially found. A complete Infrastructure study

will be performed prior to the installation of the wind turbine. Installation Site Electrical Infrastructure is discussed in Section 5 of this Feasibility Study

d. Safety and Operational Suitability

Overall, the Winter Island site is a safe and suitable site to erect a turbine. As proposed, the wind turbine is to be located toward the south end of the peninsula, potentially on the highest elevation found in Winter Island. The closest property line is about 300 feet from the turbine and the closest residential property is about 1000 feet away. Camping sites, boat access and ramps, as well as hiking trails are located on the property so proper notification should be implemented or restrictions should be made to prohibit unnecessary access of the public.

There is always a slight concern of ice throw when a turbine is erected in climates that are susceptible to winter storms. Ice can accumulate on the turbine blades and potential be thrown off if the turbine is in operation or more commonly ice fragments may fall from the machine when it is shutdown. Mitigation measures, such as ice sensors, balance monitoring, and preventative shut down, are available to minimize potential risks.

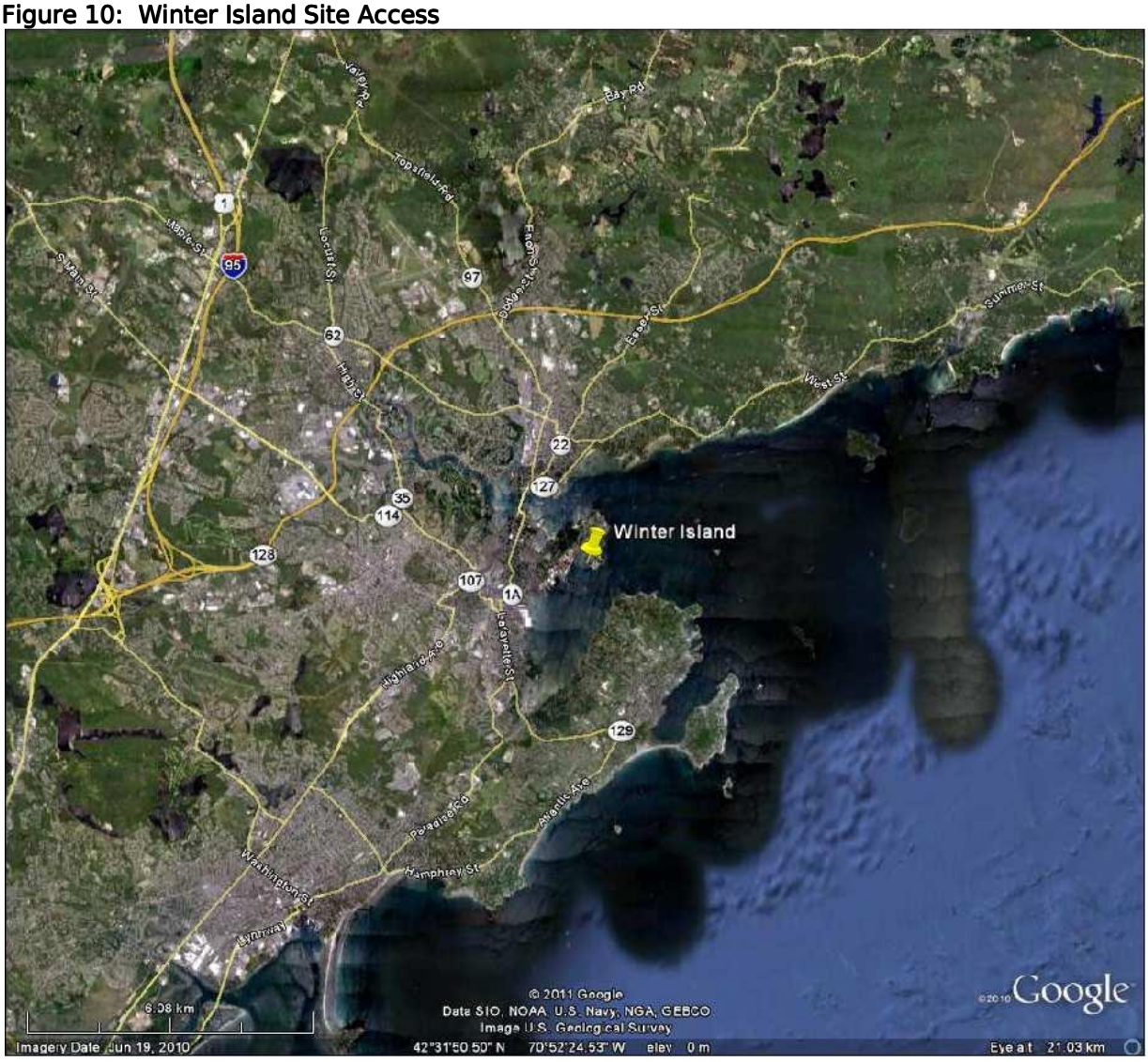
e. Spatial Separation

Not Applicable – there is only one (1) proposed turbine to be erected at the site and there are no other wind turbine generators in the vicinity of the Winter Island property.

f. Site Access

The City of Salem is accessible from either Interstate 95 or 128 and Route 1. Off of these major highways access to the Winter Island site is attainable from numerous main roadways which have fairly large turning radii allowing for the passage of the extensive length of the WTG turbine blades and turbine components. An Orthophoto map of possible access routes to the studied property is shown as Figure 10.

Figure 10: Winter Island Site Access



Direct access to Winter Island is obtainable from Winter Island Road off of Fort Avenue, which is easily accessible from Route 1A. As depicted on Figure 11, the proposed WTG will be erected in a south-central location of the City of Salem property. Direct access from the roadway will be through the park's paved drive that runs from the through the central and western portions of the site.

Figure 11: Immediate Turbine Location Access.

Although minor on-site improvements may be necessary, construction of WTG at the site is not expected to disrupt the normal facility operations as there is adequate space for construction staging and turbine erection. There is a small rotary on the access road which will be reconfigured as part of the rehabilitation of Winter Island. The cost to do so will be minimal in the overall construction cost scope.

5. Electrical Infrastructure

The existing electrical infrastructure consists of a 3-phase distribution line. All power from the proposed turbine generator will be directed via underground duct banks to the existing electrical infrastructure on Winter Island Road. The turbine will require an exterior transformer at the base of the turbine and may require additional components such as re-closers per the direction of National Grid. An Interconnection Study will be performed by the utility provider prior to connection of the turbine to the grid.

a. Potential Interconnection Locations

The site has been evaluated for potential interconnection points to the electrical transmission grid. Although National Grid has not yet finished their assessment of the line voltages for this area it has been identified that two underground 23kV three phase lines are located at the intersection of Fort Ave and Memorial Drive, which lies at an approximate distance of one mile from the site of the proposed wind turbine.

While this report discusses potential interconnection points, a full interconnect study will need to be prepared for and reviewed by National Grid against their inventory to determine the actual location of interconnection to maximize safety and reliability of the system. This study is typically a lengthy and costly process. Interconnection fees are not known until the time of filing for the permit and the study by the utility has been completed, for this reason, it is typically recommended to initiate the interconnect permit very early in the design phase of the project.

National Grid has taken the position to limit the amount of distributed generation to existing transmission lines to 3MW for 13.8kV lines. Projects exceeding these faceplate ratings will require dedicated services from the project to the nearest substation.

Distributed Generation economic benefits typically become compromised when grid interconnection lies greater than 1.5 miles from the site, as typical 3 phase transmission costs range from $50-$60/ft or $264,000 - $316,800 per mile. A connection to the one of the existing three phase lines, approximately 1.0 mile away, would yield a transmission connection cost of approximately $300,000 which includes new lines and utility poles.

b. Interconnection Feasibility

Interconnection at Winter Island does not appear to be a fatal flaw. An Interconnection Study will be performed by the utility provider prior to determine the point of connection of the turbine to the grid.

c. Electrical Output Opportunities

It is anticipated that all of the energy produced by the wind turbine will be utilized by the City of Salem. The wind at the proposed site is a natural renewable energy resource available within the peninsula boundaries that has the potential to benefit the environment as well as the city.

The turbine will generate excess power at the site; the balance of power will be “NET-METERED” behind the meter to credit the electrical power usage of other City of Salem facilities as allowed by recent legislature under the Green Communities Act. This reduction in power costs is intended to ease the cost burden implemented onto the tax payers.

d. Load Profile and Electric Rate Structure

Winter Island is located adjacent to a medium density residential neighborhood and the Salem Harbor. An already cleared section of the site is planned to be utilized for the installation of the Wind Turbine. A Met Tower with anemometers at different heights had been installed on the site and collected wind data for a time period greater than twelve (12) months.

Existing Energy Profiles and Loads

The average annual retail electricity usage (kWh) for the City of Salem is as follows in Table 8:

Table 8: Electricity Usage (kWh)

FY 2008	
Rate Class	**Electric Usage (kWh)**
G3	5,845,380
G2	1,674,088
G1	1,359,846
S1	2,315,526

Approximate Average Annual Energy Consumption: 11,200,000 kWh

Electrical use records are included as Appendix G.

ENVIRONMENTAL AND REGULATORY REVIEW AND PERMITTING PLAN

6. Environmental Concerns

a. Site Vegetation and Wetland Resources

i. Site Vegetation

The Winter Island site is located on a peninsula in the Salem Harbor. There is minimal vegetation immediately surrounding the proposed site location of the wind turbine due to the structures, paved roadway and parking areas, and cleared open space. In this area the terrain is scattered with low lying plants and shrubs with a few coniferous and deciduous trees.

ii. Wetland Resources

Using MassGIS data layers, the project site was reviewed to determine which, if any, areas were potentially environmentally sensitive. The layers that were explored were:

- *Areas of Critical and Environmental Concern*
  Areas of Critical and Environmental Concern (ACEC) are locations in Massachusetts that are valued significant because they are places within the state that contain exclusive resources of natural and cultural importance. ACECs are nominated by communities in the Commonwealth to the state Secretary of Environmental Affairs and administered by the Department of Conservation and Recreation. There were no ACEC's located in the vicinity of the project site.

- ***Scenic Landscapes***
  The Department of Conservation and Recreation's Landscape Inventory Project illustrates identified Scenic Landscapes of Massachusetts in a data layer for general planning purposes. No Scenic Landscapes are visible from the location of the proposed turbine

- ***Protected and Recreational Open Space***
  The protected and recreational open space data layer contains the boundaries of conservation lands and outdoor recreational facilities in Massachusetts. The associated database contains relevant information about each parcel, including ownership, level of protection, public accessibility, assessor's map and lot numbers, and related legal interests held on the land, including conservation restrictions. The project site is located in a Protected and Recreational Open Space classified as 'Municipal' as shown below in Figure 12.

Figure 12: Protected and Recreation Open Space Map

Image Source: MassGIS Datalayers

- ***National Wetlands Inventory Map***
  The National Wetlands Inventory is a record collection of the characteristics, extent and status of the nation's wetlands and deep water habitats in the form of topical maps administered by the U.S. Fish and Wildlife Service. Figure 13 depicts such areas as solid or hatched areas.

  Freshwater Forested/Shrub Wetland encompass Winter Island and the Salem Harbor is classified as Estuarine and Marine Deepwater. A small freshwater pond rests approximately 800 feet to the northwest of the proposed turbine construction location. Although no wetland areas will be disturbed nor will disruption to their buffer zones be required for the erection of the proposed turbine appropriate filings will be carried out as necessary.

Figure 13: National Wetlands Inventory Map

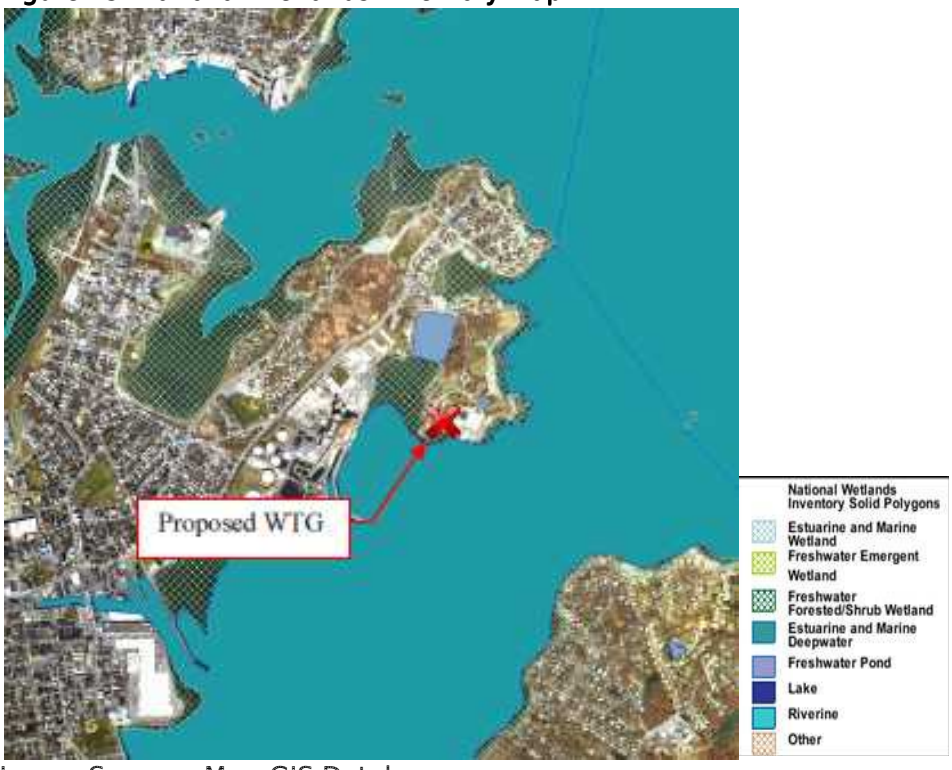


Image Source: MassGIS Datalayers

- ***Estimated Habitats for Rare Wildlife and Priority Habitats for Rare Species***
  Estimated Habitats of Rare Wildlife data layers represents estimations of the habitats of state protected rare wildlife (plants and animals) and Priority Habitats data layer represents estimations of state-listed rare species (animals only) habitats in Massachusetts. There are no Habitats for Rare Wildlife or Species at the project site or in the surrounding area of the project site.

b. Potential Environmental Impacts

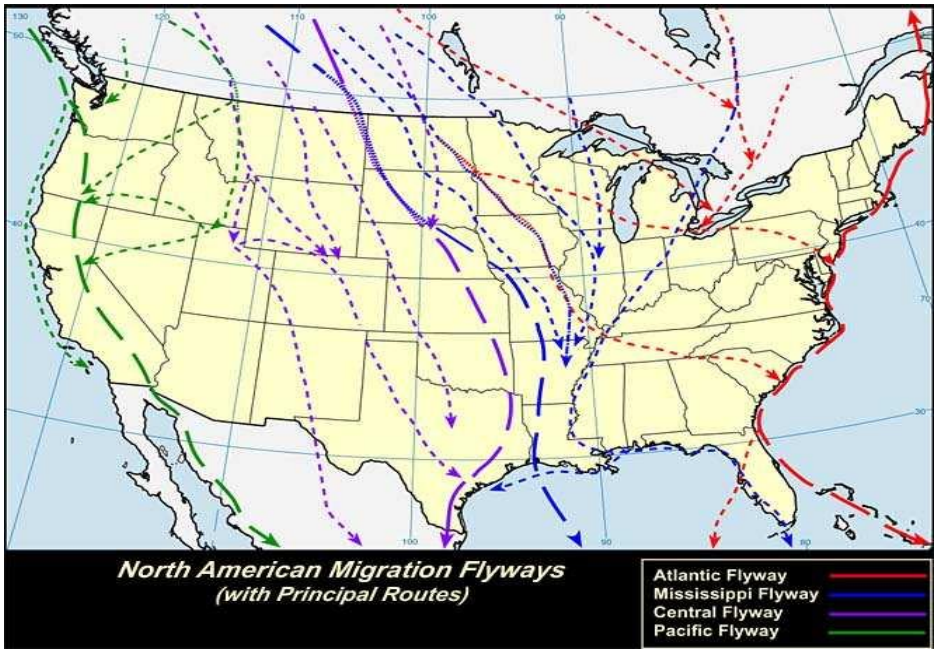
i. Impact on Bat and Avian Wildlife

Migrating Birds

According to the North American Migration Flyways Map, Figure 14, the major flyway flight path of the Atlantic Flyway is located in close proximity to the site of the proposed turbine. The Atlantic Flyway primarily runs along the offshore waters of the Atlantic coast from its northern origin in the eastern Arctic Islands and coast of Greenland down to the Caribbean Sea. The flyway embraces several primary migration routes and many more that are important as tributaries, some of the latter being branches from primary routes of other flyways.

Potential impacts to migrating birds will be somewhat of concern because of the site's closeness to the migratory flyway. Importantly, the City of Salem Turbine project is only a single large turbine, not a multi-unit wind farm. The blade speed on commercial scale turbines is very slow compared to earlier wind turbines that were smaller and rotated at high speeds.

Figure 14: North American Migration Flyways



Source: http://www.birdnature.com/allflyways.html

Avian Population Impacts

To date, no population impacts have been demonstrated or suspected to have resulted from collisions with wind turbines (Kerlinger 2005). Typically, fatalities associated with wind turbine sites have mostly involved common, widely distributed species. Accordingly, population declines associated with wind industry have not been demonstrated.

Bat Population Impacts

In New England, and particularly in the general area of the Salem, MA turbine site, there are not large colonies of bats. Instead, local species tend to congregate in small nursery groups in the spring of up to 200 bats where babies are born and raised. Most bats spend their days in eaves of houses, behind shutters of houses, or in other dark protected places. The big brown bat tends to be more tolerant of the winters in Massachusetts and will stay near and around their local areas all year. The coast of Massachusetts does not have large caves that can serve to house large numbers of bats. Accordingly, some bats (little brown myotis) do migrate to large caves in the western part of Massachusetts where they can better tolerate the winter weather.

We do not expect that bats will be a significant issue pertaining to the City of Salem Wind Turbine Project, as our local bats do not congregate in large numbers, nor do they migrate in large numbers.

Based on prior studies, it is our professional opinion that the construction of the City of Salem Wind Turbine Project will not adversely affect the resident or migrant bird and bat populations of Salem, Massachusetts.

The benefits of wind-generated power are great and are increasing nationwide during this time. It is important that the wind industry be thoughtful and responsible regarding any potential impacts it may have on existing environmental resources. The City of Salem Wind Turbine project consists of one large, slowly rotating generator on a tubular tower at a maximum height of 262-feet, with turbine blades rising on rotation to 389-feet in the air. For the reasons stated above, impacts to migration and/or resident bird species are expected to be minimal.

7. Required Reviews, Permits, and Approvals

a. Zoning Requirements

Winter Island is located on land designated as R90/R45 Residential One-Family as defined in the Zoning Ordinance for the City of Salem. The City of Salem defines Residential One-Family Districts as areas which are anticipated to be highly appropriate for single-family detached residences on large lots. Related recreational, agricultural, and educational facilities are allowed under special condition.

The City of Salem Zoning Ordinance, 29-5(J), states that wind energy conversion systems are allowed by Special Permit from the City of Salem's Board of Appeals if the conditions set forth in this section are met, however, a special permit is not required here as it is municipal land.

b. Wind Energy Conversion System Bylaws

The City of Salem has adopted a Wind Ordinance, regulating the construction of Wind Energy Conversion Systems (WECS) within the City limits. The above referenced ordinance provides guidelines for the installation of WECS while minimizing any adverse visual, safety and environmental impacts to the City of Salem.

Per section (3)bi Commercial Scale Wind Energy Conversion Systems are permitted to be constructed all land owned by the City of Salem without obtaining a Special Permit from the Planning Board. A copy of the ordinance is included in Appendix G.

c. Required Permits and Approvals

i. The Federal Aviation Association (FAA)

A Notice of Proposed Construction or Alteration is required by the FAA for any structure that is proposed to be 200 feet or above ground level. On October, 07 2009 Form 7640-1 was filed with the FAA for a 399 foot structure at the proposed site and was assigned the Aeronautical Study Number (ASN) 2009-WTE-10282-OE. The FAA has conducted their aeronautical study under the provisions of 49 U.S.C., Section 44718 and, if applicable, Title 14 of the Code of Federal Regulations, part 77. On November 11, 2009 a 'Determination of No Hazard to Air Navigation' was issued for a total height of 399' AGL. FAA determination is provided as Appendix E.

ii. The Massachusetts Aeronautics Commission (MAC)

A Request for Airspace Review by the MAC was required pursuant to the aviation law requirements of the Commonwealth. The request was filed on July 1, 2010 and a final determination stating the project does not violate MAC Laws or Regulations was issued on July 19, 2010 for a maximum height of 399 feet AGL.

iii. Historic Overlay

The site is listed in the Massachusetts State Register and the National Register of Historic Places as the Winter Island Historic and Archaeological District. Site development in this area will require review by Massachusetts Historical Commission under MGL Chap. 254. There is the possibility after filing with the MHC that an archeological survey of the proposed disturbed area will need to be prepared, as well as assessment of visual impacts. Massachusetts Cultural Resource Information for Winter Island Park is provided in Appendix N.

iv. Filing with Massachusetts Department of Environmental Protection and/or City of Salem Conservation Commission

A Request for Determination (RDA) should be filed with the City of Salem's Conservation Commission to determine if filing is necessary with either the Massachusetts Department of Environmental Protection or with the City of Salem Conservation Commission under the Wetlands Protection Act (M.G.L. chapter 131, Section 40) or City of Salem By-law. This determination will decide if the site of the proposed turbine is within resource areas protected by this act. Such resources areas include Bordering Vegetated Wetlands, Land Subject to Flooding and their associated buffer zones.

v. Article 97

As an effort to protect, preserve, and enhance all open space areas in the Commonwealth of Massachusetts Article 97 was adopted in 1972 as the 97th Amendment to the Massachusetts Constitution. It will be need to be determined, with the assistance of the City of Salem Community Development Department, whether or not Winter Island is subject to the Commonwealth of Massachusetts Executive Office of Environmental Affairs (EOEA) Article 97 Land Disposition

Policy. In the event that this land is protected by this act the City of Salem must comply with the rules and regulations set forth in Section IV of Article 97 and file an Environmental Notification Form (ENF) with EOEA's Massachusetts Environmental Protection Agency (MEPA) Office. For further reference Article 97 is attached as Appendix O.

vi. List of Potential Required Permits and Approvals

Table 9: Local Applicable Regulations

Authority	Permit or Approval	Project Application	Timeframe	Comments
City of Salem Planning Board	Special Permit	Not Applicable – City Owned Land	1 - 2 months	Project will follow all local requirements to maximum extent practical.
City of Salem Building Inspector	Building Permit	Not Applicable – City Owned Land	1 - 2 months	Project will follow all local requirements to maximum extent particle.
City of Salem Conservation Commission	Request for Determination of Applicability	Projects within wetlands or associated buffer zone	3 months	WECS to be located outside wetlands and associated buffer zone.

Table 10: State Applicable Regulations

Authority	Permit or Approval	Project Application	Timeframe	Comments
Energy Facility Board (EFSB)	Transmission line approval	Transmission interconnection Required for wind farms over 100 MW or new transmission lines over one mile long or over 69 kV		No electricity to be sold to grid. Proposed site of single turbine will be less than 100 MW and new transmission lines will be less than 100 feet.
ISO-New England	NEPOOL Interconnection System Impact Study and Facility Study (Form 18.4)	Required for projects over 5 MW	9 - 12 months	This project will be less than 5 MW therefore does not require submittal. No electricity sold to grid.
Massachusetts Aeronautical Commission (MAC)	Request for Airspace Review	Filing required for all structures greater than 200 feet	3 - 4 months	Request for Airspace review received from MAC for height up to 399 feet AGL.
Massachusetts Department of Environmental Management	Massachusetts Forest Cutting Practices Regulations	Project Criteria	Not Applicable	
Massachusetts Department of Environmental Management & US EPA	NPDES individual Storm water General Permit and Notice of Intent (joint State/Federal Program under the Clean Waters Act (CWA)	Applicable if more than one acre of land is being disturbed or if wastewater is discharged/there is storm water runoff.	9 - 12 months	Not Applicable - less than one acre of land is being disturbed. Minimal Storm water runoff.
Massachusetts Department of Environmental Protection (MassDEP)	Noise Control Policy	Project Criteria	1 - 2 months	There shall be an increase of no more than 10 dB(A) above ambient at the nearest property line

				or residence
	Water Quality Certification under the Massachusetts Water Quality Act (sect. 401)	Applicable for projects altering more than 5000 square feet of wetlands	3 months	Less than 5000 sq. ft. of wetlands disturbed
	Wetlands Program Policy	Project Criteria for Activities in the Buffer Zone under the Wetlands Protection Act Regulations	Not Applicable	Not Applicable for development outside buffer zones adjacent to wetlands
Massachusetts Department of Highways	General Access Permit	Applicable if modifications to State roadways are necessary	2 - 3 months	Modifications to roadways may be required
	Oversized or Overweight Load Permit	Required for movement of oversized project equipment.	2 - 3 months	Transportation Route approval required for oversized turbine components
Massachusetts Environmental Protection Agency (MEPA)	Notice of Intent (NOI)	Project to take place outside buffer zone of any wetland	3 months	
	Environmental Notification Form (ENF)	ENF required for projects where > 25 acres of land directly altered	3 months	Project does not trigger ENF <25 acres disturbed
	Environmental Impact Review (EIR)	EIR required for projects where > 50 acres of land altered - triggered by ENF	6 - 9 months	Project does not trigger EIR < 50 acres disturbed

Massachusetts Historical Commission	Archaeological and Historical Project Notification Form (PNF)	Required for projects that could potentially effect archaeological or historical resources	3 - 4 months	All new projects receiving funding, permits, or license from any state or federal agency must file a PNF
Massachusetts Natural Heritage and Endangered Species Program	Conservation and Management Permit	Applicable if a "take" is required as stated in the Massachusetts Endangered Species Act	3 - 4 months	Not Applicable - No 'take" of endangered, threatened, or species of special concern
	Notice of Intent (NOI)	Required for wetland alterations or projects in an "estimated habitat".	3 - 4 months	No threatened, endangered, or species of special concern listed at the proposed site by the State.
Massachusetts Turnpike Authority	Special Hauling Permit	Required for the transportation of turbine components over State Highways	24 hours notice	
Natural Heritage and Endangered Species (NHESP)	Environmental Notification Form (ENF) and Massachusetts Endangered Species Act (MESA) Checklist	Review of projects that will disturb less than 5 acres of estimated habitats	30 days	
National Grid	Interconnection with existing transmission system study	Notification must be made when doing work and/or if electricity generated will be tied into existing transmission system.		

Table 11: Federal Applicable Regulations

Authority	Permit or Approval	Project Application	Timeframe	Comments
Environmental Protection Agency (EPA)	National Pollution Discharge Elimination System (NPDES) Construction General Permit (CGP) & Notice of Intent (NOI)	Applicable if construction of WTG will result in the disturbance of > 1 acre of land	9 - 12 months	Notification Only
Federal Aviation Association (FAA)	Notice of Proposed Construction or Alteration (Form 7460-1)	Filing required for all structures greater than 200 feet	At least 30 Days prior to construction	Received FAA approval for height up to 400 feet AGL
Federal Energy Regulatory Commission (FERC)	FERC Certification of Qualifying Facility (Form No. 556)	Required in order to enter purchase/sale agreement for power w/any electric utility	10 Business Days (3 months for formal certificate)	
Fish & Wildlife Service (FWS)	Informal Consultation Notification	Endangered Species Act requires applicant to request a list of all candidate species and critical habitats prior to construction.	Not Applicable	Notification Only
	Habitat Conservation & Incidental Take Permit	Not Applicable		No Take Permit will be required
United States Fish & Wildlife Service (USFWS)	Bat and Avian Impact Review	Required by Migratory Bird Treaty Act for any project with potential to harm migratory bird species.	2 months	Required

vii. Additional Research

It is not expected that additional research will be required than that previously laid out in the local, state and federal regulations matrix above (Tables 9, 10 and 11).

viii. Estimated Timeframe for Securing Permits and Approvals

Permits and approval timeframes are listed in the applicable Local, State and Federal Regulations Charts.

WIND PLANT CONFIGURATIONS

8. Conceptual Wind Plant Configuration

a. Wind Turbine Candidates

The proposed renewable energy system is to be a 600 kW, a 1.0 MW or a 1.5 MW AC wind turbine generator. These are medium scale commercial wind turbines with specifications as shown below on Table 12:

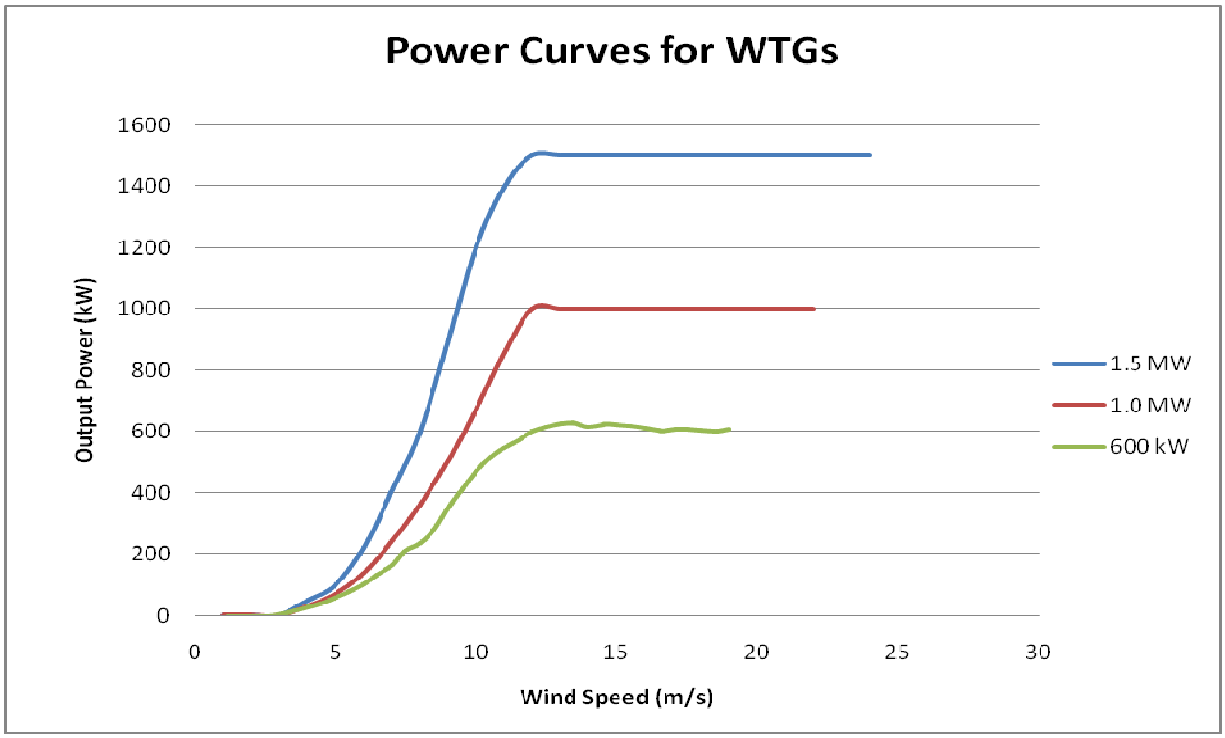
Table 12 Turbine Heights

Faceplate Rating (kW)	Available Manufacturer	Approx. Rotor Diameter	Approx. Hub Height	Approx. Max. Blade Tip Height
600	Elecon	48m (157')	60m (197')	84m (276')
1000	Mitsubishi	61m (201')	70m (230')	101m (330')
1500	GE Energy	77m (253')	80m (262')	119m (389')

Each of the specified heights are in compliance with FAA regulations and have been determined to provide no hazard to air navigation as evidence in correspondence from FAA, attached as Appendices E.

The proposed renewable energy systems are 3-bladed wind turbines with gearing, a generator, and instrumentation needed to implement “net metering” for Winter Island and the City of Salem. Chart 8 represents each of the machine’s power curves and technical specifications from each of the manufacturers has been included in Appendix I.

Chart 8: Power Curves



b. Assumed Turbine Characteristics

Per discussions with the City of Salem and the City of Salem, the wind turbine Generator chosen for installation at the proposed site shall abide by the following criteria:

- There must be prior installations of the selected WTG in the United States.
- The WTG should be as large as the site permits given that it meets all applicable setbacks and pertinent rules and regulations and height restrictions implemented by the Federal Aviation Association (FAA).
- Operation and Maintenance support must be available directly through the manufacturer.

Each proposed renewable energy system is shall be a 3-bladed wind turbine with gearing, a generator, and instrumentation needed to implement “net metering” for City of Salem. The proposed renewable energy system is to be a medium scale commercial wind turbine mounted on a monopole.

c. Wind Turbine Plant Configurations

Not Applicable - there is only one (1) proposed turbine to be erected at the site.

d. Wind Turbine Installation Location(s)

The WTG will be placed to the far southeast of the property as shown on the Orthophoto below as Figure 15 and on the Site Plan attached as Appendix J, a location of approximately 42°31’37”N 70°52’11”W and elevation equal to 6m (20’). This location is currently open from trees and shrubs, therefore site clearing for

turbine assembly will be minimal. This location was chosen because it maximizes the distance between from noise and visual receptors while keeping within the setback regulations set forth by the City of Salem.

Figure 15: Orthophoto from Google Earth

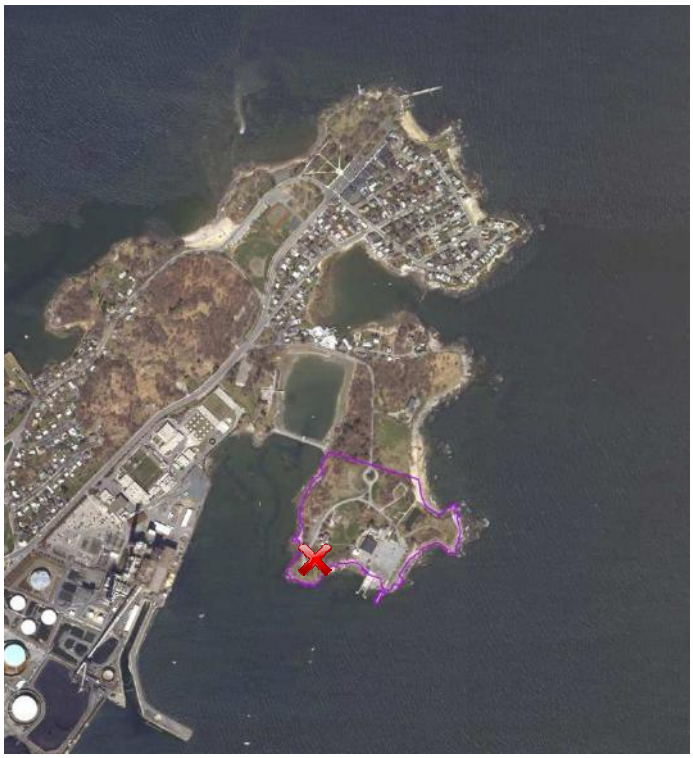


Image Source: Google Earth

Location of proposed Wind Turbine Generator

e. Spatial Separation

Not Applicable – there is only one (1) proposed turbine to be erected at the site and there are no other wind turbine generators in the vicinity of the City of Salem property.

f. Shadow Flicker Impacts

Wind Turbine Generator's blades create a moving shadow during daylight hours. This moving shadow creates a periodic obstruction of light. This periodic obstruction of light causes a "blinking" effect, which occurs approximately three times the rotational speed of the rotor. Flicker only occurs during sunny periods, when the turbine is not obscured by foliage, and when the turbine is in motion.

Although there are no regulations pertaining to flicker in the United States, the Commonwealth of Massachusetts, or the City of Salem, the standard practice is to limit the amount of flicker to any one receptor to 30 hours per year[1].

[1] Shadow Casting from Wind Turbines, www.windpower.org/en/tour/env/shadow/index.htm

This periodic shadow can be modeled using software specifically designed to measure the effect of flicker at various design points, or "receptors", and is reported in terms of hours/year. Flicker for receptors can be analyzed with WindPRO software, which accounts for several factors in its calculations including:

- Location of the Sun for each minute of every day
- Direction of the Wind Turbine (using wind direction data)
- Times the Wind Turbine is in operation (using wind speed data)
- Topography of the Landscape

Flicker analysis is accurate to 5 minute intervals[2] in its calculations but it does not take into account obstacles between the Wind Turbine and the receptors such as:

- Trees, and associated foliage
- Manmade structures including Buildings, Bridges, Walls, Dwellings, etc.

Location of Receptors

The proposed wind turbine will be located at the Winter Island site off of Winter Island Road in the City of Salem, Massachusetts. The WTG will cast a shadow to the west during early morning hours and to the east in the late afternoon hours on operational sunny days. Five (5) residential receptors were analyzed; Receptors A and C represent the neighborhoods situated to the west of the proposed turbine, adjacent to Fort Avenue. Receptors B and D are positioned in the inhabited areas north of the site. An additional receptor was positioned across Salem Harbor on Naugus Avenue in the Town of Marblehead, Massachusetts. These locations were chosen for analysis for the reason that they represent areas that may be influenced the most by the installation of a wind turbine generator and any potential flicker.

Results

The analysis for the five (5) residential receptors previously described is displayed on the tables below. The estimated hours of shadow flicker for the analysis per shadow receptor are listed in Table 12 and the estimated time of day and month of year per shadow receptor are in Table 13. The values/assumptions used in the calculations based on the installation of a 1.5 MW turbine and the "real case" scenario. The results are as follows:

[2] EMD WindPRO Software was designed to analyze the effects of Wind Turbine Generator Shadows based on 5-minute solar increments.

Table 12: Estimated Hours/Year of Flicker Shadow Generated

Shadow Receptor	Location	Shadow Hours per Year (h/yr)	Shadow Days per Year (d/yr)	Max Shadow Hours per Day (h/d)
A	End of Larkin Ln.	5:10	45	0:28
B	Winter Island Rd.	-	-	-
C	Memorial Dr. @ Victory Rd.	2:50	30	0:24
D	Bayview Ave.@ Cheval Ave.	-	-	-
E	Naugus Ave., Marblehead	-	-	-

Table 13: Estimated Time of Day and Month of Year Flicker Shadow per Receptor

Shadow Receptor	Day/Month	Time of Day	Days per Year	Avg. Duration of Flicker per Day (Min)	Maximum Duration of Flicker (Min)
A	01/25 – 02/15	$7:24_{AM} – 7:53_{AM}$	22	7	28
	10/26 – 11/17	$6:54_{AM} – 8:20_{AM}$	23	6	28
B	-	-	-	-	-
C	03/10 – 03/24	$7:20_{AM} – 7:45_{AM}$	15	5	24
	09/20 – 10/04	$7:02_{AM} – 7:26_{AM}$	15	6	23
D	-	-	-	-	-
E	-	-	-	-	-

Chart 9 visually represents the time of day and month of year when flicker shadow generation is anticipated at the two effected receptors for the 1.5MW turbine analyzed. As can be seen by this chart, each receptor will experience flicker at distinctive times of day during specific periods of the year.

The Shadow Map of Figure 16 illustrates the manner in which the turbine will cast a shadow over the surrounding terrain in total hours per year. The chart and figure represent the real case scenario effects that the turbine will have on nearby residential dwellings.

Conclusions

Using expected turbine operating hours, the only affected receptors will be A and C which lie approximately one-half mile to the northwest and west of the proposed turbine location in the residential neighborhood encompassed by Memorial Drive, Larkin Lane and Victory Road. At real case scenario, in any given calendar year, the maximum estimated hours of flicker for receptors A and C are 16-hours and 9-hours respectively, with a maximum of 28-minutes of shadow flicker per day. It should be noted that the anticipated shadow flicker is roughly half of the generally accepted threshold of 30 hours per year.

Complete WindPro Shadow Results for a 600 kW, 1.0 MW and 1.5 MW wind turbines for this Feasibility Study are available in the attached Appendix K.

Chart 9: Calendar Shadow Effects

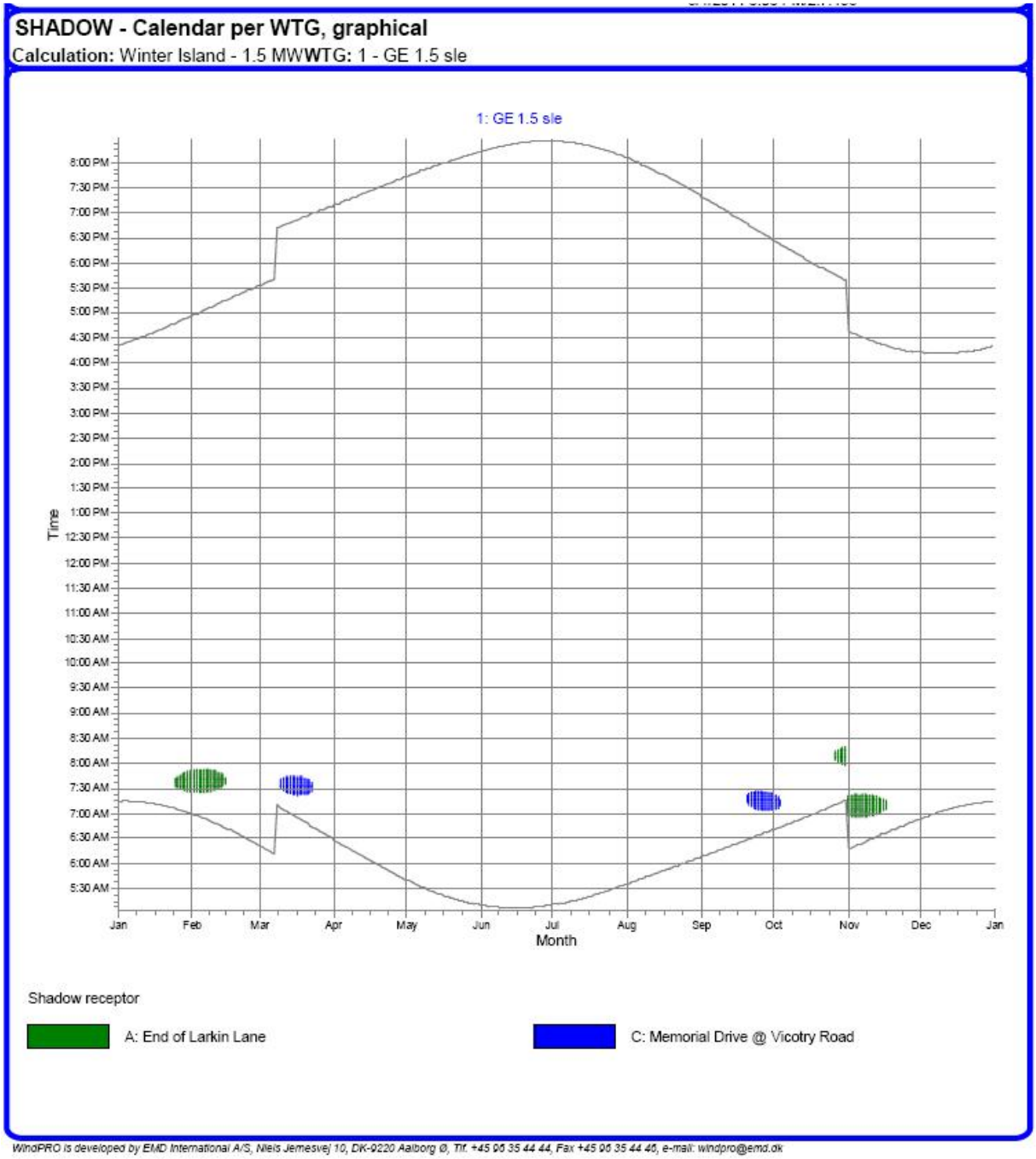
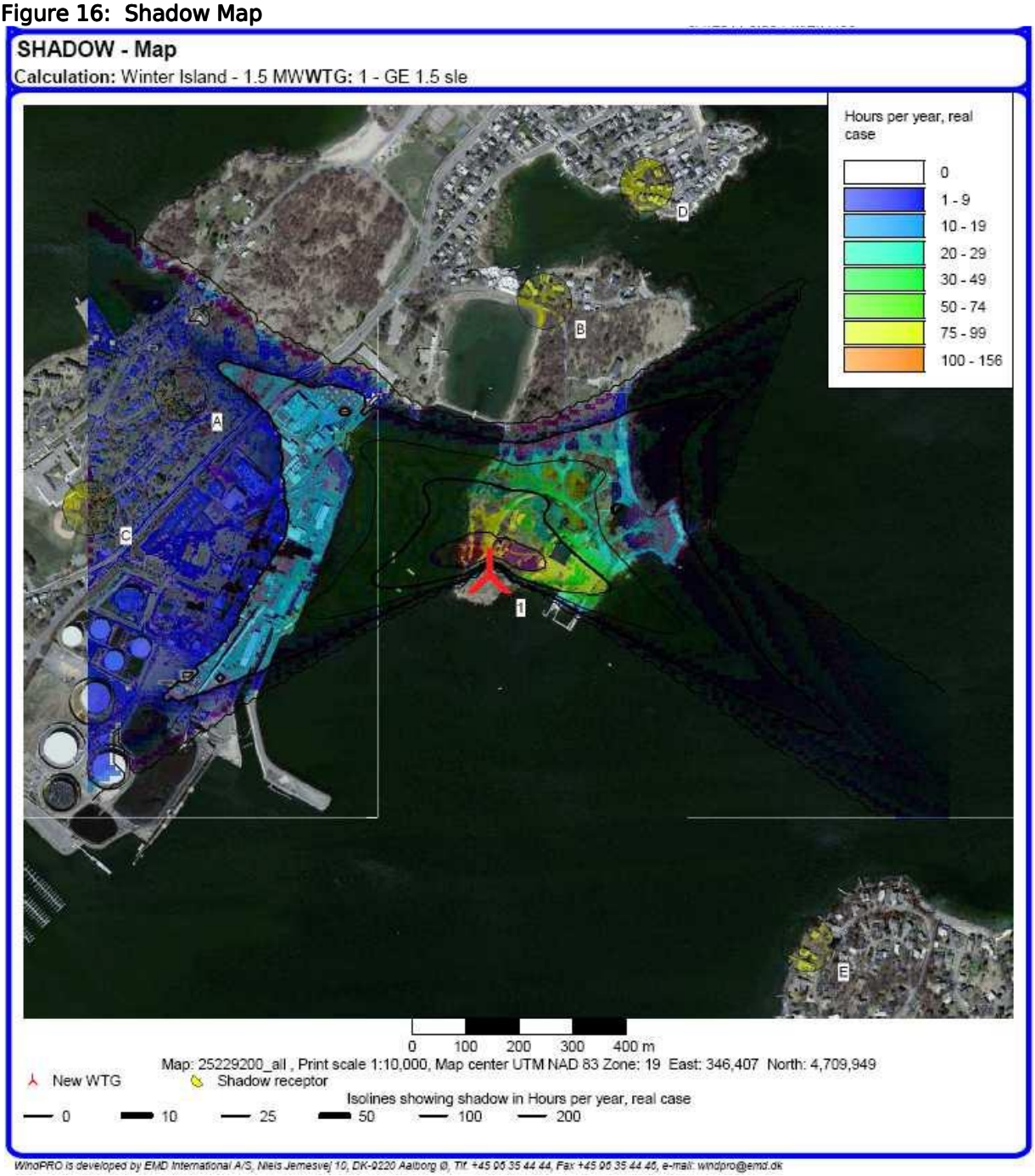


Figure 16: Shadow Map



g. Acoustic Impact

See Section 3.b.ii **Potential Noise Impact**

h. Appropriateness and Community Impact of WTG Locations

A wind turbine installed at Winter Island in Salem, Massachusetts is well suited. A turbine at Winter Island will produce on-site renewable power generation to reduce greenhouse gas emissions, offset energy costs, as well as improve the City's overall energy efficiency. The commission of a turbine, as a result of the efforts put forth by the City of Salem, will serve as a positive example for not only the neighboring public municipal communities but for private industries of the Commonwealth as well.

The location of the turbine within the city limits is quite appropriate. Winter Island sits on the outskirts of the city away from the city's densely populated areas. The turbine is proposed to be situated at a distance far enough from homes that the negative visual and audio effects of the turbine will be modest to the nearby residents. The trees will help reduce the ambient noise produced by the turbine. The shadow/flicker caused by the blades passing between the sun and earth are minimal, being less than or equal to the generally acceptable value as discussed in Section F above.

9. Project Site Plan

a. Project Site Plan

See Appendix J.

ENERGY PRODUCTION AND FINANCIAL ANALYSIS

10. Wind Plant Energy Production

The probability of exceedance for Annual Energy Production was calculated to account for uncertainties due to measurement, modeling and wind speed variability and production losses that might impact the wind turbines performance. On the following table, Table 14, we have summarized the analysis that leads to a projection of a net annual energy production at both a P50 and P90 Exceedance level using the calculated long term correlated wind speeds at the appropriate heights.

Table 14: Summary of Probability of Exceedance Annual Energy Production

	Elecon 600 kW @ 60m		Mitsubishi 1.0MW @ 70m		GE Energy 1.5MW @ 80m	
	P50	P90	P50	P90	P50	P90
Net Production (kWh)	1,226,891	884,794	1,672,389	1,189,567	3,607,026	2,570,836
Capacity Factor (%)	23	17	19	14	27	20

Complete P50 and P90 Turbine Production Calculations are included as Appendix L.

a. Behind the Meter Annual Energy Production

It is anticipated that all of the annual energy produced by will be consumed through Net-Metering for the City from the Winter Island Site.

b. Performance Degradation

The energy production was calculated using power curves as provided by each of the turbines studied manufacturers. These power curves are conservative average estimates over the expected lifetime of the machine and include performance degradation.

11. Wind Plant Costs

To produce a sensible economic pro-forma estimated capital costs were determined for the design and construction phases of this project. These values were derived using the most up to date equipment pricing from existing projects constructed in the past two (2) years in the Commonwealth of Massachusetts, influential site characteristics, and wind industry best practices. The estimated construction costs include estimated $300,000 in interconnect charges with National Grid as well as a 10% construction contingency factor. Table 15 shows the estimated capital costs for the Design and Construction phases of the project.

Table 15: Estimated Total Construction Costs

Turbine	Hub Height	Cost
600 kW	60m	$2,500,000
1.0 MW	70m	$3,400,000
1.5 MW	80m	$4,500,000

12. Project Revenues

a. Value of Power

The value of power used on site is calculated to be 13.2¢ per kWh utilizing net metering legislation and electrical records obtained from the City of Salem. The value of power is calculated as a new G-1 service rate under National Grid. As a three (3) year average of electrical including current transmission, transition, and distributions charges. Appendix G shows National Grid Electrical Prices as well as the City of Salem annual usage.

b. Value of RECs

The assumed value of Renewable Energy Credits (RECs) sold over the life of the project are 3.0¢ per kWh. Currently long term REC purchase deals by private entities and other organizations, such as MassEnergy Consumers Alliance have recently made deals at 3.0¢ per kWh.

c. Value of Wind-Generated Electricity

The value of wind-generated electricity used on site is calculated to be 13.2¢ per kWh utilizing net metering legislation and electrical records obtained from City of Salem. This cost was inflated at a rate was inflated by 2.5%.

d. Cash Flows

A complete cash flow analysis is included as the Financial Pro-Forma in Appendix M. A summary of the cash flow analysis for the 600 kW, 1.0 MW and 1.5MW turbines at the hub height explored both with and without funding from Massachusetts Clean Energy Center for both P50 and P90 Exceedance levels are in the Tables 18 and Table 19 below.

e. Sensitivity Analysis

A complete Sensitivity Analysis was prepared on the project assuming variable REC prices and utility costs as shown on the tables in Section 4(d).

13. Financial Analysis

a. Assumptions Made

In the following tables, Table 18 and Table 19, we have summarized the overall results of the economic analysis based on a set of reasonable assumptions for the following factors:

1) WTG installed cost. These values were derived using the most up to date equipment pricing from existing projects constructed in the past two (2) years in the Commonwealth of Massachusetts, influential site characteristics, and wind industry best practices and includes estimated interconnect costs with National Grid, as well as a 10% contingency factor.

2) Annual wind turbine generator operation & maintenance and insurance costs with an inflation rate of 2.5%.

3) The value of Renewable Energy Certificates (RECs) of 3.0¢/kWh.

4) The average levelized value of each kWh of electricity produced by the WTG of 13.2¢/kWh, escalated at 2.5% annually. A ten year analysis of electricity prices yields an inflation exceeding an average of 2.5% annually. A conservative value of 2.5% has been used in this analysis.

5) The possible maximum support from the Massachusetts Clean Energy Center to offset a portion of the purchase price. Below are the available incentive levels or Design & Construction grants.

Table 16: Design & Construction Incentive Levels, per Turbine

Capacity (kW)	Non-Public	Public
600	$208,325	$320,500
1000	$237,133	$364,820
1500+	$260,000	$400,000

6) Discount future income at 6% for net present value calculations.

7) Power Purchase Agreement (PPA) rate of 1.3¢/kWh was determined after speaking with numerous PPA providers. These PPA providers offered a hedge rate at 90% of the current rate.

In a PPA, a third-party owner will purchase, construct, own, operate and maintain a wind energy system and will sell power to the City at a discounted rate. For the purpose of a financial study, the savings of electricity (approximately 10%) is used as he avoided cost. As there is no capitol cost with a PPA structure, the payback is immediate, or zero years.

b. Life Cycle Cost

The life cycle cost for the wind plant configuration is summarized in Table 17.

c. Rate of Return

The rate of return for the wind plant configuration is summarized in Table 18 and Table 19.

Table 17: Cost Analysis Assumptions for Wind Turbine Generators installed at Winter Island, Salem, MA

	Elecon T600 Annual Production = 1,226,891 kWh			Mitsubishi MWT62/1.0 Annual Production = 1,672,389 kWh			GE 1.5sle Annual Production = 3,607,026 kWh		
	without MassCEC Funding	with MassCEC Funding	PPA	without MassCEC Funding	with MassCEC Funding	PPA	without MassCEC Funding	with MassCEC Funding	PPA
Total Installed Cost ($)	2,500,000	2,500,000	0	3,400,000	3,400,000	0	4,500,000	4,500,000	0
Electricity Cost ($/kWh)	0.13	0.13	0.01	0.13	0.13	0.01	0.13	0.13	0.01
Electricity Inflation Rate (%)	2.5	2.5	-	2.5	2.5	-	2.5	2.5	-
Bond Interest Rate (%)	5.0	5.0	0	5.0	5.0	0	5.0	5.0	0
Loan Term (yrs.)	20	20	0	20	20	0	20	20	0
REC Revenue ($/kWh)	0.030	0.030	0	0.030	0.030	0	0.030	0.030	0
MassCEC Funding ($)	0	320,500	0	0	364,820	0	0	400,000	0

Table 18: P50 Financial Pro-Forma Summary at Winter Island, Salem, MA

		Elecon T600	Mitsubishi MWT62/1.0	GE 1.5sle
Hub Height (m)		60	70	80
Average Wind Speed (m/s)		6.05	6.28	6.48
Simple Cash (Yrs. To Positive Return/NPV @ Yr. 20)	without MassCEC Grant	14 -$419,648	13 -$564,249	9 $1,616,178
	with MassCEC Grant	12 -$99,148	12 -$199,429	8 $2,016,178
	PPA Agreement	0 $131,398	0 $179,110	0 $386,306
Financed (Yrs. To Positive Return/NPV @ Yr. 20)	without MassCEC Grant	20 -$201,747	20 -$267,903	13 $2,008,400
	with MassCEC Grant	18 $411,318	18 $429,939	12 $2,773,536

Table 19: P90 Financial Pro-Forma Summary at Winter Island, Salem, MA

		Elecon T600	Mitsubishi MWT62/1.0	GE 1.5sle
Hub Height (m)		60	70	80
Average Wind Speed (m/s)		5.505	5.71	5.89
Simple Cash (Yrs. To Positive Return/NPV @ Yr. 20)	without MassCEC Grant	18 -$999,718	18 -$1,382,936	12 -$140,816
	with MassCEC Grant	16 -$679,218	16 -$1,018,116	11 $259,184
	PPA Agreement	0 $94,760	0 $127,400	0 $275,332
Financed (Yrs. To Positive Return/NPV @ Yr. 20)	without MassCEC Grant	26 -$781,816	26 -$1,086,590	17 $251,406
	with MassCEC Grant	23 -$168,751	24 -$388,748	16 $1,016,542

d. Sensitivity

A Sensitivity Analysis was conducted under P50 financed financial conditions for each of the turbines at their studied hub heights. The analysis was run using electricity prices ranging from 11¢ to 15¢ and Renewable Energy Credits (RECs) from 0.02 $/kWh to 0.04 $/kWh in 0.005 $/kWh increments under the assumptions stated in Table 20. The results of the Sensitivity Analysis follow.

Table 20: Assumptions of Sensitivity Analysis

	600 kW	1.0 MW	1.5 MW
Total Installed Cost ($)	2,500,000	3,400,000	4,500,000
P50 Production (kWh)	1,226,891	1,672,389	3,607,026
Electricity Inflation Rate (%)	2.5	2.5	2.5
Bond Interest Rate (%)	5.0	5.0	5.0
Loan Term (yrs.)	20	20	20
NPV Discount Rate (%)	6	6	6
MassCEC Funding ($)	320,500	364,820	400,000

600 kW at 60m w/out MASSCEC

Yrs. to Positive Return/NPV at Yr. 20

Electricity Prices, $/kWh	Renewable Energy Credits (RECs) $/kWh				
	0.02	0.025	0.03	0.035	0.04
0.11	24 -$616,990	23 -$552,416	22 -$487,841	22 -$423,267	21 -$358,692
0.12	22 -$484,048	22 -$424,524	21 -$359,989	21 -$295,375	20 -$230,800
0.13	21 -$361,206	21 -$296,632	* 20 -$232,057	20 -$167,483	19 -$102,908
0.14	20 -$233,314	20 -$168,740	19 -$104,165	19 -$39,591	18 $28,984
0.15	19 -$105,422	19 -$40,848	18 $23,727	18 $88,301	17 $152,876

600 kW at 60m with MASSCEC

Yrs. to Positive Return/NPV at Yr. 20

Electricity Prices, $/kWh	Renewable Energy Credits (RECs) $/kWh				
	0.02	0.025	0.03	0.035	0.04
0.11	21 -$3,925	21 $60,650	20 $125,224	19 $189,799	19 $254,373
0.12	20 $123,967	19 $188,541	19 $253,116	18 $317,690	18 $382,265
0.13	19 $251,854	18 $316,433	* 18 $381,008	17 $445,582	17 $510,157
0.14	18 $379,751	17 $499,325	17 $508,900	17 $573,474	16 $638,049
0.15	17 $507,643	17 $572,217	16 $636,792	16 $701,366	16 $765,941

1.0 MW at 70m w/out MASSCEC

Yrs. to Positive Return/NPV at Yr. 20

Electricity Prices, $/kWh	Renewable Energy Credits (RECs) $/kWh					
		0.02	0.025	0.03	0.035	0.04
	0.11	25 -$833,926	23 -$745,904	22 -$657,881	22 -$596,859	21 -$481,837
	0.12	22 -$659,595	22 -$571,573	21 -$483,550	19 -$395,528	20 -$307,506
	0.13	21 -$485,264	20 -$397,282	* 20 -$304,220	18 -$221,197	19 -$133,175
	0.14	20 -$310,933	19 -$222,911	19 -$134,889	19 -$46,866	18 $41,156
	0.15	19 -$136,602	19 -$48,580	18 $39,442	18 $127,464	17 $215,487

1.0 MW at 70m with MASSCEC

Yrs. to Positive Return/NPV at Yr. 20

Electricity Prices, $/kWh	Renewable Energy Credits (RECs) $/kWh					
		0.02	0.025	0.03	0.035	0.04
	0.11	22 -$136,084	21 -$48,061	20 $39,961	20 $127,983	19 $216,005
	0.12	20 $38,247	20 $126,269	19 $214,292	19 $302,314	18 $390,336
	0.13	19 $212,578	19 $300,600	* 18 $388,623	18 $476,645	17 $564,667
	0.14	18 $386,909	18 $474,931	17 $562,953	17 $650,976	17 $738,998
	0.15	17 $561,290	17 $649,262	17 $737,284	16 $825,307	16 $913,329

1.5 MW at 80m w/out MASSCEC

Yrs. to Positive Return/NPV at Yr. 20

Electricity Prices, $/kWh	Renewable Energy Credits (RECs) $/kWh				
	0.02	0.025	0.03	0.035	0.04
0.11	16 $787,596	15 $977,444	15 $1,167,291	14 $1,357,138	14 $1,546,985
0.12	15 $1,163,595	15 $1,353,442	14 $1,543,290	14 $1,733,137	13 $1,922,984
0.13	14 $1,539,599	14 $1,729,441	* 13 $1,919,288	13 $2,109,136	13 $2,298,983
0.14	13 $1,915,593	13 $2,105,440	13 $2,295,287	12 $2,485,134	12 $2,674,982
0.15	13 $2,291,591	12 $2,481,438	12 $2,671,286	12 $2,861,133	12 $3,050,980

1.5MW at 80m with MASSCEC

Yrs. to Positive Return/NPV at Yr. 20

Electricity Prices, $/kWh	Renewable Energy Credits (RECs) $/kWh				
	0.02	0.025	0.03	0.035	0.04
0.11	15 $1,552,732	14 $1,742,580	14 $1,932,427	13 $2,122,274	13 $2,312,121
0.12	14 $1,928,731	13 $2,118,578	13 $2,308,425	13 $2,498,273	12 $2,688,120
0.13	13 $2,304,730	13 $2,494,577	* 12 $2,684,424	12 $2,874,271	12 $3,064,119
0.14	12 $2,680,728	12 $2,870,576	12 $3,060,423	12 $3,250,270	11 $3,480,117
0.15	12 $3,056,727	11 $3,246,574	11 $3,436,422	11 $3,626,269	11 $3,816,116

* Discrepancy between sensitivity and proforma NPV at Yr 20 due to $0.13/kWh used in sensitivity calculations and more accurate value of $0.13237/kWh used in proforma calculations.

e. Project Viability

Multiple financial scenarios have been considered for the proposed project. These scenarios evaluated each of the three size turbines under financed, non-financed and PPA conditions with and without maximum contributions from MassCEC for turbine erection. The best financial scenario for a municipally owned and operated wind turbine is for a 1.5 MW turbine at an 80 m hub height at the Winter Island. This scenario yields a twelve (12) year payback under financed conditions and eight (8) year payback under cash conditions, with maximum contribution from MassCEC and under P50 wind speeds.

Appendix A

WindPro METEO Results

WindPRO version 2.7.473 Jun 2010

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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METEO - Main Result

Calculation: Winter Island - 600kW

Name Met Tower

Site Coordinates
UTM NAD 83 Zone: 19 East: 346,347 North: 4,709,924

Air density calculation mode	Individual per WTG
Result for WTG at hub altitude	1.238 kg/m³ to 1.240 kg/m³
Air density relative to standard	101.1 %
Hub altitude above sea level (asl)	69.0 m to 89.0 m
Annual mean temperature at hub alt.	8.8 ℃ to 8.9 ℃
Pressure at WTGs	1,001.5 hPa to 1,003.9 hPa

Calculation is based on "Met Tower", giving the Weibull distribution for the wind speed on the site.
Using the selected power curve, the expected annual energy production is calculated.

Scale 1:25,000

Meteorological Data

Weibull data 50 m above ground level

Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]	Wind gradient exponent
0 N	5.93	5.26	2.257	7.5	0.238
1 NNE	6.90	6.14	1.778	5.2	0.238
2 ENE	8.70	7.70	2.144	5.7	0.238
3 E	9.42	8.40	1.704	4.1	0.238
4 ESE	5.22	4.69	1.562	5.0	0.238
5 SSE	5.18	4.60	1.831	5.0	0.238
6 S	5.84	5.19	1.903	5.7	0.238
7 SSW	6.26	5.54	2.178	8.1	0.238
8 WSW	6.71	5.98	2.816	7.4	0.238
9 W	6.41	5.71	2.832	9.3	0.238
10 WNW	6.52	5.78	2.374	14.9	0.238
11 NNW	7.43	6.59	2.392	22.0	0.238
All	6.77	6.00	2.055	100.0	

Calculation Results

Key results for height 60.0 m above ground level
Wind energy: 2,417 kWh/m²; Mean wind speed: 6.3 m/s;

Calculated Annual Energy

WTG type						Power curve		Annual Energy			
Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Creator	Name	Result	Result-10.0%	Mean wind speed	Capacity factor
			[kW]	[m]	[m]			[MWh]	[MWh]	[m/s]	[%]
Yes	ELECON1-600	ELECON1-600-600	600	47.0	60.0	USER	ELECON	1,495.7	1,346	6.26	28.4
Yes	GE WIND ENERGY	GE 1.5sle-1,500	1,500	77.0	80.0	EMD	Level 0 - Calculated - 10%<TI<15% - 2006	4,287.1	3,858	6.71	32.6
No	MItsubishi	MWT62/1.0-1,000	1,000	61.4	70.0	USER	Level 0	2,062.3	1,856	6.50	23.5

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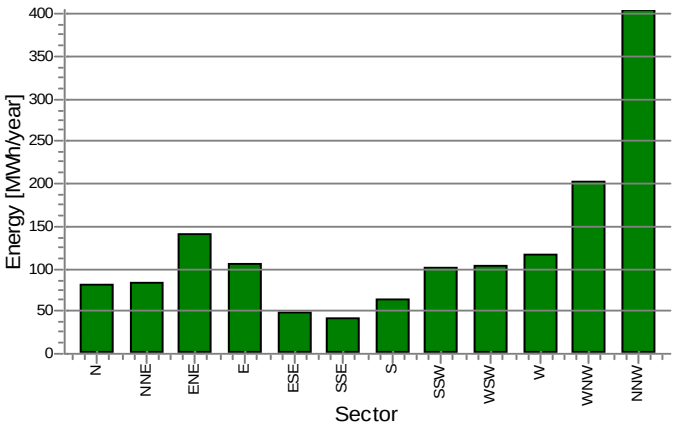
METEO - Production Analysis

Calculation: Winter Island - 600kW**WTG:** ELECON1-600 ELECON1-600 60Hz 600 47.0 !O!, Hub height: 60.0 m, Air density: 1.240 kg/m³

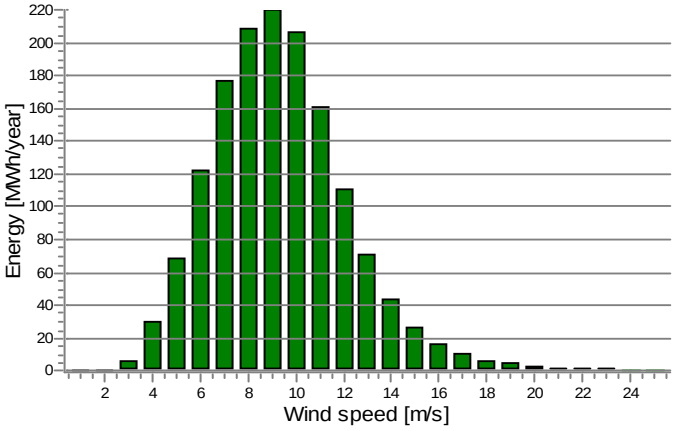
Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	80.8	84.5	140.1	105.9	48.2	42.4	64.3	101.4	104.0	115.9	203.3	405.0	1,495.7
Resulting energy	**[MWh]**	**80.8**	**84.5**	**140.1**	**105.9**	**48.2**	**42.4**	**64.3**	**101.4**	**104.0**	**115.9**	**203.3**	**405.0**	**1,495.7**
Specific energy	[kWh/m²]													862
Specific energy	[kWh/kW]													2,493
Directional Distribution	[%]	5.4	5.6	9.4	7.1	3.2	2.8	4.3	6.8	7.0	7.7	13.6	27.1	100.0
Utilization	[%]	41.8	32.2	28.8	19.3	36.5	40.5	39.1	40.3	42.7	43.3	40.9	37.6	35.4
Operational	[Hours/year]	582	402	448	318	394	393	447	629	578	730	1,166	1,719	7,807
Full Load Equivalent	[Hours/year]	135	141	233	176	80	71	107	169	173	193	339	675	2,493
A- parameter	[m/s]	6.2	7.2	9.1	9.8	5.4	5.4	6.1	6.5	7.0	6.7	6.8	7.8	7.1
Mean wind speed	[m/s]	5.5	6.4	8.0	8.7	4.9	4.8	5.4	5.8	6.2	6.0	6.0	6.9	6.3
k- parameter		2.34	1.86	2.22	1.78	1.64	1.91	1.98	2.26	2.90	2.91	2.45	2.47	2.13
Frequency	[%]	7.5	5.2	5.7	4.1	5.0	5.0	5.7	8.1	7.4	9.3	14.9	22.0	100.0
Power density	[W/m²]													276

Energy vs. sector



Energy vs. wind speed



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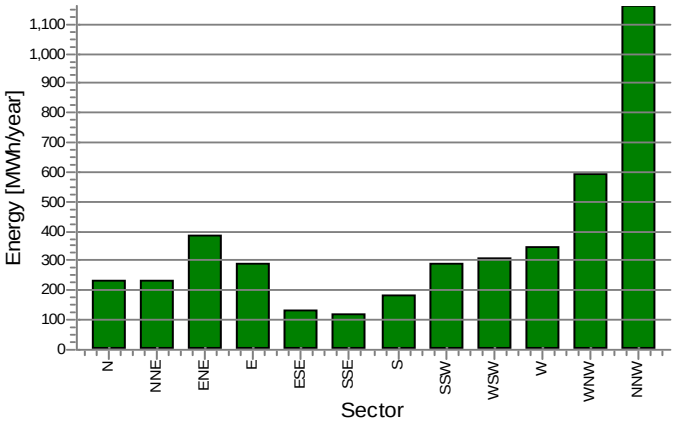
METEO - Production Analysis

Calculation: Winter Island - 600kW**WTG:** GE WIND ENERGY GE 1.5sle 1500 77.0 !O!, Hub height: 80.0 m, Air density: 1.238 kg/m³

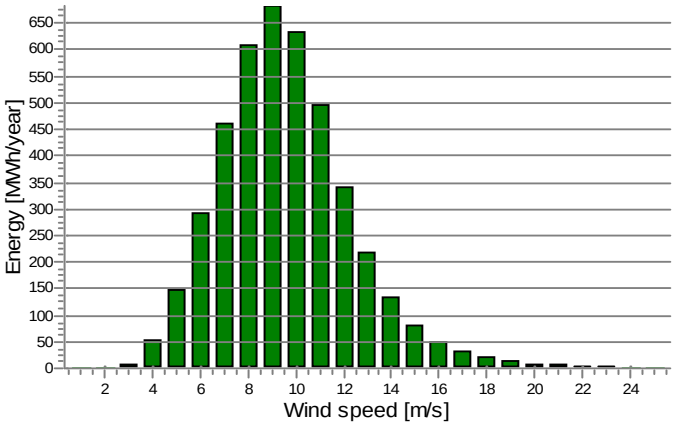
Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	235.5	235.9	388.3	288.6	132.2	119.8	182.8	293.3	309.3	346.5	593.0	1,161.9	4,287.1
Resulting energy	**[MWh]**	**235.5**	**235.9**	**388.3**	**288.6**	**132.2**	**119.8**	**182.8**	**293.3**	**309.3**	**346.5**	**593.0**	**1,161.9**	**4,287.1**
Specific energy	[kWh/m²]													921
Specific energy	[kWh/kW]													2,858
Directional Distribution	[%]	5.5	5.5	9.1	6.7	3.1	2.8	4.3	6.8	7.2	8.1	13.8	27.1	100.0
Utilization	[%]	38.8	30.0	25.6	17.6	34.8	37.8	36.4	37.3	39.5	40.3	37.8	34.1	32.6
Operational	[Hours/year]	578	399	445	316	391	390	444	625	573	724	1,158	1,707	7,751
Full Load Equivalent	[Hours/year]	157	157	259	192	88	80	122	196	206	231	395	775	2,858
A- parameter	[m/s]	6.6	7.7	9.7	10.5	5.8	5.8	6.5	7.0	7.5	7.2	7.3	8.3	7.6
Mean wind speed	[m/s]	5.9	6.8	8.6	9.3	5.2	5.1	5.8	6.2	6.7	6.4	6.5	7.4	6.7
k- parameter		2.50	2.02	2.38	1.94	1.80	2.07	2.14	2.42	3.06	3.07	2.61	2.63	2.27
Frequency	[%]	7.5	5.2	5.7	4.1	5.0	5.0	5.7	8.1	7.4	9.3	14.9	22.0	100.0
Power density	[W/m²]													320

Energy vs. sector



Energy vs. wind speed



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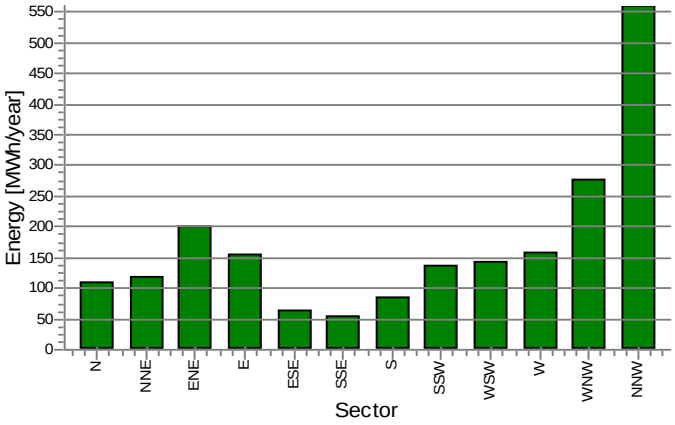
METEO - Production Analysis

Calculation: Winter Island - 600kW**WTG:** MItsubishi MWT62/1.0 1000 61.4 !O!, Hub height: 70.0 m, Air density: 1.239 kg/m³

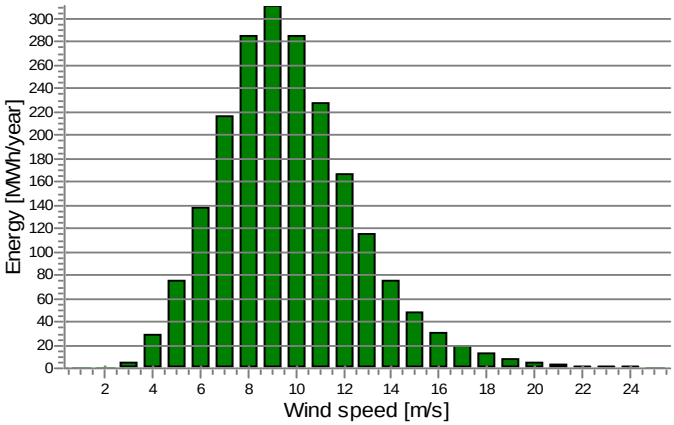
Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	108.6	117.6	200.5	156.5	64.2	56.2	86.7	137.4	141.5	157.1	276.3	559.8	2,062.3
Resulting energy	**[MWh]**	**108.6**	**117.6**	**200.5**	**156.5**	**64.2**	**56.2**	**86.7**	**137.4**	**141.5**	**157.1**	**276.3**	**559.8**	**2,062.3**
Specific energy	[kWh/m²]													697
Specific energy	[kWh/kW]													2,062
Directional Distribution	[%]	5.3	5.7	9.7	7.6	3.1	2.7	4.2	6.7	6.9	7.6	13.4	27.1	100.0
Utilization	[%]	30.3	24.7	22.3	15.8	27.5	29.4	28.8	29.5	30.9	31.2	29.9	27.9	26.4
Operational	[Hours/year]	568	392	437	311	384	383	436	614	563	712	1,137	1,677	7,615
Full Load Equivalent	[Hours/year]	109	118	201	156	64	56	87	137	142	157	276	560	2,062
A- parameter	[m/s]	6.4	7.5	9.4	10.2	5.7	5.6	6.3	6.8	7.3	6.9	7.1	8.1	7.3
Mean wind speed	[m/s]	5.7	6.6	8.3	9.1	5.0	5.0	5.6	6.0	6.5	6.2	6.3	7.1	6.5
k- parameter		2.42	1.94	2.30	1.86	1.72	1.99	2.06	2.34	2.98	2.99	2.53	2.55	2.20
Frequency	[%]	7.5	5.2	5.7	4.1	5.0	5.0	5.7	8.1	7.4	9.3	14.9	22.0	100.0
Power density	[W/m²]													299

Energy vs. sector



Energy vs. wind speed



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Diane Gagnon / dgagnon@meridianassoc.com

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METEO - Power Curve Analysis

Calculation: Winter Island - 600kW**WTG:** ELECON1-600 ELECON1-600 60Hz 600 47.0 !O! ELECON, Hub height: 60.0 m

Name: ELECON
Source: ENERGY RESEARCH CENTER OF NETH.

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type
4/22/2008	USER	4/22/2008	5/14/2008	25.0	Pitch	Standard pitch

HP curve comparison - Note: For standard air density and weibull k parameter = 2

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	797	1,278	1,769	2,243	2,638	2,990
ELECON1-600 ELECON1-600 60Hz 600 47.0 !O! ELECON	[MWh]	900	1,401	1,905	2,366	2,762	3,086
Check value	[%]	-11	-9	-7	-5	-5	-3

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

Original data from Windcat, Air density: 1.225 kg/m³

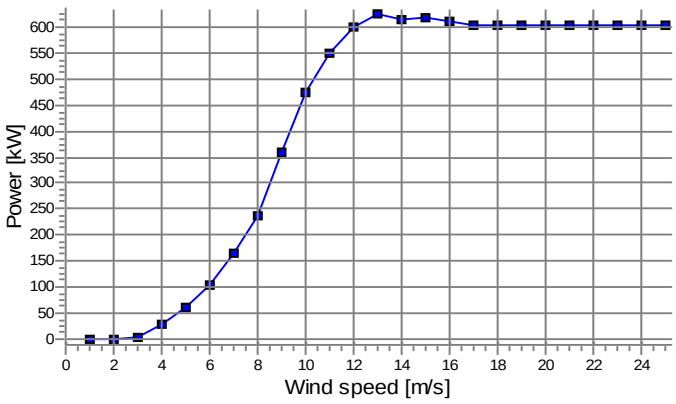
Wind speed [m/s]	Power [kW]	Ce	Wind speed [m/s]	Ct curve
1.1	-1.0	-0.68	1.0	0.10
1.5	-0.7	-0.19	2.0	0.10
2.0	-0.7	-0.08	3.0	0.10
2.6	-2.0	-0.11	4.0	0.80
3.1	3.7	0.12	5.0	0.82
3.6	14.9	0.31	6.0	0.84
4.0	25.5	0.38	7.0	0.79
4.6	42.7	0.42	8.0	0.72
5.0	59.2	0.44	9.0	0.66
5.5	75.8	0.43	10.0	0.59
6.0	103.6	0.45	11.0	0.53
6.4	132.7	0.47	12.0	0.46
7.0	164.6	0.45	13.0	0.40
7.5	210.5	0.47	14.0	0.33
8.0	234.2	0.43	15.0	0.28
8.5	277.9	0.43	16.0	0.23
9.1	359.9	0.46	17.0	0.20
9.5	414.0	0.45	18.0	0.16
10.0	469.4	0.44	19.0	0.13
10.5	516.3	0.41	20.0	0.12
11.0	545.0	0.39	21.0	0.12
11.5	572.3	0.35	22.0	0.11
12.0	598.9	0.33	23.0	0.11
12.5	615.3	0.30	24.0	0.10
13.0	625.9	0.27		
13.5	628.5	0.24		
14.0	615.7	0.21		
14.5	623.0	0.19		
15.0	621.2	0.17		
15.5	616.5	0.16		
16.0	611.7	0.14		
16.5	602.1	0.13		
17.1	605.4	0.11		
17.5	605.6	0.11		
18.0	603.9	0.10		
18.5	601.1	0.09		

Power, Efficiency and energy vs. wind speed

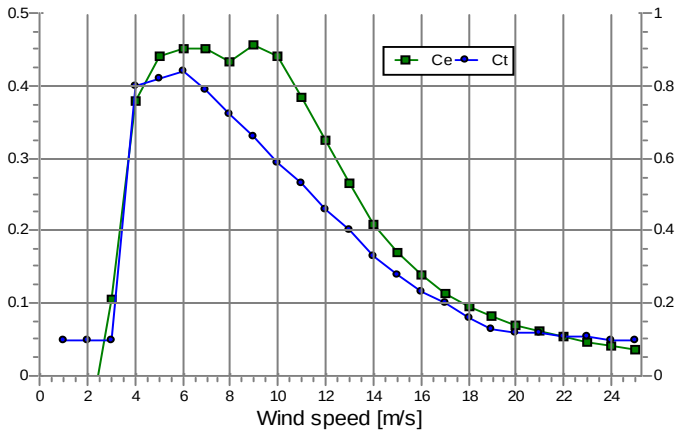
Data used in calculation, Air density: 1.240 kg/m³ New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Ce	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	-1.1	-1.06	0.50- 1.50	-0.3	-0.3	0.0
2.0	-0.7	-0.08	1.50- 2.50	-0.8	-1.1	-0.1
3.0	3.1	0.11	2.50- 3.50	5.5	4.5	0.3
4.0	26.0	0.38	3.50- 4.50	29.4	33.8	2.3
5.0	59.1	0.44	4.50- 5.50	68.7	102.5	6.9
6.0	104.5	0.45	5.50- 6.50	121.7	224.2	15.0
7.0	166.3	0.45	6.50- 7.50	177.3	401.5	26.8
8.0	238.0	0.43	7.50- 8.50	208.6	610.1	40.8
9.0	358.3	0.46	8.50- 9.50	220.1	830.2	55.5
10.0	473.6	0.44	9.50-10.50	206.7	1,036.9	69.3
11.0	548.8	0.38	10.50-11.50	160.7	1,197.6	80.1
12.0	601.3	0.32	11.50-12.50	111.0	1,308.5	87.5
13.0	626.2	0.26	12.50-13.50	71.5	1,380.0	92.3
14.0	616.9	0.21	13.50-14.50	43.8	1,423.7	95.2
15.0	620.1	0.17	14.50-15.50	26.5	1,450.3	97.0
16.0	610.5	0.14	15.50-16.50	16.2	1,466.5	98.0
17.0	605.4	0.11	16.50-17.50	10.1	1,476.6	98.7
18.0	603.3	0.10	17.50-18.50	6.6	1,483.2	99.2
19.0	605.5	0.08	18.50-19.50	4.4	1,487.5	99.5
20.0	605.5	0.07	19.50-20.50	2.9	1,490.5	99.6
21.0	605.5	0.06	20.50-21.50	2.0	1,492.5	99.8
22.0	605.5	0.05	21.50-22.50	1.4	1,493.9	99.9
23.0	605.5	0.05	22.50-23.50	0.9	1,494.8	99.9
24.0	605.5	0.04	23.50-24.50	0.7	1,495.5	100.0
25.0	605.5	0.04	24.50-25.50	0.3	1,495.7	100.0

Power curve
Data used in calculation



Ce and Ct curve



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Calculated:
2/9/2011 10:08 AM/2.7.473

METEO - Power Curve Analysis

Calculation: Winter Island - 600kW**WTG:** GE WIND ENERGY GE 1.5sle 1500 77.0 !O! Level 0 - Calculated - 10%<TI<15% - 2006, Hub height: 80.0 m

Name: Level 0 - Calculated - 10%<TI<15% - 2006
Source: Manufacturer

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type
12/31/2006	EMD	11/21/2000	1/10/2007	25.0	Pitch	User defined

Based on GE document 1.5sl_sle_PCD_allComp_xxxxxxxx.ENxx.03.pdf. Special adapted power curves for air densities 1.02-1.20 kg/m³ available from manufacturer. When using this PC, WindPRO's standard algorithm for air density adaptation will be used.

HP curve comparison - Note: For standard air density and weibull k parameter = 2

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	2,126	3,366	4,628	5,833	6,826	7,716
GE WIND ENERGY GE 1.5sle 1500 77.0 !O! Level 0 - Calculated - 10%<TI<15% - 2006	[MWh]	2,230	3,492	4,738	5,867	6,837	7,627
Check value	[%]	-5	-4	-2	-1	0	1

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

Original data from Windcat, Air density: 1.225 kg/m³

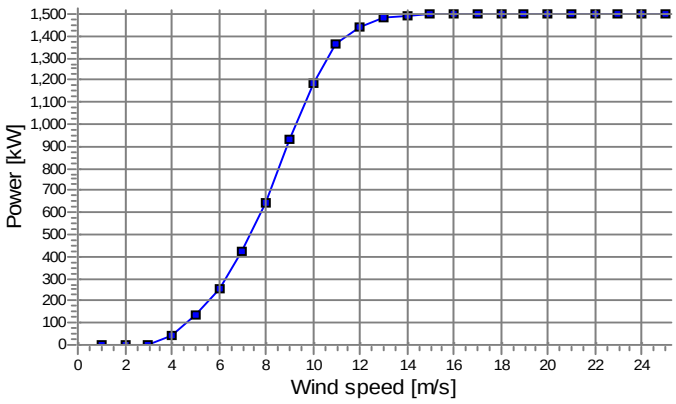
Wind speed [m/s]	Power [kW]	Ce	Wind speed [m/s]	Ct curve
3.0	0.0	0.00	3.0	1.27
3.5	20.0	0.16	4.0	1.03
4.0	43.0	0.24	5.0	0.91
4.5	83.0	0.32	6.0	0.89
5.0	131.0	0.37	7.0	0.89
5.5	185.0	0.39	8.0	0.87
6.0	250.0	0.41	9.0	0.80
6.5	326.0	0.42	10.0	0.69
7.0	416.0	0.43	11.0	0.55
7.5	521.0	0.43	12.0	0.42
8.0	640.0	0.44	13.0	0.32
8.5	785.0	0.45	14.0	0.25
9.0	924.0	0.44	15.0	0.20
9.5	1,062.0	0.43	16.0	0.17
10.0	1,181.0	0.41	17.0	0.14
10.5	1,283.0	0.39	18.0	0.12
11.0	1,359.0	0.36	19.0	0.10
11.5	1,402.0	0.32	20.0	0.09
12.0	1,436.0	0.29	21.0	0.07
12.5	1,463.0	0.26	22.0	0.07
13.0	1,481.0	0.24	23.0	0.06
13.5	1,488.0	0.21	24.0	0.05
14.0	1,494.0	0.19	25.0	0.05
14.5	1,500.0	0.17		
15.0	1,500.0	0.16		
15.5	1,500.0	0.14		
16.0	1,500.0	0.13		
16.5	1,500.0	0.12		
17.0	1,500.0	0.11		
17.5	1,500.0	0.10		
18.0	1,500.0	0.09		
18.5	1,500.0	0.08		
19.0	1,500.0	0.08		
19.5	1,500.0	0.07		
20.0	1,500.0	0.07		
20.5	1,500.0	0.06		
21.0	1,500.0	0.06		
21.5	1,500.0	0.05		
22.0	1,500.0	0.05		
22.5	1,500.0	0.05		
23.0	1,500.0	0.04		
23.5	1,500.0	0.04		
24.0	1,500.0	0.04		
24.5	1,500.0	0.04		
25.0	1,500.0	0.03		

Power, Efficiency and energy vs. wind speed

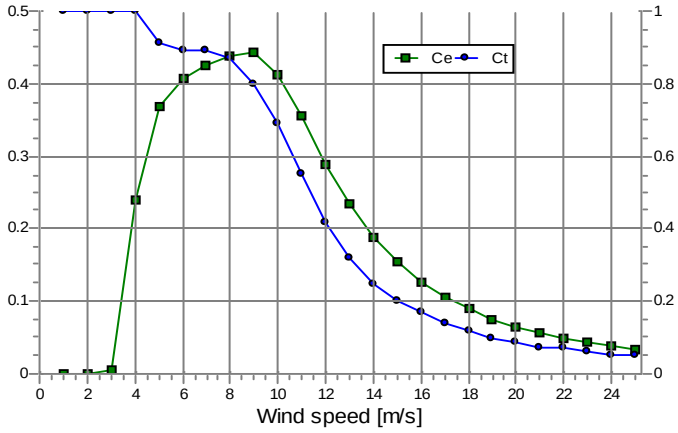
Data used in calculation, Air density: 1.238 kg/m³ New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Ce	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	0.0	0.00	0.50- 1.50	0.0	0.0	0.0
2.0	0.0	0.00	1.50- 2.50	0.0	0.0	0.0
3.0	0.4	0.01	2.50- 3.50	8.3	8.3	0.2
4.0	44.1	0.24	3.50- 4.50	51.2	59.5	1.4
5.0	132.8	0.37	4.50- 5.50	148.9	208.5	4.9
6.0	253.0	0.41	5.50- 6.50	293.3	501.8	11.7
7.0	420.8	0.43	6.50- 7.50	459.1	960.9	22.4
8.0	647.7	0.44	7.50- 8.50	609.8	1,570.8	36.6
9.0	932.9	0.44	8.50- 9.50	682.5	2,253.2	52.6
10.0	1,189.2	0.41	9.50-10.50	633.7	2,886.9	67.3
11.0	1,363.4	0.36	10.50-11.50	495.1	3,382.0	78.9
12.0	1,439.3	0.29	11.50-12.50	339.7	3,721.7	86.8
13.0	1,481.9	0.23	12.50-13.50	216.6	3,938.3	91.9
14.0	1,494.9	0.19	13.50-14.50	133.0	4,071.3	95.0
15.0	1,500.0	0.15	14.50-15.50	80.8	4,152.1	96.8
16.0	1,500.0	0.13	15.50-16.50	49.4	4,201.4	98.0
17.0	1,500.0	0.11	16.50-17.50	30.7	4,232.2	98.7
18.0	1,500.0	0.09	17.50-18.50	19.6	4,251.8	99.2
19.0	1,500.0	0.08	18.50-19.50	12.7	4,264.5	99.5
20.0	1,500.0	0.07	19.50-20.50	8.4	4,272.9	99.7
21.0	1,500.0	0.06	20.50-21.50	5.6	4,278.5	99.8
22.0	1,500.0	0.05	21.50-22.50	3.8	4,282.2	99.9
23.0	1,500.0	0.04	22.50-23.50	2.5	4,284.8	99.9
24.0	1,500.0	0.04	23.50-24.50	1.7	4,286.5	100.0
25.0	1,500.0	0.03	24.50-25.50	0.7	4,287.1	100.0

Power curve
Data used in calculation



Ce and Ct curve



Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
2/9/2011 10:08 AM/2.7.473

METEO - Power Curve Analysis

Calculation: Winter Island - 600kW**WTG:** MItsubishi MWT62/1.0 1000 61.4 !O! Level 0 , Hub height: 70.0 m

Name: Level 0
Source: Manufacturer

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type
3/1/2003	USER	6/13/2001	12/15/2010	25.0	Pitch	Standard pitch

Calculated by Enercon

HP curve comparison - Note: For standard air density and weibull k parameter = 2

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	1,358	2,167	2,993	3,787	4,447	5,035
MItsubishi MWT62/1.0 1000 61.4 !O! Level 0	[MWh]	1,101	1,781	2,505	3,208	3,846	4,394
Check value	[%]	23	22	19	18	16	15

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

Original data from Windcat, Air density: 1.225 kg/m³

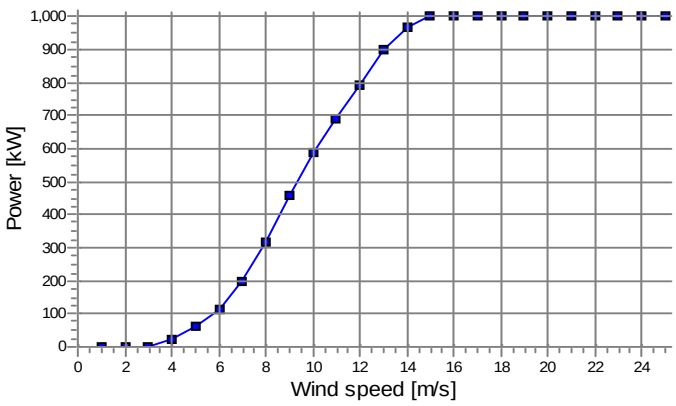
Wind speed [m/s]	Power [kW]	Ce	Wind speed [m/s]	Ct curve
1.0	0.0	0.00	1.0	0.10
2.0	0.0	0.00	2.0	0.10
3.0	0.0	0.00	3.0	0.10
4.0	24.0	0.21	4.0	0.80
5.0	64.0	0.28	5.0	0.82
6.0	111.0	0.28	6.0	0.84
7.0	197.0	0.32	7.0	0.79
8.0	314.0	0.34	8.0	0.72
9.0	454.0	0.34	9.0	0.66
10.0	582.0	0.32	10.0	0.59
11.0	686.0	0.28	11.0	0.53
12.0	783.0	0.25	12.0	0.46
13.0	891.0	0.22	13.0	0.40
14.0	966.0	0.19	14.0	0.33
15.0	1,001.0	0.16	15.0	0.28
16.0	1,001.0	0.13	16.0	0.23
17.0	1,001.0	0.11	17.0	0.20
18.0	1,001.0	0.09	18.0	0.16
19.0	1,001.0	0.08	19.0	0.13
20.0	1,001.0	0.07	20.0	0.12
21.0	1,001.0	0.06	21.0	0.12
22.0	1,001.0	0.05	22.0	0.11
23.0	1,001.0	0.05	23.0	0.11
24.0	1,001.0	0.04	24.0	0.10
25.0	1,001.0	0.04		

Power, Efficiency and energy vs. wind speed

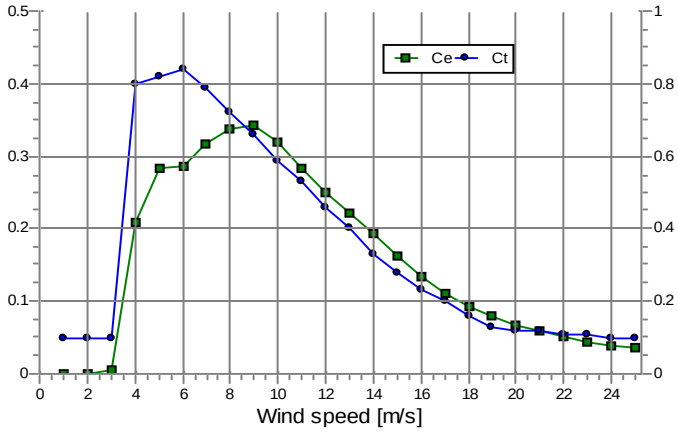
Data used in calculation, Air density: 1.239 kg/m³ New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Ce	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	0.0	0.00	0.50- 1.50	0.0	0.0	0.0
2.0	0.0	0.00	1.50- 2.50	0.0	0.0	0.0
3.0	0.3	0.01	2.50- 3.50	5.4	5.4	0.3
4.0	24.6	0.21	3.50- 4.50	29.1	34.5	1.7
5.0	64.8	0.28	4.50- 5.50	74.7	109.2	5.3
6.0	112.9	0.28	5.50- 6.50	138.8	248.0	12.0
7.0	200.0	0.32	6.50- 7.50	216.7	464.7	22.5
8.0	318.1	0.34	7.50- 8.50	284.9	749.6	36.3
9.0	458.5	0.34	8.50- 9.50	311.3	1,060.9	51.4
10.0	586.6	0.32	9.50-10.50	285.3	1,346.2	65.3
11.0	691.4	0.28	10.50-11.50	227.4	1,573.6	76.3
12.0	790.2	0.25	11.50-12.50	166.3	1,739.9	84.4
13.0	896.5	0.22	12.50-13.50	115.4	1,855.2	90.0
14.0	968.7	0.19	13.50-14.50	76.1	1,931.3	93.6
15.0	1,001.0	0.16	14.50-15.50	48.1	1,979.4	96.0
16.0	1,001.0	0.13	15.50-16.50	29.8	2,009.2	97.4
17.0	1,001.0	0.11	16.50-17.50	18.7	2,028.0	98.3
18.0	1,001.0	0.09	17.50-18.50	12.0	2,040.0	98.9
19.0	1,001.0	0.08	18.50-19.50	7.9	2,047.9	99.3
20.0	1,001.0	0.07	19.50-20.50	5.3	2,053.1	99.6
21.0	1,001.0	0.06	20.50-21.50	3.5	2,056.7	99.7
22.0	1,001.0	0.05	21.50-22.50	2.4	2,059.1	99.8
23.0	1,001.0	0.04	22.50-23.50	1.6	2,060.7	99.9
24.0	1,001.0	0.04	23.50-24.50	1.1	2,061.8	100.0
25.0	1,001.0	0.03	24.50-25.50	0.5	2,062.3	100.0

Power curve
Data used in calculation



Ce and Ct curve



Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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Calculated:
2/9/2011 10:08 AM/2.7.473

METEO - Wind Data Analysis

Calculation: Winter Island - 600kW**Wind data:** A - Met Tower; Hub height: 60.0

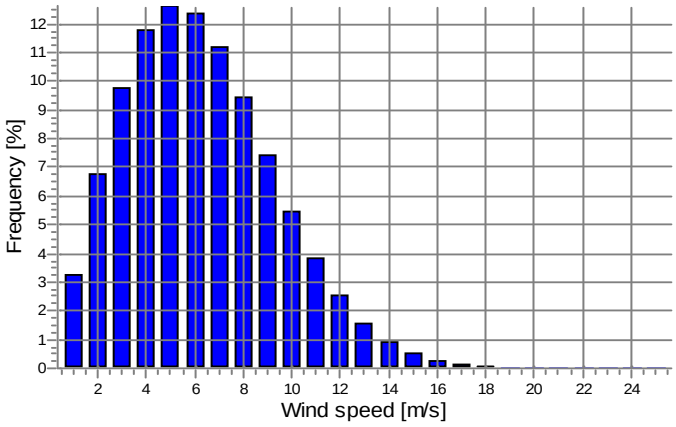
Site Coordinates
UTM NAD 83 Zone: 19 East: 346,347 North: 4,709,924
ELECON1-600 ELECON1-600 60Hz 600 47.0 !O!

Meteo data
Met Tower

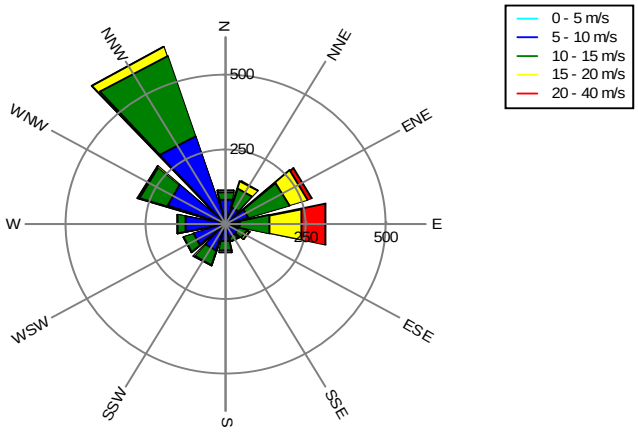
Weibull Data

Sector	A- parameter	Wind speed	k- parameter	Frequency	Wind gradient exponent
	[m/s]	[m/s]		[%]	
0 N	6.20	5.49	2.337	7.5	0.238
1 NNE	7.20	6.40	1.858	5.2	0.238
2 ENE	9.08	8.04	2.224	5.7	0.238
3 E	9.83	8.75	1.784	4.1	0.238
4 ESE	5.45	4.87	1.642	5.0	0.238
5 SSE	5.41	4.80	1.911	5.0	0.238
6 S	6.10	5.41	1.983	5.7	0.238
7 SSW	6.53	5.79	2.258	8.1	0.238
8 WSW	7.01	6.25	2.896	7.4	0.238
9 W	6.69	5.97	2.912	9.3	0.238
10 WNW	6.81	6.04	2.454	14.9	0.238
11 NNW	7.76	6.89	2.472	22.0	0.238
All	7.07	6.26	2.128	100.0	

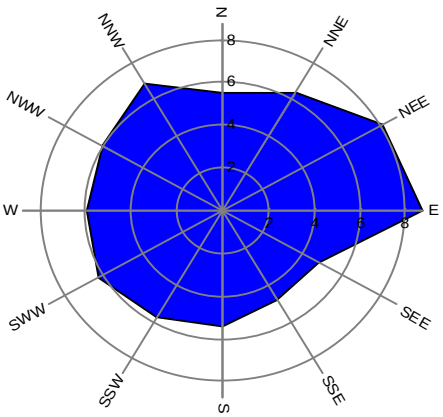
Weibull Distribution



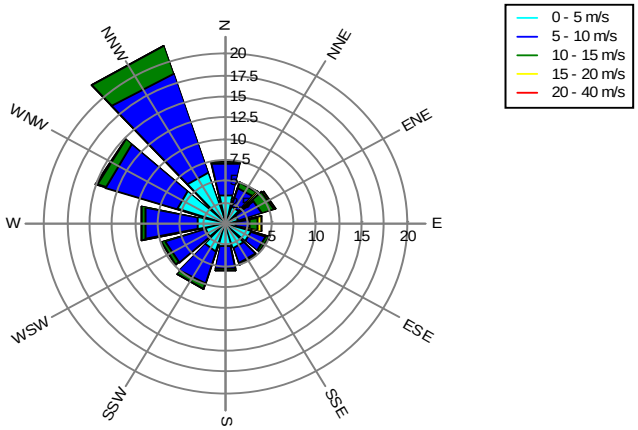
Energy Rose (kWh/m²/year)



Mean wind speed (m/s)



Frequency (%)



Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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Calculated:
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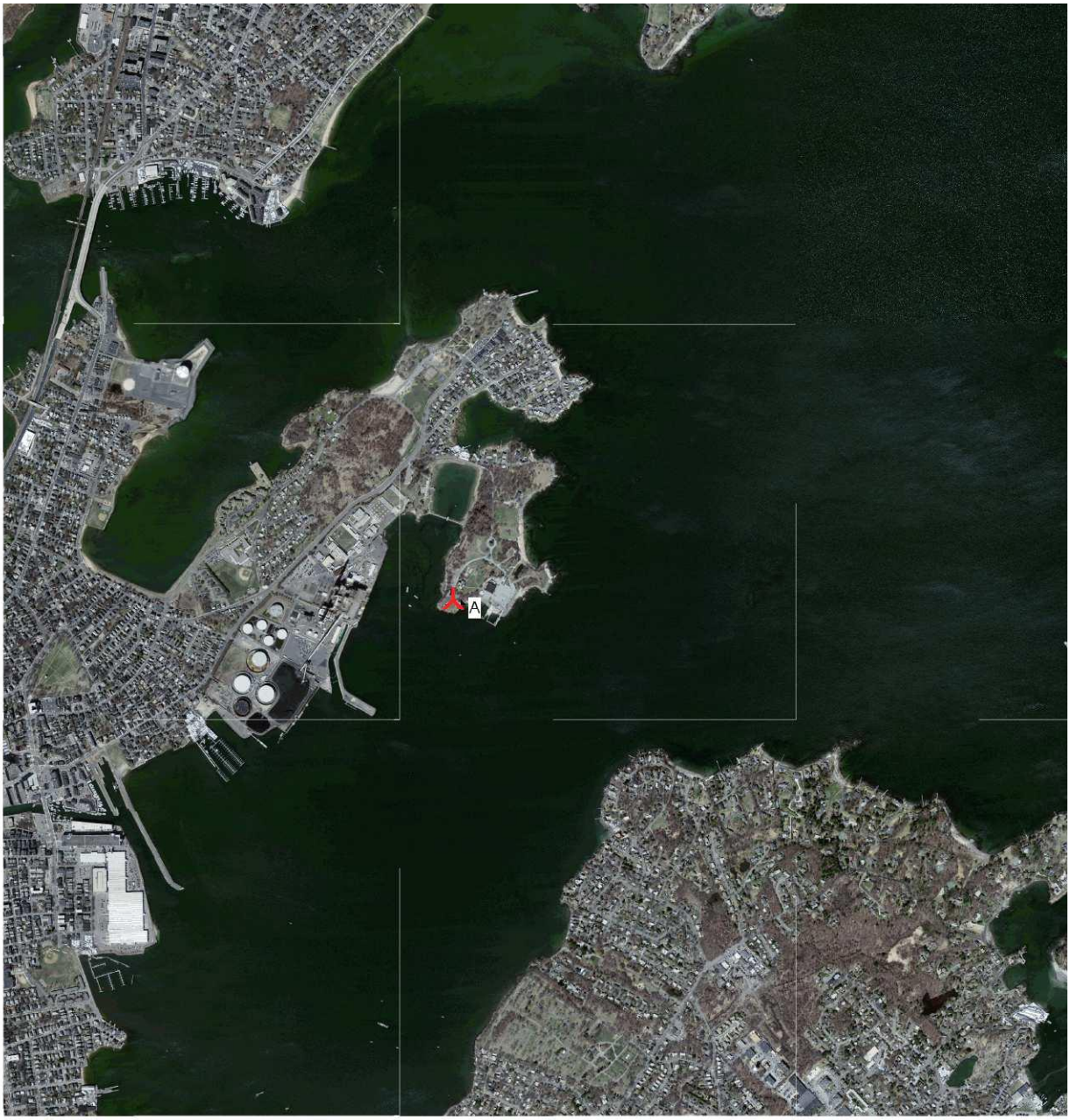
METEO - Map

Calculation: Winter Island - 600kW**Wind data:** A - Met Tower; Hub height: 60.0



0 250 500 750 1000m

Map: 25229200_all , Print scale 1:25,000, Map center UTM NAD 83 Zone: 19 East: 346,347 North: 4,709,924

New WTG Meteorological Data

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
2/9/2011 10:11 AM/2.7.473

METEO - Main Result

Calculation: Winter Island - 1.0MW

Name Met Tower

Site Coordinates
UTM NAD 83 Zone: 19 East: 346,347 North: 4,709,924

Air density calculation mode	Individual per WTG
Result for WTG at hub altitude	1.238 kg/m³ to 1.240 kg/m³
Air density relative to standard	101.1 %
Hub altitude above sea level (asl)	69.0 m to 89.0 m
Annual mean temperature at hub alt.	8.8 ℃ to 8.9 ℃
Pressure at WTGs	1,001.5 hPa to 1,003.9 hPa

Calculation is based on "Met Tower", giving the Weibull distribution for the wind speed on the site.
Using the selected power curve, the expected annual energy production is calculated.

Scale 1:25,000

Meteorological Data

Weibull data 50 m above ground level

Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]	Wind gradient exponent
0 N	5.93	5.26	2.257	7.5	0.238
1 NNE	6.90	6.14	1.778	5.2	0.238
2 ENE	8.70	7.70	2.144	5.7	0.238
3 E	9.42	8.40	1.704	4.1	0.238
4 ESE	5.22	4.69	1.562	5.0	0.238
5 SSE	5.18	4.60	1.831	5.0	0.238
6 S	5.84	5.19	1.903	5.7	0.238
7 SSW	6.26	5.54	2.178	8.1	0.238
8 WSW	6.71	5.98	2.816	7.4	0.238
9 W	6.41	5.71	2.832	9.3	0.238
10 WNW	6.52	5.78	2.374	14.9	0.238
11 NNW	7.43	6.59	2.392	22.0	0.238
All	6.77	6.00	2.055	100.0	

Calculation Results

Key results for height 70.0 m above ground level
Wind energy: 2,619 kWh/m²; Mean wind speed: 6.5 m/s;

Calculated Annual Energy

WTG type						Power curve		Annual Energy			
Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Creator	Name	Result	Result-10.0%	Mean wind speed	Capacity factor
			[kW]	[m]	[m]			[MWh]	[MWh]	[m/s]	[%]
Yes	ELECON1-600	ELECON1-600-600	600	47.0	60.0	USER	ELECON	1,495.7	1,346	6.26	28.4
Yes	GE WIND ENERGY	GE 1.5sle-1,500	1,500	77.0	80.0	EMD	Level 0 - Calculated - 10%<TI<15% - 2006	4,287.1	3,858	6.71	32.6
No	MItsubishi	MWT62/1.0-1,000	1,000	61.4	70.0	USER	Level 0	2,062.3	1,856	6.50	23.5

Project:
WI-Salem_WindPRO

Description:
Winter Island
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Calculated:
2/9/2011 10:11 AM/2.7.473

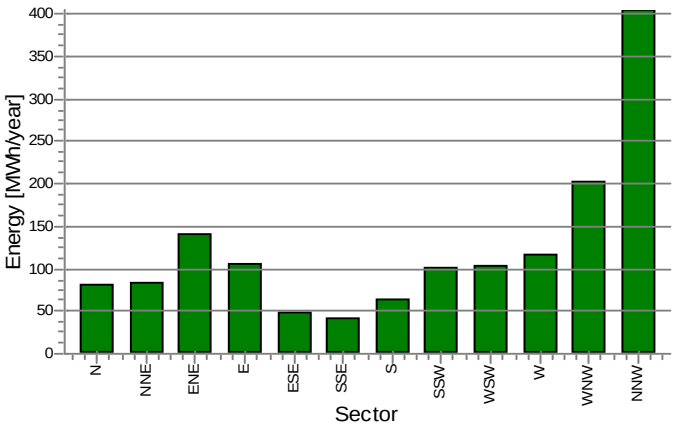
METEO - Production Analysis

Calculation: Winter Island - 1.0MW**WTG:** ELECON1-600 ELECON1-600 60Hz 600 47.0 !O!, Hub height: 60.0 m, Air density: 1.240 kg/m³

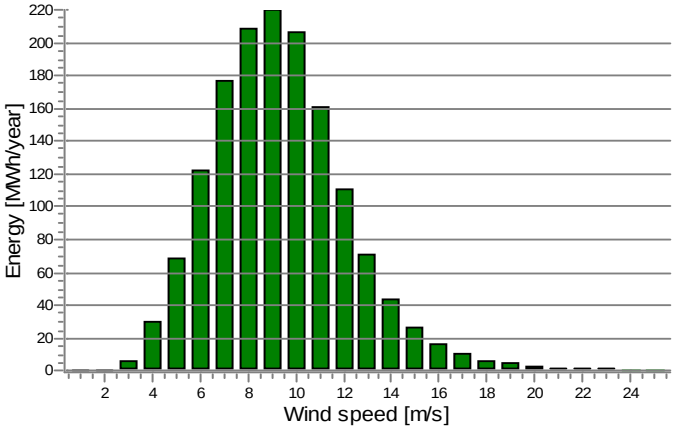
Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	80.8	84.5	140.1	105.9	48.2	42.4	64.3	101.4	104.0	115.9	203.3	405.0	1,495.7
Resulting energy	**[MWh]**	**80.8**	**84.5**	**140.1**	**105.9**	**48.2**	**42.4**	**64.3**	**101.4**	**104.0**	**115.9**	**203.3**	**405.0**	**1,495.7**
Specific energy	[kWh/m²]													862
Specific energy	[kWh/kW]													2,493
Directional Distribution	[%]	5.4	5.6	9.4	7.1	3.2	2.8	4.3	6.8	7.0	7.7	13.6	27.1	100.0
Utilization	[%]	41.8	32.2	28.8	19.3	36.5	40.5	39.1	40.3	42.7	43.3	40.9	37.6	35.4
Operational	[Hours/year]	582	402	448	318	394	393	447	629	578	730	1,166	1,719	7,807
Full Load Equivalent	[Hours/year]	135	141	233	176	80	71	107	169	173	193	339	675	2,493
A- parameter	[m/s]	6.2	7.2	9.1	9.8	5.4	5.4	6.1	6.5	7.0	6.7	6.8	7.8	7.1
Mean wind speed	[m/s]	5.5	6.4	8.0	8.7	4.9	4.8	5.4	5.8	6.2	6.0	6.0	6.9	6.3
k- parameter		2.34	1.86	2.22	1.78	1.64	1.91	1.98	2.26	2.90	2.91	2.45	2.47	2.13
Frequency	[%]	7.5	5.2	5.7	4.1	5.0	5.0	5.7	8.1	7.4	9.3	14.9	22.0	100.0
Power density	[W/m²]													276

Energy vs. sector



Energy vs. wind speed



Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
2/9/2011 10:11 AM/2.7.473

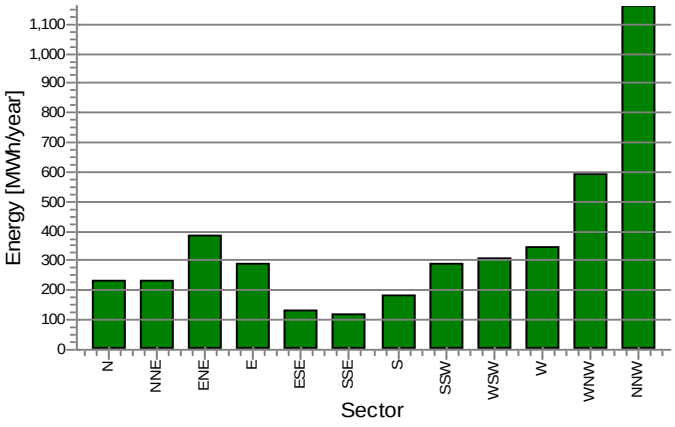
METEO - Production Analysis

Calculation: Winter Island - 1.0MW**WTG:** GE WIND ENERGY GE 1.5sle 1500 77.0 !O!, Hub height: 80.0 m, Air density: 1.238 kg/m³

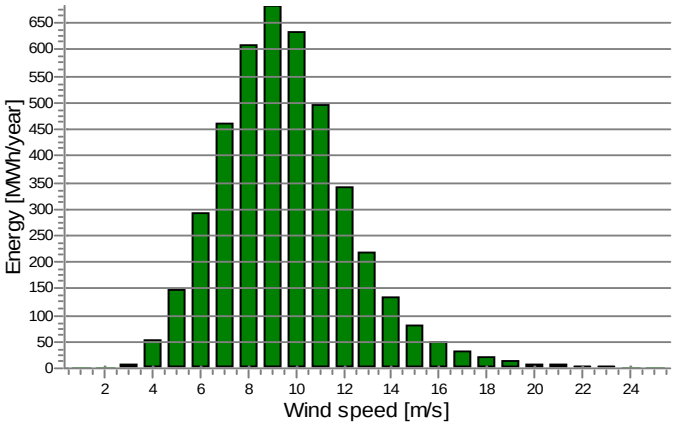
Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	235.5	235.9	388.3	288.6	132.2	119.8	182.8	293.3	309.3	346.5	593.0	1,161.9	4,287.1
Resulting energy	**[MWh]**	**235.5**	**235.9**	**388.3**	**288.6**	**132.2**	**119.8**	**182.8**	**293.3**	**309.3**	**346.5**	**593.0**	**1,161.9**	**4,287.1**
Specific energy	[kWh/m²]													921
Specific energy	[kWh/kW]													2,858
Directional Distribution	[%]	5.5	5.5	9.1	6.7	3.1	2.8	4.3	6.8	7.2	8.1	13.8	27.1	100.0
Utilization	[%]	38.8	30.0	25.6	17.6	34.8	37.8	36.4	37.3	39.5	40.3	37.8	34.1	32.6
Operational	[Hours/year]	578	399	445	316	391	390	444	625	573	724	1,158	1,707	7,751
Full Load Equivalent	[Hours/year]	157	157	259	192	88	80	122	196	206	231	395	775	2,858
A- parameter	[m/s]	6.6	7.7	9.7	10.5	5.8	5.8	6.5	7.0	7.5	7.2	7.3	8.3	7.6
Mean wind speed	[m/s]	5.9	6.8	8.6	9.3	5.2	5.1	5.8	6.2	6.7	6.4	6.5	7.4	6.7
k- parameter		2.50	2.02	2.38	1.94	1.80	2.07	2.14	2.42	3.06	3.07	2.61	2.63	2.27
Frequency	[%]	7.5	5.2	5.7	4.1	5.0	5.0	5.7	8.1	7.4	9.3	14.9	22.0	100.0
Power density	[W/m²]													320

Energy vs. sector



Energy vs. wind speed



Project:
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US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

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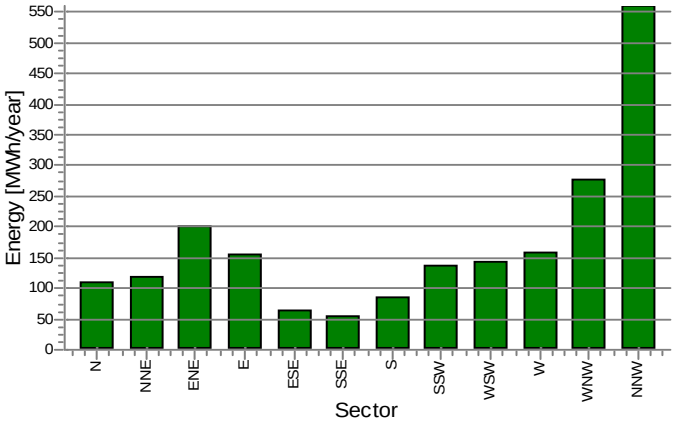
METEO - Production Analysis

Calculation: Winter Island - 1.0MW**WTG:** MItsubishi MWT62/1.0 1000 61.4 !O!, Hub height: 70.0 m, Air density: 1.239 kg/m³

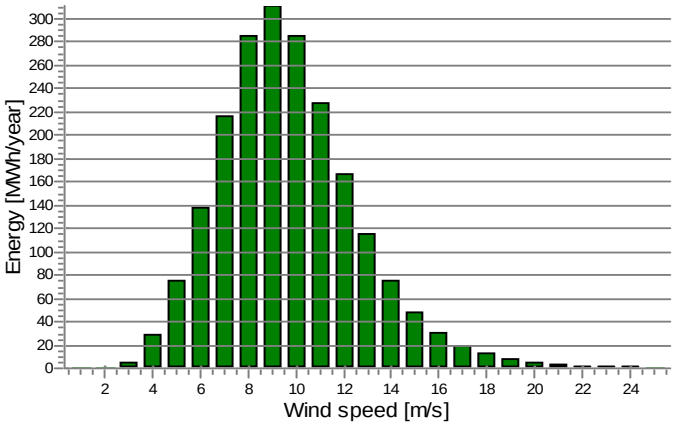
Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	108.6	117.6	200.5	156.5	64.2	56.2	86.7	137.4	141.5	157.1	276.3	559.8	2,062.3
Resulting energy	**[MWh]**	**108.6**	**117.6**	**200.5**	**156.5**	**64.2**	**56.2**	**86.7**	**137.4**	**141.5**	**157.1**	**276.3**	**559.8**	**2,062.3**
Specific energy	[kWh/m²]													697
Specific energy	[kWh/kW]													2,062
Directional Distribution	[%]	5.3	5.7	9.7	7.6	3.1	2.7	4.2	6.7	6.9	7.6	13.4	27.1	100.0
Utilization	[%]	30.3	24.7	22.3	15.8	27.5	29.4	28.8	29.5	30.9	31.2	29.9	27.9	26.4
Operational	[Hours/year]	568	392	437	311	384	383	436	614	563	712	1,137	1,677	7,615
Full Load Equivalent	[Hours/year]	109	118	201	156	64	56	87	137	142	157	276	560	2,062
A- parameter	[m/s]	6.4	7.5	9.4	10.2	5.7	5.6	6.3	6.8	7.3	6.9	7.1	8.1	7.3
Mean wind speed	[m/s]	5.7	6.6	8.3	9.1	5.0	5.0	5.6	6.0	6.5	6.2	6.3	7.1	6.5
k- parameter		2.42	1.94	2.30	1.86	1.72	1.99	2.06	2.34	2.98	2.99	2.53	2.55	2.20
Frequency	[%]	7.5	5.2	5.7	4.1	5.0	5.0	5.7	8.1	7.4	9.3	14.9	22.0	100.0
Power density	[W/m²]													299

Energy vs. sector



Energy vs. wind speed



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Diane Gagnon / dgagnon@meridianassoc.com

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METEO - Power Curve Analysis

Calculation: Winter Island - 1.0MW**WTG:** ELECON1-600 ELECON1-600 60Hz 600 47.0 !O! ELECON, Hub height: 60.0 m

Name: ELECON
Source: ENERGY RESEARCH CENTER OF NETH.

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type
4/22/2008	USER	4/22/2008	5/14/2008	25.0	Pitch	Standard pitch

HP curve comparison - Note: For standard air density and weibull k parameter = 2

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	797	1,278	1,769	2,243	2,638	2,990
ELECON1-600 ELECON1-600 60Hz 600 47.0 !O! ELECON	[MWh]	900	1,401	1,905	2,366	2,762	3,086
Check value	[%]	-11	-9	-7	-5	-5	-3

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

Original data from Windcat, Air density: 1.225 kg/m³

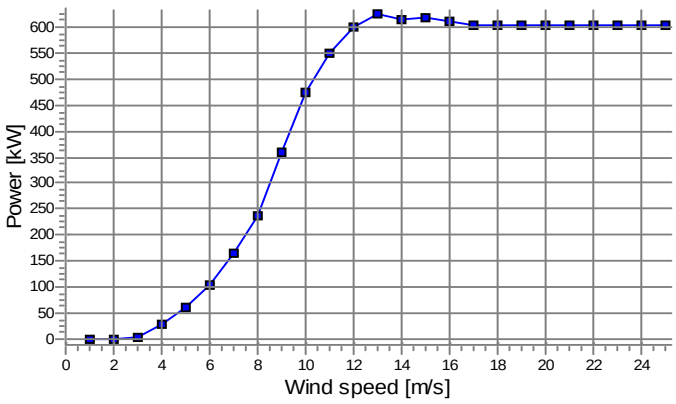
Wind speed [m/s]	Power [kW]	Ce	Wind speed [m/s]	Ct curve
1.1	-1.0	-0.68	1.0	0.10
1.5	-0.7	-0.19	2.0	0.10
2.0	-0.7	-0.08	3.0	0.10
2.6	-2.0	-0.11	4.0	0.80
3.1	3.7	0.12	5.0	0.82
3.6	14.9	0.31	6.0	0.84
4.0	25.5	0.38	7.0	0.79
4.6	42.7	0.42	8.0	0.72
5.0	59.2	0.44	9.0	0.66
5.5	75.8	0.43	10.0	0.59
6.0	103.6	0.45	11.0	0.53
6.4	132.7	0.47	12.0	0.46
7.0	164.6	0.45	13.0	0.40
7.5	210.5	0.47	14.0	0.33
8.0	234.2	0.43	15.0	0.28
8.5	277.9	0.43	16.0	0.23
9.1	359.9	0.46	17.0	0.20
9.5	414.0	0.45	18.0	0.16
10.0	469.4	0.44	19.0	0.13
10.5	516.3	0.41	20.0	0.12
11.0	545.0	0.39	21.0	0.12
11.5	572.3	0.35	22.0	0.11
12.0	598.9	0.33	23.0	0.11
12.5	615.3	0.30	24.0	0.10
13.0	625.9	0.27		
13.5	628.5	0.24		
14.0	615.7	0.21		
14.5	623.0	0.19		
15.0	621.2	0.17		
15.5	616.5	0.16		
16.0	611.7	0.14		
16.5	602.1	0.13		
17.1	605.4	0.11		
17.5	605.6	0.11		
18.0	603.9	0.10		
18.5	601.1	0.09		

Power, Efficiency and energy vs. wind speed

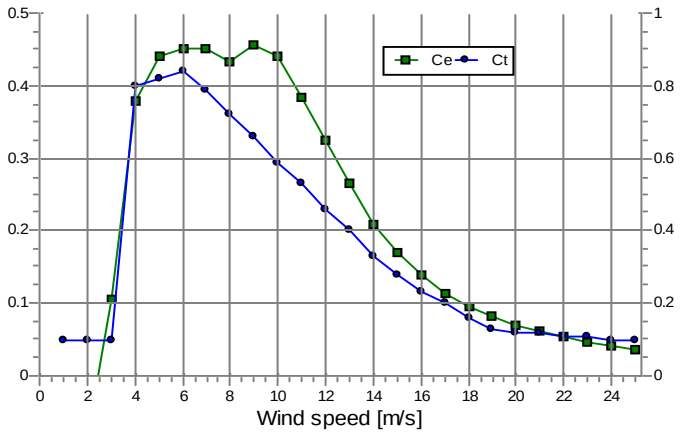
Data used in calculation, Air density: 1.240 kg/m³ New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Ce	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	-1.1	-1.06	0.50- 1.50	-0.3	-0.3	0.0
2.0	-0.7	-0.08	1.50- 2.50	-0.8	-1.1	-0.1
3.0	3.1	0.11	2.50- 3.50	5.5	4.5	0.3
4.0	26.0	0.38	3.50- 4.50	29.4	33.8	2.3
5.0	59.1	0.44	4.50- 5.50	68.7	102.5	6.9
6.0	104.5	0.45	5.50- 6.50	121.7	224.2	15.0
7.0	166.3	0.45	6.50- 7.50	177.3	401.5	26.8
8.0	238.0	0.43	7.50- 8.50	208.6	610.1	40.8
9.0	358.3	0.46	8.50- 9.50	220.1	830.2	55.5
10.0	473.6	0.44	9.50-10.50	206.7	1,036.9	69.3
11.0	548.8	0.38	10.50-11.50	160.7	1,197.6	80.1
12.0	601.3	0.32	11.50-12.50	111.0	1,308.5	87.5
13.0	626.2	0.26	12.50-13.50	71.5	1,380.0	92.3
14.0	616.9	0.21	13.50-14.50	43.8	1,423.7	95.2
15.0	620.1	0.17	14.50-15.50	26.5	1,450.3	97.0
16.0	610.5	0.14	15.50-16.50	16.2	1,466.5	98.0
17.0	605.4	0.11	16.50-17.50	10.1	1,476.6	98.7
18.0	603.3	0.10	17.50-18.50	6.6	1,483.2	99.2
19.0	605.5	0.08	18.50-19.50	4.4	1,487.5	99.5
20.0	605.5	0.07	19.50-20.50	2.9	1,490.5	99.6
21.0	605.5	0.06	20.50-21.50	2.0	1,492.5	99.8
22.0	605.5	0.05	21.50-22.50	1.4	1,493.9	99.9
23.0	605.5	0.05	22.50-23.50	0.9	1,494.8	99.9
24.0	605.5	0.04	23.50-24.50	0.7	1,495.5	100.0
25.0	605.5	0.04	24.50-25.50	0.3	1,495.7	100.0

Power curve
Data used in calculation



Ce and Ct curve



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Calculated:
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METEO - Power Curve Analysis

Calculation: Winter Island - 1.0MW**WTG:** GE WIND ENERGY GE 1.5sle 1500 77.0 !O! Level 0 - Calculated - 10%<TI<15% - 2006, Hub height: 80.0 m

Name: Level 0 - Calculated - 10%<TI<15% - 2006
Source: Manufacturer

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type
12/31/2006	EMD	11/21/2000	1/10/2007	25.0	Pitch	User defined

Based on GE document 1.5sl_sle_PCD_allComp_xxxxxxxx.ENxx.03.pdf. Special adapted power curves for air densities 1.02-1.20 kg/m³ available from manufacturer. When using this PC, WindPRO's standard algorithm for air density adaptation will be used.

HP curve comparison - Note: For standard air density and weibull k parameter = 2

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	2,126	3,366	4,628	5,833	6,826	7,716
GE WIND ENERGY GE 1.5sle 1500 77.0 !O! Level 0 - Calculated - 10%<TI<15% - 2006	[MWh]	2,230	3,492	4,738	5,867	6,837	7,627
Check value	[%]	-5	-4	-2	-1	0	1

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

Original data from Windcat, Air density: 1.225 kg/m³

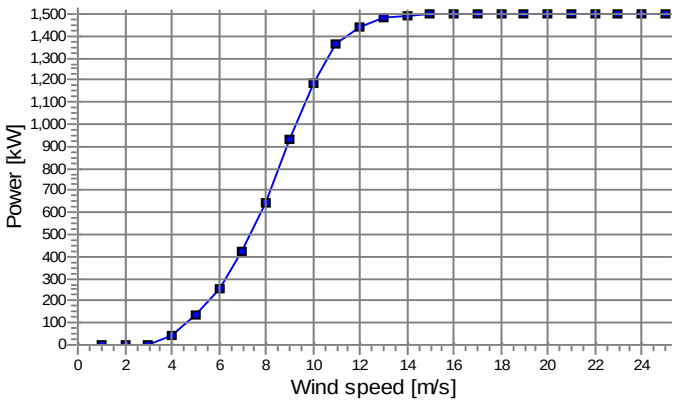
Wind speed [m/s]	Power [kW]	Ce	Wind speed [m/s]	Ct curve
3.0	0.0	0.00	3.0	1.27
3.5	20.0	0.16	4.0	1.03
4.0	43.0	0.24	5.0	0.91
4.5	83.0	0.32	6.0	0.89
5.0	131.0	0.37	7.0	0.89
5.5	185.0	0.39	8.0	0.87
6.0	250.0	0.41	9.0	0.80
6.5	326.0	0.42	10.0	0.69
7.0	416.0	0.43	11.0	0.55
7.5	521.0	0.43	12.0	0.42
8.0	640.0	0.44	13.0	0.32
8.5	785.0	0.45	14.0	0.25
9.0	924.0	0.44	15.0	0.20
9.5	1,062.0	0.43	16.0	0.17
10.0	1,181.0	0.41	17.0	0.14
10.5	1,283.0	0.39	18.0	0.12
11.0	1,359.0	0.36	19.0	0.10
11.5	1,402.0	0.32	20.0	0.09
12.0	1,436.0	0.29	21.0	0.07
12.5	1,463.0	0.26	22.0	0.07
13.0	1,481.0	0.24	23.0	0.06
13.5	1,488.0	0.21	24.0	0.05
14.0	1,494.0	0.19	25.0	0.05
14.5	1,500.0	0.17		
15.0	1,500.0	0.16		
15.5	1,500.0	0.14		
16.0	1,500.0	0.13		
16.5	1,500.0	0.12		
17.0	1,500.0	0.11		
17.5	1,500.0	0.10		
18.0	1,500.0	0.09		
18.5	1,500.0	0.08		
19.0	1,500.0	0.08		
19.5	1,500.0	0.07		
20.0	1,500.0	0.07		
20.5	1,500.0	0.06		
21.0	1,500.0	0.06		
21.5	1,500.0	0.05		
22.0	1,500.0	0.05		
22.5	1,500.0	0.05		
23.0	1,500.0	0.04		
23.5	1,500.0	0.04		
24.0	1,500.0	0.04		
24.5	1,500.0	0.04		
25.0	1,500.0	0.03		

Power, Efficiency and energy vs. wind speed

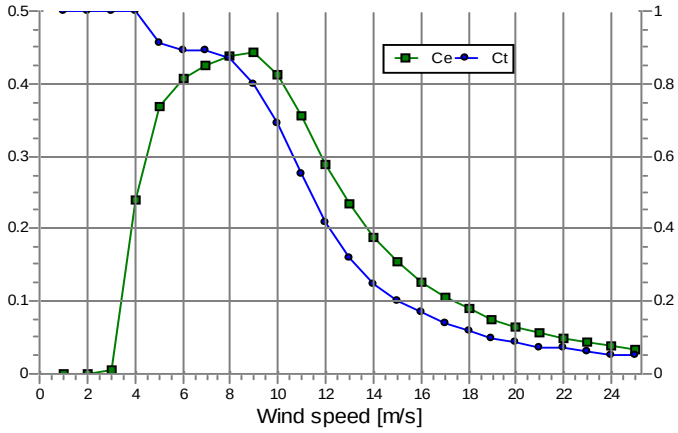
Data used in calculation, Air density: 1.238 kg/m³ New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Ce	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	0.0	0.00	0.50- 1.50	0.0	0.0	0.0
2.0	0.0	0.00	1.50- 2.50	0.0	0.0	0.0
3.0	0.4	0.01	2.50- 3.50	8.3	8.3	0.2
4.0	44.1	0.24	3.50- 4.50	51.2	59.5	1.4
5.0	132.8	0.37	4.50- 5.50	148.9	208.5	4.9
6.0	253.0	0.41	5.50- 6.50	293.3	501.8	11.7
7.0	420.8	0.43	6.50- 7.50	459.1	960.9	22.4
8.0	647.7	0.44	7.50- 8.50	609.8	1,570.8	36.6
9.0	932.9	0.44	8.50- 9.50	682.5	2,253.2	52.6
10.0	1,189.2	0.41	9.50-10.50	633.7	2,886.9	67.3
11.0	1,363.4	0.36	10.50-11.50	495.1	3,382.0	78.9
12.0	1,439.3	0.29	11.50-12.50	339.7	3,721.7	86.8
13.0	1,481.9	0.23	12.50-13.50	216.6	3,938.3	91.9
14.0	1,494.9	0.19	13.50-14.50	133.0	4,071.3	95.0
15.0	1,500.0	0.15	14.50-15.50	80.8	4,152.1	96.8
16.0	1,500.0	0.13	15.50-16.50	49.4	4,201.4	98.0
17.0	1,500.0	0.11	16.50-17.50	30.7	4,232.2	98.7
18.0	1,500.0	0.09	17.50-18.50	19.6	4,251.8	99.2
19.0	1,500.0	0.08	18.50-19.50	12.7	4,264.5	99.5
20.0	1,500.0	0.07	19.50-20.50	8.4	4,272.9	99.7
21.0	1,500.0	0.06	20.50-21.50	5.6	4,278.5	99.8
22.0	1,500.0	0.05	21.50-22.50	3.8	4,282.2	99.9
23.0	1,500.0	0.04	22.50-23.50	2.5	4,284.8	99.9
24.0	1,500.0	0.04	23.50-24.50	1.7	4,286.5	100.0
25.0	1,500.0	0.03	24.50-25.50	0.7	4,287.1	100.0

Power curve
Data used in calculation



Ce and Ct curve



Project:
WI-Salem_WindPRO

Description:
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METEO - Power Curve Analysis

Calculation: Winter Island - 1.0MW**WTG:** MItsubishi MWT62/1.0 1000 61.4 !O! Level 0 , Hub height: 70.0 m

Name: Level 0
Source: Manufacturer

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type
3/1/2003	USER	6/13/2001	12/15/2010	25.0	Pitch	Standard pitch

Calculated by Enercon

HP curve comparison - Note: For standard air density and weibull k parameter = 2

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	1,358	2,167	2,993	3,787	4,447	5,035
MItsubishi MWT62/1.0 1000 61.4 !O! Level 0	[MWh]	1,101	1,781	2,505	3,208	3,846	4,394
Check value	[%]	23	22	19	18	16	15

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

Original data from Windcat, Air density: 1.225 kg/m³

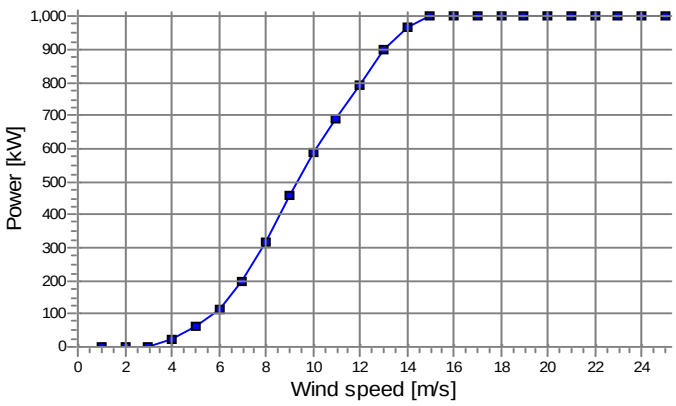
Wind speed [m/s]	Power [kW]	Ce	Wind speed [m/s]	Ct curve
1.0	0.0	0.00	1.0	0.10
2.0	0.0	0.00	2.0	0.10
3.0	0.0	0.00	3.0	0.10
4.0	24.0	0.21	4.0	0.80
5.0	64.0	0.28	5.0	0.82
6.0	111.0	0.28	6.0	0.84
7.0	197.0	0.32	7.0	0.79
8.0	314.0	0.34	8.0	0.72
9.0	454.0	0.34	9.0	0.66
10.0	582.0	0.32	10.0	0.59
11.0	686.0	0.28	11.0	0.53
12.0	783.0	0.25	12.0	0.46
13.0	891.0	0.22	13.0	0.40
14.0	966.0	0.19	14.0	0.33
15.0	1,001.0	0.16	15.0	0.28
16.0	1,001.0	0.13	16.0	0.23
17.0	1,001.0	0.11	17.0	0.20
18.0	1,001.0	0.09	18.0	0.16
19.0	1,001.0	0.08	19.0	0.13
20.0	1,001.0	0.07	20.0	0.12
21.0	1,001.0	0.06	21.0	0.12
22.0	1,001.0	0.05	22.0	0.11
23.0	1,001.0	0.05	23.0	0.11
24.0	1,001.0	0.04	24.0	0.10
25.0	1,001.0	0.04		

Power, Efficiency and energy vs. wind speed

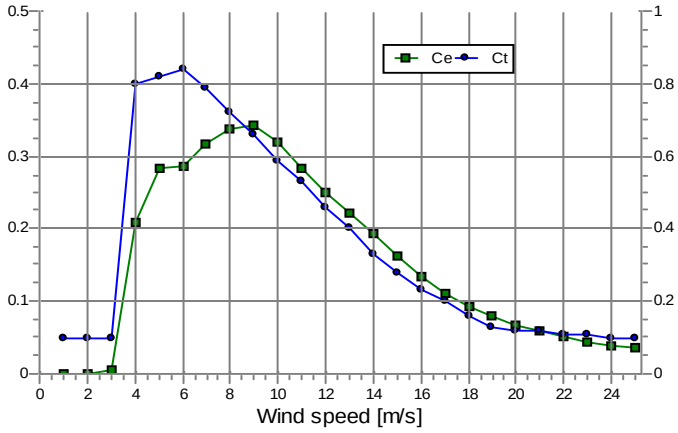
Data used in calculation, Air density: 1.239 kg/m³ New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Ce	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	0.0	0.00	0.50- 1.50	0.0	0.0	0.0
2.0	0.0	0.00	1.50- 2.50	0.0	0.0	0.0
3.0	0.3	0.01	2.50- 3.50	5.4	5.4	0.3
4.0	24.6	0.21	3.50- 4.50	29.1	34.5	1.7
5.0	64.8	0.28	4.50- 5.50	74.7	109.2	5.3
6.0	112.9	0.28	5.50- 6.50	138.8	248.0	12.0
7.0	200.0	0.32	6.50- 7.50	216.7	464.7	22.5
8.0	318.1	0.34	7.50- 8.50	284.9	749.6	36.3
9.0	458.5	0.34	8.50- 9.50	311.3	1,060.9	51.4
10.0	586.6	0.32	9.50-10.50	285.3	1,346.2	65.3
11.0	691.4	0.28	10.50-11.50	227.4	1,573.6	76.3
12.0	790.2	0.25	11.50-12.50	166.3	1,739.9	84.4
13.0	896.5	0.22	12.50-13.50	115.4	1,855.2	90.0
14.0	968.7	0.19	13.50-14.50	76.1	1,931.3	93.6
15.0	1,001.0	0.16	14.50-15.50	48.1	1,979.4	96.0
16.0	1,001.0	0.13	15.50-16.50	29.8	2,009.2	97.4
17.0	1,001.0	0.11	16.50-17.50	18.7	2,028.0	98.3
18.0	1,001.0	0.09	17.50-18.50	12.0	2,040.0	98.9
19.0	1,001.0	0.08	18.50-19.50	7.9	2,047.9	99.3
20.0	1,001.0	0.07	19.50-20.50	5.3	2,053.1	99.6
21.0	1,001.0	0.06	20.50-21.50	3.5	2,056.7	99.7
22.0	1,001.0	0.05	21.50-22.50	2.4	2,059.1	99.8
23.0	1,001.0	0.04	22.50-23.50	1.6	2,060.7	99.9
24.0	1,001.0	0.04	23.50-24.50	1.1	2,061.8	100.0
25.0	1,001.0	0.03	24.50-25.50	0.5	2,062.3	100.0

Power curve
Data used in calculation



Ce and Ct curve



Project:
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Description:
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METEO - Wind Data Analysis

Calculation: Winter Island - 1.0MW**Wind data:** A - Met Tower; Hub height: 70.0

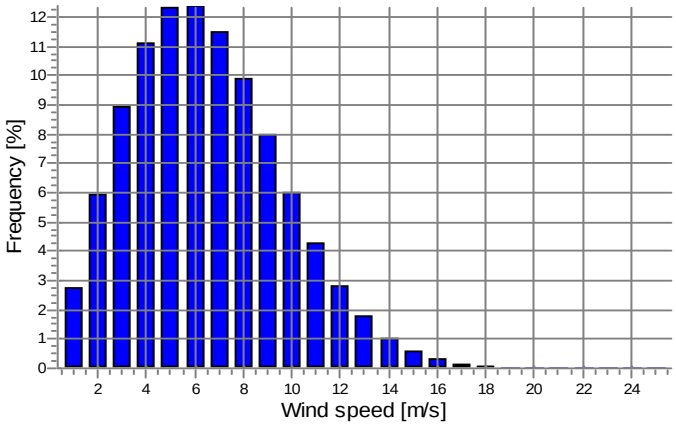
Site Coordinates
UTM NAD 83 Zone: 19 East: 346,347 North: 4,709,924
MItsubishi MWT62/1.0 1000 61.4 !O!

Meteo data
Met Tower

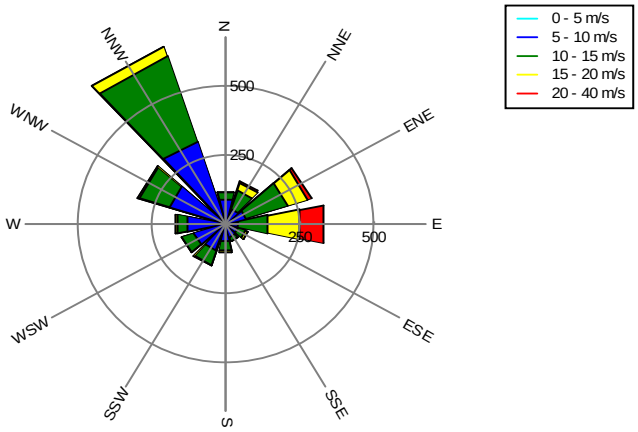
Weibull Data

Sector	A- parameter	Wind speed	k- parameter	Frequency	Wind gradient exponent
	[m/s]	[m/s]		[%]	
0 N	6.43	5.70	2.417	7.5	0.238
1 NNE	7.47	6.63	1.938	5.2	0.238
2 ENE	9.42	8.35	2.304	5.7	0.238
3 E	10.20	9.06	1.864	4.1	0.238
4 ESE	5.65	5.04	1.722	5.0	0.238
5 SSE	5.61	4.97	1.991	5.0	0.238
6 S	6.33	5.61	2.063	5.7	0.238
7 SSW	6.78	6.01	2.338	8.1	0.238
8 WSW	7.27	6.49	2.976	7.4	0.238
9 W	6.94	6.20	2.992	9.3	0.238
10 WNW	7.07	6.27	2.534	14.9	0.238
11 NNW	8.05	7.15	2.552	22.0	0.238
All	7.33	6.50	2.199	100.0	

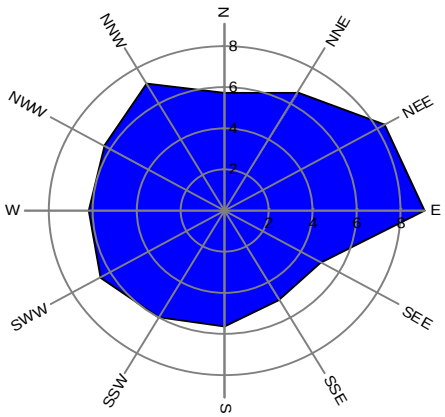
Weibull Distribution



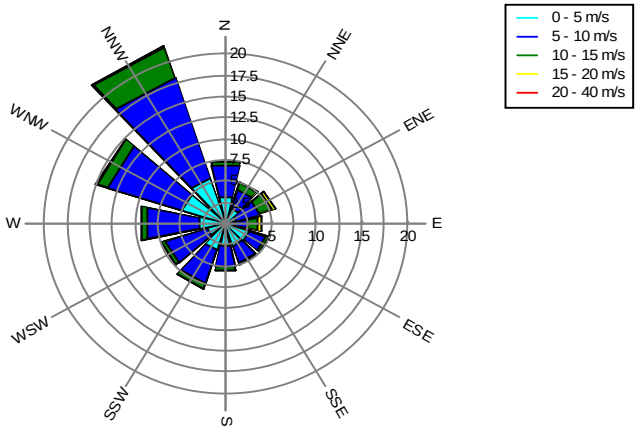
Energy Rose (kWh/m²/year)



Mean wind speed (m/s)



Frequency (%)



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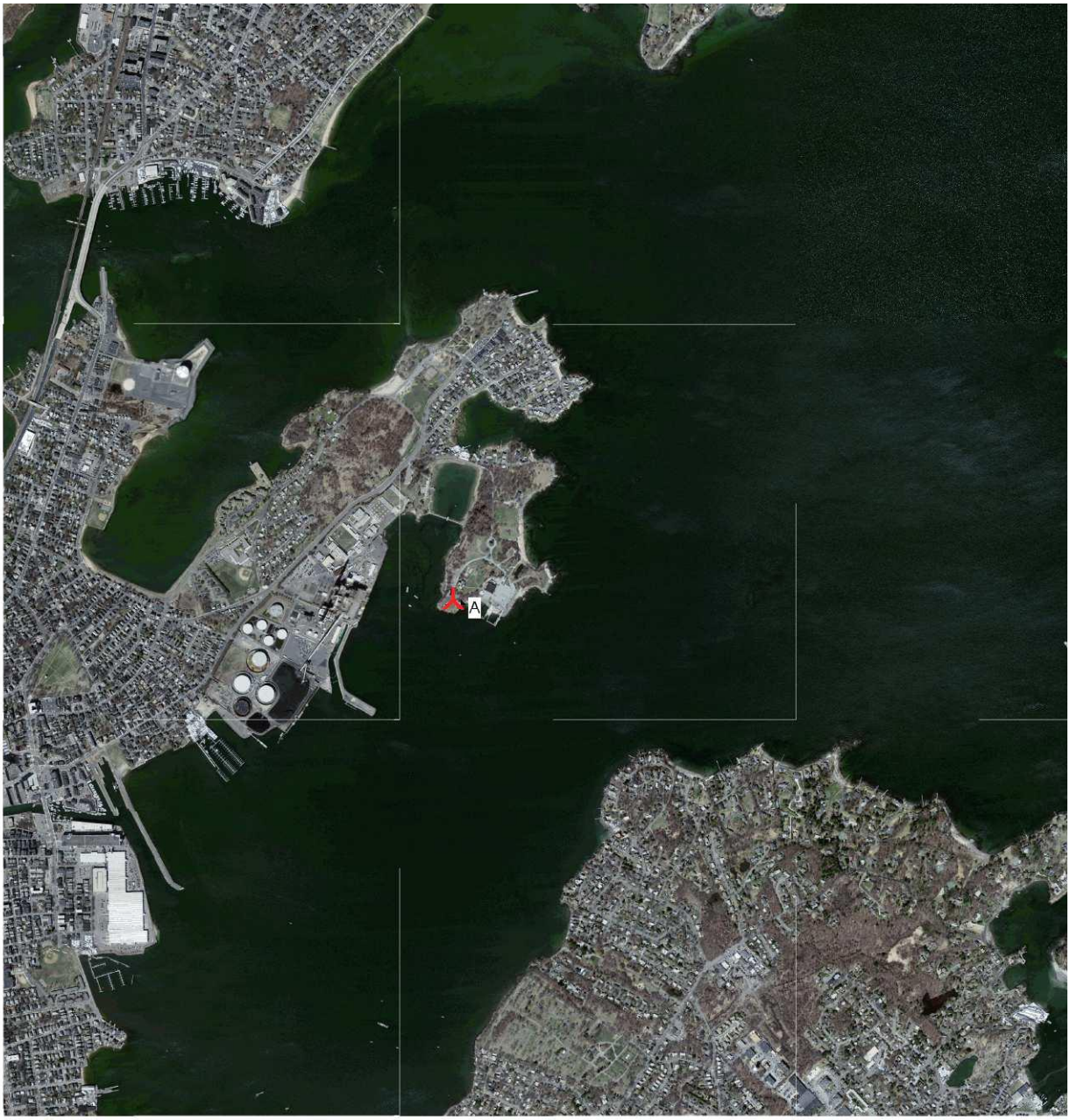
METEO - Map

Calculation: Winter Island - 1.0MW**Wind data:** A - Met Tower; Hub height: 70.0



0 250 500 750 1000m

Map: 25229200_all , Print scale 1:25,000, Map center UTM NAD 83 Zone: 19 East: 346,347 North: 4,709,924

New WTG Meteorological Data

Project:
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METEO - Main Result

Calculation: Winter Island - 1.5MW

Name Met Tower

Site Coordinates
UTM NAD 83 Zone: 19 East: 346,347 North: 4,709,924

Air density calculation mode	Individual per WTG
Result for WTG at hub altitude	1.238 kg/m³ to 1.240 kg/m³
Air density relative to standard	101.1 %
Hub altitude above sea level (asl)	69.0 m to 89.0 m
Annual mean temperature at hub alt.	8.8 ℃ to 8.9 ℃
Pressure at WTGs	1,001.5 hPa to 1,003.9 hPa

Calculation is based on "Met Tower", giving the Weibull distribution for the wind speed on the site.
Using the selected power curve, the expected annual energy production is calculated.

Scale 1:25,000

Meteorological Data

Weibull data 50 m above ground level

Sector	A- parameter [m/s]	Wind speed [m/s]	k- parameter	Frequency [%]	Wind gradient exponent
0 N	5.93	5.26	2.257	7.5	0.238
1 NNE	6.90	6.14	1.778	5.2	0.238
2 ENE	8.70	7.70	2.144	5.7	0.238
3 E	9.42	8.40	1.704	4.1	0.238
4 ESE	5.22	4.69	1.562	5.0	0.238
5 SSE	5.18	4.60	1.831	5.0	0.238
6 S	5.84	5.19	1.903	5.7	0.238
7 SSW	6.26	5.54	2.178	8.1	0.238
8 WSW	6.71	5.98	2.816	7.4	0.238
9 W	6.41	5.71	2.832	9.3	0.238
10 WNW	6.52	5.78	2.374	14.9	0.238
11 NNW	7.43	6.59	2.392	22.0	0.238
All	6.77	6.00	2.055	100.0	

Calculation Results

Key results for height 80.0 m above ground level
Wind energy: 2,805 kWh/m²; Mean wind speed: 6.7 m/s;

Calculated Annual Energy

WTG type						Power curve		Annual Energy			
Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Creator	Name	Result	Result-10.0%	Mean wind speed	Capacity factor
			[kW]	[m]	[m]			[MWh]	[MWh]	[m/s]	[%]
Yes	ELECON1-600	ELECON1-600-600	600	47.0	60.0	USER	ELECON	1,495.7	1,346	6.26	28.4
Yes	GE WIND ENERGY	GE 1.5sle-1,500	1,500	77.0	80.0	EMD	Level 0 - Calculated - 10%<TI<15% - 2006	4,287.1	3,858	6.71	32.6
No	MItsubishi	MWT62/1.0-1,000	1,000	61.4	70.0	USER	Level 0	2,062.3	1,856	6.50	23.5

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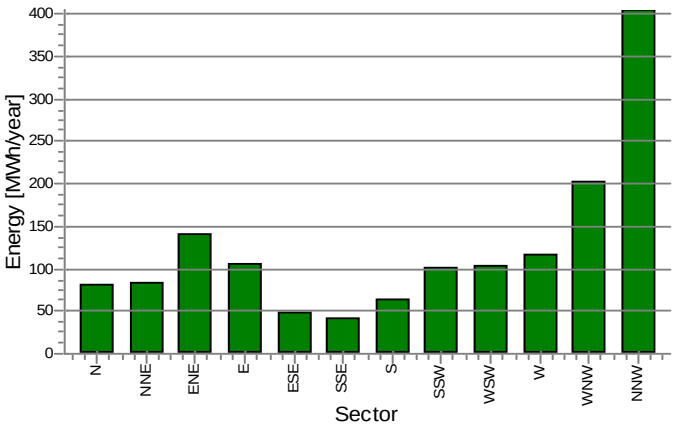
METEO - Production Analysis

Calculation: Winter Island - 1.5MW**WTG:** ELECON1-600 ELECON1-600 60Hz 600 47.0 !O!, Hub height: 60.0 m, Air density: 1.240 kg/m³

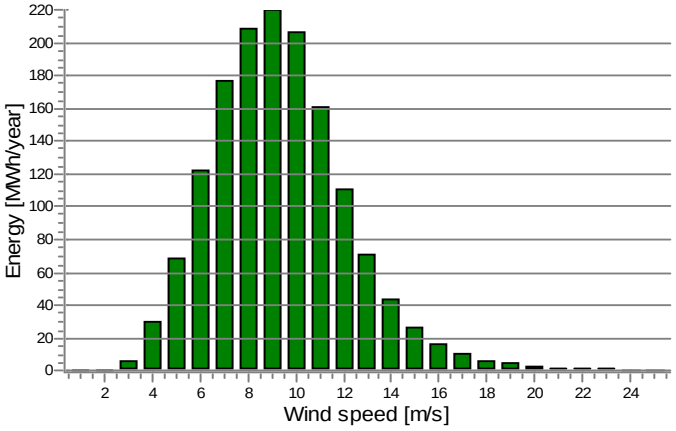
Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	80.8	84.5	140.1	105.9	48.2	42.4	64.3	101.4	104.0	115.9	203.3	405.0	1,495.7
Resulting energy	**[MWh]**	**80.8**	**84.5**	**140.1**	**105.9**	**48.2**	**42.4**	**64.3**	**101.4**	**104.0**	**115.9**	**203.3**	**405.0**	**1,495.7**
Specific energy	[kWh/m²]													862
Specific energy	[kWh/kW]													2,493
Directional Distribution	[%]	5.4	5.6	9.4	7.1	3.2	2.8	4.3	6.8	7.0	7.7	13.6	27.1	100.0
Utilization	[%]	41.8	32.2	28.8	19.3	36.5	40.5	39.1	40.3	42.7	43.3	40.9	37.6	35.4
Operational	[Hours/year]	582	402	448	318	394	393	447	629	578	730	1,166	1,719	7,807
Full Load Equivalent	[Hours/year]	135	141	233	176	80	71	107	169	173	193	339	675	2,493
A- parameter	[m/s]	6.2	7.2	9.1	9.8	5.4	5.4	6.1	6.5	7.0	6.7	6.8	7.8	7.1
Mean wind speed	[m/s]	5.5	6.4	8.0	8.7	4.9	4.8	5.4	5.8	6.2	6.0	6.0	6.9	6.3
k- parameter		2.34	1.86	2.22	1.78	1.64	1.91	1.98	2.26	2.90	2.91	2.45	2.47	2.13
Frequency	[%]	7.5	5.2	5.7	4.1	5.0	5.0	5.7	8.1	7.4	9.3	14.9	22.0	100.0
Power density	[W/m²]													276

Energy vs. sector



Energy vs. wind speed



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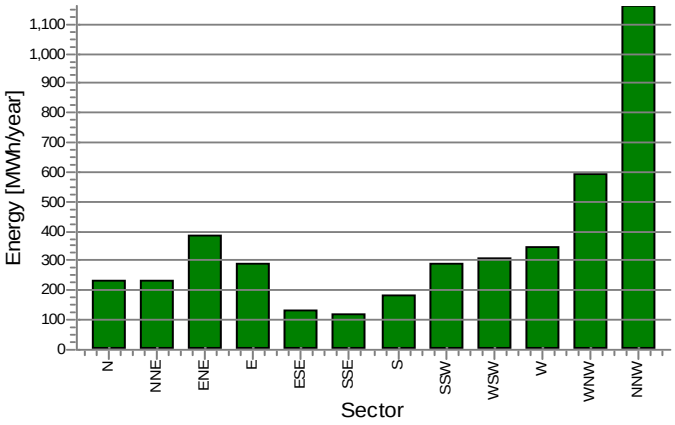
METEO - Production Analysis

Calculation: Winter Island - 1.5MW**WTG:** GE WIND ENERGY GE 1.5sle 1500 77.0 !O!, Hub height: 80.0 m, Air density: 1.238 kg/m³

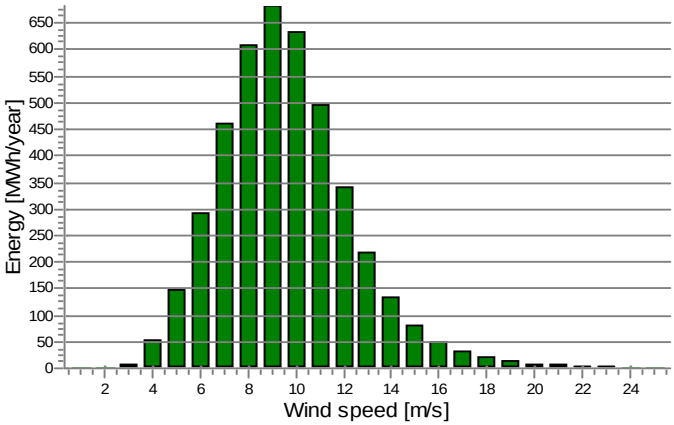
Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	235.5	235.9	388.3	288.6	132.2	119.8	182.8	293.3	309.3	346.5	593.0	1,161.9	4,287.1
Resulting energy	**[MWh]**	**235.5**	**235.9**	**388.3**	**288.6**	**132.2**	**119.8**	**182.8**	**293.3**	**309.3**	**346.5**	**593.0**	**1,161.9**	**4,287.1**
Specific energy	[kWh/m²]													921
Specific energy	[kWh/kW]													2,858
Directional Distribution	[%]	5.5	5.5	9.1	6.7	3.1	2.8	4.3	6.8	7.2	8.1	13.8	27.1	100.0
Utilization	[%]	38.8	30.0	25.6	17.6	34.8	37.8	36.4	37.3	39.5	40.3	37.8	34.1	32.6
Operational	[Hours/year]	578	399	445	316	391	390	444	625	573	724	1,158	1,707	7,751
Full Load Equivalent	[Hours/year]	157	157	259	192	88	80	122	196	206	231	395	775	2,858
A- parameter	[m/s]	6.6	7.7	9.7	10.5	5.8	5.8	6.5	7.0	7.5	7.2	7.3	8.3	7.6
Mean wind speed	[m/s]	5.9	6.8	8.6	9.3	5.2	5.1	5.8	6.2	6.7	6.4	6.5	7.4	6.7
k- parameter		2.50	2.02	2.38	1.94	1.80	2.07	2.14	2.42	3.06	3.07	2.61	2.63	2.27
Frequency	[%]	7.5	5.2	5.7	4.1	5.0	5.0	5.7	8.1	7.4	9.3	14.9	22.0	100.0
Power density	[W/m²]													320

Energy vs. sector



Energy vs. wind speed



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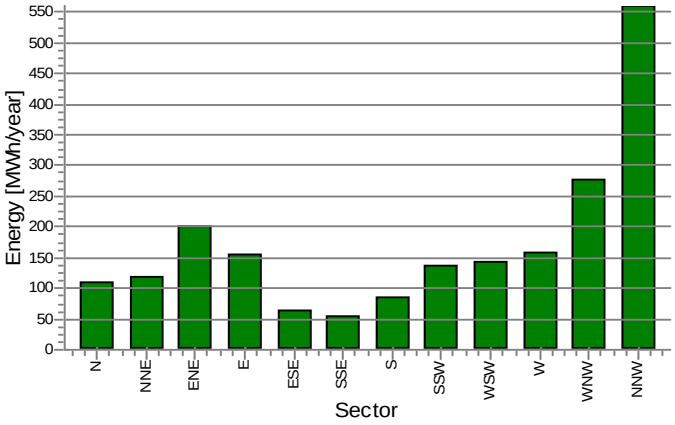
METEO - Production Analysis

Calculation: Winter Island - 1.5MW**WTG:** MItsubishi MWT62/1.0 1000 61.4 !O!, Hub height: 70.0 m, Air density: 1.239 kg/m³

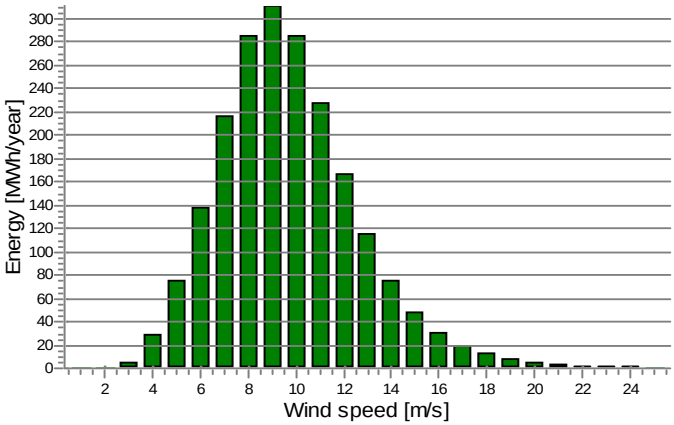
Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	108.6	117.6	200.5	156.5	64.2	56.2	86.7	137.4	141.5	157.1	276.3	559.8	2,062.3
Resulting energy	**[MWh]**	**108.6**	**117.6**	**200.5**	**156.5**	**64.2**	**56.2**	**86.7**	**137.4**	**141.5**	**157.1**	**276.3**	**559.8**	**2,062.3**
Specific energy	[kWh/m²]													697
Specific energy	[kWh/kW]													2,062
Directional Distribution	[%]	5.3	5.7	9.7	7.6	3.1	2.7	4.2	6.7	6.9	7.6	13.4	27.1	100.0
Utilization	[%]	30.3	24.7	22.3	15.8	27.5	29.4	28.8	29.5	30.9	31.2	29.9	27.9	26.4
Operational	[Hours/year]	568	392	437	311	384	383	436	614	563	712	1,137	1,677	7,615
Full Load Equivalent	[Hours/year]	109	118	201	156	64	56	87	137	142	157	276	560	2,062
A- parameter	[m/s]	6.4	7.5	9.4	10.2	5.7	5.6	6.3	6.8	7.3	6.9	7.1	8.1	7.3
Mean wind speed	[m/s]	5.7	6.6	8.3	9.1	5.0	5.0	5.6	6.0	6.5	6.2	6.3	7.1	6.5
k- parameter		2.42	1.94	2.30	1.86	1.72	1.99	2.06	2.34	2.98	2.99	2.53	2.55	2.20
Frequency	[%]	7.5	5.2	5.7	4.1	5.0	5.0	5.7	8.1	7.4	9.3	14.9	22.0	100.0
Power density	[W/m²]													299

Energy vs. sector



Energy vs. wind speed



Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
2/9/2011 10:13 AM/2.7.473

METEO - Power Curve Analysis

Calculation: Winter Island - 1.5MW**WTG:** ELECON1-600 ELECON1-600 60Hz 600 47.0 !O! ELECON, Hub height: 60.0 m

Name: ELECON
Source: ENERGY RESEARCH CENTER OF NETH.

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type
4/22/2008	USER	4/22/2008	5/14/2008	25.0	Pitch	Standard pitch

HP curve comparison - Note: For standard air density and weibull k parameter = 2

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	797	1,278	1,769	2,243	2,638	2,990
ELECON1-600 ELECON1-600 60Hz 600 47.0 !O! ELECON	[MWh]	900	1,401	1,905	2,366	2,762	3,086
Check value	[%]	-11	-9	-7	-5	-5	-3

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

Original data from Windcat, Air density: 1.225 kg/m³

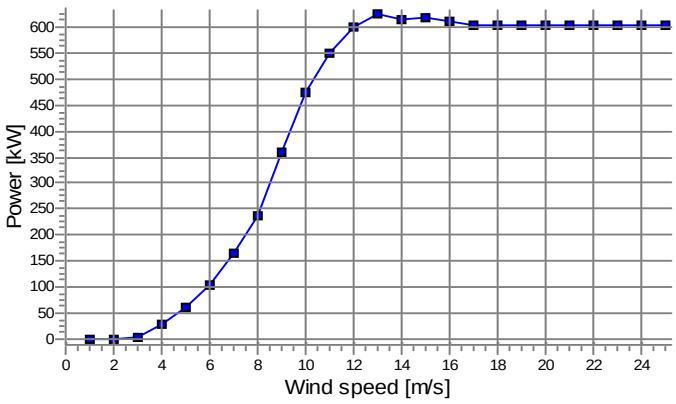
Wind speed [m/s]	Power [kW]	Ce	Wind speed [m/s]	Ct curve
1.1	-1.0	-0.68	1.0	0.10
1.5	-0.7	-0.19	2.0	0.10
2.0	-0.7	-0.08	3.0	0.10
2.6	-2.0	-0.11	4.0	0.80
3.1	3.7	0.12	5.0	0.82
3.6	14.9	0.31	6.0	0.84
4.0	25.5	0.38	7.0	0.79
4.6	42.7	0.42	8.0	0.72
5.0	59.2	0.44	9.0	0.66
5.5	75.8	0.43	10.0	0.59
6.0	103.6	0.45	11.0	0.53
6.4	132.7	0.47	12.0	0.46
7.0	164.6	0.45	13.0	0.40
7.5	210.5	0.47	14.0	0.33
8.0	234.2	0.43	15.0	0.28
8.5	277.9	0.43	16.0	0.23
9.1	359.9	0.46	17.0	0.20
9.5	414.0	0.45	18.0	0.16
10.0	469.4	0.44	19.0	0.13
10.5	516.3	0.41	20.0	0.12
11.0	545.0	0.39	21.0	0.12
11.5	572.3	0.35	22.0	0.11
12.0	598.9	0.33	23.0	0.11
12.5	615.3	0.30	24.0	0.10
13.0	625.9	0.27		
13.5	628.5	0.24		
14.0	615.7	0.21		
14.5	623.0	0.19		
15.0	621.2	0.17		
15.5	616.5	0.16		
16.0	611.7	0.14		
16.5	602.1	0.13		
17.1	605.4	0.11		
17.5	605.6	0.11		
18.0	603.9	0.10		
18.5	601.1	0.09		

Power, Efficiency and energy vs. wind speed

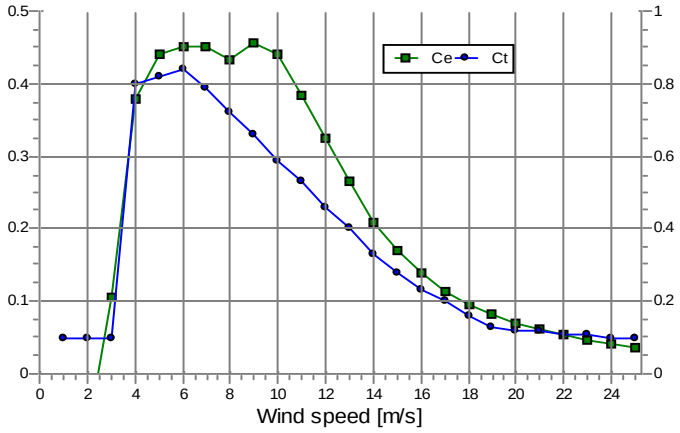
Data used in calculation, Air density: 1.240 kg/m³ New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Ce	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	-1.1	-1.06	0.50- 1.50	-0.3	-0.3	0.0
2.0	-0.7	-0.08	1.50- 2.50	-0.8	-1.1	-0.1
3.0	3.1	0.11	2.50- 3.50	5.5	4.5	0.3
4.0	26.0	0.38	3.50- 4.50	29.4	33.8	2.3
5.0	59.1	0.44	4.50- 5.50	68.7	102.5	6.9
6.0	104.5	0.45	5.50- 6.50	121.7	224.2	15.0
7.0	166.3	0.45	6.50- 7.50	177.3	401.5	26.8
8.0	238.0	0.43	7.50- 8.50	208.6	610.1	40.8
9.0	358.3	0.46	8.50- 9.50	220.1	830.2	55.5
10.0	473.6	0.44	9.50-10.50	206.7	1,036.9	69.3
11.0	548.8	0.38	10.50-11.50	160.7	1,197.6	80.1
12.0	601.3	0.32	11.50-12.50	111.0	1,308.5	87.5
13.0	626.2	0.26	12.50-13.50	71.5	1,380.0	92.3
14.0	616.9	0.21	13.50-14.50	43.8	1,423.7	95.2
15.0	620.1	0.17	14.50-15.50	26.5	1,450.3	97.0
16.0	610.5	0.14	15.50-16.50	16.2	1,466.5	98.0
17.0	605.4	0.11	16.50-17.50	10.1	1,476.6	98.7
18.0	603.3	0.10	17.50-18.50	6.6	1,483.2	99.2
19.0	605.5	0.08	18.50-19.50	4.4	1,487.5	99.5
20.0	605.5	0.07	19.50-20.50	2.9	1,490.5	99.6
21.0	605.5	0.06	20.50-21.50	2.0	1,492.5	99.8
22.0	605.5	0.05	21.50-22.50	1.4	1,493.9	99.9
23.0	605.5	0.05	22.50-23.50	0.9	1,494.8	99.9
24.0	605.5	0.04	23.50-24.50	0.7	1,495.5	100.0
25.0	605.5	0.04	24.50-25.50	0.3	1,495.7	100.0

Power curve
Data used in calculation



Ce and Ct curve



Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
2/9/2011 10:13 AM/2.7.473

METEO - Power Curve Analysis

Calculation: Winter Island - 1.5MW**WTG:** GE WIND ENERGY GE 1.5sle 1500 77.0 !O! Level 0 - Calculated - 10%<TI<15% - 2006, Hub height: 80.0 m

Name: Level 0 - Calculated - 10%<TI<15% - 2006
Source: Manufacturer

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type
12/31/2006	EMD	11/21/2000	1/10/2007	25.0	Pitch	User defined

Based on GE document 1.5sl_sle_PCD_allComp_xxxxxxxx.ENxx.03.pdf. Special adapted power curves for air densities 1.02-1.20 kg/m³ available from manufacturer. When using this PC, WindPRO's standard algorithm for air density adaptation will be used.

HP curve comparison - Note: For standard air density and weibull k parameter = 2

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	2,126	3,366	4,628	5,833	6,826	7,716
GE WIND ENERGY GE 1.5sle 1500 77.0 !O! Level 0 - Calculated - 10%<TI<15% - 2006	[MWh]	2,230	3,492	4,738	5,867	6,837	7,627
Check value	[%]	-5	-4	-2	-1	0	1

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

Original data from Windcat, Air density: 1.225 kg/m³

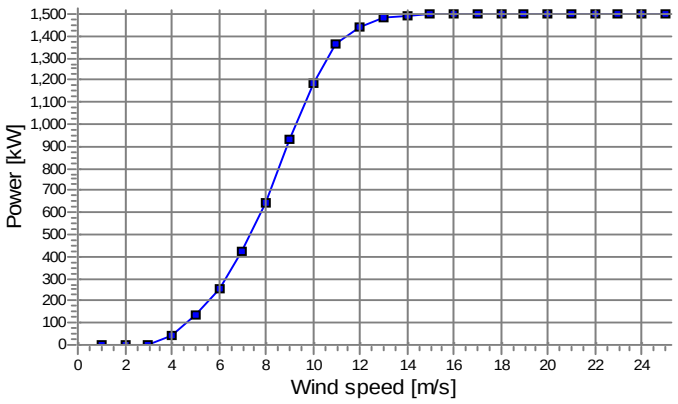
Wind speed [m/s]	Power [kW]	Ce	Wind speed [m/s]	Ct curve
3.0	0.0	0.00	3.0	1.27
3.5	20.0	0.16	4.0	1.03
4.0	43.0	0.24	5.0	0.91
4.5	83.0	0.32	6.0	0.89
5.0	131.0	0.37	7.0	0.89
5.5	185.0	0.39	8.0	0.87
6.0	250.0	0.41	9.0	0.80
6.5	326.0	0.42	10.0	0.69
7.0	416.0	0.43	11.0	0.55
7.5	521.0	0.43	12.0	0.42
8.0	640.0	0.44	13.0	0.32
8.5	785.0	0.45	14.0	0.25
9.0	924.0	0.44	15.0	0.20
9.5	1,062.0	0.43	16.0	0.17
10.0	1,181.0	0.41	17.0	0.14
10.5	1,283.0	0.39	18.0	0.12
11.0	1,359.0	0.36	19.0	0.10
11.5	1,402.0	0.32	20.0	0.09
12.0	1,436.0	0.29	21.0	0.07
12.5	1,463.0	0.26	22.0	0.07
13.0	1,481.0	0.24	23.0	0.06
13.5	1,488.0	0.21	24.0	0.05
14.0	1,494.0	0.19	25.0	0.05
14.5	1,500.0	0.17		
15.0	1,500.0	0.16		
15.5	1,500.0	0.14		
16.0	1,500.0	0.13		
16.5	1,500.0	0.12		
17.0	1,500.0	0.11		
17.5	1,500.0	0.10		
18.0	1,500.0	0.09		
18.5	1,500.0	0.08		
19.0	1,500.0	0.08		
19.5	1,500.0	0.07		
20.0	1,500.0	0.07		
20.5	1,500.0	0.06		
21.0	1,500.0	0.06		
21.5	1,500.0	0.05		
22.0	1,500.0	0.05		
22.5	1,500.0	0.05		
23.0	1,500.0	0.04		
23.5	1,500.0	0.04		
24.0	1,500.0	0.04		
24.5	1,500.0	0.04		
25.0	1,500.0	0.03		

Power, Efficiency and energy vs. wind speed

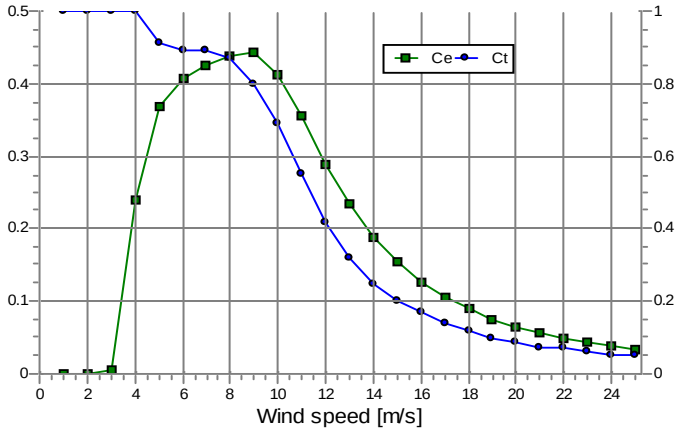
Data used in calculation, Air density: 1.238 kg/m³ New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Ce	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	0.0	0.00	0.50- 1.50	0.0	0.0	0.0
2.0	0.0	0.00	1.50- 2.50	0.0	0.0	0.0
3.0	0.4	0.01	2.50- 3.50	8.3	8.3	0.2
4.0	44.1	0.24	3.50- 4.50	51.2	59.5	1.4
5.0	132.8	0.37	4.50- 5.50	148.9	208.5	4.9
6.0	253.0	0.41	5.50- 6.50	293.3	501.8	11.7
7.0	420.8	0.43	6.50- 7.50	459.1	960.9	22.4
8.0	647.7	0.44	7.50- 8.50	609.8	1,570.8	36.6
9.0	932.9	0.44	8.50- 9.50	682.5	2,253.2	52.6
10.0	1,189.2	0.41	9.50-10.50	633.7	2,886.9	67.3
11.0	1,363.4	0.36	10.50-11.50	495.1	3,382.0	78.9
12.0	1,439.3	0.29	11.50-12.50	339.7	3,721.7	86.8
13.0	1,481.9	0.23	12.50-13.50	216.6	3,938.3	91.9
14.0	1,494.9	0.19	13.50-14.50	133.0	4,071.3	95.0
15.0	1,500.0	0.15	14.50-15.50	80.8	4,152.1	96.8
16.0	1,500.0	0.13	15.50-16.50	49.4	4,201.4	98.0
17.0	1,500.0	0.11	16.50-17.50	30.7	4,232.2	98.7
18.0	1,500.0	0.09	17.50-18.50	19.6	4,251.8	99.2
19.0	1,500.0	0.08	18.50-19.50	12.7	4,264.5	99.5
20.0	1,500.0	0.07	19.50-20.50	8.4	4,272.9	99.7
21.0	1,500.0	0.06	20.50-21.50	5.6	4,278.5	99.8
22.0	1,500.0	0.05	21.50-22.50	3.8	4,282.2	99.9
23.0	1,500.0	0.04	22.50-23.50	2.5	4,284.8	99.9
24.0	1,500.0	0.04	23.50-24.50	1.7	4,286.5	100.0
25.0	1,500.0	0.03	24.50-25.50	0.7	4,287.1	100.0

Power curve
Data used in calculation



Ce and Ct curve



Project:
WI-Salem_WindPRO

Description:
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Salem, MA

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Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
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Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
2/9/2011 10:13 AM/2.7.473

METEO - Power Curve Analysis

Calculation: Winter Island - 1.5MW**WTG:** MItsubishi MWT62/1.0 1000 61.4 !O! Level 0 , Hub height: 70.0 m

Name: Level 0
Source: Manufacturer

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type
3/1/2003	USER	6/13/2001	12/15/2010	25.0	Pitch	Standard pitch

Calculated by Enercon

HP curve comparison - Note: For standard air density and weibull k parameter = 2

Vmean	[m/s]	5	6	7	8	9	10
HP value	[MWh]	1,358	2,167	2,993	3,787	4,447	5,035
MItsubishi MWT62/1.0 1000 61.4 !O! Level 0	[MWh]	1,101	1,781	2,505	3,208	3,846	4,394
Check value	[%]	23	22	19	18	16	15

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see WindPRO manual chapter 3.5.2.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

Original data from Windcat, Air density: 1.225 kg/m³

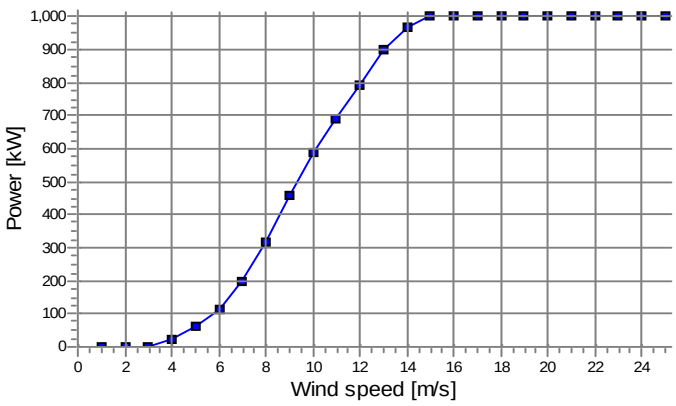
Wind speed [m/s]	Power [kW]	Ce	Wind speed [m/s]	Ct curve
1.0	0.0	0.00	1.0	0.10
2.0	0.0	0.00	2.0	0.10
3.0	0.0	0.00	3.0	0.10
4.0	24.0	0.21	4.0	0.80
5.0	64.0	0.28	5.0	0.82
6.0	111.0	0.28	6.0	0.84
7.0	197.0	0.32	7.0	0.79
8.0	314.0	0.34	8.0	0.72
9.0	454.0	0.34	9.0	0.66
10.0	582.0	0.32	10.0	0.59
11.0	686.0	0.28	11.0	0.53
12.0	783.0	0.25	12.0	0.46
13.0	891.0	0.22	13.0	0.40
14.0	966.0	0.19	14.0	0.33
15.0	1,001.0	0.16	15.0	0.28
16.0	1,001.0	0.13	16.0	0.23
17.0	1,001.0	0.11	17.0	0.20
18.0	1,001.0	0.09	18.0	0.16
19.0	1,001.0	0.08	19.0	0.13
20.0	1,001.0	0.07	20.0	0.12
21.0	1,001.0	0.06	21.0	0.12
22.0	1,001.0	0.05	22.0	0.11
23.0	1,001.0	0.05	23.0	0.11
24.0	1,001.0	0.04	24.0	0.10
25.0	1,001.0	0.04		

Power, Efficiency and energy vs. wind speed

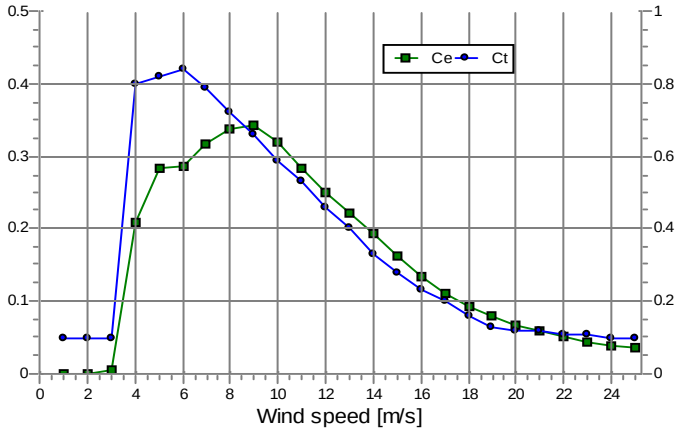
Data used in calculation, Air density: 1.239 kg/m³ New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Ce	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	0.0	0.00	0.50- 1.50	0.0	0.0	0.0
2.0	0.0	0.00	1.50- 2.50	0.0	0.0	0.0
3.0	0.3	0.01	2.50- 3.50	5.4	5.4	0.3
4.0	24.6	0.21	3.50- 4.50	29.1	34.5	1.7
5.0	64.8	0.28	4.50- 5.50	74.7	109.2	5.3
6.0	112.9	0.28	5.50- 6.50	138.8	248.0	12.0
7.0	200.0	0.32	6.50- 7.50	216.7	464.7	22.5
8.0	318.1	0.34	7.50- 8.50	284.9	749.6	36.3
9.0	458.5	0.34	8.50- 9.50	311.3	1,060.9	51.4
10.0	586.6	0.32	9.50-10.50	285.3	1,346.2	65.3
11.0	691.4	0.28	10.50-11.50	227.4	1,573.6	76.3
12.0	790.2	0.25	11.50-12.50	166.3	1,739.9	84.4
13.0	896.5	0.22	12.50-13.50	115.4	1,855.2	90.0
14.0	968.7	0.19	13.50-14.50	76.1	1,931.3	93.6
15.0	1,001.0	0.16	14.50-15.50	48.1	1,979.4	96.0
16.0	1,001.0	0.13	15.50-16.50	29.8	2,009.2	97.4
17.0	1,001.0	0.11	16.50-17.50	18.7	2,028.0	98.3
18.0	1,001.0	0.09	17.50-18.50	12.0	2,040.0	98.9
19.0	1,001.0	0.08	18.50-19.50	7.9	2,047.9	99.3
20.0	1,001.0	0.07	19.50-20.50	5.3	2,053.1	99.6
21.0	1,001.0	0.06	20.50-21.50	3.5	2,056.7	99.7
22.0	1,001.0	0.05	21.50-22.50	2.4	2,059.1	99.8
23.0	1,001.0	0.04	22.50-23.50	1.6	2,060.7	99.9
24.0	1,001.0	0.04	23.50-24.50	1.1	2,061.8	100.0
25.0	1,001.0	0.03	24.50-25.50	0.5	2,062.3	100.0

Power curve
Data used in calculation



Ce and Ct curve



Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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2/9/2011 10:13 AM / 8

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(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
2/9/2011 10:13 AM/2.7.473

METEO - Wind Data Analysis

Calculation: Winter Island - 1.5MW**Wind data:** A - Met Tower; Hub height: 80.0

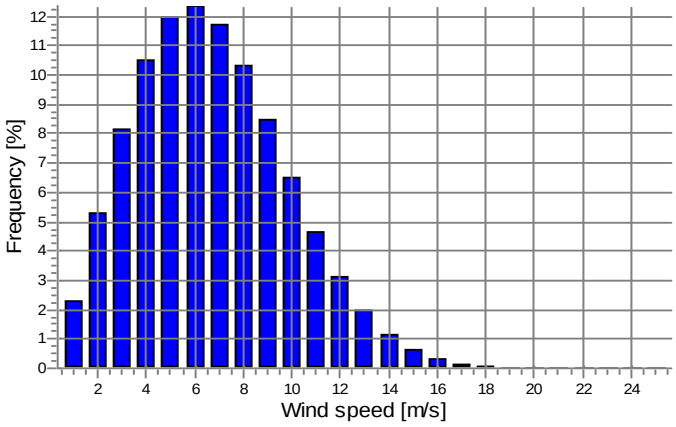
Site Coordinates
UTM NAD 83 Zone: 19 East: 346,347 North: 4,709,924
GE WIND ENERGY GE 1.5sle 1500 77.0 !O!

Meteo data
Met Tower

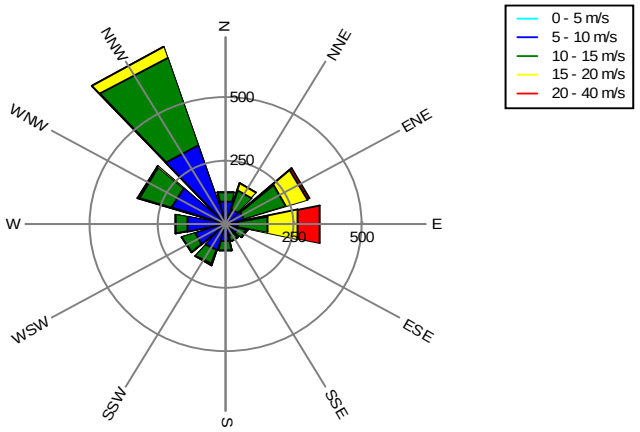
Weibull Data

Sector	A- parameter	Wind speed	k- parameter	Frequency	Wind gradient exponent
	[m/s]	[m/s]		[%]	
0 N	6.64	5.89	2.497	7.5	0.238
1 NNE	7.71	6.84	2.018	5.2	0.238
2 ENE	9.72	8.62	2.384	5.7	0.238
3 E	10.53	9.34	1.944	4.1	0.238
4 ESE	5.83	5.19	1.802	5.0	0.238
5 SSE	5.79	5.13	2.071	5.0	0.238
6 S	6.54	5.79	2.143	5.7	0.238
7 SSW	7.00	6.20	2.418	8.1	0.238
8 WSW	7.50	6.71	3.056	7.4	0.238
9 W	7.17	6.41	3.072	9.3	0.238
10 WNW	7.30	6.48	2.614	14.9	0.238
11 NNW	8.31	7.39	2.632	22.0	0.238
All	7.57	6.71	2.269	100.0	

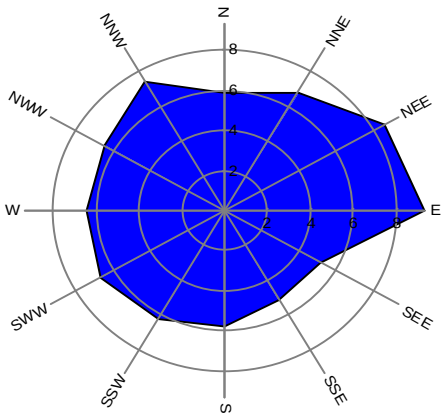
Weibull Distribution



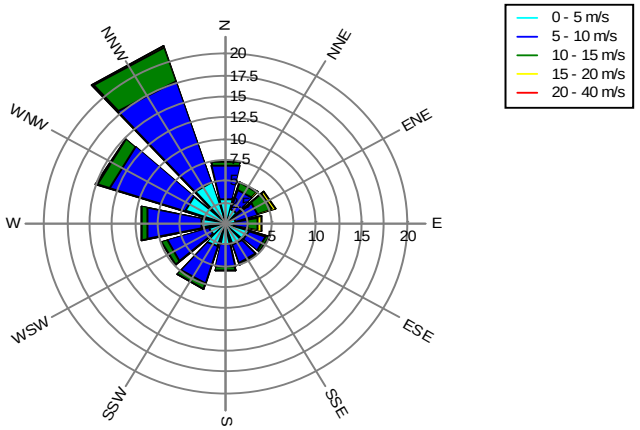
Energy Rose (kWh/m²/year)



Mean wind speed (m/s)



Frequency (%)



Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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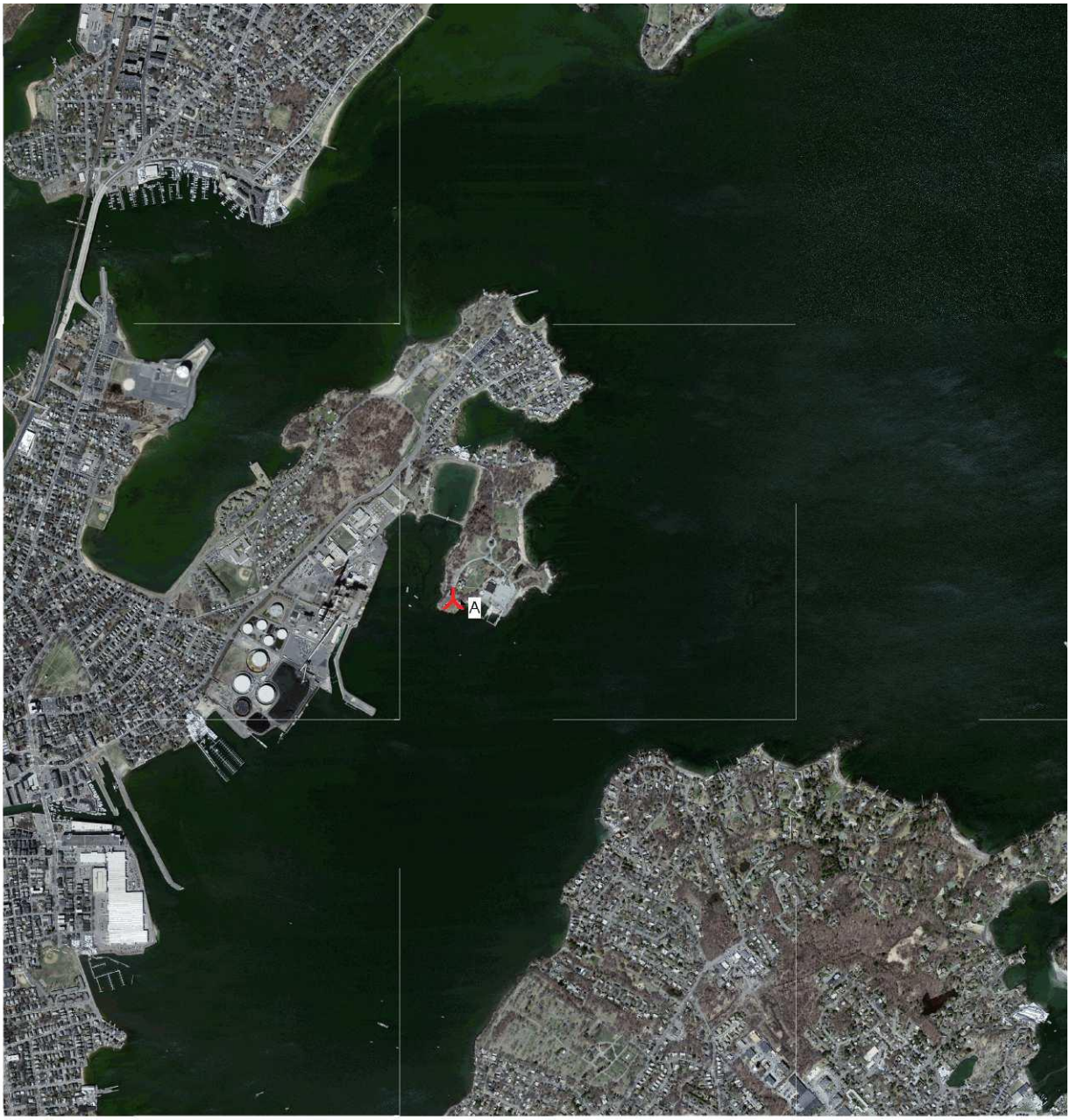
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
2/9/2011 10:13 AM/2.7.473

METEO - Map

Calculation: Winter Island - 1.5MW**Wind data:** A - Met Tower; Hub height: 80.0



0 250 500 750 1000m

Map: 25229200_all , Print scale 1:25,000, Map center UTM NAD 83 Zone: 19 East: 346,347 North: 4,709,924

New WTG Meteorological Data

Appendix B

WindPro VISUAL Results

WindPRO version 2.7.473 Jun 2010

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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9/28/2010 10:37 AM / 1

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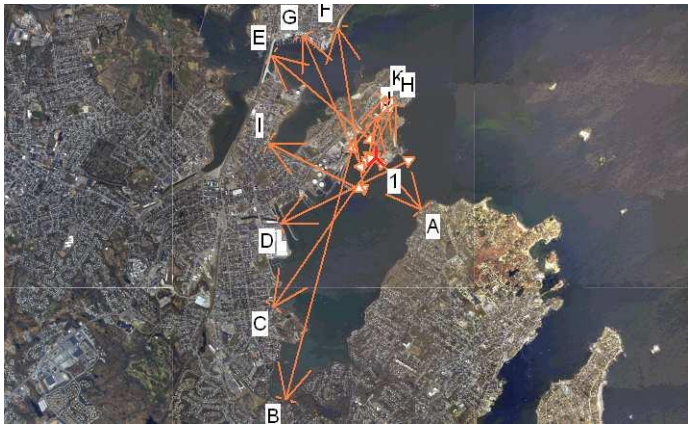
Calculated:
7/22/2010 4:03 PM/2.7.468

VISUAL - Main result

Calculation: Winter Island - 1.5MW



Scale 1:100,000

New WTG Camera

A Naugus Beach, Marblehead

B Salem-Marblehead Causeway

C Ocean Ave., Salem

D Shetland Park, Salem

E Salem-Beverly Bridge

F Independence Park, Beverly

G Beverly Port Marina

H Cheval Road, Salem

I Collins Cove, Salem

J Winter Island Causeway, Salem

K Columbus Ave., Salem Willows

WTG siting

	WTG type						Distance to camera										
	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	A [m]	B [m]	C [m]	D [m]	E [m]	F [m]	G [m]	H [m]	I [m]	J [m]	K [m]
1 New	Yes	GE WIND ENERGY	GE 1.5sle-1,500	1,500	77.0	80.0	916	3,416	2,402	1,544	1,934	1,791	1,885	771	1,437	540	820

Project:
WI-Salem_WindPRO

WTGs: 1

Recommended observation distance: 21 cm
Photo exposed: 2/10/2010 12:00:00 PM
Lens: 36 mm Film: 35x26 mm Pixels: 3456x2592
Eye point: UTM NAD 83 Zone: 19 East: 346,955 North: 4,709,233
Wind direction: 180° Direction of photo: 318°
Camera: Naugus Beach, Marblehead
Photo: F:\~\5209\images\2010-2-8_5209_Winter Island_photos for montage\Naugus Beach Marblehead\IMG_2574.JPG

Created by:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Project:
WI-Salem_WindPRO

WTGs: 1

Recommended observation distance: 21 cm
Photo exposed: 2/10/2010 2:37:00 PM
Lens: 36 mm Film: 35x26 mm Pixels: 3456x2592
Eye point: UTM NAD 83 Zone: 19 East: 345,151 North: 4,706,731
Wind direction: 176° Direction of photo: 14°
Camera: Salem-Marblehead Causeway
Photo: F:\~\5209\images\2010-2-8_5209_Winter Island_photos for montage\Salem-Marblehead Causway\IMG_2603.JPG

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Project:
WI-Salem_WindPRO

WTGs: 1

Recommended observation distance: 21 cm
Photo exposed: 2/10/2010 2:51:00 PM
Lens: 36 mm Film: 35x26 mm Pixels: 3456x2592
Eye point: UTM NAD 83 Zone: 19 East: 344,989 North: 4,707,951
Wind direction: 0°Direction of photo: 33°
Camera: Ocean Ave., Salem
Photo: F:\~\5209\images\2010-2-8_5209_Winter Island_photos for montage\Ocean Ave Salem\IMG_2628.JPG

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Project:
WI-Salem_WindPRO

WTGs: 1

Recommended observation distance: 21 cm
Photo exposed: 2/10/2010 3:08:00 PM
Lens: 36 mm Film: 35x26 mm Pixels: 3456x2592
Eye point: UTM NAD 83 Zone: 19 East: 345,084 North: 4,709,052
Wind direction: 0° Direction of photo: 63°
Camera: Shetland Park, Salem
Photo: F:\~\5209\images\2010-2-8_5209_Winter Island_photos for montage\Shetland Park Salem\IMG_2633.JPG

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Project:
WI-Salem_WindPRO

WTGs: 1

Recommended observation distance: 21 cm
Photo exposed: 2/10/2010 3:46:00 PM
Lens: 36 mm Film: 35x26 mm Pixels: 3456x2592
Eye point: UTM NAD 83 Zone: 19 East: 344,969 North: 4,711,275
Wind direction: 0°Direction of photo: 129°
Camera: Salem-Beverly Bridge
Photo: F:\~\5209\images\2010-2-8_5209_Winter Island_photos for montage\Beverly Salem Bridge\IMG_2722.JPG

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Diane Gagnon / dgagnon@meridianassoc.com

Project:
WI-Salem_WindPRO

WTGs: 1

Recommended observation distance: 21 cm
Photo exposed: 2/12/2010 12:00:00 PM
Lens: 36 mm Film: 35x26 mm Pixels: 3456x2592
Eye point: UTM NAD 83 Zone: 19 East: 345,849 North: 4,711,644
Wind direction: 0°Direction of photo: 170°
Camera: Independence Park, Beverly
Photo: F:\~\5209\images\2010-2-8_5209_Winter Island_photos for montage\Independance Park Beverly\IMG_2751.JPG

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Project:
WI-Salem_WindPRO

WTGs: 1

Recommended observation distance: 21 cm
Photo exposed: 2/12/2010 12:00:00 PM
Lens: 36 mm Film: 35x26 mm Pixels: 3456x2592
Eye point: UTM NAD 83 Zone: 19 East: 345,387 North: 4,711,544
Wind direction: 0° Direction of photo: 155°
Camera: Beverly Port Marina
Photo: F:\~\5209\images\2010-2-8_5209_Winter Island_photos for montage\Beverly Port Marina\IMG_2741.JPG

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(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Project:
WI-Salem_WindPRO

Recommended observation distance: 21 cm
WTGs: 1
Photo exposed: 2/12/2010 12:00:00 PM
Lens: 36 mm Film: 35x26 mm Pixels: 3456x2592
Eye point: UTM NAD 83 Zone: 19 East: 346,613 North: 4,710,654
Wind direction: 0° Direction of photo: 203°
Camera: Cheval Road, Salem
Photo: F:\~\5209\images\2010-2-8_5209_Winter Island_photos for montage\Cheval-Bayview Salem\2010-3-17_reshoot on sunny day\IMG_2836.JPG

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(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Project:
WI-Salem_WindPRO

WTGs: 1

Recommended observation distance: 21 cm
Photo exposed: 2/18/2010 12:00:00 PM
Lens: 36 mm Film: 35x26 mm Pixels: 3456x2592
Eye point: UTM NAD 83 Zone: 19 East: 344,932 North: 4,710,118
Wind direction: 135°Direction of photo: 116°
Camera: Collins Cove, Salem
Photo: F:\~\5209\images\2010-2-8_5209_Winter Island_photos for montage\Collins St Salem\IMG_2718.JPG

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Diane Gagnon / dgagnon@meridianassoc.com

Project:
WI-Salem_WindPRO

WTGs: 1

Recommended observation distance: 21 cm
Photo exposed: 2/18/2010 12:00:00 PM
Lens: 36 mm Film: 35x26 mm Pixels: 3456x2592
Eye point: UTM NAD 83 Zone: 19 East: 346,351 North: 4,710,466
Wind direction: 0°Direction of photo: 190°
Camera: Winter Island Causeway, Salem
Photo: F:\~\5209\images\2010-2-8_5209_Winter Island_photos for montage\Winter Island Causeway Salem\IMG_2675.JPG

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(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Project:
WI-Salem_WindPRO

WTGs: 1

Recommended observation distance: 21 cm
Photo exposed: 2/18/2010 12:00:00 PM
Lens: 36 mm Film: 35x26 mm Pixels: 3456x2592
Eye point: UTM NAD 83 Zone: 19 East: 346,483 North: 4,710,736
Wind direction: 0°Direction of photo: 195°
Camera: Columbus Ave., Salem Willows
Photo: F:\~\5209\images\2010-2-8_5209_Winter Island_photos for montage\Columbus Ave Salem\IMG_2689.JPG

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Diane Gagnon / dgagnon@meridianassoc.com

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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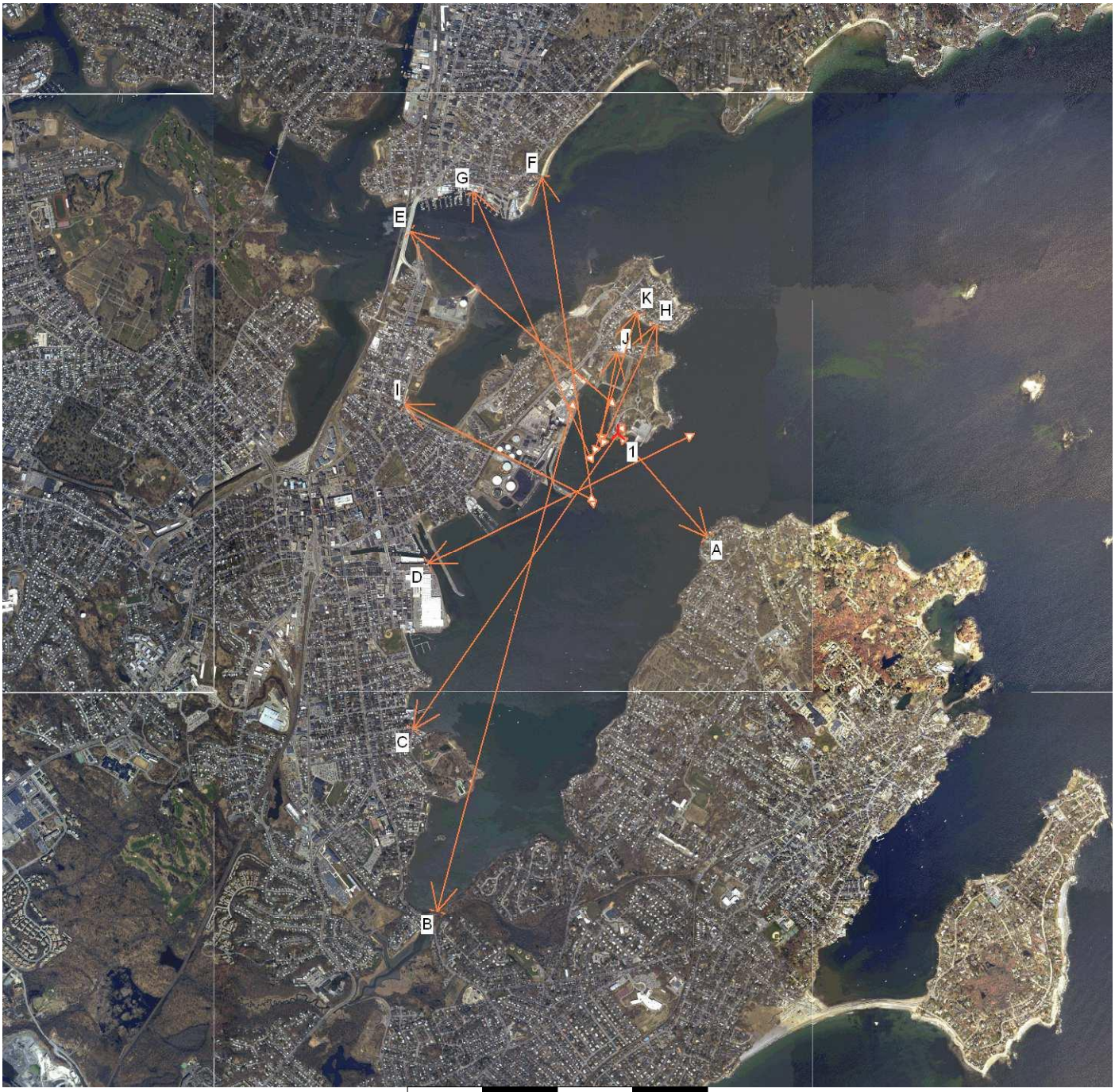
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
7/22/2010 4:03 PM/2.7.468

VISUAL - Map

Calculation: Winter Island - 1.5MW



Map: 253918_allpics , Print scale 1:40,000, Map center UTM NAD 83 Zone: 19 East: 345,944 North: 4,709,187

New WTG Camera

Appendix C

WindPro DECIBEL Results

WindPRO version 2.7.453 Apr 2010

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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6/28/2010 3:23 PM / 1

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US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon, dgagnon@meridianassoc.com

Calculated:
6/28/2010 3:19 PM/2.7.453

DECIBEL - Main Result

Calculation: Winter Island - 1.5MW

Noise calculation model:
ISO 9613-2 General
Wind speed:
6.6 m/s
Ground attenuation:
None
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
2: WTG plus ambient noise is compared to ambient noise plus margin (FR etc.)
Noise values in calculation:
All noise values are mean values (Lwa) (Normal)
Pure tones:
Pure and Impulse tone penalty are added to WTG source noise
Height above ground level, when no value in NSA object:
0.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)

Scale 1:40,000

New WTG Noise sensitive area

WTGs

	UTM NAD83 Zone: 19				WTG type							Noise data							
	East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Creator	Name	Wind speed	Status	Hub height	LwA,ref	Pure tones	Octave data	
	UTM NAD83 Zone: 19		[m]					[kW]	[m]	[m]			[m/s]		[m]	[dB(A)]			
1	346,356	4,709,927	10.2	GE 1.5 sle	Yes	GE WIND ENERGY	GE 1.5sle-1,500	1,500	77.0	80.0	EMD	Level 0 - - Standard operation - 01-2005	6.6	From slope	80.0	102.6	0 dB	No	*)

***)Notice: One or more noise data for this WTG is generic or input by user**

Calculation Results

Sound Level

Noise sensitive area		UTM NAD83 Zone: 19			Demands			Sound Level			Demands fulfilled ?
No.	Name	East	North	Z	Imission height	Ambient noise	Additional exposure	Ambient+WTGs	From WTGs	Ambient+WTGs	Additional exposure	Noise
				[m]	[m]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
A	End of Larkin Lane	345,775	4,710,262	7.0	0.0	33.0	10.0	43.0	36.7	38.3	5.3	Yes
B	Winter Island Road	346,459	4,710,435	3.2	0.0	33.0	10.0	43.0	39.2	40.1	7.1	Yes
C	Memorial Drive @ Victory Road	345,609	4,710,052	2.5	0.0	33.0	10.0	43.0	35.5	37.4	4.4	Yes
D	Bayview Ave @ Cheval Ave	346,651	4,710,655	5.6	0.0	33.0	10.0	43.0	35.1	37.2	4.2	Yes
E	Naugus Ave, Marblehead	346,954	4,709,229	9.8	0.0	33.0	10.0	43.0	33.5	36.3	3.3	Yes

Distances (m)

	WTG
NSA	1
A	671
B	519
C	758
D	786
E	919

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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6/28/2010 3:23 PM / 2

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152 Conant Street
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(978) 299 0447 x 214
Diane Gagnon, dgagnon@meridianassoc.com

Calculated:
6/28/2010 3:19 PM/2.7.453

DECIBEL - Detailed results

Calculation: Winter Island - 1.5MW**Noise calculation model:** ISO 9613-2 General 6.6 m/s

Assumptions

Calculated L(DW) = LWA,ref + K + Dc - (Adiv + Aatm + Agr + Abar + Amisc) - Cmet
(when calculated with ground attenuation, then Dc = Domega)

LWA,ref:	Sound pressure level at WTG
K:	Pure tone
Dc:	Directivity correction
Adiv:	the attenuation due to geometrical divergence
Aatm:	the attenuation due to atmospheric absorption
Agr:	the attenuation due to ground effect
Abar:	the attenuation due to a barrier
Amisc:	the attenuation due to miscellaneous other effects
Cmet:	Meteorological correction

Calculation Results

Noise sensitive area: A End of Larkin Lane

WTG **Wind speed: 6.6 m/s**

No.	Distance [m]	Sound distance [m]	Calculated [dB(A)]	LwA,ref [dB(A)]	Dc [dB]	Adiv [dB]	Aatm [dB]	Agr [dB]	Abar [dB]	Amisc [dB]	A [dB]	Cmet [dB]
1	671	676	**36.72**	102.6	3.00	67.60	1.28	0.00	0.00	0.00	68.88	0.00
Sum	36.72											

Noise sensitive area: B Winter Island Road

WTG **Wind speed: 6.6 m/s**

No.	Distance [m]	Sound distance [m]	Calculated [dB(A)]	LwA,ref [dB(A)]	Dc [dB]	Adiv [dB]	Aatm [dB]	Agr [dB]	Abar [dB]	Amisc [dB]	A [dB]	Cmet [dB]
1	519	526	**39.19**	102.6	3.00	65.41	1.00	0.00	0.00	0.00	66.41	0.00
Sum	39.19											

Noise sensitive area: C Memorial Drive @ Victory Road

WTG **Wind speed: 6.6 m/s**

No.	Distance [m]	Sound distance [m]	Calculated [dB(A)]	LwA,ref [dB(A)]	Dc [dB]	Adiv [dB]	Aatm [dB]	Agr [dB]	Abar [dB]	Amisc [dB]	A [dB]	Cmet [dB]
1	758	763	**35.50**	102.6	3.00	68.65	1.45	0.00	0.00	0.00	70.10	0.00
Sum	35.50											

Noise sensitive area: D Bayview Ave @ Cheval Ave

WTG **Wind speed: 6.6 m/s**

No.	Distance [m]	Sound distance [m]	Calculated [dB(A)]	LwA,ref [dB(A)]	Dc [dB]	Adiv [dB]	Aatm [dB]	Agr [dB]	Abar [dB]	Amisc [dB]	A [dB]	Cmet [dB]
1	786	790	**35.15**	102.6	3.00	68.95	1.50	0.00	0.00	0.00	70.45	0.00
Sum	35.15											

Noise sensitive area: E Naugus Ave, Marblehead

WTG **Wind speed: 6.6 m/s**

No.	Distance [m]	Sound distance [m]	Calculated [dB(A)]	LwA,ref [dB(A)]	Dc [dB]	Adiv [dB]	Aatm [dB]	Agr [dB]	Abar [dB]	Amisc [dB]	A [dB]	Cmet [dB]
1	919	923	**33.54**	102.6	3.00	70.30	1.75	0.00	0.00	0.00	72.06	0.00
Sum	33.54											

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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Diane Gagnon, dgagnon@meridianassoc.com

Calculated:
6/28/2010 3:19 PM/2.7.453

DECIBEL - Assumptions for noise calculation

Calculation: Winter Island - 1.5MW**Noise calculation model:** ISO 9613-2 General 6.6 m/s

Noise calculation model:
ISO 9613-2 General
Wind speed:
6.6 m/s
Ground attenuation:
None
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
2: WTG plus ambient noise is compared to ambient noise plus margin (FR etc.)
Noise values in calculation:
All noise values are mean values (Lwa) (Normal)
Pure tones:
Pure and Impulse tone penalty are added to WTG source noise
Height above ground level, when no value in NSA object:
0.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)
Octave data not required
Air absorption: 1.9 dB/km

WTG: GE WIND ENERGY GE 1.5sle 1500 77.0 !O!
Noise: Level 0 - - Standard operation - 01-2005

Source	Source/Date	Creator	Edited
Manufacturer	1/7/2005	EMD	6/27/2005 11:37 AM

+/- 2dB per IEC 61400-14 CDV

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones
From slope	80.0	6.6	102.6	No

NSA: End of Larkin Lane-A
Predefined calculation standard:
Imission height(a.g.l.): Use standard value from calculation model

Ambient noise: 33.0 dB(A)
Margin or Allowed additional exposure: 10.0 dB(A)
Sound level always accepted: 43.0 dB(A)
Distance demand: 0.0 m

NSA: Winter Island Road-B
Predefined calculation standard:
Imission height(a.g.l.): Use standard value from calculation model

Ambient noise: 33.0 dB(A)
Margin or Allowed additional exposure: 10.0 dB(A)
Sound level always accepted: 43.0 dB(A)
Distance demand: 0.0 m

NSA: Memorial Drive @ Victory Road-C
Predefined calculation standard:
Imission height(a.g.l.): Use standard value from calculation model

Ambient noise: 33.0 dB(A)
Margin or Allowed additional exposure: 10.0 dB(A)
Sound level always accepted: 43.0 dB(A)
Distance demand: 0.0 m

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/28/2010 3:23 PM / 4

Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon, dgagnon@meridianassoc.com

Calculated:
6/28/2010 3:19 PM/2.7.453

DECIBEL - Assumptions for noise calculation

Calculation: Winter Island - 1.5MW**Noise calculation model:** ISO 9613-2 General 6.6 m/s

NSA: Bayview Ave @ Cheval Ave-D
Predefined calculation standard:
Imission height(a.g.l.): Use standard value from calculation model

Ambient noise: 33.0 dB(A)
Margin or Allowed additional exposure: 10.0 dB(A)
Sound level always accepted: 43.0 dB(A)
Distance demand: 0.0 m

NSA: Naugus Ave, Marblehead-E
Predefined calculation standard:
Imission height(a.g.l.): Use standard value from calculation model

Ambient noise: 33.0 dB(A)
Margin or Allowed additional exposure: 10.0 dB(A)
Sound level always accepted: 43.0 dB(A)
Distance demand: 0.0 m

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

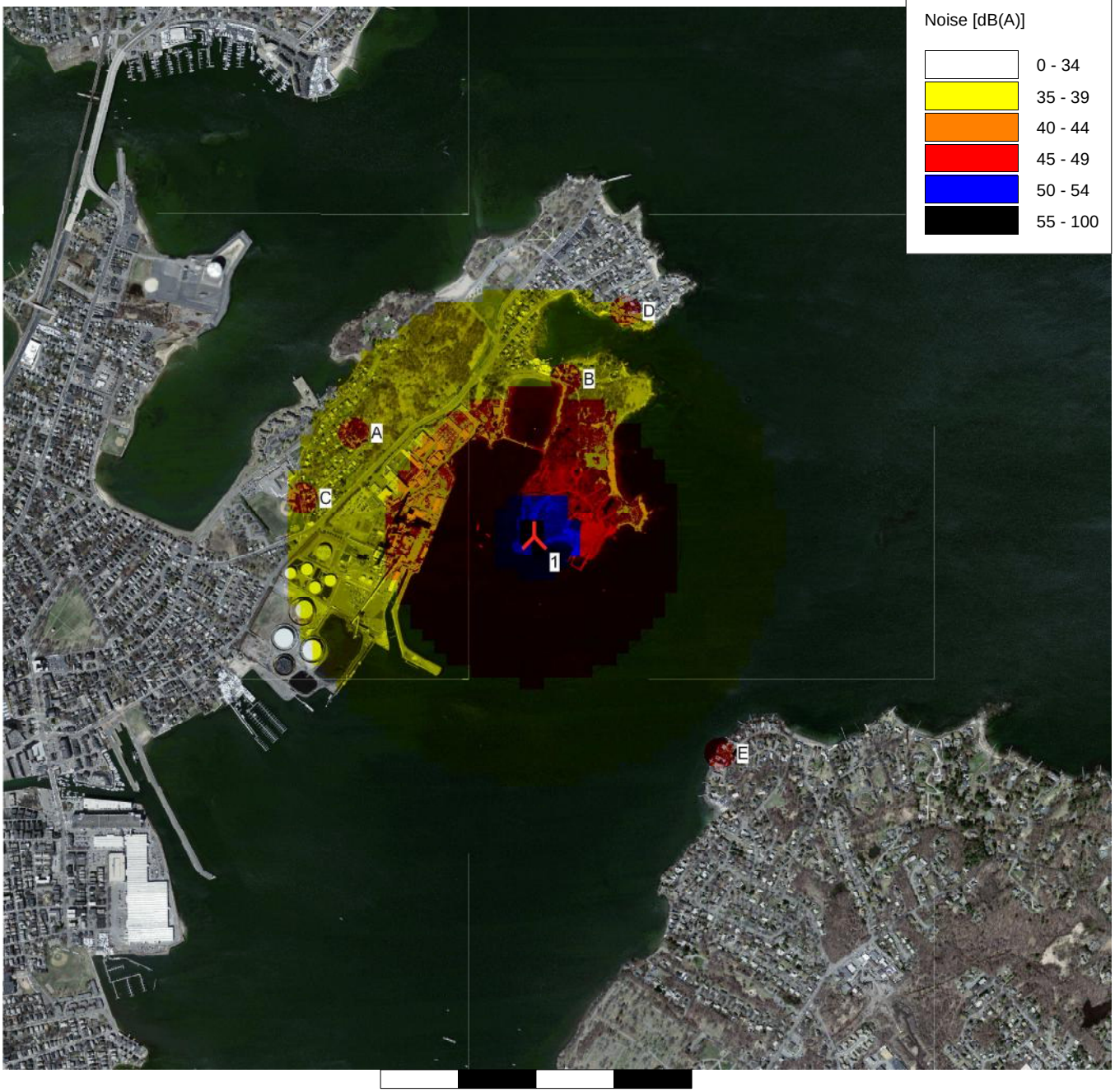
Printed/Page
6/28/2010 3:23 PM / 5

Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon, dgagnon@meridianassoc.com

Calculated:
6/28/2010 3:19 PM/2.7.453

DECIBEL - Map 6.6 m/s

Calculation: Winter Island - 1.5MW**Noise calculation model:** ISO 9613-2 General 6.6 m/s



Map: 25229200_all , Print scale 1:20,000, Map center UTM NAD 83 Zone: 19 East: 346,356 North: 4,709,927
Noise calculation model: ISO 9613-2 General. Wind speed: 6.6 m/s

New WTG Noise sensitive area

Height above sea level from active line object

35.0 dB(A) 40.0 dB(A) 45.0 dB(A) 50.0 dB(A) 55.0 dB(A)

Appendix D

Winter Island Wind Turbine Noise Study

Winter Island Wind Turbine Noise Study

Salem, Massachusetts

Report No. 10-1
September 2010

Prepared for:

Meridian Associates
152 Conant Street
Beverly, MA 01915-1659

Prepared by:

Howard Quin
HOWARD QUIN CONSULTING
17 Birchwood Ave
Sudbury, MA 01776
T 978.766.8296

in association with

Harris Miller Miller & Hanson Inc.
77 South Bedford Street
Burlington, MA 01803
T 781.229.0707

Contents

Figures

Tables

Executive Summary

Howard Quin Consulting in association with Harris Miller Miller & Hanson Inc. (HMMH) has completed a noise study for a proposed GE 1.5 MW wind turbine installation at Winter Island in Salem Harbor. In this report, we have reviewed applicable noise standards and criteria and described the modeling used to project noise emissions from the selected wind turbine, and analyzed all of this information to assess potential noise impacts from the project.

Based on this study, we conclude the following:

- The Massachusetts Department of Environmental Protection (DEP) and City of Salem noise guideline of 10 dB(A) increases in noise levels will probably not be exceeded by the proposed wind turbine operation in any noise-sensitive area at any time of day or night.
- The Project will be in compliance with the DEP noise guidance for a pure tone condition.

While the turbine operation may be audible at some of the nearest homes during nighttime hours with windows open, we believe that the noise will not be considered intrusive.

1 Introdu tion

The City of Salem MA, is exploring the opportunity of constructing a utility-scale wind turbine at Winter Island in Salem Harbor (see Figure 1). The Project being considered is a wind turbine with a nameplate capacity of 1.5 MW. The wind turbine would provide the City of Salem with clean renewable energy to support the town's electricity needs.

Howard Quin Consulting in association with HMMH was contracted by Meridian Associates to perform a noise study for the proposed wind turbine installation. In this report, we review applicable noise standards and criteria, describe the modeling used to project noise emissions from the selected wind turbine, and analyze all of this information to assess potential noise impacts from the project. Appendix A provides a description of the various noise metrics used in this report.

2 Noise Standards and riteria

Applicable noise standards for the proposed wind turbine are the Salem noise ordinance, and the Massachusetts Department of Environmental Protection (DEP) noise guidelines, which are identical. The Code of Massachusetts Regulations (Title 310, Section 7.10, amended September 1, 1972) empowers the Division of Air Quality Control (DAQC) of the Department of Environmental Protection (DEP) to enforce its noise standards. According to DAQC Policy 90-001 (February 1, 1990), a source of sound will be considered to be violating the Department's noise regulation if the source (1) increases the broadband sound level by more than 10 dBA above ambient, or (2) produces a "pure tone condition," when any octave-band center frequency sound pressure level exceeds the two adjacent frequency sound pressure levels by 3 decibels or more. Ambient is defined as the background A-weighted sound level that is exceeded 90 percent of the time (i.e. L90) measured during equipment operating hours. A wind turbine only operates when there is sufficient wind speed to run it, which is generally 4 meters per second (m/s) (9 mph) measured at a height of 10 meters (m). (This is the standard height at which wind is usually measured at airports and meteorological stations; it corresponds to a hub height wind of about 5 m/s). Therefore, it is appropriate to estimated likely background L90 when winds are blowing at speeds of 4 m/s or higher, for purposes of comparison to the turbine noise emissions.

H:\GIS\USA\MA\304290_Quin_Noise\304290_Quin_Salem_Location_Map.mxd

▲ Proposed Wind Turbine Location

Salem Wind Project

Salem, Massachusetts

Figure 1: Wind Turbine Noise Study Area

Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs

HARRIS MILLER MILLER & HANSON INC.

3 Predicted Wind Turbine Noise Levels and Impact

The operational noise levels from the proposed wind turbine were predicted in the Salem study area using 1) reference noise emissions information for the GE 1.5 MW turbine provided by the manufacturer, 2) aerial photography and digital terrain information from MassGIS, and 3) the SoundPLAN® noise prediction model.

3.1 Noise Prediction Model and Noise Source Characteristics

The SoundPLAN® computer noise model was used for computing sound levels from the proposed wind turbine throughout the surrounding community. An industry standard, SoundPLAN was developed by Braunstein + Berndt GmbH to provide estimates of sound levels at distances from specific noise sources taking into account the effects of terrain features including relative elevations of noise sources, receivers, and intervening objects (buildings, hills, trees), and ground effects due to areas of hard ground (pavement, water) and soft ground (grass, field, forest). In addition to computing sound levels at specific receiver positions, SoundPLAN can compute noise contours showing areas of equal and similar sound level.

As input, SoundPLAN incorporated a *geometric model* of the study area, reference *noise source* levels. SoundPLAN uses a *sound propagation model* to project noise levels from turbine operations into the surrounding community. The three-dimensional geometric model of the study area was developed from aerial photography and digital terrain information (with 1-m contour intervals) provided through the MassGIS Executive Office of Energy and Environmental Affairs.

The reference noise source levels were obtained from publicly published data, in the form of octave-band A-weighted Sound Power Levels (LwA)[1] for the reference wind speed of 8 m/s measured at a height of 10 m. The A-weighted spectrum levels total are shown in Table 1 as included in the SoundPLAN noise prediction model. The values in the table include 2 decibels added to the manufacturer's specified sound power levels in each band to serve as a design margin for uncertainties in turbine noise emissions and sound propagation.

Table 1. Reference Sound Power Level Spectrum for GE 1.5 MW at 8 m/s wind speed

Octave-band Center Frequency (Hz)	Sound Power Level, dB(A)
63	87.1
125	96.0
250	99.2
500	100.6
1000	99.9
2000	96.5
4000	89.3
8000	80.1
A-weighted, total	**106.0**

[1] The Sound Power Level represents the total sound energy produced by the wind turbine under the specified operating conditions. Sound Power Levels cannot be measured directly; instead they are computed from reference sound pressure level measurements, conducted by the manufacturer.

The sound propagation model within SoundPLAN that was used for this study was ISO 9613-2.[2] This international standard propagation model is used nearly universally in the U.S. for wind turbine noise studies, due to its conservative propagation equations. ISO 9613-2 uses "worst-case" downwind propagation conditions in all directions, and accounts for variations in terrain and the effects of ground type. In order to be conservative about noise attenuation from ground effects, we have used a ground attenuation G factor of 0.8 at soft ground locations, which is slightly "harder" than the standard recommendation of 1.0.

2 Predi ted Turbine Noise Le els in the ommunity

Table 2 shows the predicted Leq noise levels from the proposed GE 1.5 MW wind turbine at the noise measurement sites. For the turbine noise predictions in this report, the noise levels are based on the standard reference wind speed of 8 m/s (18 mph) as measured at a height of 10 m (33 ft). Figure 2 shows the predicted turbine noise levels in the form of noise contours on the aerial photograph of the study area.

Table 2. Predicted Noise Levels from Proposed Wind Turbine

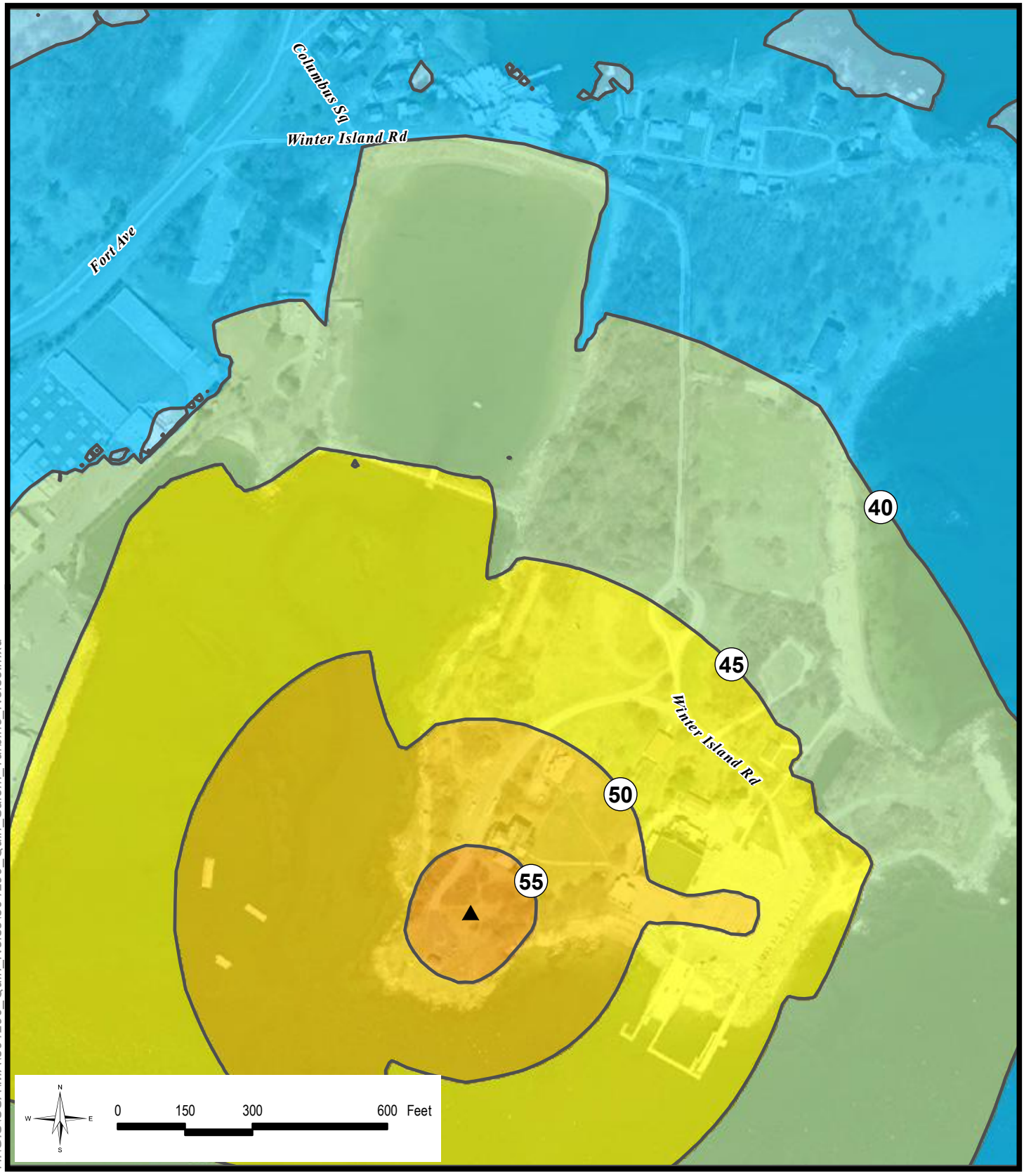
Site Address	Predi ted Turbine Le d A	stimated a round Le d A	stimated Total Le d A	stimated ifferen e d A
Fort Ave. and Winter Island Road (non-resident)	40	32	41	9
Four Closest Residences, on Winter Island Road	37	32	38	6
Plummer Home for Boys	39	32	40	8
Building Directly Beneath Turbine	53	32	53	21

omparison with pe ted Ambient L 0

As discussed above in Section 2, the Mass DEP noise guidelines state that a noise source should not increase the broadband sound level by more than 10 dBA above ambient. Ambient is defined as the background L90 measured during equipment operating hours. A wind turbine only operates when there is sufficient wind speed to run it, which is generally 4 m/s (9 mph) measured at a height of 10 m. Therefore, it will be appropriate to determine the background L90 when winds are blowing at speeds of 4 m/s or higher, for purposes of comparison to the turbine noise emissions.

Since actual measured sound levels are not available at each location, we can only estimate likely compliance based on sound levels for similar areas. Typically, conservative background estimates at a rural location would be about 28 decibels during wind turbine operation. In a suburban area, a conservative background level during turbine operation would be 32 dBA. In an area with nighttime road or industrial activity, 35 dBA is a conservative noise level. In this manner, likely compliance with DEP criteria can be assessed. It is expected that most background sound on Winter Island is from surf and wind noise. We have conservatively estimated the background from this at 32 dBA, typical of quieter suburban areas. We have also used this background for the receptors on the landward side of the island as well as also being typical of a quiet suburban area.

[2] International Organization for Standardization (ISO), International Standard ISO 9613-2, "Acoustics – Attenuation of Sound during Propagation Outdoors", Part 2: General Method of Calculation, 1996-12-15.



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▲ Proposed Wind Turbine Location

	< 30
	30 - 35
	35 - 40
	40 - 45
	45 - 50
	50 - 55
	> 55

dB(A)

Salem Wind Project

Salem, Massachusetts

Figure 2: Wind Turbine Noise Contours

Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs

HARRIS MILLER MILLER & HANSON INC.

As shown in Table 2 and Figure 3, the expected turbine levels will not likely cause a 10 dBA over background exceedance at any of the receptors. Note also that higher wind conditions will also introduce higher surf noise as well, which will raise the expected background levels.

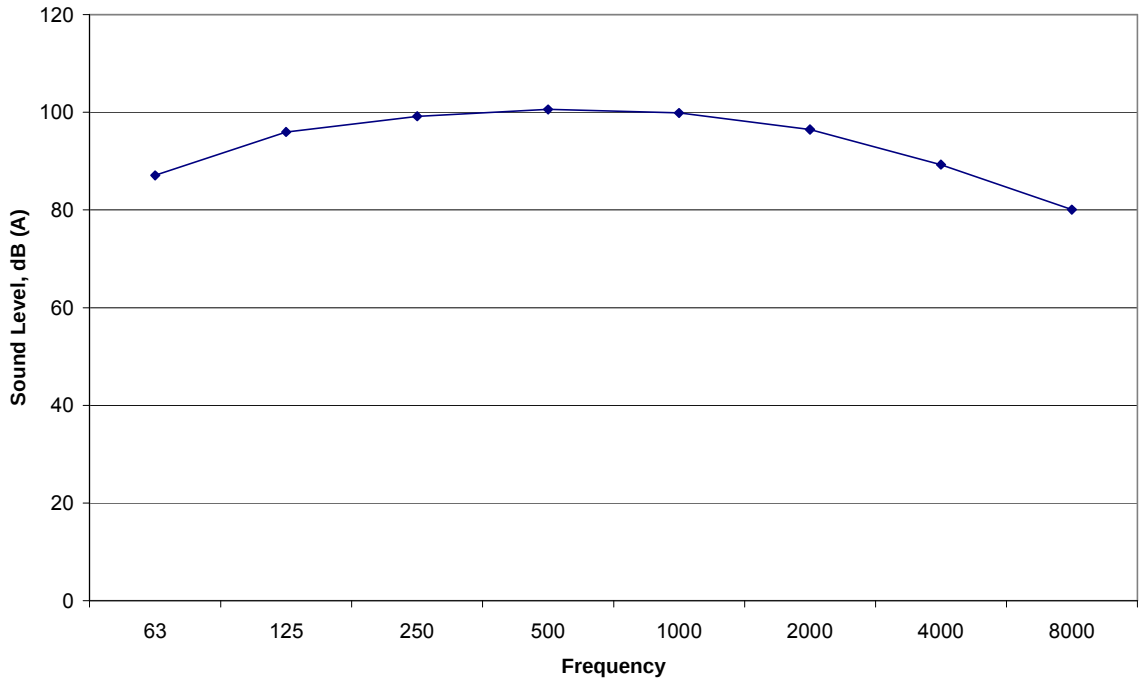
3.4 Pure tone evaluation

A sound is said to have a "pure tone component" if one octave band in the frequency spectrum is 3 dB or more higher than the two adjacent octave bands. Figure 3 shows a frequency plot of the A-weighted sound power level of a GE 1.5 MW wind turbine.[3] The graph shows the spectrum shape of the noise emanating from the turbine with a wind speed of 8 m/s measured at 10-m height; the spectrum shape heard throughout the surrounding community would be similar.

An examination of the *unweighted* octave band levels computed at each receptor indicated that there would not be a pure tone, as defined by a 3 dB exceedance of the level in each adjacent band. Therefore, the turbine noise should comply with the MA DEP pure tone requirements.

Figure 3

GE 1.5 MW Wind Turbine Sound Power Levels



[3] "Technical Documentation, Wind Turbine Generator System, GE 1.5 sl/s," 2005, GE Energy. The values in the graph include 2 decibels added to the manufacturer's specified sound power levels in each band to serve as a design margin for uncertainties in turbine noise emissions and sound propagation.

3.5 Conclusions

The Massachusetts DEP and City of Salem noise guidelines will not likely be exceeded by the proposed wind turbine operation in any noise-sensitive area at any time of day or night. While the turbine operation is predicted to be audible at some of the nearest homes during nighttime hours with windows open, we believe that the noise will not be considered intrusive.

Appendix A Description of Noise Metrics

This Appendix describes the noise metrics used in this report.

A.1. A-weighted Sound Level, dBA

Loudness is a subjective quantity that enables a listener to order the magnitude of different sounds on a scale from soft to loud. Although the perceived loudness of a sound is based somewhat on its frequency and duration, chiefly it depends upon the sound pressure level. Sound pressure level is a measure of the sound pressure at a point relative to a standard reference value; sound pressure level is always expressed in decibels (dB), a logarithmic quantity.

Another important characteristic of sound is its frequency, or "pitch." This is the rate of repetition of sound pressure oscillations as they reach our ears. Frequency is expressed in units known as Hertz (abbreviated "Hz" and equivalent to one cycle per second). Sounds heard in the environment usually consist of a range of frequencies. The distribution of sound energy as a function of frequency is termed the "frequency spectrum." The frequency spectrum of sound is often represented as the sum of the sound energy in frequency bands that are one octave or 1/3-octave wide. An octave represents a doubling of frequency.

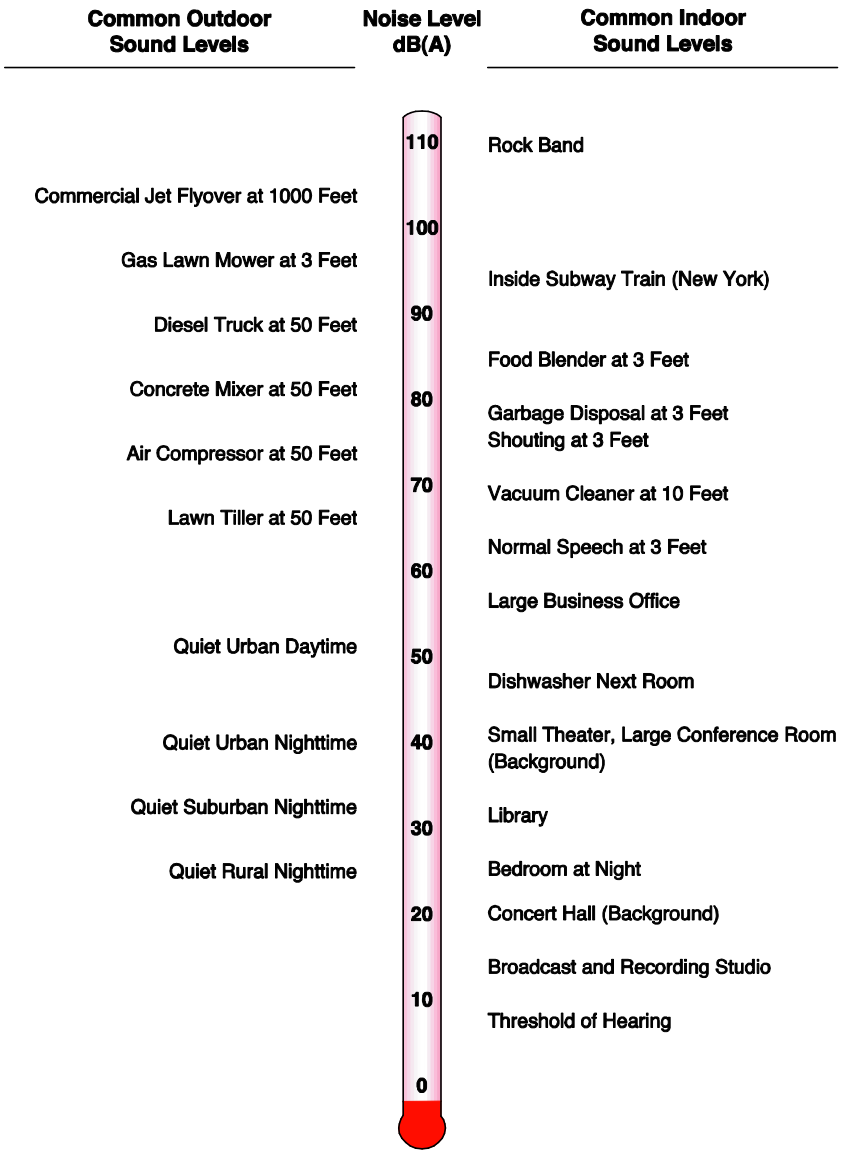
The human ear does not respond equally to identical noise levels at different frequencies. Although the normal frequency range of hearing for most people extends from a low of about 20 Hz to a high of 10,000 Hz to 20,000 Hz, people are most sensitive to sounds in the voice range, between about 500 Hz to 2,000 Hz. Therefore, to correlate the amplitude of a sound with its level as perceived by people, the sound energy spectrum is adjusted, or "weighted."

The weighting system most commonly used to correlate with people's response to noise is "A-weighting" (or the "A-filter") and the resultant noise level is called the "A-weighted noise level" (dBA). A-weighting significantly de-emphasizes those parts of the frequency spectrum from a noise source that occurs both at lower frequencies (those below about 500 Hz) and at very high frequencies (above 10,000 Hz) where we do not hear as well. The filter has very little effect, or is nearly "flat," in the middle range of frequencies between 500 and 10,000 Hz. A-weighted sound levels have been found to correlate better than other weighting networks with human perception of "noisiness." One of the primary reasons for this is that the A-weighting network emphasizes the frequency range where human speech occurs, and noise in this range interferes with speech communication. The Figure 1 below shows common indoor and outdoor A-weighted sound levels and the environments or sources that produce them.

A.2. Equivalent Sound Level, Leq

The Equivalent Sound Level, abbreviated L_{eq}, is a measure of the total exposure resulting from the accumulation of A-weighted sound levels over a particular period of interest -- for example, an hour, an 8-hour school day, nighttime, or a full 24-hour day. However, because the length of the period can be different depending on the time frame of interest, the applicable period should always be identified or clearly understood when discussing the metric. Such durations are often identified through a subscript, for example L_{eq1h}, or $L_{eq(24)}$.

L_{eq} may be thought of as a constant sound level over the period of interest that contains as much sound energy as (is "equivalent" to) the actual time-varying sound level with its normal peaks and valleys. It is important to recognize, however, that the two signals (the constant one and the time-varying one) would sound very different from each other. Also, the "average" sound level suggested by L_{eq} is not an



arithmetic value, but a logarithmic, or "energy-averaged" sound level. Thus, the loudest events may dominate the noise environment described by the metric, depending on the relative loudness of the events.

A.3. Statistical Sound Level Descriptors

Statistical descriptors of the time-varying sound level are often used instead of, or in addition to L_{eq} to provide more information about how the sound level varied during the time period of interest. The descriptor includes a subscript that indicates the percentage of time the sound level is exceeded during the period. The L_{50} is an example, which represents the sound level exceeded 50 percent of the time, and equals the median sound level. Another commonly used descriptor is the L_{10}, which represents the sound level exceeded 10 percent of the measurement period and describes the sound level during the louder portions of the period. The L_{90} is often used to describe the quieter background sound levels that occurred, since it represents the level exceeded 90 percent of the period.

Appendix E

Federal Aviation Administration Determination

Federal Aviation Administration
Air Traffic Airspace Branch, ASW-520
2601 Meacham Blvd.
Fort Worth, TX 76137-0520

Aeronautical Study No.
2009-WTE-10282-OE

Issued Date: 11/12/2009

Diane Gagnon
Meridian Associates, Inc.
152 Conant Street
Beverly, MA 01915

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Wind Turbine Wind Turbine Generator
Location:	Salem, MA
Latitude:	42-31-37.00N NAD 83
Longitude:	70-52-11.40W
Heights:	399 feet above ground level (AGL)
	419 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure would have no substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on the operation of air navigation facilities. Therefore, pursuant to the authority delegated to me, it is hereby determined that the structure would not be a hazard to air navigation provided the following condition(s) is(are) met:

As a condition to this Determination, the structure is marked and/or lighted in accordance with FAA Advisory circular 70/7460-1 K Change 2, Obstruction Marking and Lighting, white paint/synchronized red lights - Chapters 4,12&13(Turbines).

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be completed and returned to this office any time the project is abandoned or:

_____ At least 10 days prior to start of construction (7460-2, Part I)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part II)

See attachment for additional condition(s) or information.

This determination expires on 11/12/2011 unless:

(a) extended, revised or terminated by the issuing office.
(b) the construction is subject to the licensing authority of the Federal Communications Commission (FCC) and an application for a construction permit has been filed, as required by the FCC, within 6 months of the date of this determination. In such case, the determination expires on the date prescribed by the FCC for completion of construction, or the date the FCC denies the application.

NOTE: REQUEST FOR EXTENSION OF THE EFFECTIVE PERIOD OF THIS DETERMINATION MUST BE POSTMARKED OR DELIVERED TO THIS OFFICE AT LEAST 15 DAYS PRIOR TO THE EXPIRATION DATE.

This determination is subject to review if an interested party files a petition that is received by the FAA on or before December 12, 2009. In the event a petition for review is filed, it must contain a full statement of the basis upon which it is made and be submitted in triplicate to the Manager, Airspace and Rules Division - Room 423, Federal Aviation Administration, 800 Independence Ave., Washington, D.C. 20591.

This determination becomes final on December 22, 2009 unless a petition is timely filed. In which case, this determination will not become final pending disposition of the petition. Interested parties will be notified of the grant of any review. For any questions regarding your petition, please contact Office of Airspace and Rules via telephone -- 202-267-8783 - or facsimile 202-267-9328.

This determination is based, in part, on the foregoing description which includes specific coordinates, heights, frequency(ies) and power. Any changes in coordinates, heights, and frequencies or use of greater power will void this determination. Any future construction or alteration, including increase to heights, power, or the addition of other transmitters, requires separate notice to the FAA.

This determination does include temporary construction equipment such as cranes, derricks, etc., which may be used during actual construction of the structure. However, this equipment shall not exceed the overall heights as indicated above. Equipment which has a height greater than the studied structure requires separate notice to the FAA.

This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

This aeronautical study considered and analyzed the impact on existing and proposed arrival, departure, and en route procedures for aircraft operating under both visual flight rules and instrument flight rules; the impact on all existing and planned public-use airports, military airports and aeronautical facilities; and the cumulative impact resulting from the studied structure when combined with the impact of other existing or proposed structures. The study disclosed that the described structure would have no substantial adverse effect on air navigation.

An account of the study findings, aeronautical objections received by the FAA during the study (if any), and the basis for the FAA's decision in this matter can be found on the following page(s).

If we can be of further assistance, please contact Michael Blaich, at (404) 305-7081. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2009-WTE-10282-OE.

Signature Control No: 659464-120138557 (DNH -WT)
Sheri Edgett-Baron
Acting Manager, Obstruction Evaluation Service

Attachment(s)

Additional Information
Map(s)

The proposed construction would be located approximately 4.00 nautical miles (NM) southeast of the Beverly Municipal Airport (BVY). It would exceed the Obstruction Standards of Title 14, Code of Federal Regulations (14 CFR), Part 77 as follows:

Section 77.23(a)(2) by 13 feet - a height that exceeds 386 feet above ground level within 4.00 NM as applied to BVY.

The proposal was not circularized for public comment because current FAA obstruction evaluation policy exempts from circularization those proposals that exceed the above cited obstruction standard. This is provided the proposal does not lie within an airport traffic pattern. This policy does not affect the public's right to petition for review determinations regarding structures, which exceed the subject obstruction standards.

AERONAUTICAL STUDY FOR POSSIBLE INSTRUMENT FLIGHT RULES (IFR) EFFECT DISCLOSED THE FOLLOWING:

> The proposed structure would have no effect on any existing or proposed IFR arrival/departure routes, operations, or procedures.

> The proposed structure would have no effect on any existing or proposed IFR en route routes, operations, or procedures.

> The proposed structure would have no effect on any existing or proposed IFR minimum flight altitudes.

AERONAUTICAL STUDY FOR POSSIBLE VISUAL FLIGHT RULES (VFR) EFFECT DISCLOSED THE FOLLOWING:

> The proposed structure would have no effect on any existing or proposed VFR arrival or departure routes, operations or procedures.

> The proposed structure would not conflict with airspace required to conduct normal VFR traffic pattern operations at any known public use or military airports.

> The proposed structure would not penetrate those altitudes normally considered available to airmen for VFR en route flight.

> The proposed structure will be appropriately obstruction marked and lighted to make it more conspicuous to airmen flying in VFR weather conditions at night.

The cumulative impact of the proposed structure, when combined with other existing structures is not considered significant. Study did not disclose any adverse effect on existing or proposed public-use or military airports or navigational facilities. Nor would the proposal affect the capacity of any known existing or planned public-use or military airport.

Therefore, it is determined that the proposed construction would not have a substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on any air navigation facility and would not be a hazard to air navigation.


BRIDGEPORT
WITCH
Ipswich
SNOW (Pvt)
TOPSFIELD
269 TOF
BEVERLY (BVY)
GT 125.2
ATIS 119.2
122.95
Manchester
SALEM
512
(500) stacks
485
(420)
LYNDY
382 LQ
LYNN
122.1R
VOR-DME
BOSTON
112.7 Ch 74 BOS
122.4
BRIDGEPORT
Fl (2)
516
stacks
691
(505)
393
70
40
30
26
270

DEVAL L. PATRICK, GOVERNOR
TIMOTHY P. MURRAY, LT. GOVERNOR
JEFFREY B. MULLAN, SECRETARY & CEO
CHRISTOPHER WILLENBORG, ADMINISTRATOR

Moving Massachusetts Forward.
massDOT
Aeronautics

July 19, 2010

Jonathan Markey
500 Cummings Center, Suite 5950
Beverly, MA 01915

RE: File No: 10-BVY-V0399-03, Wind Turbine, Salem, MA

Dear Mr. Markey:

Enclosed is a copy of the final determination by the Massachusetts Department of Transportation (MassDOT) Aeronautics Division on your *Request for Airspace Review* of the above referenced proposal. The Aeronautics Division's assistance is offered pursuant to the aviation law requirements of the Commonwealth.

Please note that although the proposal is not subject to further action required by the Aeronautics Division's laws or regulations, this office may offer additional comments after considering FAA's determination of its impact to a public use airport or NAVAID facility through the aeronautical study process.

This project does not violate MassDOT-Aero airspace laws or regulations.

If you have any questions, please feel free to contact me.

Sincerely,

Joanne M Ruddy

Joanne M. Ruddy
Airport Engineer
MassDOT- Aeronautics Division
Phone: 617.412.3689
Email: joanne.ruddy@state.ma.us

Enclosed: Airspace Review Form

Moving Massachusetts Forward.
massDOT
Aeronautics

RECEIVED
JUL - 6 2010
MASSDOT AERONAUTICS DIVISION

For Office Use Only
☒ Airspace Analysis Initials JMP
☐ Comments Received
☐ Aeronautical Study Initiated

REQUEST FOR AIRSPACE REVIEW

MassDOT File No.: 10-BVY-V0399-03 FAA File No.: 2009-WTE-10282-OE (For reference only)

Notice is required by 780 CMR (Code of Massachusetts Regulations) 111.7, *Hazards to air navigation.* Pursuant to Massachusetts General Laws (MGL) Chapter 90, Section 35B, the MassDOT Aeronautics Division agrees to perform an AIRSPACE ANALYSIS and render a determination for the project listed below. **IMPORTANT: All shaded areas must be completed.**

Sponsor (include name, address & telephone number):

Town of Salem
Ms Cindy Keegan, Chair
93 Washington Street
Salem, MA 01970 978-745-9595

Sponsor's Representative (same data if applicable):

Jonathan Markey
500 Cummings Center, Suite 5950
Beverly, MA 01915

Project Description (please type or print clearly):

Proposed Installation of 1.5mw Wind turbine generator @ Winter Island Salem. MA.

☒ REQUIRED: Attach 8½ x 11 inch map (e.g. USGS Quad sheet) showing location of project

Location, Height & Elevation Data:

Nearest City, State: Salem, MA

	Degrees	Minutes	Seconds
Latitude	42	31	37.00
Longitude	70	52	11.40

Datum ☒ NAD 83 or ☐ NAD 27
Site elevation above MSL (ft.): 20 msl
Maximum height above ground (ft.): 399 agl
Maximum elevation above MSL (ft.): 419 msl

Nearest Public-Use Aviation Facility: Beverly Municipal Airport

Print or type, below, the name of person filing this request for review	Signature	Date
Diane Gagnon	Diane Gagnon	7/01/2010

********** DO NOT WRITE BELOW THIS LINE – FOR MASSDOT OFFICE USE ONLY **********

MassDOT's AIRSPACE ANALYSIS concludes the following:

Closest Runway: 34 Distance from RW end: 3.8 NM Offset from RW CL: 4171 FT ☒ Left ☐ Right

- ☐ Project violates MGL Ch. 90, §35B by _____ ft. [Runway Horizontal Plane - 3,000' x 2 Statute Miles, 150' above RW]
- ☐ Project violates MGL Ch. 90, §35B by _____ ft. [Runway Approach Plane - 3,000' x 3,000' @ 20:1 slope]
- ☐ Project violates 702 CMR, §5.03(1)(a) by _____ ft. [Runway Approach Plane / Land - 500' x 10,000' @ 20:1 slope]
- ☐ Project violates 702 CMR, §5.03(2)(a) by _____ ft. [Runway Approach Plane / Water - 500' x 10,000' @ 20:1 slope]
- ☒ Project does not violate MASSDOT Airspace Laws or Regs.

MassDOT hereby issues the following DETERMINATION:

☐ Permit is required* pursuant to MGL Ch.90, §35B, for: ☐ Runway Horizontal Plane ☐ Runway Approach Plane
* Sponsor must submit a separate written request for a MassDOT Airspace Permit. Request should be addressed to: Aeronautics Adminstrator, MassDOT Aeronautics Division, Logan Office Center, One Harborside Drive, East Boston, MA 02128-2909

☒ Permit is not required pursuant to MGL Ch.90, §35B ☐ No violation of Laws or Regs ☐ Ch. 90 violation ≤ 30' agl

☐ MassDOT has the following additional concerns:
☐ FAA Standards ☐ Noise
☐ Traffic Pattern ☐ Wildlife
☐ VFR Route ☐ Other

This determination is based on the foregoing description of the proposed project including the location, height and elevation data provided by the Sponsor. Any change in the data provided to the MassDOT from that which is shown herein will render this determination null and void and will necessitate a new request for review.

Mgr. of Airport Engineering, MassDOT Aeronautics Division — Date: 07/15/10

E: 826033.0CA13

Appendix F

Electronic Communications Facilities

FCC Registered Antenna Towers

Distance	Town/City	Location	Latitude	Longitude	Elevation (m)	Height (m)	Total (m)
2.3	Beverly	376 Hale Street	42.5510	-70.8412	12	60	72
2.9	Marblehead	4 Community Road	42.4852	-70.8737	16	17	33

FCC Registered Boradcast Mobile Towers

Distance	Town/City	Location	Latitude	Longitude	Elevation (m)	Height (m)	Total (m)
0.8	Marblehead	Mound Road	42.5184	-70.8609	9		9

FCC Registered Commercial Cell Phone Towers

Distance	Town/City	Location	Latitude	Longitude	Elevation (m)	Height (m)	Total (m)
2.9	Salem	12 First Street	42.5026	-70.9176	37	47	84
2.3	Salem	Hillside Avenue	42.5154	-70.9142	31	46	77
1.3	Marblehead	Tioga Way					

FCC Registered Private Land Mobile Towers

Distance	Town/City	Location	Latitude	Longitude	Elevation (m)	Height (m)	Total (m)
1.0	Salem	Cor.Lafayette St. & Derby Street	42.5168	-70.8856	1		
1.3	Salem	48 Lafayette Street	42.6440	-70.8687	1		
1.2	Salem	50 Peter Street	42.5240	-70.8934	5		
2.2	Salem	81 Highland Avenue	42.5109	-70.9073	23	38	61
0.3	Salem	24 Fort Avenue	42.5262	-70.8764	3		
1.0	Salem	29 Congress Street	42.5184	-70.8859	0		
1.0	Salem	Pingree Street	42.5168	-70.8856	1		
0.4	Salem	Off Winter Island	42.5215	-70.8756	0		
1.5	Beverly	15 Hale Street	42.5481	-70.8773	14		
1.6	Beverly	15 Hale Street	42.5495	-70.8773	14		
2.3	Beverly	Solier Road	42.5595	-70.8784	10		
2.4	Beverly	100 Cummings Center	42.5578	-70.8922	14		
3.0	Beverly	Cabot Street/1A	42.5685	-70.8883	12		
2.2	Beverly	230 Elliot Street	42.5556	-70.8856	3		
2.8	Beverly	Off Sohier Road	42.5662	-70.8773	24		
1.7	Marblehead	Tower Way					
2.0	Marblehead	Vine Street					

2.2	Marblehead	80 Commercial Street	42.4971	-70.8527	4		
2.5	Marblehead	Kimball Street	42.5027	-70.8344	8		

FCC Registered Microwave Towers

Distance	Town/City	Location	Latitude	Longitude	Elevation (m)	Height (m)	Total (m)
1.3	Salem	1 Salem Grn	42.5221	-70.8951	7	23	30
1.0	Salem	35 Congress Street	42.5180	-70.8880	2	30	32
1.9	Salem	27 Congress Street	42.5139	-70.9050	20	37	57
2.4	Salem	81 Highland Avenue	42.5025	-70.9050	24	41	65
2.0	Salem	40r Highland Avenue	42.5148	-70.9071	24	24	48
0.3	Salem	24 Fort Avenue	42.5262	-70.8764	3	54	57
1.5	Beverly	Cabot Street	42.5472	-70.8792	15		15
2.4	Beverly	900 Cummings Center	42.5589	-70.8873	3	20	23
2.4	Beverly	100 Cummings Center	42.5598	-70.8861	3	26	29
2.5	Beverly	800 Cummings Center	42.5614	-70.8875	4	14	18
2.7	Beverly	85 Herrick Road	42.5648	-70.8758	22	30	52
1.4	Marblehead	46 Tioga Way	42.5101	-70.8561	21	46	67
1.4	Marblehead	Tioga Way	42.5101	-70.8559	21	54	75
1.4	Marblehead	46 Tioga Way	42.5099	-70.8560	20	50	70

FCC Registered Paging Towers

Distance	Town/City	Location	Latitude	Longitude	Elevation (m)	Height (m)	Total (m)
2.9	Salem	12 First Street	42.5028	-70.9175	37	46	83
2.6	Beverly	Herrick Street	42.5643	-70.8761	21	24	45

FCC Registered Maritime Coast & Aviation Ground Towers

Distance	Town/City	Location	Latitude	Longitude	Elevation (m)	Height (m)	Total (m)
0.9	Salem	17 Collins Street	42.5287	-70.8873	0	7	7
0.4	Salem	25 Derby Street	42.5226	-70.8778	0	3	3
1.5	Salem	27 Garden Street	42.5134	-70.8948	6		6
1.6	Salem	23 Glendale Street	42.5084	-70.8895	7	5	12
0.9	Salem	Off Winter Island	42.5251	-70.8537	-5	7	2
0.6	Salem	10 White Street	42.5223	-70.8820	0	8	8
0.8	Salem	Beverly/Salem Bridge	42.5343	-70.8834	3	3	6

0.4	Salem	24 Fort Avenue	42.5234	-70.8784	8	10	18
1.1	Salem	23 Congress Street	42.5195	-70.8898	0	6	6
0.7	Salem	10 White Street	42.5223	-70.8842	5	6	11
1.0	Salem	23 Congress Street	42.5194	-70.8903	0	10	10
1.8	Beverly	Kernwood Drawbridge	42.5430	-70.8985		3	3
1.0	Beverly	Tucks Point	42.5395	-70.8801	2	8	10
1.2	Beverly	43 Water Street	42.5415	-70.8834	2	7	9
0.9	Beverly	Congress Street @ Draw Shanty	42.5231	-70.8876	3	8	11
2.4	Marblehead	Corinthian Lane	42.5040	-70.8362	0	3	3
2.6	Marblehead	89 Front Street	42.5009	-70.8348	10	11	21
2.7	Marblehead	6 Cliff Street	42.4965	-70.8369	19	6	25
1.1	Marblehead	208 Beacon Street	42.5140	-70.8578	19	7	26
1.5	Marblehead	5 Calthrope Road	42.5126	-70.8481	14	7	21
1.3	Marblehead	32 Tioga Way	42.5109	-70.8567	21	9	30
2.3	Marblehead	4 Cliff Street	42.4962	-70.8527	3	7	10

Beverly

FCC Registered Antenna Towers: 6

- KELLYE E ABERNATHY, Boulder Lane, Type: Pole, Structure height: 34.1 m, Overall height: 34.1 m
  Registrant: Cingular Wireless LLC, 5601 Legacy Drive, Ms: A-3, Plano, TX 75024, Phone: (469) 229-7422, Email: kellye.e.abernathy@cingular.com
- Lisa M Minney, Dunham Rd. Extension, Lot #6 (Bs03xc065), Type: Tower, Structure height: 56.6 m, Overall height: 60.4 m, , Licensee ID: L01051441
  Registrant: Stc Six Company, 6391 Sprint Parkway, Overland Park, KS 66251, Phone: (877) 265-6872, Email: ssusaregulatory@mail.sprint.com
- Edward G Roach, 274 North Main Street, Type: Tower, Structure height: 45.7 m, Overall height: 47.8 m, , Licensee ID: L00131772
  Registrant: Sba Properties, Inc., 5900 Broken Sound Pkwy., Nw, Boca Raton, FL 33487, Phone: (561) 995-7670, Email: eroach@sbasite.com
- Tim Canelli, Hunt Center, 75 Lindall Street, Type: Tower, Structure height: 18.3 m, Overall height: 32.9 m
  Registrant: Consolidated Spectrum Services, 22 Merril Drive, Atkinson, NH 03811, Phone: (603) 362-5977, Email: howard@fcc1.biz
- Richard J Byrne, 46 L.P. Henderson Road, Type: Tower, Structure height: 27.1 m, Overall height: 27.1 m
  Registrant: Towerco Assets LLC, 5000 Valleystone Drive, Suite 200, Cary, NC 27519, Phone: (919) 653-5710, Email: afry@towerco.com
- EDWARD T MOORE, 376 Hale Street (Leasehold), Type: Pole, Structure height: 58.7 m, Overall height: 60 m
  Registrant: Glover Property Management, Inc., 8 Doaks Lane, Marblehead, MA 01945, Phone: (781) 639-1113, Email: tedmoore@gloverproperty.com

FCC Registered Private Land Mobile Towers: 13 (See the full list of FCC Registered Private Land Mobile Towers in Beverly, MA)
FCC Registered Broadcast Land Mobile Towers: 1 (See the full list of FCC Registered Broadcast Land Mobile Towers)
FCC Registered Microwave Towers: 11 (See the full list of FCC Registered Microwave Towers in this town)
FCC Registered Paging Towers: 2 (See the full list of FCC Registered Paging Towers)
FCC Registered Maritime Coast & Aviation Ground Towers: 4 (See the full list of FCC Registered Maritime Coast & Aviation Ground Towers)
FCC Registered Amateur Radio Licenses: 134 (See the full list of FCC Registered Amateur Radio Licenses in Beverly)

FAA Registered Aircrafts: 24 (See the full list of FAA Registered Aircrafts in Beverly)

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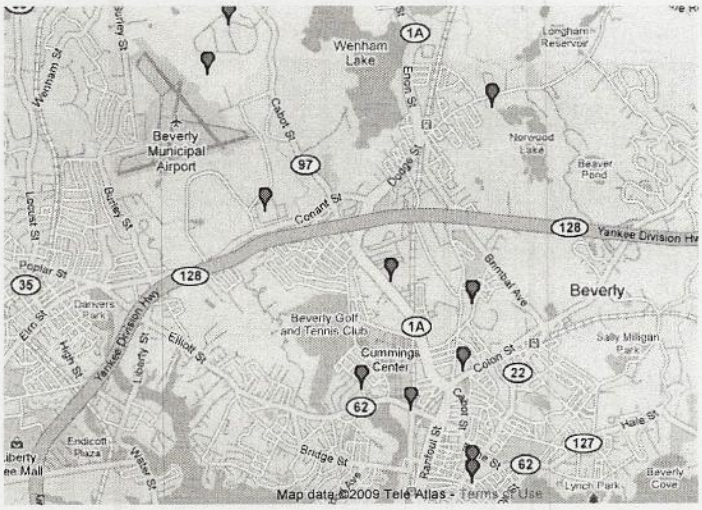
FCC Registered Land Mobile Towers in Beverly, Massachusetts

Back to: Beverly, MA, Massachusetts, Massachusetts forum, All US cities.

Private, Broadcast

FCC Registered Private Land Mobile Towers in Beverly, MA



Note: Not all land mobile towers must be registered in the FCC database, so the above map may not list all the towers in the area.

Full list of 13 FCC Registered Private Land Mobile Towers in Beverly, MA:

15 Hale St (Lat: 42.548139 Lon: -70.877278), Call Sign: KAY259, Licensee ID: L00008964
Assigned Frequencies : 154.070 MHz
Grant Date: 04/09/2003, Expiration Date: 04/05/2013
Registrant: City Of Beverly, 15 Hale St, Beverly, MA 01915-4502

15 Hale St (Lat: 42.549528 Lon: -70.877278), Call Sign: KCG966, Licensee ID: L00008964
Assigned Frequencies : 45.4800 MHz
Grant Date: 11/19/1997, Expiration Date: 01/27/2003, Cancelation Date: 12/18/2002
Registrant: City Of Beverly, 15 Hale St, Beverly, MA 01915

Henderson Rd (Lat: 42.594528 Lon: -70.910333), Call Sign: KNBV916, Licensee ID: L00008964
Assigned Frequencies : 153.875 MHz
Grant Date: 06/01/2005, Expiration Date: 08/28/2015
Registrant: Massachusetts, Commonwealth Of, 13 Morningside Dr, Beverly, MA 01915, Phone: (978) 922-5680, Fax: (978) 922-8990, Email: mfoster@beverlyma.gov

Henderson Rd (Lat: 42.589528 Lon: -70.913111), Call Sign: WNCD529, Licensee ID: L00003516
Assigned Frequencies : 153.965 MHz
Grant Date: 12/04/2004, Expiration Date: 03/02/2015
Registrant: Commonwealth Of Massachusetts, 400 Worcester Rd, Framingham, MA 01702-5399, Phone: (508) 820-2023, Fax: (508) 875-2517, Email: tom.muise@state.ma.us

Solier Rd (Lat: 42.559528 Lon: -70.878389), Call Sign: KKD372, Licensee ID: L00008964
Assigned Frequencies : 155.205 MHz
Grant Date: 05/24/2002, Expiration Date: 05/24/2012
Registrant: Beverly Public Schools, 4 Colon St, Beverly, MA 01915, Phone: (508) 921-6109

100 Cummings Center (Lat: 42.557778 Lon: -70.892222), Type: Bant, Structure height: 20 m, Overall height: 27 m, Call Sign: WPLX656
Assigned Frequencies : 464.475 MHz
Grant Date: 04/24/2003, Expiration Date: 04/06/2013, Certifier: James Gillette
Registrant: North Shore Two Way, 13 Morningside Drive, Beverly, MA 01915, Phone: (978) 927-5575, Fax: (978) 922-8990, Email: mfoster@shore.net

7 Sonning Rd (Lat: 42.586194 Lon: -70.874500), Call Sign: KDZ559
Assigned Frequencies : 152.900 MHz
Grant Date: 07/18/1996, Expiration Date: 09/19/2001, Cancelation Date: 02/17/2002
Registrant: Michaud & Raymond Oil Inc, 84 Congress St, Salem, MA 01970

Lat: 42.568500 Lon: -70.888278, Call Sign: WPYW502, Licensee ID: L00729124
Assigned Frequencies : 72.1200 MHz
Grant Date: 11/17/2003, Expiration Date: 11/17/2013, Certifier: John Beal
Registrant: Shore Country Day School

230 Illiott Street (Lat: 42.555556 Lon: -70.885556), Call Sign: WQBD464
469.162 MHz, 35.0200 MHz, 30.8400 MHz, 154.540 MHz, 33.4000 MHz, 33.1600 MHz, 31.2400 MHz, 468.487 MHz, 468.762 MHz, 468.837 MHz... (+21 more)
Grant Date: 09/23/2004, Expiration Date: 09/23/2014, Certifier: Beth Cotner
Registrant: Dolfen Consulting Group, 95 Willow Lane, Bristol, IL 60512-9711, Phone: (630) 553-5886, Fax: (630) 566-1755, Email: mdolfen@aol.com

Beverly, MA, Lat: 42.566194 Lon: -70.877278, Call Sign: WQCK331
Assigned Frequencies : 72.4400 MHz, 75.5200 MHz
Grant Date: 03/23/2005, Expiration Date: 03/23/2015, Certifier: William Ambrefe
Registrant: Signal Communications Corporation, 4 Wheeling Ave, Woburn, MA 01801, Phone: (781) 933-0998, Fax: (781) 933-5019, Email: jwatts@sigcom.com

Lat: 42.566194 Lon: -70.877278, Call Sign: WQDK651
Assigned Frequencies : 453.087 MHz
Grant Date: 09/20/2005, Expiration Date: 09/20/2015, Certifier: William Ambrefe
Registrant: Agent, 6 Pequot Way, Canton, MA 02021, Phone: (781) 828-1955, Fax: (781) 828-3719, Email: davewestcott@easton-electronics.com

Lat: 42.575667 Lon: -70.905472, Call Sign: WQHB261
Assigned Frequencies : 72.2800 MHz
Grant Date: 06/15/2007, Expiration Date: 06/15/2017, Certifier: Don Godfrey
Registrant: Primex Wireless, Inc, 965 Wells St, Lake Geneva, WI 53147, Phone: (800) 537-0464

Lat: 42.566194 Lon: -70.877278, Call Sign: WQHN497
Assigned Frequencies : 153.942 MHz, 153.942 MHz
Grant Date: 09/18/2007, Expiration Date: 09/18/2017, Certifier: Andrew Tilton
Registrant: The Alarm Room, 44 Suffolk Drive, East Hartford, CT 06118-2652, Phone: (860) 982-5676, Email: alarmroom2000@yahoo.com

Private, Broadcast

Full list of 1 FCC Registered Broadcast Land Mobile Towers in Beverly, MA:

Call Sign: KA74862
Assigned Frequencies : 450.650 MHz, 450.450 MHz, 455.450 MHz, 455.650 MHz
Grant Date: 11/30/1981, Expiration Date: 04/01/1998, Cancelation Date: 09/24/2000
Registrant: Fsam Corp., 36r Union Street, Manchester, MA 01944

Private, Broadcast

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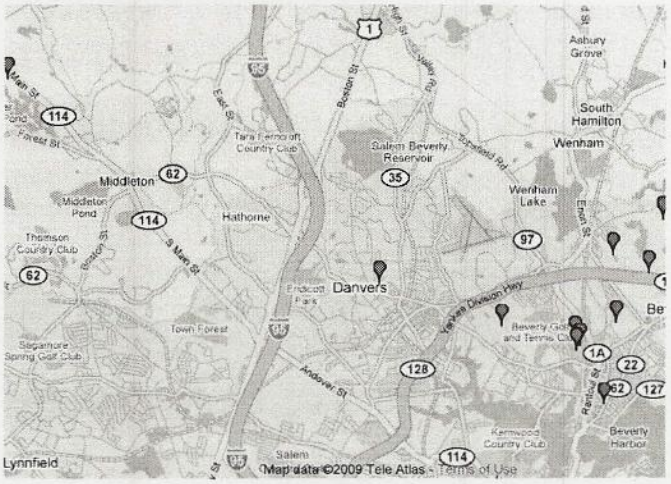
FCC Registered Microwave, Paging and Maritime Coast & Aviation Ground Towers in Beverly, Massachusetts

Back to: Beverly, MA, Massachusetts, Massachusetts forum, All US cities.

Microwave, Paging, Maritime Coast

FCC Registered Microwave Towers in Beverly, MA



Note: Not all towers must be registered in the FCC database, so the above map may not list all the towers in the area.

Full list of 11 FCC Registered Microwave Towers in Beverly, MA:

BEVERLY, Brimball Hill Rd (Lat: 42.579250 Lon: -70.876944), Type: Tank, Structure height: 34.4 m, Overall height: 40.5 m, Call Sign: WMM416
Assigned Frequencies : 10642.5 MHz
Grant Date: 03/06/2001, Expiration Date: 02/01/2011, Certifier: Carol L Tacker
Registrant: Cingular Wireless LLC, 5601 Legacy Drive, Ms A-3, Plano, TX 75024, Phone: (469) 229-7506, Fax: (469) 229-7295, Email: barbara.haby@cingular.com

BEVERLY, Lat: 42.547222 Lon: -70.879167, Call Sign: WPQS238
Assigned Frequencies : 956.318 MHz
Grant Date: 09/13/2000, Expiration Date: 09/13/2010, Certifier: Brian P Moriarty
Registrant: Utc Spectrum Services, 1140 Connecticut Ave. Nw Suite 1140, Washington, DC 20036, Phone: (202) 872-0030, Fax: (202) 331-7639, Email: rmcilwai@utc.org

BOS9043011, 900 Cummings Ctr (Lat: 42.558944 Lon: -70.887333), Type: Pole, Structure height: 13.4 m, Overall height: 20.1 m, Call Sign: WPQY332
Assigned Frequencies : 21275.0 MHz
Grant Date: 11/27/2000, Expiration Date: 11/27/2010, Cancelation Date: 06/26/2002, Certifier: Terri B Natoli Esq
Registrant: Backlink Iv, LLC, 460 Herndon Parkway, Suite 100, Herndon, VA 20170, Phone: (703) 326-4650, Fax: (703) 326-4185, Email: terri.natoli@teligent.com

BOSP027, 100 Cummings Ctr. (Lat: 42.559806 Lon: -70.886111), Type: Pole, Structure height: 18.3 m, Overall height: 25.9 m, Call Sign: WPRR785
Assigned Frequencies : 22625.0 MHz, 22475.0 MHz
Grant Date: 01/03/2001, Expiration Date: 01/03/2011, Cancelation Date: 06/26/2002, Certifier: Terri B Natoli Esq
Registrant: Backlink Iv, LLC, 460 Herndon Parkway, Suite 100, Herndon, VA 20170, Phone: (703) 326-4650, Fax: (703) 326-4185, Email: terri.natoli@teligent.com

BOS9043010, 800 Cummings Ctr. (Lat: 42.561361 Lon: -70.887500), Type: Pole, Structure height: 11.9 m, Overall height: 14.3 m, Call Sign: WPRS451
Assigned Frequencies : 21425.0 MHz
Grant Date: 01/11/2001, Expiration Date: 01/11/2011, Cancelation Date: 06/26/2002, Certifier: Terri B Natoli Esq
Registrant: Backlink Iv, LLC, 460 Herndon Parkway, Suite 100, Herndon, VA 20170, Phone:

(703) 326-4650, Fax: (703) 326-4185, Email: terri.natoli@teligent.com

Hunt Center, MA, Hunt Center, 75 Lindall Street (Lat: 42.573139 Lon: -70.943417), Type: Tower, Structure height: 18.3 m, Overall height: 32.9 m, Call Sign: WPYR927
Assigned Frequencies : 23175.0 MHz
Grant Date: 10/09/2003, Expiration Date: 10/09/2013, Certifier: Gerard Geggis
Registrant: Consolidated Spectrum Services, 22 Merrill Drive, Atkinson, NH 03811, Phone: (603) 362-5977, Fax: (603) 362-5977, Email: howard@fcc1.biz

Beverly Hospital, CA, 85 Herrick St (Lat: 42.564778 Lon: -70.875750), Type: Pole, Structure height: 24.4 m, Overall height: 29.5 m, Call Sign: WPYR928
Assigned Frequencies : 21975.0 MHz
Grant Date: 10/09/2003, Expiration Date: 10/09/2013, Certifier: Gerard Geggis
Registrant: Consolidated Spectrum Services, 22 Merrill Driive, Atkinson, NH 03811, Phone: (603) 362-5977, Fax: (603) 362-5977, Email: howard@fcc1.biz

DUNHAM, Dunham Rd. Extension, Lot #6 (Bs03xc065) (Lat: 42.575278 Lon: -70.866667), Type: Tower, Structure height: 58.2 m, Call Sign: WQAL420
Assigned Frequencies : 23075.0 MHz
Grant Date: 06/28/2004, Expiration Date: 06/28/2014, Certifier: Russell Leathe
Registrant: Peak Networks Inc., 32 Third Ave., Burlington, MA 01803, Phone: (781) 425-6500, Fax: (781) 270-5023

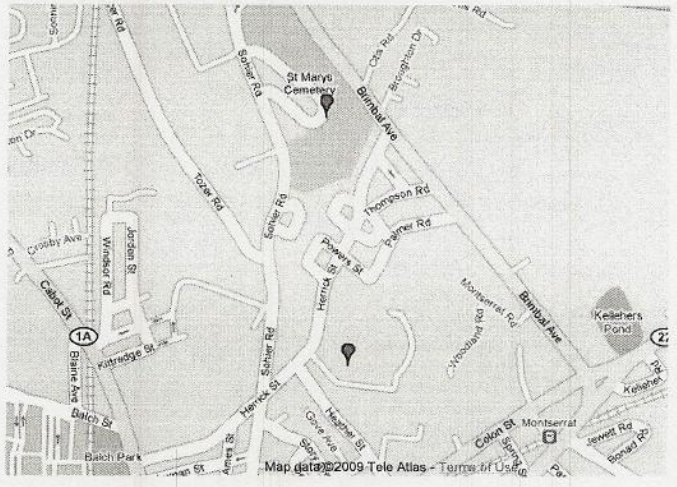
BOS0512, 274 North Main Street (Lat: 42.616611 Lon: -71.049639), Type: Tower, Structure height: 45.7 m, Overall height: 47.8 m, Call Sign: WQBM781, Licensee ID: L00608820
Assigned Frequencies : 10597.5 MHz
Grant Date: 11/08/2004, Expiration Date: 11/08/2014, Cancelation Date: 05/26/2006, Certifier: Eric M Botto
Registrant: Fibertower Corporation, 185 Berry Street, Suite 4800, San Francisco, CA 94107, Phone: (415) 659-3500, Fax: (415) 659-0007, Email: tarun@fibertower.com

8 Enon St. (Lat: 42.586750 Lon: -70.862528), Overall height: 18.9 m, Call Sign: WLO995
Assigned Frequencies : 947.000 MHz
Grant Date: 04/22/1991, Expiration Date: 04/01/2014
Registrant: Citicasters Licenses, Inc., 2625 S. Memorial Drive, Suite A, Tulsa, OK 74129, Phone: (918) 664-4581, Fax: (918) 664-3066, Email: fcccontact@clearchannel.com

BEVERLY, Folly Hill Off Trask Ln (Lat: 42.563972 Lon: -70.908389), Type: Tank, Structure height: 43.9 m, Call Sign: WLU807
Assigned Frequencies : 10637.5 MHz, 11245.0 MHz
Grant Date: 02/06/2001, Expiration Date: 02/01/2011
Registrant: Verizon Wireless, 1120 Sanctuary Pkwy, #150 Gasa5reg, Alpharetta, GA 30004, Phone: (770) 797-1070, Fax: (770) 797-1036, Email: network.regulatory@verizonwireless.com

Microwave, Paging, Maritime Coast

FCC Registered Paging Towers in Beverly, MA



Note: Not all towers must be registered in the FCC database, so the above map may not list all the towers in the area.

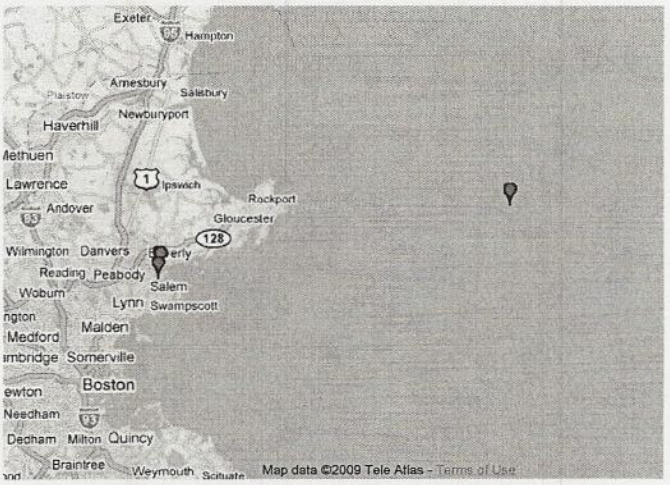
Full list of 2 FCC Registered Paging Towers in Beverly, MA:

Beverly Hospital, Herrick Street (Lat: 42.564250 Lon: -70.876139), Overall height: 24.4 m, Call Sign: KNKD581
Assigned Frequencies : 43.4200 MHz
Expiration Date: 04/01/1999, Cancelation Date: 03/31/1999
Registrant: Mobilemedia Communications, Inc., Debtor-In-Possession, 2101 Wilson Boulevard, Suite 935, Arlington, VA 22201, Phone: (703) 312-5153, Fax: (703) 312-5155, Email: cpinkerton@mobilecomm.com

112 Sohier Road (Lat: 42.570917 Lon: -70.876972), Call Sign: KNKK735
Assigned Frequencies : 931.937 MHz
Grant Date: 08/19/1999, Expiration Date: 04/01/2009, Certifier: John A Fellows
Registrant: Drinker Biddle & Reath LLP, 1500 K Street, N.W. - Suite 1100, Washington, DC 20005, Phone: (202) 230-5180, Fax: (202) 387-3467, Email: mark.denbo@dbr.com

Microwave, Paging, Maritime Coast

FCC Registered Maritime Coast & Aviation Ground Towers in Beverly, MA



Note: Not all towers must be registered in the FCC database, so the above map may not list all the towers in the area.

Full list of 4 FCC Registered Maritime Coast & Aviation Ground Towers in Beverly, MA:

Kernwood Ave Kernwood Drawbridge (Lat: 42.646750 Lon: -70.082806), Type: Building, Overall height: 3 m, Call Sign: WHD809
Assigned Frequencies : 156.450 MHz, 156.650 MHz, 156.800 MHz
Grant Date: 03/21/1994, Expiration Date: 03/21/1999, Cancelation Date: 05/06/2001
Registrant: State Of Massachusetts, 519 Appleton St, Arlington, MA 02174

Tucks Pt (Lat: 42.539528 Lon: -70.880056), Type: Building, Overall height: 8 m, Call Sign: WHH341, Licensee ID: L00352143
Assigned Frequencies : 156.800 MHz, 156.450 MHz
Grant Date: 06/06/2001, Expiration Date: 06/25/2011
Registrant: Jubilee Yacht Club Inc, Tucks Pt, Beverly, MA 01915-6104

43 Water St (Lat: 42.541472 Lon: -70.883389), Type: Building, Overall height: 7 m, Call Sign: WQB456, Licensee ID: L00560015
Assigned Frequencies : 156.450 MHz, 156.800 MHz, 156.975 MHz
Grant Date: 07/03/2003, Expiration Date: 07/14/2013
Registrant: Beverly Port Marina Inc, 43 Water St, Beverly, MA 01915

Near Congress St At Draw Shanty (Lat: 42.523139 Lon: -70.887556), Type: Building, Overall height: 8 m, Call Sign: WRD625
Assigned Frequencies : 156.800 MHz, 156.425 MHz, 156.450 MHz
Grant Date: 01/09/2004, Expiration Date: 04/07/2014
Registrant: Massachusetts Bay Transportation Authority Chief Engineers Office, 32 Cobble Hill Rd., Somerville,, MA 02143, Phone: (617) 222-5439, Fax: (617) 222-3605

Marblehead

FCC Registered Cell Phone Towers: 1

- Tioga Way, Type: Mast, Structure height: 47.2 m, Call Sign: KNKA201
  880.020 MHz, 835.020 MHz, 891.510 MHz, 846.510 MHz, 835.020 MHz, 880.020 MHz, 880.020 MHz, 835.020 MHz, 891.510 MHz, 846.510 MHz... (+8 more)
  Grant Date: 11/15/2004, Expiration Date: 10/01/2014
  Registrant: Verizon Wireless, 1120 Sanctuary Pkwy, #150 Gasa5reg, Alpharetta, GA 30004, Phone: (770) 797-1070, Fax: (770) 797-1036, Email: network.regulatory@verizonwireless.com

FCC Registered Antenna Towers: 1

- 4 Community Rd, Type: Bant, Structure height: 17 m, Overall height: 17 m
  Registrant: At&t Wireless Services, 1150 Connecticut Ave Nw 4th Flr, Washington, DC 20036, Phone: (202) 223-9222, Email: esther.hilliard@attws.com

FCC Registered Private Land Mobile Towers: 4

- Tower Way, Call Sign: KQO302, Licensee ID: L00026047
  Assigned Frequencies : 155.835 MHz
  Grant Date: 04/27/2005, Expiration Date: 05/16/2015
  Registrant: Marblehead, Town Of, Marblehead, MA 01945, Phone: (617) 631-0102
- Vine St, Call Sign: KCC809, Licensee ID: L00026047
  Assigned Frequencies : 153.665 MHz
  Grant Date: 08/30/2005, Expiration Date: 11/06/2015
  Registrant: Marblehead, Town Of, 80 Commercial St, Marblehead, MA 01945, Phone: (781) 631-0240
- 80 Commercial St, Call Sign: WNLQ584, Licensee ID: L00026047
  Assigned Frequencies : 173.262 MHz
  Grant Date: 04/10/2003, Expiration Date: 05/06/2013
  Registrant: Marblehead, Town Of, 80 Commercial St, Marblehead, MA 01945, Phone: (617) 631-5600
- Lat: 42.502667 Lon: -70.834444, Call Sign: WQDB575
  Assigned Frequencies : 152.442 MHz, 152.277 MHz, 152.307 MHz, 152.322 MHz, 152.367 MHz
  Grant Date: 07/14/2005, Expiration Date: 07/14/2015, Certifier: Robert Hastings
  Registrant: Skylines Unlimited Inc, 100 Stone Church Road, Carlisle, PA 17013, Phone: (717) 218-5003, Fax: (717) 218-5005, Email: skylines@comcast.net

FCC Registered Broadcast Land Mobile Towers: 1

- Lat: 42.518417 Lon: -70.860889, Call Sign: KCH739
  Assigned Frequencies : 153.230 MHz
  Grant Date: 03/30/1972, Expiration Date: 04/01/1975, Cancelation Date: 09/24/2000
  Registrant: North Shore Broadcasting Corp

FCC Registered Microwave Towers: 4 (See the full list of FCC Registered Microwave Towers in this town)
FCC Registered Maritime Coast & Aviation Ground Towers: 7 (See the full list of FCC Registered Maritime Coast & Aviation Ground Towers)
FCC Registered Amateur Radio Licenses: 102 (See the full list of FCC Registered Amateur Radio Licenses in Marblehead)

FAA Registered Aircrafts: 19 (See the full list of FAA Registered Aircrafts in Marblehead))

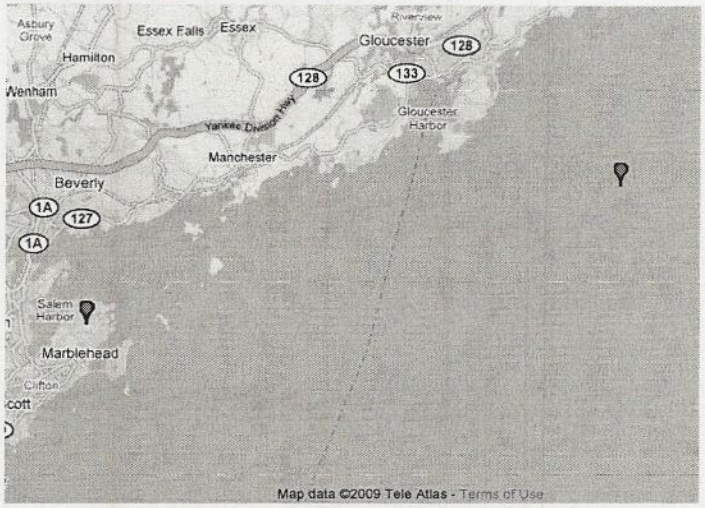
City-Data.com FORUM

FCC Registered Microwave, Paging and Maritime Coast & Aviation Ground Towers in Marblehead, Massachusetts

Back to: Marblehead, MA, Massachusetts, Massachusetts forum, All US cities.

Microwave, Maritime Coast

FCC Registered Microwave Towers in Marblehead, MA



Note: Not all towers must be registered in the FCC database, so the above map may not list all the towers in the area.

Full list of 4 FCC Registered Microwave Towers in Marblehead, MA:

STATION, 46 Tioga Way (Lat: 42.510083 Lon: -70.856139), Overall height: 45.7 m, Call Sign: WNEM493
Assigned Frequencies : 21825.0 MHz
Grant Date: 02/28/1991, Expiration Date: 02/28/1996, Cancelation Date: 01/22/1996
Registrant: Phone: (508) 658-0400

MARBLEHEAD, Tioga Way (Lat: 42.510111 Lon: -70.855889), Type: Tower, Structure height: 54.3 m, Call Sign: WPJA549
Assigned Frequencies : 10658.1 MHz
Grant Date: 02/06/2001, Expiration Date: 02/01/2011
Registrant: Verizon Wireless, 1120 Sanctuary Pkwy, #150 Gasa5reg, Alpharetta, GA 30004, Phone: (770) 797-1070, Fax: (770) 797-1036, Email: network.regulatory@verizonwireless.com

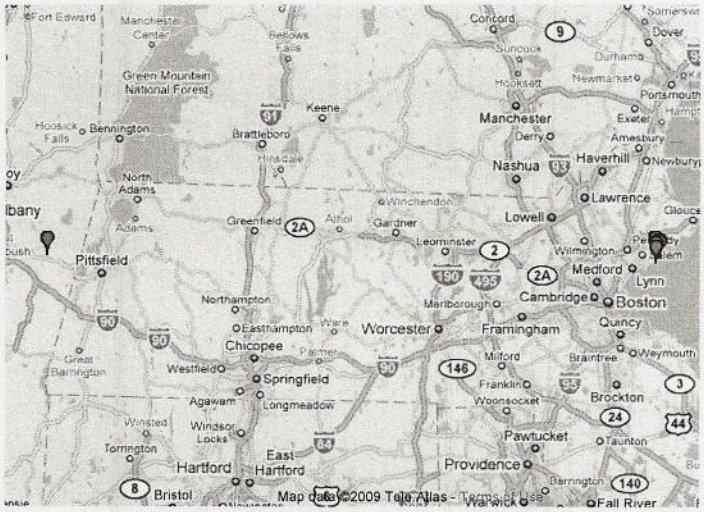
Various Locations (Lat: 42.566750 Lon: -70.566139), Overall height: 2.4 m, Call Sign: WPNH741
Assigned Frequencies : 956.431 MHz
Grant Date: 03/04/2008, Expiration Date: 03/16/2018
Registrant: Phone: (412) 430-3974

MARBLEHEAD, 46 Tioga Way (Lat: 42.509917 Lon: -70.856028), Type: Mast, Structure height: 46.9 m, Overall height: 50 m, Call Sign: WLV730
Assigned Frequencies : 10626.2 MHz
Grant Date: 05/09/2000, Expiration Date: 04/01/2010, Certifier: Carol L Tacker
Registrant: Cingular Wireless LLC, 5601 Legacy Drive Ms A-3, Plano, TX 75024, Phone: (469) 229-7506, Fax: (469) 229-7295, Email: barbara.haby@cingular.com

Microwave, Maritime Coast

FCC Registered Maritime Coast & Aviation Ground Towers in Marblehead.

MA



Note: Not all towers must be registered in the FCC database, so the above map may not list all the towers in the area.

Full list of 7 FCC Registered Maritime Coast & Aviation Ground Towers in Marblehead, MA:

Corinthian Lane Jack Point (Lat: 42.503972 Lon: -70.836167), Type: Building, Overall height: 3 m, Call Sign: KUZ480, Licensee ID: L00493105
Assigned Frequencies : 156.450 MHz, 156.475 MHz, 156.800 MHz
Grant Date: 06/05/2002, Expiration Date: 06/05/2012
Registrant: Corinthian Yacht Club, Marblehead, MA 01945

89 Front St (Lat: 42.500917 Lon: -70.834778), Type: Building, Overall height: 11 m, Call Sign: WHD511, Licensee ID: L00007792
Assigned Frequencies : 156.425 MHz, 156.450 MHz, 156.800 MHz, 156.900 MHz
Grant Date: 01/26/1999, Expiration Date: 04/06/2004, Cancelation Date: 06/06/2004
Registrant: Marblehead Trading Co, 89 Front St, Marblehead, MA 01945

6 Cliff St (Lat: 42.485639 Lon: -70.849778), Type: Building, Overall height: 6 m, Call Sign: WHD738, Licensee ID: L00007792
Assigned Frequencies : 156.975 MHz, 156.450 MHz, 156.800 MHz
Grant Date: 01/23/1995, Expiration Date: 01/23/2000, Cancelation Date: 05/06/2001
Registrant: Marblehead Trading Company, 89 Front St, Marblehead, MA 01945

208 Beacon St (Lat: 42.513972 Lon: -70.857833), Type: Building, Overall height: 7 m, Call Sign: WHU316, Licensee ID: L00007035
Assigned Frequencies : 156.450 MHz, 156.575 MHz, 156.800 MHz
Grant Date: 02/23/1996, Expiration Date: 04/26/2001, Cancelation Date: 07/29/2001
Registrant: West Shore Marine Inc, 208 Beacon St, Marblehead, MA 01945

5 Calthrope Rd (Lat: 42.512583 Lon: -70.848111), Type: Building, Overall height: 7 m, Call Sign: WHU589, Licensee ID: L00007945
Assigned Frequencies : 156.425 MHz, 156.450 MHz, 156.800 MHz
Grant Date: 02/26/2004, Expiration Date: 05/13/2014
Registrant: Cloutman Marine Services Inc, 7 Calthrope Rd., Marblehead, MA 01945, Phone: (781) 631-9751, Fax: (781) 631-9751, Email: cloutmanmarine@aol.com

32 Tioga Way (Lat: 42.505639 Lon: -73.499556), Type: Building, Overall height: 9 m, Call Sign: WHX269
Assigned Frequencies : 156.425 MHz, 156.450 MHz, 156.500 MHz, 156.800 MHz
Grant Date: 03/29/1999, Expiration Date: 06/02/2004, Cancelation Date: 08/08/2004
Registrant: Hansen Marine Engineering Inc, 32 Tioga Way, Marblehead, MA 01945

4 Cliff Street (Lat: 42.496222 Lon: -70.852667), Type: Bant, Structure height: 2 m, Overall height: 7 m, Call Sign: WQGN227
Assigned Frequencies : 156.575 MHz, 156.800 MHz, 156.525 MHz, 156.925 MHz,

156.500 MHz, 156.450 MHz, 156.425 MHz, 156.475 MHz
Grant Date: 03/07/2007, Expiration Date: 03/07/2017, Certifier: Stephen Karger
Registrant: Marblehead Yacht Club, Inc., 4 Cliff Street, Marblehead, MA 01945, Phone: (781) 631-9771, Email: stevemyc@verizon.net

Microwave, Maritime Coast

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Back to: Marblehead, MA, Massachusetts, All US cities.

Salem

FCC Registered Cell Phone Towers: 1

- 12 First Street, Type: Building, Structure height: 43.9 m, Overall height: 46.3 m, Call Sign: KNKA201
  880.020 MHz, 835.020 MHz, 891.510 MHz, 846.510 MHz, 835.020 MHz, 880.020 MHz, 880.020 MHz, 835.020 MHz, 891.510 MHz, 846.510 MHz... (+8 more)
  Grant Date: 11/15/2004, Expiration Date: 10/01/2014
  Registrant: Verizon Wireless, 1120 Sanctuary Pkwy, #150 Gasa5reg, Alpharetta, GA 30004, Phone: (770) 797-1070, Fax: (770) 797-1036, Email: network.regulatory@verizonwireless.com

FCC Registered Antenna Towers: 1

- Off Highland Ave, Type: Pole, Structure height: 32.6 m, Overall height: 32.6 m
  Registrant: At&t Wireless Services Inc, 1150 Connecticut Ave Nw 4th Fl, Washington, DC 20036, Phone: (202) 223-9222, Email: esther.hilliard@attws.com

FCC Registered Commercial Land Mobile Towers: 2 (See the full list of FCC Registered Commercial Land Mobile Towers in Salem, MA)
FCC Registered Private Land Mobile Towers: 14 (See the full list of FCC Registered Private Land Mobile Towers)
FCC Registered Microwave Towers: 12 (See the full list of FCC Registered Microwave Towers in this town)
FCC Registered Paging Towers: 4 (See the full list of FCC Registered Paging Towers)
FCC Registered Maritime Coast & Aviation Ground Towers: 13 (See the full list of FCC Registered Maritime Coast & Aviation Ground Towers)
FCC Registered Amateur Radio Licenses: 94 (See the full list of FCC Registered Amateur Radio Licenses in Salem)

FAA Registered Aircrafts: 12 (See the full list of FAA Registered Aircrafts in Salem)

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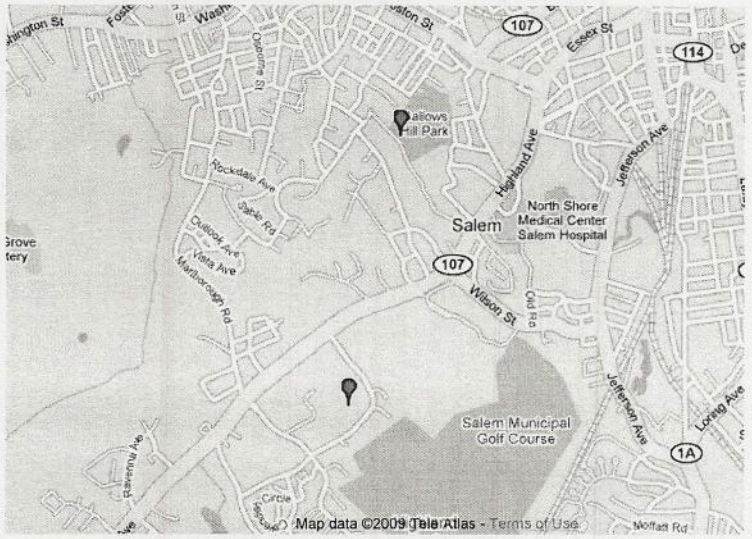
FCC Registered Land Mobile Towers in Salem, Massachusetts

Back to: Salem, MA, Massachusetts, Massachusetts forum, All US cities.

Commercial, Private

FCC Registered Commercial Land Mobile Towers in Salem, MA



Note: Not all land mobile towers must be registered in the FCC database, so the above map may not list all the towers in the area.

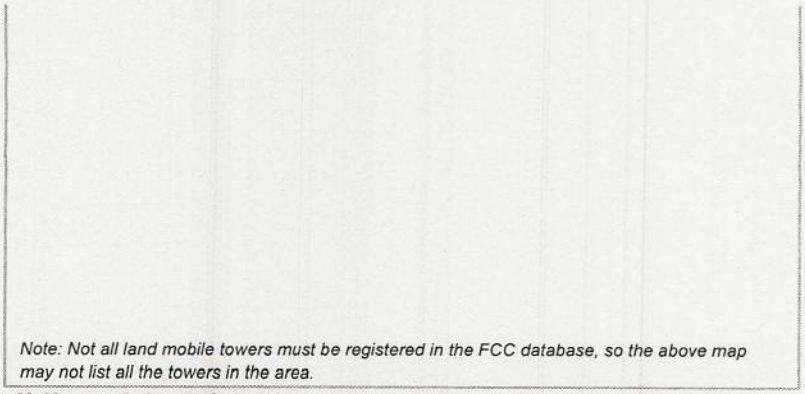
Full list of 2 FCC Registered Commercial Land Mobile Towers in Salem, MA:

12 First St (Lat: 42.502583 Lon: -70.917556), Type: Tower, Structure height: 47 m, Call Sign: WPGR943, Licensee ID: L00120834
Assigned Frequencies : 929.987 MHz
Grant Date: 03/08/2000, Expiration Date: 03/08/2010, Cancelation Date: 04/29/2003
Registrant: Map Paging Co Inc, 840 Greenbrier Cir Ste 202, Chesapeake, VA 23320, Phone: (757) 424-1191

Hillside Ave. (Lat: 42.515361 Lon: -70.914222), Type: Tower, Structure height: 46 m, Call Sign: WPLA763, Licensee ID: L00124895
858.012 MHz, 858.587 MHz, 859.012 MHz, 859.587 MHz, 860.587 MHz, 862.012 MHz, 862.037 MHz, 862.062 MHz, 862.087 MHz, 862.112 MHz... (+157 more)
Grant Date: 01/01/2002, Expiration Date: 02/06/2012
Registrant: Nextel Communications Of The Mid-Atlantic, Inc., 2001 Edmund Halley Drive, Reston, VA 20191, Phone: (703) 433-4000, Fax: (703) 433-4035

Commercial, Private

FCC Registered Private Land Mobile Towers in Salem, MA



Note: Not all land mobile towers must be registered in the FCC database, so the above map may not list all the towers in the area.

Full list of 14 FCC Registered Private Land Mobile Towers in Salem, MA:

Cor Lafayette & New Derby Sts Salem Fire Headquartes (Lat: 42.516750 Lon: -70.885611), Call Sign: KCH507, Licensee ID: L00048268
Assigned Frequencies : 46.4200 MHz, 154.070 MHz
Grant Date: 09/16/2003, Expiration Date: 11/25/2013
Registrant: City Of Salem, Cor Lafayette & New Derby Sts, Salem, MA 01970

48 Lafayette St (Lat: 42.516750 Lon: -70.885611), Call Sign: KNAL781, Licensee ID: L00048268
Assigned Frequencies : 153.875 MHz
Grant Date: 12/15/2000, Expiration Date: 02/06/2011
Registrant: City Of Salem, 48 Lafayette St, Salem, MA 01970, Phone: (508) 744-3936, Email: wij983@aol.com

50 St Peter St (Lat: 42.523972 Lon: -70.893389), Call Sign: KGC459, Licensee ID: L00030366
Assigned Frequencies : 482.912 MHz
Grant Date: 03/28/2002, Expiration Date: 02/25/2012
Registrant: County Of Essex, 20 Manning Ave, Middleton, MA 01949, Phone: (978) 750-1900, Fax: (978) 750-1934

50 St Peter (Lat: 42.523972 Lon: -70.893389), Call Sign: WCG573, Licensee ID: L00030366
Assigned Frequencies : 485.912 MHz
Grant Date: 03/26/2002, Expiration Date: 02/25/2012
Registrant: County Of Essex, 20 Manning Ave, Middleton, MA 01942, Phone: (978) 750-1900, Fax: (978) 750-1934

303 Highland Ave (Lat: 42.502861 Lon: -70.924500), Call Sign: KDO435
Assigned Frequencies : 460.975 MHz, 460.975 MHz
Grant Date: 12/08/2004, Expiration Date: 12/08/2014
Registrant: Blooston, Mordkofsky, Dickens, Duffy & Prendergast, 2120 L Street, N.W., Suite 300, Washington, DC 20037, Phone: (202) 828-5536, Fax: (202) 828-5568

81 Highland Ave (Lat: 42.510917 Lon: -70.907278), Type: Building, Structure height: 38 m, Call Sign: WPMM793
Assigned Frequencies : 462.775 MHz
Grant Date: 07/24/2003, Expiration Date: 09/23/2013, Certifier: Paul Lane
Registrant: North Shore Medical Center Inc, 81 Highland Avenue, Salem, Ma, MA 01970, Phone: (978) 354-2211, Fax: (978) 825-6970, Email: dhmalionek@partners.org

24 Fort Ave (Lat: 42.526194 Lon: -70.876444), Call Sign: KUW882
Assigned Frequencies : 48.4400 MHz, 48.0600 MHz, 48.1400 MHz, 48.4800 MHz, 451.150 MHz
Grant Date: 05/04/2004, Expiration Date: 06/29/2014
Registrant: Utilties Telecom Council, 1901 Pennsylvania Ave, Nw Suite 500, Washington, DC 20006, Phone: (202) 872-0030, Fax: (202) 872-1331, Email: klaus.bender@utc.org

24 Fort Ave (Lat: 42.526194 Lon: -70.876444), Call Sign: WDF85
Assigned Frequencies : 37.6000 MHz
Grant Date: 08/30/2002, Expiration Date: 09/23/2012, Certifier: James G Claypool
Registrant: Dominion Resources Services, Inc., 8th And Main - 5th Floor, Richmond, VA 23261, Phone: (804) 775-5906, Fax: (804) 771-6570, Email: kathy.s.brown@dom.com

End Of Mussolini Rd (Lat: 42.505639 Lon: -70.926722), Call Sign: WNHT792, Licensee ID: L00006600
Assigned Frequencies : 173.203 MHz
Grant Date: 10/16/1996, Expiration Date: 10/16/2001, Cancelation Date: 10/05/2001
Registrant: National Grid Usa Service Comany Inc, 55 Bearfoot Rd, Northborough, MA 01532

29 Congress St (Lat: 42.518417 Lon: -70.885889), Call Sign: KNGT804, Licensee ID: L00020523
Assigned Frequencies : 462.400 MHz
Grant Date: 04/08/2003, Expiration Date: 06/22/2013
Registrant: Shetland Properties Of Salem Inc, 29 Congress St, Salem, MA 01970

Lat: 42.502500 Lon: -70.924167, Call Sign: WPWR646
464.337 MHz, 464.062 MHz, 469.187 MHz, 469.262 MHz, 469.087 MHz, 469.012 MHz, 469.212 MHz, 469.037 MHz, 469.062 MHz, 464.387 MHz... (+21 more)
Grant Date: 01/10/2003, Expiration Date: 01/10/2013, Certifier: Lawrence Kimmelman
Registrant: Federal Licensing Inc, 1588 Fairfield Road, Gettysburg, PA 17325, Phone: (717) 334-9262, Fax: (717) 334-6440

SALEM, MA, Lat: 42.516750 Lon: -70.885611, Call Sign: WPZQ979
Assigned Frequencies : 75.5600 MHz
Grant Date: 02/24/2004, Expiration Date: 02/24/2014, Certifier: Robert W Turner
Registrant: Signal Communications Corp, 4 Wheeling Ave, Woburn, MA 01801, Phone: (781) 933-0998, Fax: (781) 933-5019, Email: jwatts@sigcom.com

Lat: 42.570083 Lon: -70.889778, Call Sign: WQAG831
Assigned Frequencies : 461.462 MHz, 466.462 MHz
Grant Date: 05/27/2004, Expiration Date: 05/27/2014, Certifier: Cynthia Mcgurren
Registrant: All-Comm Technologies Inc, 5 Whitmore Rd, Revere, MA 02154, Phone: (781) 289-3000, Fax: (781) 289-7300

Lat: 42.521472 Lon: -70.875556, Call Sign: WQCS285, Licensee ID: L00048268
Assigned Frequencies : 4940.00 MHz
Grant Date: 05/12/2005, Expiration Date: 05/12/2015, Certifier: John A Jodoin
Registrant: Salem Police Department, 95 Margin Street, Salem, MA 01970, Phone: (978) 744-0171, Fax: (978) 744-5325, Email: salem.police@verizon.net

Commercial, Private

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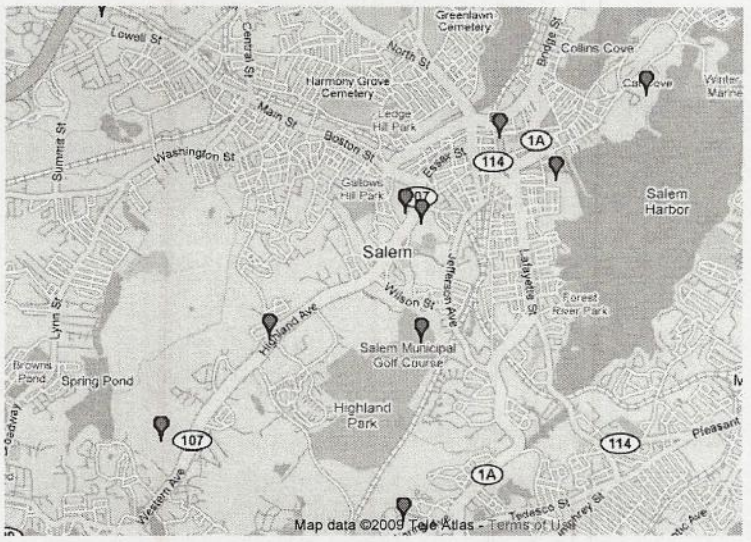
FCC Registered Microwave, Paging and Maritime Coast & Aviation Ground Towers in Salem, Massachusetts

Back to: Salem, MA, Massachusetts, Massachusetts forum, All US cities.

Microwave, Paging, Maritime Coast

FCC Registered Microwave Towers in Salem, MA



Note: Not all towers must be registered in the FCC database, so the above map may not list all the towers in the area.

Full list of 12 FCC Registered Microwave Towers in Salem, MA:

STATION, 303 Highland Ave (Lat: 42.502861 Lon: -70.924472), Structure height: 45.7 m, Call Sign: WNEF975
Assigned Frequencies : 952.112 MHz, 928.112 MHz
Grant Date: 09/17/1999, Expiration Date: 10/26/2009
Registrant: Phone: (202) 659-0830

Various Locations (Lat: 42.533417 Lon: -70.946139), Overall height: 6.1 m, Call Sign: WPNM693
Assigned Frequencies : 952.656 MHz
Grant Date: 09/18/1998, Expiration Date: 09/18/2008, Cancelation Date: 11/22/2008
Registrant: Phone: (781) 647-2387

BOS0007173, 1 Salem Grn (Lat: 42.522139 Lon: -70.895056), Type: Pole, Structure height: 20.4 m, Overall height: 22.9 m, Call Sign: WPQX827
Assigned Frequencies : 19520.0 MHz
Grant Date: 11/15/2000, Expiration Date: 11/15/2010, Cancelation Date: 06/26/2002, Certifier: Terri B Natoli Esq
Registrant: Backlink Iv, LLC, 460 Herndon Parkway, Suite 100, Herndon, VA 20170, Phone: (703) 326-4650, Fax: (703) 326-4185, Email: terri.natoli@teligent.com

BOSP033, 35 Congress St. (Lat: 42.518000 Lon: -70.887972), Type: Pole, Structure height: 27.1 m, Overall height: 30.2 m, Call Sign: WPQX828
Assigned Frequencies : 17960.0 MHz
Grant Date: 11/15/2000, Expiration Date: 11/15/2010, Cancelation Date: 06/26/2002, Certifier: Terri B Natoli Esq
Registrant: Backlink Iv, LLC, 460 Herndon Parkway, Suite 100, Herndon, VA 20170, Phone: (703) 326-4650, Fax: (703) 326-4185, Email: terri.natoli@teligent.com

Shetland Office Pk, 27 Congress Street (Lat: 42.513889 Lon: -70.905000), Type: Pipe, Structure height: 30.5 m, Overall height: 36.5 m, Call Sign: WQCU731
Assigned Frequencies : 21975.0 MHz
Grant Date: 05/31/2005, Expiration Date: 05/31/2015, Certifier: Rick Hampton
Registrant: Partners Healthcare, One Constitution Plaza, 2 Nd. Floor, Charlestown, MA 02129, Phone: (617) 726-6633, Fax: (617) 726-5606, Email: rhampton@partners.org

North Shore Med., MA, 81 Highland Avenue (Lat: 42.502500 Lon: -70.905000), Type: Building, Structure height: 41.2 m, Call Sign: WQCU732
Assigned Frequencies : 23175.0 MHz
Grant Date: 05/31/2005, Expiration Date: 05/31/2015, Certifier: Rick Hampton
Registrant: Partners Healthcare, One Constitution Plaza, 2 Nd. Floor, Charlestown, MA 02129, Phone: (617) 726-6633, Fax: (617) 726-5606, Email: rhampton@partners.org

BOS1903, Cain Road (Lat: 42.493111 Lon: -70.938333), Type: Tower, Structure height: 51.8 m, Call Sign: WQHQ689
Assigned Frequencies : 19460.0 MHz
Grant Date: 10/09/2007, Expiration Date: 10/09/2017, Certifier: Joseph M Sandri Jr.
Registrant: Fibertower Corporation, 1667 K Street Nw, Suite 250, Washington, DC 20006, Phone: (202) 223-1028, Fax: (202) 315-3415, Email: jsandri@fibertower.com

BOSFP19-01, 1000 Loring Avenue (Lat: 42.485278 Lon: -70.907222), Type: Bant, Structure height: 36.6 m, Call Sign: WQHQ859
Assigned Frequencies : 17820.0 MHz, 17900.0 MHz, 17980.0 MHz
Grant Date: 10/10/2007, Expiration Date: 10/10/2017, Certifier: Joseph M Sandri Jr.
Registrant: Fibertower Corporation, 1667 K Street Nw, Suite 250, Washington, DC 20006, Phone: (202) 223-1028, Fax: (202) 315-3415, Email: jsandri@fibertower.com

Salem MA 8, 0 Cain Rd. (Lat: 42.493111 Lon: -70.938306), Type: Tower, Structure height: 51.8 m, Call Sign: WQIE206
Assigned Frequencies : 10995.0 MHz, 11035.0 MHz
Grant Date: 01/15/2008, Expiration Date: 01/15/2018, Certifier: William Chastain
Registrant: Radio Dynamics Corporation, Silver Spring, MD 20914, Phone: (301) 493-5171, Fax: (301) 576-4553, Email: workorder@radyn.com

BOS1908, 40r Highland Avenue (Lat: 42.514833 Lon: -70.907111), Type: Bant, Structure height: 23.8 m, Call Sign: WQIQ563
Assigned Frequencies : 19380.0 MHz, 21975.0 MHz
Grant Date: 04/15/2008, Expiration Date: 04/15/2018, Certifier: Joseph M Sandri Jr.
Registrant: Fibertower Corporation, 1667 K Street Nw, Suite 250, Washington, DC 20006, Phone: (202) 223-1028, Fax: (202) 315-3415, Email: jsandri@fibertower.com

SALEM HARBOR, 24 Fort Ave (Lat: 42.526194 Lon: -70.876417), Structure height: 152.4 m, Overall height: 53.6 m, Call Sign: KEO36
Assigned Frequencies : 6605.00 MHz
Grant Date: 07/23/1999, Expiration Date: 07/23/2009
Registrant: Keller And Heckman LLP, 1001 G Street, N.W. Suite 500 West, Washington, DC 20001, Phone: (202) 434-4130, Fax: (202) 434-4646, Email: black@khlaw.com

SALEM, Cain Rd (Lat: 42.493111 Lon: -70.938333), Type: Mast, Structure height: 51.8 m, Call Sign: WLW294
Assigned Frequencies : 10647.5 MHz, 10582.5 MHz, 10561.2 MHz
Grant Date: 05/09/2000, Expiration Date: 04/01/2010, Certifier: Carol L Tacker
Registrant: Cingular Wireless LLC, 5601 Legacy Drive Ms A-3, Plano, TX 75024, Phone: (469) 229-7506, Fax: (469) 229-7295, Email: barbara.haby@cingular.com

Microwave, Paging, Maritime Coast

FCC Registered Paging Towers in Salem, MA

Note: Not all towers must be registered in the FCC database, so the above map may not list all the towers in the area.

Full list of 4 FCC Registered Paging Towers in Salem, MA:

12 First Street (Lat: 40.502778 Lon: -70.917500), Type: Building, Structure height: 42.7 m, Overall height: 45.7 m, Call Sign: KNKG540
Assigned Frequencies : 931.787 MHz
Grant Date: 05/11/1999, Expiration Date: 04/01/2009, Cancelation Date: 04/21/2004, Certifier: Paul H Kuzia
Registrant: Wilkinson Barker Knauer, LLP, 2300 N Street, N.W., 7th Floor, Washington, DC 20037, Phone: (202) 783-4141, Fax: (202) 783-5851, Email: kzachem@wbklaw.com

303 Highland Ave (Lat: 42.501472 Lon: -70.924750), Type: Tower, Structure height: 51.8 m, Call Sign: KNKJ292
Assigned Frequencies : 454.450 MHz
Grant Date: 05/11/1999, Expiration Date: 04/01/2009, Certifier: Shawn E Endsley
Registrant: Usa Mobility Wireless, Inc., 300 Technology Drive #400, Plano, TX 75074, Phone: (972) 801-1626, Fax: (972) 801-1699, Email: kitty.wenrick@usamobility.com

12 First St. (Lat: 42.502583 Lon: -70.917528), Overall height: 42.7 m, Call Sign: KNKS214
Assigned Frequencies : 931.487 MHz
Grant Date: 02/09/1996, Expiration Date: 02/09/2006, Cancelation Date: 02/01/2005, Certifier: William Buxbaum
Registrant: Network Services, LLC Debtor-In-Possession, 525 South Douglas Street, El Segundo, CA 90245, Phone: (310) 615-6523, Fax: (310) 615-6581, Email: wbuxbaum@networkservices.net

Salem Cellular, 1 Cain Road (Lat: 42.494250 Lon: -70.937528), Call Sign: KNKG864
Assigned Frequencies : 931.912 MHz, 931.912 MHz, 931.912 MHz, 931.912 MHz
Grant Date: 04/27/1999, Expiration Date: 04/01/2009, Cancelation Date: 08/08/2001
Registrant: Joyce & Jacobs, 1019 19th Street, N.W., 14th Fl., Ph-2, Washington, DC 20036, Phone: (202) 457-0100

Microwave, Paging, Maritime Coast

FCC Registered Maritime Coast & Aviation Ground Towers in Salem, MA

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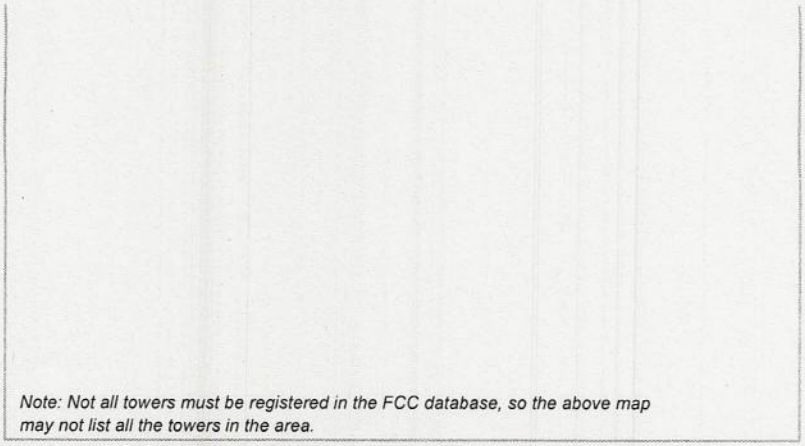

Note: Not all towers must be registered in the FCC database, so the above map may not list all the towers in the area.

Full list of 13 FCC Registered Maritime Coast & Aviation Ground Towers in Salem, MA:

17 Collins St (Lat: 42.528694 Lon: -70.887278), Type: Building, Overall height: 7 m, Call Sign: KFT320, Licensee ID: L00969185
Assigned Frequencies : 156.450 MHz, 156.800 MHz
Grant Date: 09/14/2005, Expiration Date: 09/14/2015
Registrant: Michael Sosnowski, 17 Collins St, Salem, MA 01970, Phone: (978) 745-6182

25 Derby St (Lat: 42.522583 Lon: -70.877833), Type: Building, Overall height: 3 m, Call Sign: KMC963, Licensee ID: L00004191
Assigned Frequencies : 156.450 MHz, 156.600 MHz, 156.800 MHz, 156.900 MHz
Grant Date: 12/10/1996, Expiration Date: 01/30/2002, Cancelation Date: 05/05/2002
Registrant: Cargill Incorporated, 25 Derby St, Salem, MA 01970

Joseph Carty 27 Gardner St (Lat: 42.513417 Lon: -70.894778), Type: Tower, Call Sign: KSK231
Assigned Frequencies : 156.450 MHz, 156.600 MHz, 156.800 MHz, 156.475 MHz
Grant Date: 08/09/1993, Expiration Date: 08/09/1998, Cancelation Date: 05/06/2001
Registrant: North East Surf Patrol Inc, Salem, MA 01970

23 Glendale St (Lat: 42.508417 Lon: -70.889500), Type: Building, Overall height: 5 m, Call Sign: KZJ397
Assigned Frequencies : 156.450 MHz, 156.350 MHz, 156.800 MHz
Grant Date: 07/20/1994, Expiration Date: 07/20/1999, Cancelation Date: 05/06/2001
Registrant: Fred J Dion Yacht Yard Inc, 23 Glendale St, Salem, MA 01945

Harbormaster Office Winter Island (Lat: 42.525083 Lon: -70.853667), Type: Building, Overall height: 7 m, Call Sign: WHU375
Assigned Frequencies : 156.450 MHz, 156.475 MHz, 156.600 MHz, 156.700 MHz, 156.800 MHz
Grant Date: 11/10/1998, Expiration Date: 11/03/2003, Cancelation Date: 01/04/2004
Registrant: Salem, Port Of, Winter Island, Salem, MA 01971

Hawthorne Cove Marina 10 White St (Lat: 42.522306 Lon: -70.882000), Type: Building, Overall height: 8 m, Call Sign: WHU677
Assigned Frequencies : 156.450 MHz, 156.500 MHz, 156.525 MHz, 156.800 MHz, 156.925 MHz
Grant Date: 02/14/2000, Expiration Date: 03/07/2005, Cancelation Date: 05/07/2005
Registrant: Winthrop Towing And Salvage Inc, 256 Marginal St, East Boston, MA 02128

Bridge St Beverly Salem Bridge (Lat: 42.534250 Lon: -70.883389), Type: Building, Overall height: 3 m, Call Sign: WHU903
Assigned Frequencies : 156.450 MHz, 156.650 MHz, 156.800 MHz
Grant Date: 03/21/1994, Expiration Date: 03/21/1999, Cancelation Date: 05/06/2001
Registrant: State Of Massachusetts, 519 Appleton St, Arlington, MA 02174

Salem Harbor Generating Station 24 Fort Ave (Lat: 42.523417 Lon: -70.878389), Type: Tower, Call Sign: WHV620
Assigned Frequencies : 156.450 MHz, 156.600 MHz, 156.800 MHz, 156.900 MHz
Grant Date: 02/15/2001, Expiration Date: 05/20/2002, Cancelation Date: 08/25/2002
Registrant: Wiley Rein & Fielding LLP, 1776 K Street, N.W., Washington, DC 20006, Phone: (202) 719-7235, Fax: (202) 719-7049, Email: kdesoto@wrf.com

23 Congress St. (Lat: 42.519528 Lon: -70.889778), Type: Building, Overall height: 6 m, Call Sign: WRD637, Licensee ID: L00004024
Assigned Frequencies : 156.450 MHz, 156.425 MHz, 156.800 MHz
Grant Date: 06/13/1996, Expiration Date: 06/13/2001, Cancelation Date: 09/16/2001
Registrant: Pickering Wharf Marina, 23 Congress St, Salem, MA 01970

10 White St (Lat: 42.522306 Lon: -70.884222), Type: Building, Overall height: 6 m, Call Sign: WXZ473, Licensee ID: L00013704
Assigned Frequencies : 156.450 MHz, 156.800 MHz
Grant Date: 06/08/2000, Expiration Date: 08/17/2005, Cancelation Date: 01/07/2006
Registrant: Hawthorne Cove Marina, 10 White St, Salem, MA 01970

23 Congress St. (Lat: 42.519444 Lon: -70.890278), Type: Bant, Structure height: 10 m, Call Sign: WPUX710, Licensee ID: L00826084
Assigned Frequencies : 156.450 MHz, 156.800 MHz, 156.425 MHz
Grant Date: 05/22/2002, Expiration Date: 05/22/2012, Certifier: Timothy C Pickering Mr
Registrant: Pickering Wharf Marina

Salem Harbor Generating Station 24 Fort Ave (Lat: 42.523417 Lon: -70.878389), Type: Tower, Structure height: 10 m, Call Sign: WPVP928
Assigned Frequencies : 156.800 MHz, 156.900 MHz, 156.450 MHz, 156.600 MHz
Grant Date: 07/30/2002, Expiration Date: 10/31/2002, Cancelation Date: 02/02/2003, Certifier: Melissa Pusch
Registrant: Wiley Rein & Fielding LLP, 1776 K Street, N.W., Washington, DC 20006, Phone: (202) 719-7235, Fax: (202) 719-7049, Email: kdesoto@wrf.com

Salem Harbor Generating Station 24 Fort Ave (Lat: 42.523417 Lon: -70.878389), Type: Tower, Structure height: 10 m, Call Sign: WPVX756
Assigned Frequencies : 156.600 MHz, 156.800 MHz, 156.900 MHz, 156.450 MHz
Grant Date: 09/03/2002, Expiration Date: 09/03/2012, Certifier: James G Claypool
Registrant: Dominion Resources Services, Inc., 8th And Main - 5th Floor, Richmond, VA 23261, Phone: (804) 775-5906, Fax: (804) 771-6570, Email: kathy.s.brown@dom.com

Microwave, Paging, Maritime Coast

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Back to: Salem, MA, Massachusetts, All US cities.

Appendix G

Energy Use Records

Facility ID#	vlook	Utility Type	SERVICE ADDRESS	DEPT	SF	Year Built	ACCT #	RATE	UOM	USAGE fy2008	COST fy2008
F34	F34	ELECTRIC	77 Wilson St (hs)	SCHOOLS	471500	1910	4045362001	G3	kWh	2492000	$448,560
F32	F32	ELECTRIC	29 Highland Ave	SCHOOLS	240000	1910	1593191006	G3	kWh	1022000	$183,960
F26	F26	ELECTRIC	53 Liberty Hill Ave	SCHOOLS	91223	1970	9101615006	G3	kWh	538400	$96,912
F28	F28	ELECTRIC	1 Freddrick ST	SCHOOLS	107271	1972	5327292003	G3	kWh	510900	$91,962
F38	F38	ELECTRIC	79 Wilson St	SCHOOLS	96016	2001	7788200007	G3	kWh	506000	$96,140
F30	F30	ELECTRIC	23 Memorial Drive	SCHOOLS	76153	1967	7854681009	G3	kWh	409120	$73,642
F36	F36	ELECTRIC	211 Lafayette St	SCHOOLS	84005	1915	2647358005	G3	kWh	366960	$66,053
F15	F15	ELECTRIC	91 Margin St (billed to 95 Margin)	POLICE DEPT	31160	1991	3824320008	G2	kWh	356320	$64,138
F11	F11	ELECTRIC	1 Liberty Street	PARKING	NOT RELEVANT		8829126005	G2	kWh	327800	$59,004
F7	F7	ELECTRIC	370 Essex St	LIBRARY	27782	1850	0082823005	G2	kWh	257520	$46,354
F27	F27	ELECTRIC	10 Skerry Street	SCHOOLS	52399	2004	8849805007	G2	kWh	198100	$35,658
F47	#N/A	ELECTRIC	Highland Ave Pole 2844	ELECTRICAL			5326977007	G2	kWh	170000	$30,600
F3	F3	ELECTRIC	48 Lafayette Street	FIRE DEPT	19620	1950	6388107002	G2	kWh	152000	$27,360
F22	F22	ELECTRIC	3 Jefferson Ave	DPW	38587		5253545000	G2	kWh	132160	$23,789
F8	F8	ELECTRIC	10 Congress St	PARKING	NOT RELEVANT		1404579005	G2	kWh	127228	$22,901
F18	F18	ELECTRIC	93 Washington St	PUBLIC PROPERTY	18108	1857	6334650007	G2	kWh	89760	$16,157
F42	F42	ELECTRIC	32 Clifton Avenue	DPW	8637	1950	1404582002	G1	kWh	80000	$14,400
F1	F1	ELECTRIC	5 Broad St	COUNCIL ON AGING	21672	circa 1850	4007457001	G1	kWh	79320	$14,278
F50	F50	ELECTRIC	77 Wilson St (Salerno Automotive)	SCHOOLS	6500	1990	0327269009	G1	kWh	59124	$10,642
F301	#N/A	ELECTRIC	COR Margin Mill St	ELECTRICAL			7565589001	G1	kWh	57114	$10,281
F17	F17	ELECTRIC	118 Washington St	PUBLIC PROPERTY	50787		8994475006	G1	kWh	54135	$9,744
F17	F17	ELECTRIC	118 Washington St	PUBLIC PROPERTY	50787		5254775002	G1	kWh	50784	$9,141
F17	F17	ELECTRIC	118 Washington St	PUBLIC PROPERTY	50787		4008647009	G1	kWh	46857	$8,434
F302	#N/A	ELECTRIC	Washington St	ELECTRICAL			7545639000	G1	kWh	38621	$6,952
F39	F39	ELECTRIC	79 Wilson st (BILLED TO 75 WILSON)	PARKS & REC			1560879004	G1	kWh	33804	$6,085
F49	#N/A	ELECTRIC	50 Winter Island Road	PARKS & REC			9102310000	G1	kWh	33624	$6,052
F303	#N/A	ELECTRIC	Derby St	ELECTRICAL			7545603000	G1	kWh	32512	$5,852
F25	F25	ELECTRIC	Ravenna Ave	DPW			6537345007	G1	kWh	32497	$5,849
F304	#N/A	ELECTRIC	Essex Liberty ISCT	ELECTRICAL			7581514004	G1	kWh	31655	$5,698
F305	#N/A	ELECTRIC	Washington SQ	ELECTRICAL			6298001006	G1	kWh	31232	$5,622
F306	#N/A	ELECTRIC	Essex St Mall	ELECTRICAL			2631613004	G1	kWh	26094	$4,697
F307	#N/A	ELECTRIC	Home Street	DPW			5291147008	G1	kWh	25073	$4,513
F6	F6	ELECTRIC	415 Essex Street	FIRE DEPT	9882	1920	6298000009	G1	kWh	23100	$4,158
F308	#N/A	ELECTRIC	Blaney St Pole 0056-0	ELECTRICAL			0065628006	G1	kWh	22629	$4,073
F309	#N/A	ELECTRIC	Winter Island RD	PARKING			7544750019	G1	kWh	20913	$3,764
F310	#N/A	ELECTRIC	N Greenway St	ELECTRICAL			7544469004	G1	kWh	20608	$3,709
F311	#N/A	ELECTRIC	140 North St Pole 961	ELECTRICAL			2577381010	G1	kWh	19944	$3,590
F312	#N/A	ELECTRIC	98 North ST Unit 1, Traffic Signal	ELECTRICAL			4687627009	G1	kWh	18972	$3,415
F313	#N/A	ELECTRIC	Jefferson Ave Pole 35	ELECTRICAL			9030526007	G1	kWh	17618	$3,171
F17	F17	ELECTRIC	118 Washington St	PUBLIC PROPERTY	50787		6501478008	G1	kWh	17500	$3,150
L201	#N/A	ELECTRIC	City Hall -st lights	ELECTRICAL			4045336001	S1	kWh	2229720	$401,350
L202	#N/A	ELECTRIC	Charter Crombie ISCT	PARKING			7783293002	S1	kWh	33887	$6,100
L203	#N/A	ELECTRIC	44 Lafayette St	ELECTRICAL			2799477000	S1	kWh	20640	$3,715
L204	#N/A	ELECTRIC	310 1/2 Essex St	PARKS & REC			1328017000	S1	kWh	11046	$1,988
L205	#N/A	ELECTRIC	Beside Delandes	PARKING			9030506005	S1	kWh	5504	$991
L206	#N/A	ELECTRIC	2 Floodlights P.185, Broad St	COUNCIL ON AGING			1561863000	S1	kWh	3588	$646
L207	#N/A	ELECTRIC	Almeda St	DPW			5295719000	S1	kWh	2811	$506

L208	#N/A	ELECTRIC	W Washington Sq	PUBLIC PROPERTY			2803486000	S1	kWh	2352	$423
L209	#N/A	ELECTRIC	Salem CMN	PUBLIC PROPERTY			7783304000	S1	kWh	2028	$365
L210	#N/A	ELECTRIC	Derby St Pole 6203	ELECTRICAL			1556144007	S1	kWh	1500	$270
L211	#N/A	ELECTRIC	Essex Street	LIBRARY			4049373000	S1	kWh	1262	$227
L212	#N/A	ELECTRIC	Greenlawn Ave	ELECTRICAL			2803588009	S1	kWh	1188	$214
F24	F24	ELECTRIC	Swampscott Rd	DPW			2799481004	G1	kWh	17200	$3,096
F314	#N/A	ELECTRIC	Greenlawn Cemetery, Sargent st pole	PUBLIC PROPERTY			3824418012	G1	kWh	16829	$3,029
F315	#N/A	ELECTRIC	85 Federal St, Pole 1883	ELECTRICAL			7841708028	G1	kWh	16545	$2,978
F16	F16	ELECTRIC	Winter Island Rd	HARBORMASTER			8793177007	G1	kWh	16339	$2,941
F2	F2	ELECTRIC	142 North Street	FIRE DEPT	5514	1950	5068594002	G1	kWh	16100	$2,898
F316	#N/A	ELECTRIC	Boston St Pole 341	ELECTRICAL			6318958008	G1	kWh	16005	$2,881
F4	F4	ELECTRIC	62 Loring Avenue	FIRE DEPT	4726	1950	2555796008	G1	kWh	13653	$2,458
F49	#N/A	ELECTRIC	50 Winter Island Road	PARKS & REC			1310059003	G1	kWh	12624	$2,272
F317	#N/A	ELECTRIC	Highland Ave Pump	DPW			7783320004	G1	kWh	12320	$2,218
F20	F20	ELECTRIC	57 Orne Street	DPW			6316097002	G1	kWh	12180	$2,192
F318	#N/A	ELECTRIC	Washington Front ISCT	ELECTRICAL			3932014002	G1	kWh	12000	$2,160
F5	F5	ELECTRIC	27 Fort Avenue	FIRE DEPT	6270	1950	0064142016	G1	kWh	11473	$2,065
F319	#N/A	ELECTRIC	Lafayette Wash ISCT	ELECTRICAL			7544751007	G1	kWh	11319	$2,037
F320	#N/A	ELECTRIC	87 Memorial Drive	PARKS & REC			2555721010	G1	kWh	10154	$1,828
F321	#N/A	ELECTRIC	COR Webb Essex St	ELECTRICAL			8793317010	G1	kWh	9795	$1,763
F322	#N/A	ELECTRIC	Boston Nichols ISCT	ELECTRICAL			0202014006	G1	kWh	9528	$1,715
F20	F20	ELECTRIC	57 Orne Street	DPW			0086615009	G1	kWh	9327	$1,679
F323	#N/A	ELECTRIC	Bridge Flint St Pole 603	ELECTRICAL			5071543000	G1	kWh	9324	$1,678
F324	#N/A	ELECTRIC	Cor Hawthorne BLVD	ELECTRICAL			1310408015	G1	kWh	9315	$1,677
F12	F12	ELECTRIC	2 Church Street	PARKING	NOT RELEVANT		2556846007	G1	kWh	9205	$1,657
F325	#N/A	ELECTRIC	229 North St	ELECTRICAL			1331445018	G1	kWh	9149	$1,647
F326	#N/A	ELECTRIC	Liberty Hill Ave Pole 1095	PUBLIC PROPERTY			5273418004	G1	kWh	9058	$1,630
F327	#N/A	ELECTRIC	350 Lafayette St	ELECTRICAL			8792718013	G1	kWh	8938	$1,609
F328	#N/A	ELECTRIC	10 Church St	ELECTRICAL			5051247007	G1	kWh	8746	$1,574
F14	F14	ELECTRIC	50 Leavitt St	POLICE DEPT	1352	1950	6297029000	G1	kWh	8429	$1,517
F329	#N/A	ELECTRIC	2 New Liberty St	ELECTRICAL			1310022006	G1	kWh	7520	$1,354
F330	#N/A	ELECTRIC	Salem GRN	ELECTRICAL			2555794004	G1	kWh	7096	$1,277
F331	#N/A	ELECTRIC	First Traders Way	ELECTRICAL			7565857004	G1	kWh	7050	$1,269
F332	#N/A	ELECTRIC	Wilson RD	ELECTRICAL			6425604008	G1	kWh	6912	$1,244
F23	F23	ELECTRIC	Colby Street Ext	DPW			1441009008	G1	kWh	6600	$1,188
F333	#N/A	ELECTRIC	Wilson St	PARKS & REC			7562919007	G1	kWh	6394	$1,151
F334	#N/A	ELECTRIC	Boston St	ELECTRICAL			2576911005	G1	kWh	5379	$968
F335	#N/A	ELECTRIC	Central St Mall	ELECTRICAL			8792203008	G1	kWh	5085	$915
F336	#N/A	ELECTRIC	Lemon St	ELECTRICAL			5051833012	G1	kWh	5001	$900
F337	#N/A	ELECTRIC	COR New Derby Wash ST	ELECTRICAL			7545641019	G1	kWh	4936	$888
F338	#N/A	ELECTRIC	Highld Jackson ISCT	ELECTRICAL			1328018007	G1	kWh	4868	$876
F339	#N/A	ELECTRIC	N Woodside ISCT	ELECTRICAL			2685691009	G1	kWh	4800	$864
F340	#N/A	ELECTRIC	Swampscott Rd Pole 4311	DPW			5068224005	G1	kWh	4799	$864
F341	#N/A	ELECTRIC	COR Essex Wash St	ELECTRICAL			7545611002	G1	kWh	4524	$814
F342	#N/A	ELECTRIC	Boston Federal ISCT Pole 355	ELECTRICAL			4049580005	G1	kWh	4428	$797
F19	F19	ELECTRIC	32 Derby SQ	PUBLIC PROPERTY	4000	1829	0144687007	G1	kWh	4393	$791
F19	F19	ELECTRIC	32 Derby SQ	PUBLIC PROPERTY	4000	1829	1386250005	G1	kWh	4081	$735
F343	#N/A	ELECTRIC	Bridge Oliver ISCT	ELECTRICAL			64227005	G1	kWh	3987	$718

F10	F10	ELECTRIC	Crombie St.	PARKING	NOT RELEVANT	6501090004	G1	kWh	3848	$693
F344	#N/A	ELECTRIC	Webb Pickman	ELECTRICAL		4049278000	G1	kWh	3636	$654
F345	#N/A	ELECTRIC	20 Salem St	ELECTRICAL		1386247008	G1	kWh	3495	$629
F346	#N/A	ELECTRIC	Highland Ave	ELECTRICAL		2574205004	G1	kWh	3358	$604
F29	F29	ELECTRIC	Powder House LN	SCHOOLS	NOT RELEVANT	7819262011	G1	kWh	3322	$598
F9	F9	ELECTRIC	Sewall St PKG Park	PARKING	NOT RELEVANT	0083951008	G1	kWh	3272	$589
F347	#N/A	ELECTRIC	N Cressey ISCT	ELECTRICAL		5294734003	G1	kWh	3264	$588
F348	#N/A	ELECTRIC	Washington Sq	ELECTRICAL		6425599002	G1	kWh	3240	$583
F349	#N/A	ELECTRIC	Bridge Skerry ISCT	ELECTRICAL		7671830002	G1	kWh	3228	$581
F350	#N/A	ELECTRIC	Jefferson Read ISCT	ELECTRICAL		5295455001	G1	kWh	3036	$546
F351	#N/A	ELECTRIC	Rice St	ELECTRICAL		0126809005	G1	kWh	3032	$546
F352	#N/A	ELECTRIC	Jefferson Wilson St	ELECTRICAL		2685689009	G1	kWh	2928	$527
F353	#N/A	ELECTRIC	238 Lafayette St	ELECTRICAL		8919264009	G1	kWh	2520	$454
F354	#N/A	ELECTRIC	Bridge St	ELECTRICAL		2557030003	G1	kWh	2450	$441
F355	#N/A	ELECTRIC	Winter Island RD	WINTER ISLAND COMMISION		6297999007	G1	kWh	2378	$428
F49	#N/A	ELECTRIC	50 Winter Island Road	PARKS & REC		7545535007	G1	kWh	2112	$380
F356	#N/A	ELECTRIC	Broad Flint ISCT	ELECTRICAL		0083953002	G1	kWh	2072	$373
F357	#N/A	ELECTRIC	Bridge Osgood ISCT	ELECTRICAL		1441005000	G1	kWh	1848	$333
F358	#N/A	ELECTRIC	163 Boston St	ELECTRICAL		2799491000	G1	kWh	1800	$324
F359	#N/A	ELECTRIC	44 Lafayette St Pole 19	ELECTRICAL		2685693003	G1	kWh	1752	$315
F360	#N/A	ELECTRIC	Loring Rainbow ISCT	ELECTRICAL		2803463007	G1	kWh	1728	$311
F361	#N/A	ELECTRIC	Laurel St	ELECTRICAL		7787259006	G1	kWh	1728	$311
F362	#N/A	ELECTRIC	Linden Forrest St	ELECTRICAL		8919263002	G1	kWh	1728	$311
F363	#N/A	ELECTRIC	Hancock St	ELECTRICAL		8919266003	G1	kWh	1728	$311
F364	#N/A	ELECTRIC	Summit Ave	ELECTRICAL		9034308005	G1	kWh	1728	$311
F365	#N/A	ELECTRIC	Linden Ocean ISCT	ELECTRICAL		202010008	G1	kWh	1728	$311
F366	#N/A	ELECTRIC	Bridge Peter ISCT	ELECTRICAL		1441008001	G1	kWh	1680	$302
F367	#N/A	ELECTRIC	Jefferson Clevelan ISC	ELECTRICAL		7671832006	G1	kWh	1680	$302
F13	F13	ELECTRIC	Church Street	PARKING	NOT RELEVANT	2555509005	G1	kWh	1377	$248
F368	#N/A	ELECTRIC	Congress St	ELECTRICAL		6298668001	G1	kWh	1360	$245
F369	#N/A	ELECTRIC	1 Winter St	ELECTRICAL		0202015003	G1	kWh	1344	$242
F370	#N/A	ELECTRIC	Mack Pk Tremont ISCT	ELECTRICAL		5178527006	G1	kWh	1296	$233
F371	#N/A	ELECTRIC	North St Pole 3913-1	ELECTRICAL		7566128002	G1	kWh	1257	$226
F372	#N/A	ELECTRIC	44 Lafayette St	ELECTRICAL		9034567004	G1	kWh	1248	$225
F373	#N/A	ELECTRIC	Boston St Pole 537	ELECTRICAL		5295308007	G1	kWh	1212	$218
F374	#N/A	ELECTRIC	Boston St Pole 4099	ELECTRICAL		6541510003	G1	kWh	1212	$218
F375	#N/A	ELECTRIC	North St Pole 966	ELECTRICAL		8813869008	G1	kWh	1202	$216
F376	#N/A	ELECTRIC	160 Lafayette St	ELECTRICAL		3932010004	G1	kWh	1092	$197
F377	#N/A	ELECTRIC	North St Pole 3922	ELECTRICAL		7566129009	G1	kWh	993	$179
F378	#N/A	ELECTRIC	Bridge St Trffc Sig @ St Peter	ELECTRICAL		6666732007	G1	kWh	974	$175
F379	#N/A	ELECTRIC	Bridge St, trffc Control	ELECTRICAL		8806756005	G1	kWh	969	$174
F380	#N/A	ELECTRIC	Marlborough RD	ELECTRICAL		5071922001	G1	kWh	945	$170
F381	#N/A	ELECTRIC	Marlborough Rd Pole 4255	ELECTRICAL		3932012008	G1	kWh	864	$156
F382	#N/A	ELECTRIC	N Franklin St	ELECTRICAL		9034816002	G1	kWh	864	$156
F383	#N/A	ELECTRIC	Bridge ST, Trffc Control Box	ELECTRICAL		2846538003	G1	kWh	852	$153
F384	#N/A	ELECTRIC	N Federal St	ELECTRICAL		6541604000	G1	kWh	648	$117
F385	#N/A	ELECTRIC	Boston Rawlins St	ELECTRICAL		4049363004	G1	kWh	636	$114
F386	#N/A	ELECTRIC	Bride St, Traff Control Box	ELECTRICAL		0647637009	G1	kWh	494	$89

F387	#N/A	ELECTRIC	S Washington Sq	ELECTRICAL	8793356008	G1	kWh	490	$88
F388	#N/A	ELECTRIC	Lafayette St	ELECTRICAL	6425603001	G1	kWh	432	$78
F389	#N/A	ELECTRIC	Liberty Hill Ave	ELECTRICAL	2685692006	G1	kWh	216	$39
F390	#N/A	ELECTRIC	Kernwood Ave	ELECTRICAL	3932013005	G1	kWh	216	$39
F391	#N/A	ELECTRIC	Memorial DR Pole 250	ELECTRICAL	6425600000	G1	kWh	96	$17
F392	#N/A	ELECTRIC	33 Fort Ave Pole 1733	ELECTRICAL	3804272001	G1	kWh	88	$16
F393	#N/A	ELECTRIC	Loring Ave Light Pole 186	ELECTRICAL	5051728007	G1	kWh	7	$1
F394	#N/A	ELECTRIC	92 Columbus Ave Pole 1394	ELECTRICAL	2557016003	G1	kWh	5	$1
F395	#N/A	ELECTRIC	E Washington Sq	ELECTRICAL	5051216002	G1	kWh	0	$0
F396	#N/A	ELECTRIC	56 Liberty Hill Ave	SCHOOLS	9103029008	G1	kWh	0	$0

Appendix H

City of Salem Wind Ordinance

City of Salem

In the year two thousand and nine

An Ordinance to amend an Ordinance relative to Zoning

Be it ordained by the City Council of the City of Salem, as follows:

Section 1. Section 5-3, Special Permit Uses of Article V, Use Regulations of the City's Zoning Ordinance is hereby amended by inserting the following new Special Permit use:

"**(n)** ***Land-based Wind Energy Facilities***

(1) Purpose and Intent
The purpose of this section is to accommodate wind energy facilities in appropriate locations, while minimizing any adverse visual, safety, and environmental impacts of the facilities.

(2) Definitions

a. Wind Energy Facility: All equipment, machinery and structures utilized in connection with the conversion of wind to electricity. This includes, but is not limited to, all transmission, storage, collection and supply equipment, substations, transformers, site access, services roads and machinery associated with the use. A wind energy facility may consist of one or more wind turbines.

   i. Residential Scale Wind Energy Facilities shall be considered those with a rated nameplate capacity less than or equal to 60 kilowatts per turbine, and a height up to 150 feet.
   ii. Commercial Scale Wind Energy Facilities shall be considered those with a rated nameplate capacity greater than 60 kilowatts per turbine and/or a blade-tip height greater than 150 feet.
   iii. Distributed generation facilities are those which are primarily designed to provide electrical output, or the value thereof, for the use of adjacent structures.

b. Rated Nameplate Capacity: The maximum rated output of electric power production equipment

c. Height: The height of the turbine measured from the natural grade to the tip of the blade at its highest point.

d. Clear area: Area surrounding a wind turbine to be kept free of habitable structures.

e. Nacelle: The frame and housing at the top of the tower that encloses the gearbox and generator and protects them from the weather.

f. Rotor: The blades and hub of the wind turbine that rotate during turbine operation.

g. Wind Monitoring or Meteorological ("test") Towers: A temporary tower equipped with devices to measure wind speeds and direction, and used to determine how much wind power a site can be expected to generate.

(3) Applicability
A Land-based Wind Energy Facility may not be issued a building permit unless or until a special permit has been issued by the Planning Board, irrespective of whether the use is a principal or accessory use. The Planning Board shall approve, or approve with conditions, if the petitioner can fulfill the requirements of this section.

a. Wind monitoring or meteorological towers shall be exempt from height and other dimensional regulations of the Zoning Ordinance and shall follow the setback requirements of this section. Wind monitoring or meteorological towers over a height of 200 feet shall require a Special Permit from the Planning Board. Wind monitoring or meteorological towers equal to or less than 200 feet in height shall be allowed as a matter of right subject to the issuance of a building permit for a temporary structure.

b. This section specifies where Wind Energy Facilities shall be permitted by Special Permit (SP) and where Wind Energy Facilities are (N) not allowed. Additionally:
   i. Wind Energy Facilities shall be allowed on all land owned by the City of Salem.
   ii. Wind Energy Facilities shall not be permitted on lots less than 40,000 square feet.

	RC	R1	R2	R3	B1	B2	B4	B5	I	BPD	NRCC
Residential Scale	SP	SP	SP	SP	SP	SP	SP	N	SP	SP	SP
Commercial Scale	N	N	N	SP	N	N	N	N	SP	SP	N

c. All wind energy facilities shall be constructed and operated in locations that minimize any adverse visual, safety, and environmental impacts. No special permit shall be granted unless the Planning Board finds:
   i. the specific site is an appropriate location for such use;
   ii. the use will not adversely affect the neighborhood;
   iii. there will be no serious hazard to people or vehicles from the use;
   iv. no nuisance will be created by the use; and
   v. adequate and appropriate facilities will be provided for the proper operation of the use.

(4) Site Control

The applicant shall submit documentation of the legal right to install and use the proposed facility at the time of application for a Special Permit. Documentation should also include proof of control over the setback area. Control shall mean legal authority to prevent the use of any structure within the setback area for human habitation or other use permitting human occupancy.

(5) Proof of Liability Insurance

Prior to the issuance of a building permit, the applicant shall be required to provide evidence of liability insurance and documentation that said amount is sufficient to cover loss or damage to persons and structures occasioned by the failure of the facility.

(6) Special Permit Regulations

Proposed wind energy conversion facilities shall be consistent with all applicable local, state and federal requirements, including but not limited to all applicable electrical, construction, noise, safety, and environmental and communications requirements. All wind energy conversion facilities shall comply with the requirements set forth in this section, unless waived by the Planning Board.

a. Height

Commercial Scale Wind Energy Facilities shall be no higher than 400 feet; Residential Scale Wind Energy Facilities shall be no higher than 150 ft. The height shall be measured from the natural grade to the highest point reached by the rotor blades. The Planning Board may allow this height to be exceeded as part of the special permit process if the project proponent can demonstrate that

the additional height is needed and that the additional benefits of the higher tower outweigh any increased adverse impacts.

b. Monopole Towers

Monopole towers are the preferred type of support for wind turbines.

c. Setback or Clear Area

The following setbacks shall be observed:

i. The minimum distance from the base of any wind turbine tower to any property line shall be equal to 75% of the height of the structure or the setback provisions of the zoning district, whichever is greater;

ii. The minimum distance from the base of any wind turbine to any dwelling, business or institutional use shall be equal to the total height of the structure.

iii. The purpose of the setbacks is to provide a clear area, to be kept free of habitable structures. The clear area does not need to be cleared of trees and vegetation; to the extent possible, existing on-site trees and vegetation shall be preserved. Wetland buffer areas may be within the clear area.

iv. The Planning Board may reduce the setbacks as appropriate based on site specific considerations.

d. Visual Impact

The proponent shall demonstrate through project siting and proposed mitigation that the wind energy conversion facility minimizes any impact on the visual character of surrounding neighborhoods and the community. This may include, but not be limited to, information regarding site selection, turbine design, buffering, lighting and cable layout.

e. Color

Wind energy conversion facilities shall be painted a non-reflective color that blends with the sky and clouds.

f. Equipment Shelters

All equipment necessary for monitoring and operation of wind energy facilities should preferably be contained within the turbine tower. If this is not feasible, ancillary equipment may be located outside the tower. Whenever reasonable, structures should be joined or clustered and contained either within an underground vault, enclosed within a separate structure, or shielded from view either by year-round landscaping or vegetated buffers to avoid adverse visual impacts.

g. Lighting and Signage

i. Wind turbines shall be lighted only if required by the Federal Aviation Administration (FAA). The proponent shall provide a copy of the FAA's determination to establish the required markings and/or lights for the structure.

ii. Lighting of equipment, structures and any other facilities on site shall be shielded from abutting properties.

iii. Signs on the facility shall comply with the City of Salem's sign regulations and be limited to those needed to identify the property and the owner and warn of any danger, and educational signs providing information on the technology and renewable energy usage.

h. Utility Connections

All utility connections from the commercial wind facility site shall be underground unless the applicant demonstrates by substantial evidence that the construction of such underground facilities would be

unreasonable owing to circumstances relating to the solid conditions, shape or topography of such a site, or if the utility provider requires the connections to be above ground.

i. Land Clear/Open Space/Rare Species

Wind energy facilities shall be designed to minimize land clearing and fragmentation of open space areas and shall avoid permanently protected open space when feasible. Wind turbines should be sited to make use of previously developed areas wherever possible. Wind energy facilities shall also be located in a manner that does not have significant negative impacts on rare species, including avian species in the vicinity.

j. Noise

The wind energy facility and associated equipment shall conform to Massachusetts noise regulations (310 CMR 7.10). An analysis, prepared by a qualified engineer, shall be presented to demonstrate compliance with these noise standards and be consistent with the Massachusetts Department of Environmental Protection guidance for noise measurement.

k. Shadowing/Flickering

Wind energy conversion facilities shall be sited in a manner that does not result in significant shadowing or flicker impacts. The proponent has the burden of proving that this effect does not have significant adverse impact on neighboring adjacent uses either through siting or mitigation.

l. Safety Standards

i. No hazardous materials or waste shall be discharged on the site of any wind energy facility. If any hazardous materials are to be used on site, there shall be provisions for full containment of such materials or waste. An enclosed containment area, designed to contain at least 110 percent of the volume of the hazardous materials or waste stored or used on the site may be required to meet this requirement. The wind energy conversion towers shall also be designed to prevent unauthorized use.

ii. A Wind Energy Facility, regardless of height above the ground, shall be equipped with a site-specific fire detection and fire suppression system of a type which has been listed by the Underwriters Laboratory (UL) and/or approved by Factory Mutual (FM). The site-specific fire detection and fire suppression system and components shall be approved by the Fire Marshal

iii. Access to the site must be clear and maintained to a level of acceptance by the Fire Marshall.

iv. Warning signs indicating voltage must be placed at the base of all ground/base mounted electrical equipment.

v. Electrical equipment shall be locked or fenced to prevent entry.

vi. While monopole construction is preferable in the event guy wires are used, then visible reflective colored objects such as flags, reflectors, or tape shall be placed on all guy wires up to a height of ten feet above the ground or surface where the wind energy equipment is mounted.

vii. Annual reports to the Fire Department detailing the year's operations, including but not limited to, number of days of operations, energy production, and maintenance items/issues.

viii. Hazardous materials are limited to lube oil or coolants used for routine maintenance and may be stored in limited quantities in their original packaging. Waste oils or coolants shall not be stored on site.

ix. Unauthorized access- no ladders, step bolts, or other climbing means shall be readily accessible to the public for a minimum of fifteen feet above the ground or surface where the wind energy equipment is mounted.

x. The owner of a proposed wind project shall provide a project summary, electrical schematic, and site plan to the Salem Fire Department with a proposed emergency response plan prior to issuance of a special permit.

(7) Submission Requirements
Fifteen (15) collated sets of application materials shall be submitted with any application for a Wind Energy Facility Special Permit. Application materials shall include all plans and materials required in this section:

a. Documentation
Applications must include: documentation of the legal right to install and use the proposed facility and proof of control over the setback or clear areas, proof of financial surety, proof of liability insurance, certification of lighting requirements from the FAA, certification of attainment for Federal Communications Commission (47 CFR Part 15) relating to interference with radio or television reception, and a statement that satisfies noise requirements

b. Site Plan Requirements
   i. A one-inch-equals-200 feet vicinity plan, signed and sealed by a Registered Professional Engineer or Licensed Surveyor must be submitted showing:
   ii. Property lines, buildings (including accessory structures), public and private roads within 300 feet of the subject property.
   iii. Proposed location of wind energy conversion facility, including all turbines, fencing, associated ground equipment, transmission infrastructure, access roads, parking area and any other construction or development attendant to the wind energy conversion facility.
   iv. Distances, at grade, from the proposed wind energy conversion facility to each building on the vicinity plan shall be shown.
   v. The proposed changes to the existing property including grading and vegetation removal.
   vi. A landscape plan showing existing trees and shrubs, as well as those proposed to be added, indentified by size and species
   vii. Tree cover and average height of trees on the subject property and adjacent properties within 300 feet.
   viii. Contours at each two feet Above Mean Sea Level for the subject property and adjacent properties within 300 feet.
   ix. Zoning district designation for the subject parcel

c. Elevations
Elevations shall be either at a 1/4' or 1/8' inch scale showing views at-grade from the north, south, east and west for a 50-foot radius around the proposed wind energy facility. Elevations shall show all equipment, security barriers, structures, existing and proposed trees and shrubs, and grade changes.

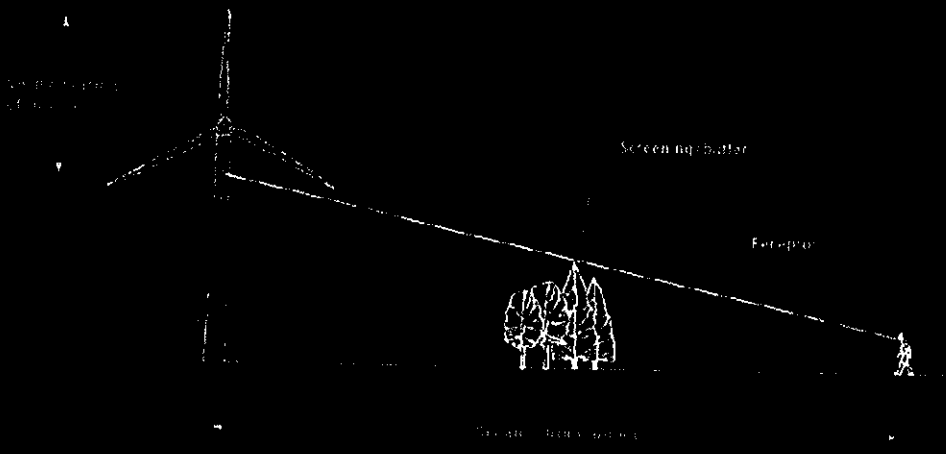
d. Photographs and Sight-line Diagrams
   i. Color photographs of the current view shall be submitted from at least two locations to show the existing conditions.

ii. Each of the existing condition photographs shall have the proposed wind energy facility superimposed on it to accurately simulate the proposed wind energy facility.

iii. Color photographs of the existing conditions at the base of the proposed turbine site shall be submitted. These photographs shall serve as the documentation of the natural condition of the site.

iv. Sight-line diagrams from at least two locations, such as a public roadway or the closest habitable structure, shall be depicted in profile drawings at a scale of one inch equals 40 feet. The diagrams shall show the lowest point of the turbine visible from each location and all intervening trees and buildings.

Figure 1: Example Site-line Diagram



e. Materials & Colors
Specifications for the proposed wind energy facility shall be provided for all equipment and attendant facilities.

f. Balloon or Crane Test
Prior to, or at the time of filing an application for a Special Permit, the applicant shall arrange for a balloon or crane test at the proposed site to illustrate the height of the proposed facility. The date, time, and location of such test shall be advertised in a newspaper of general circulation at least 14 days, but not more than 21 days prior to the test. In addition, notice shall be provided to 300 ft abutters and abutting municipalities. Notice of the Balloon test may be combined with the notice of the public hearing.

(8) Professional Fees
The City may retain a technical expert/consultant to verify information presented by the applicant at the cost of the applicant.

(9) Utility Notification
No residential scale wind energy system shall be installed until evidence has been given that the utility company has been informed of the costumer's intent to install an interconnected customer owned generator. Off grid systems shall be exempt from this requirement.

(10) Use by Telecommunications Carriers

Wind energy conversion facilities may be used to locate telecommunications antennas, subject to applicable regulations governing such uses, and subject to the following requirements:

a. all ground mounted telecommunications equipment shall be located in either a shelter within the turbine tower or otherwise screened from view year-round; and
b. antennas should be flush-mounted to be keeping in the design of the wind turbine tower; and
c. all cabling associated with the personal wireless facility shall be contained within the tower structure or enclosed within a conduit painted to match the turbine mount.

(11) Term of Special Permit.

A Special Permit issued for any wind energy conversion facility shall be valid for 25 years. At the end of that time period, the wind energy conversion facility shall be removed by the applicant unless a renewal or extension of the Special Permit is granted by the Planning Board. Upon request, the Planning Board may extend, renew, or modify the Special Permit if the operation of the facility is satisfactory.

(12) Monitoring and Maintenance

a. After the wind energy conversion facility is operational, the owner shall submit to the City at annual intervals from the date of issuance of the Special Permit, a report detailing operating data for the facility.

b. Notice shall be provided to the City of any change of ownership.

c. The owner shall maintain the wind energy conversion facility in good condition. Such maintenance shall include, but not be limited to, painting, structural integrity of the foundation, the support structure, the security barrier (if applicable) and maintenance of the buffer areas and landscaping if present.

(13) Abandonment or Discontinuation of Use

a. At such time that a wind energy conversion facility is scheduled to be abandoned or discontinued, the applicant will notify the City of Salem by certified U.S. mail of the proposed date of abandonment or discontinuation of operations. In the event that an applicant fails to give such notice, a wind energy facility will be considered to be abandoned if it is not operated continuously for a period of one year, or if it is designated as a safety hazard by the building commissioner.

b. Upon abandonment or discontinuation of use, the owner shall physically remove the wind energy conversion facility within 90 days, unless an extension is granted by the Planning Board. "Physically remove" shall mean removal of all equipment and restoration of the location to its natural condition as shown in the baseline documentation photos except that, new landscaping and grading done as part of the turbine installation may remain.

c. If the applicant fails to remove a wind energy conversion facility in accordance with this section, the City shall have the authority to enter the subject property and physically remove the facility. The applicant may be required to provide a form of surety at the time of construction to cover the costs of the removal in the event the City must remove the

facility. The applicant shall submit a fully inclusive estimate of costs associated with removal, prepared by a qualified engineer. The amount of the surety should be for 150% of the cost at the time. The amount shall include a mechanism for a Cost of Living Adjustment after 10 and 15 years."

Section II. This Ordinance shall take effect as provided by City Charter.

In City Council September 25, 2008
Referred to the Planning Board to schedule a joint public hearing with the Planning Board and invite the Renewable Energy Task Force to the public hearing.
Public Hearing held on November 12, 2008 and advertised in the Salem News on October 29, 2008 and November 5, 2008
Referred to the Planning Board for their recommendation
In City Council December 11, 2008
Planning Board recommendation recieved and referred to the Committee on Administration and Finance
In City Council January 22, 2009
Adopted for first passage as amended by unanimous roll call vote of 11 yeas, 0 nays, 0 absent and referred to the Committee on Ordinances, Licenses and Legal Affairs and schedule a Special Meeting to adopt for second passage.
A motion for immediate reconsideration in the hopes it would not prevail was denied.

ATTEST:

CHERYL A. LAPOINTE
CITY CLERK

Appendix I

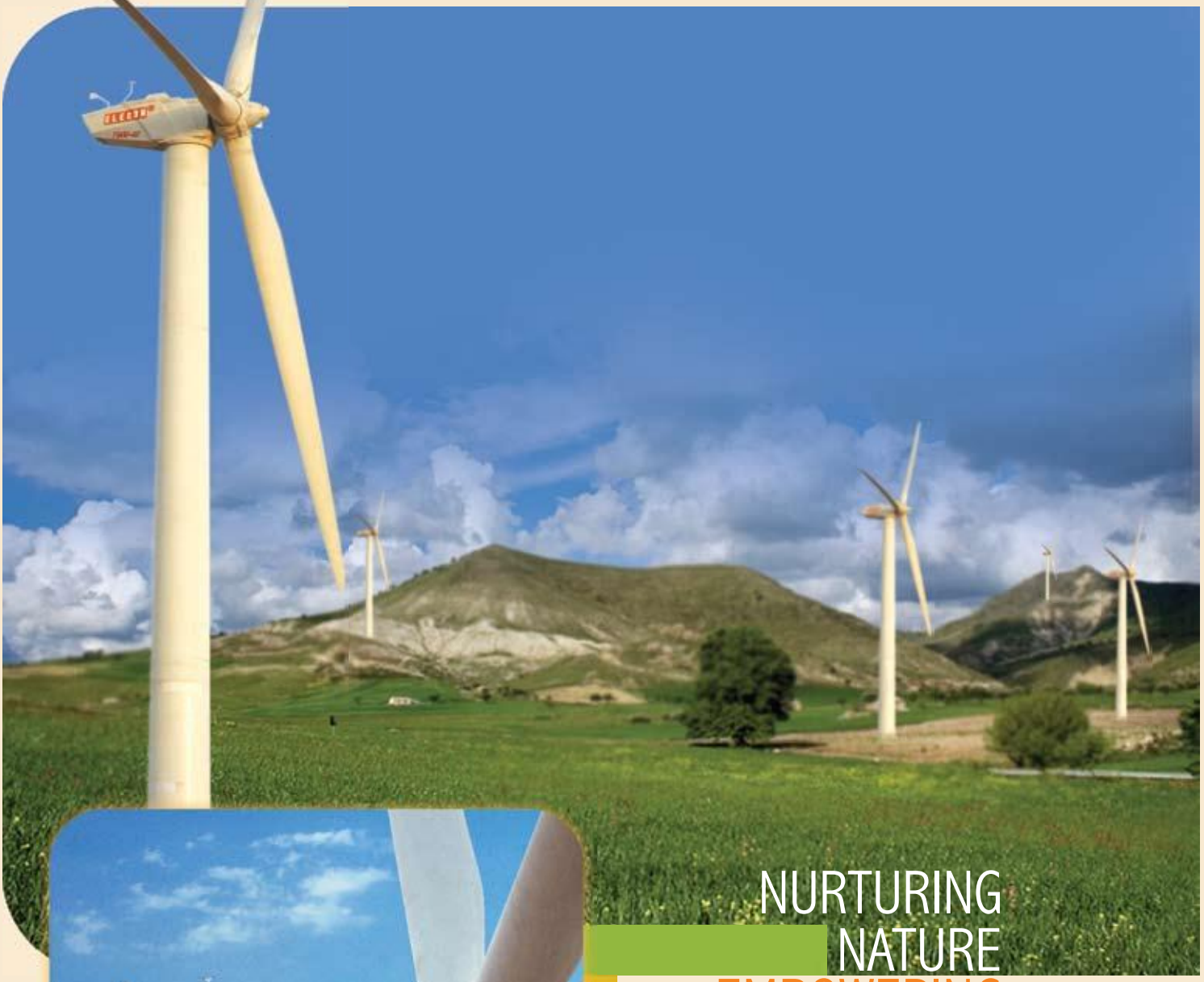
Turbine Candidate Specifications

ELECON

TURBOWINDS

600 KW WIND TURBINE GENERATOR

60 Hz Application



NURTURING NATURE
EMPOWERING FUTURE

Catalogue No.: 186/AE/03/09/INT

ELECON TURBOWINDS

INTRODUCTION

Elecon Engineering Company Ltd., a publically traded company, has been a pioneer in the design and manufacturing of Material Handling and Power Transmission (Gearbox) Equipment since 1951. Over a decade ago, Elecon successfully diversified into the quality manufacturing of Wind Turbine Generators.

Elecon Alternate Energy Division Offices

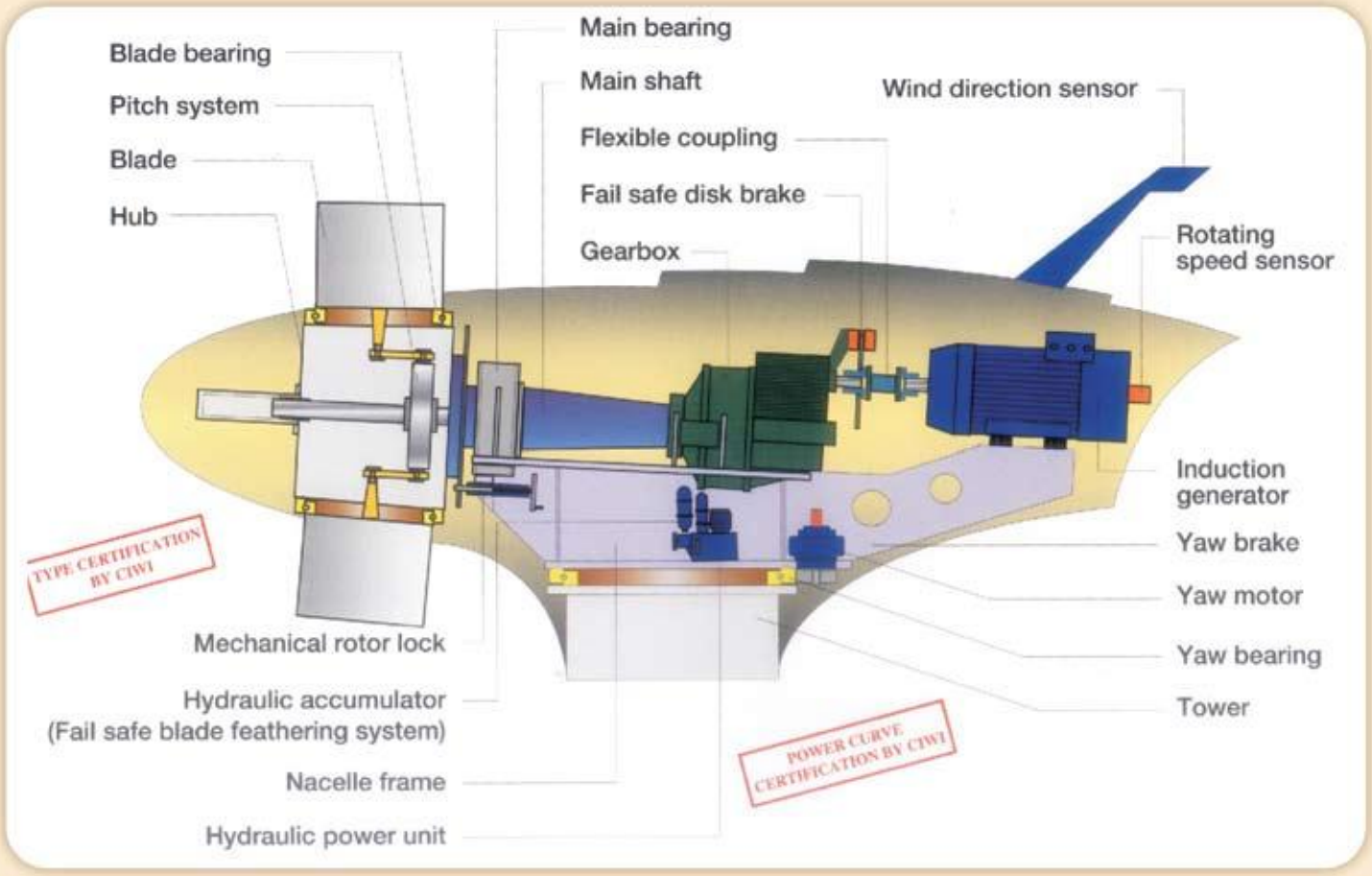
Elecon-Turbowinds T600-48DS

Elecon Wind Turbine in USA

Elecon, a MNRE/C-WET approved manufacturer, now offers dual speed and active stall hydraulically pitch controlled Wind Turbine Generators of 600 kw rating, manufactured under the technical collaboration of M/s TURBOWINDS n.v. Belgium.

Elecon's Alternate Energy Division is currently focusing on the manufacturing of a dual speed 600 kw Wind Turbine Generator, T600-48DS. The hydraulically controlled active stall T600 is manufactured with the technical collaboration of Turbowinds N.V. Belgium.

For nearly two decades, Turbowinds has designed and manufactured high output wind turbines for installations around the world. This experience has allowed Turbowinds to positively contribute to the reduction of Co_2 emissions and environmental preservation worldwide.



T600 - 48DS FEATURES:

- The Elecon - Turbowinds T600-48DS has been optimized for Class II and lower wind conditions as well as a wide range of climatic environments.
- The T600-48DS is provided with dual speed generator, allowing the wind turbine to effectively produce higher energy output even in low wind conditions.
- A heavy duty 3-stage Elecon gearbox, specifically designed and manufactured for the T600, contributes to the high level of operational dependability.
- The blades supplied with the T600-48DS are manufactured by the world's foremost supplier of wind turbine blades and have been robustly designed for both reliability and superior aerodynamic characteristics.
- The T600 Active Pitch Controls are hydraulically operated to harness optimum wind at all times.
- A unique safety feature of the T600 is the failsafe blade feathering in the event of grid loss or elevated wind conditions to prevent damage to the drive train.
- The T600 also features independent over-speed trips, which activate a disc braking safety system to prevent damage to the turbine.

TECHNICAL SPECIFICATION

Turbine type : **T600-48 Dual speed**

General :

Rated power	600 kw
Rotor diameter	48m
Hub height	50m/55m/60m

Rotor :

Number of blades	3
Rotor speed	15 / 23 pm
Blade construction	FRP
Aerofoil	DU97-W-300, DU91-W2-250 FFA-W3-211, NACA63418
Control	Active stall
Pitch actuation	Hydraulic
Hub type	Rigid
Cone angle	-2 Degree
Tilt angle	-4 Degree

Transmission : (Gearbox)

Type	1-stage planetary 2-stage parallel
Rating -	600 kw
Gear Ratio	1:78.26

Brake :

Type	Fail-Safe disk brake
Position	High speed shaft

Generator :

Type	Dual speed Induction generator
Rating	120 kw/600 kw
Rotation speed	1200 / 1800 rpm
Voltage/Frequency	690 Volt/60Hz*

Nacelle :

Frame	Welded high strength steel structure
Housing	FRP

Tower :

Material	Welded steel
Type	Tapered cylinder
	Paint / Hot Dip Galvanized

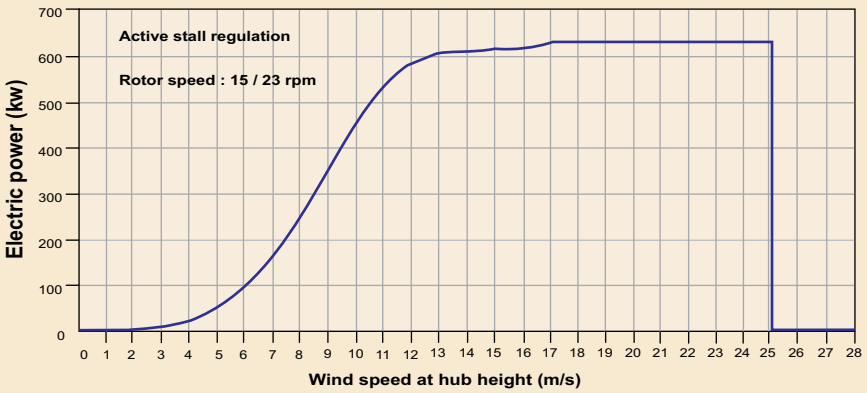
Performance :

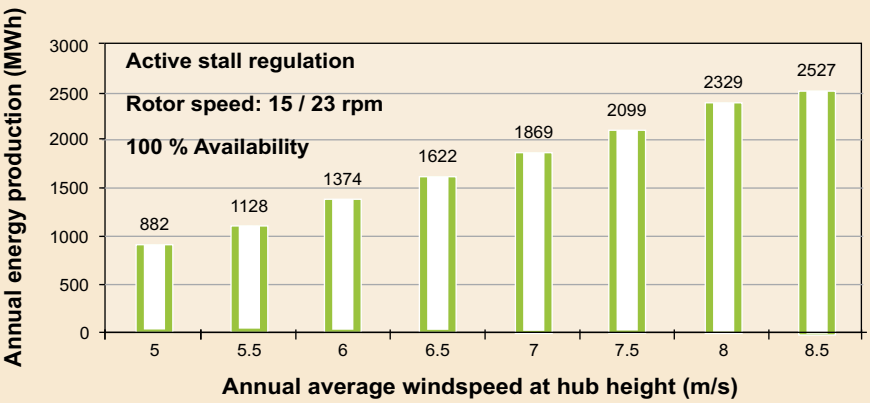
Rated power	600 kw
Rated wind speed	12.5 m/s
Cut in	3.5 m/s
Cut out	25 m/s
Survival	60 m/s

Weights :

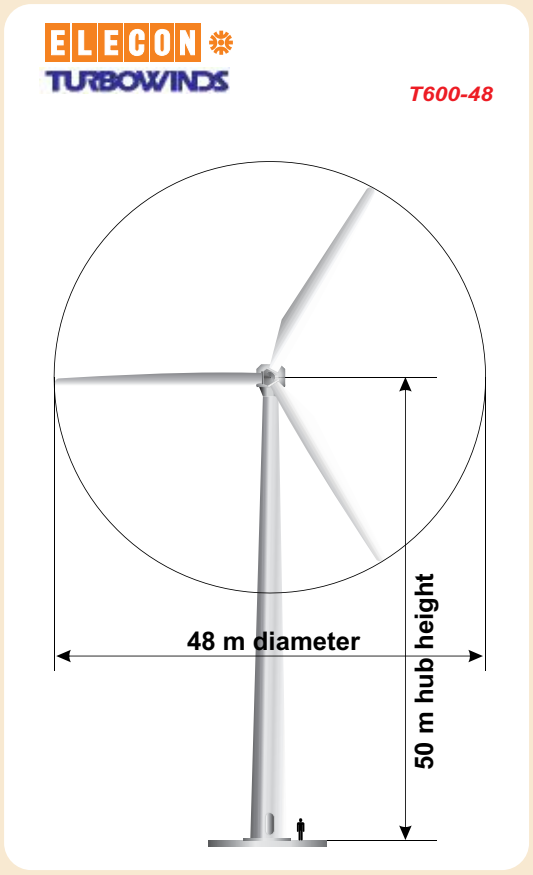
Nacelle including rotor	35,000 Kgs
Rotor (Hub & 3 Blades)	14,500 kgs
Tower (50 Mt)	56,000 Kgs
Tower (55 Mt)	65,000 Kgs
Tower (60 Mt)	68,000 Kgs

* T600 Options available include cold weather package and 50 Hz compatibility





* Estimate based on Weibull Distribution



ELECON Wind Turbine GEAR BOX

The T600 Gearbox is
a combination of Planetary
and Helical with
shaft mount and torque arm
support.

Wind Turbine Gearboxes
up to 2MW can be manufactured in
Elecon Facilities

For further details contact :
GEAR DIVN. : Tel. : +91 (2692) 236469,236513,236516,
Fax : +91 (2692) 236527
Email : infogear@gear.elecon.com

MITSUBISHI WIND TURBINE GENERATOR

MWT62/1.0 (MWT-1000A)

Technical Data

Operation Data

Cut-in	3.0 m/s
Rated	12.5 m/s
Cut-out	25.0 m/s
Wind Class	IEC Class IIA

Rotor

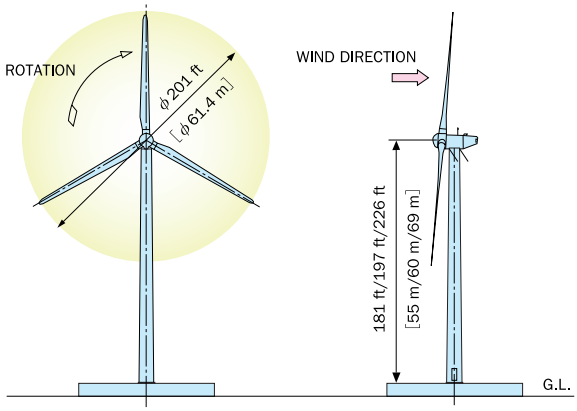
Diameter	61.4 m
Swept Area	2,960 m^2
Rotational Speed	19.8 rpm
Blade Length	29.5 m
Aerodynamic Brake	Blade Feathering

Generator

Type	Induction Generator (4 Pole Type)
Rated Power	1,000 kW
Voltage	690 V/600 V (50 Hz/60 Hz)
Frequency	50 Hz/60 Hz

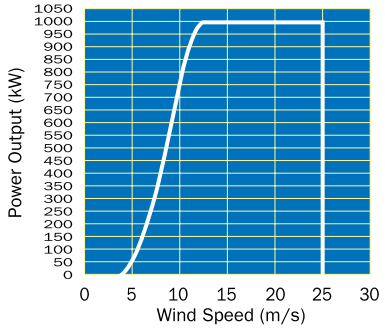
Tower

Hub Height	50 m/60 m/69 m



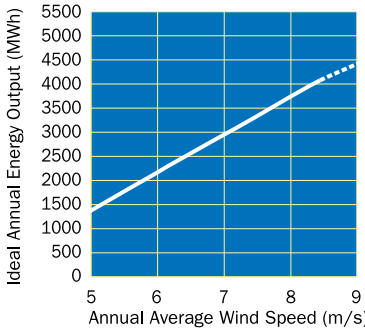
Impressive Performance

Power Curve



- Air Density: 1.225 kg/m^3
- Wind conditions with 10% turbulence
- Calculated at the output of inverter

Ideal Annual Energy Production and Capacity Factor



- Calculated on Rayleigh distribution
- Calculated at the output of inverter
- Site conditions may vary capacity factor

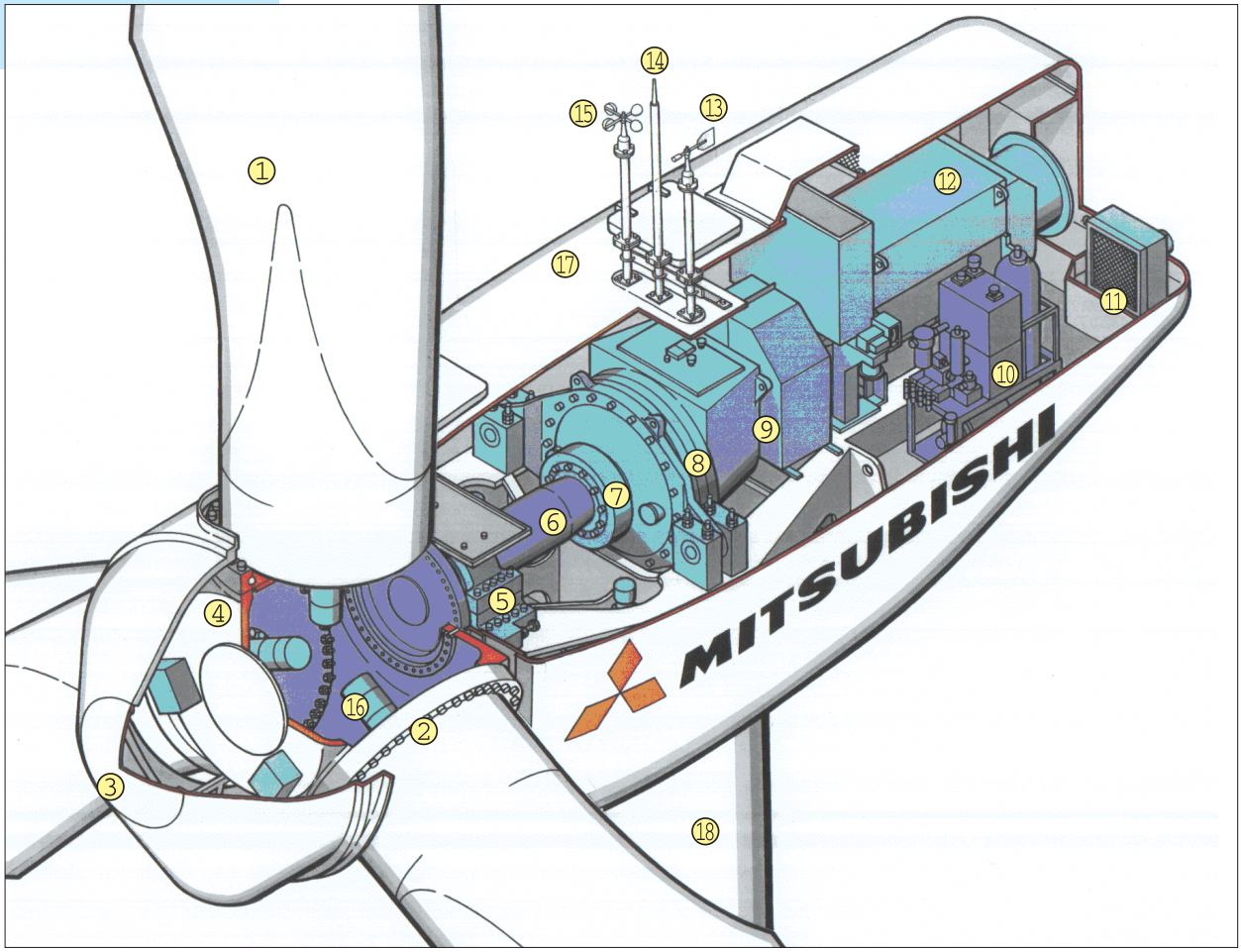
MITSUBISHI HEAVY INDUSTRIES, LTD.

Superior Technology for A Brighter Future

MITSUBISHI WIND TURBINE GENERATOR

MWT62/1.0 (MWT-1000A)

- **High performance in moderate wind speed area (IEC Class IIA)**
- **Proven Reliability**



Schematic Diagram

① Blade
② Blade Bearing
③ Front Capsule
④ Rotor Head
⑤ Main Bearing
⑥ Main Shaft
⑦ Coupling (Low Speed)
⑧ Gear Box
⑨ Coupling (High Speed)
⑩ Hydraulic Unit
⑪ L.O. Cooler (with Fan)
⑫ Generator
⑬ Wind Vane
⑭ Lightning Rod
⑮ Anemometer
⑯ Hydraulic Pitch Link System
⑰ Nacelle
⑱ Tower

MITSUBISHI HEAVY INDUSTRIES, LTD.

Power Systems Headquarters, Renewable Energy Business Division, Wind Turbine Business Unit
3-1, Minatomirai 3-chome, Nishi-ku, Yokohama 220-8401, Japan
Phone: +81-45-200-7910 Fax: +81-45-200-7738
URL: http://www.mhi.co.jp

ISO9001 REGISTERED FIRM
DNV Certification B.V., THE NETHERLANDS
MGMT. SYS. RvA C 024

<North America>
Mitsubishi Power Systems, Inc. (MPS)
100 Colonial Center Parkway, Lake Mary,
FL 32746, U.S.A.
Phone: +1-407-688-6100 Fax: +1-407-688-6481
URL: http://www.mpshq.com

Los Angeles Office
100 Bayview Circle, Suite 6000
Newport Beach, CA 92660, U.S.A.
Phone: +1-949-856-8400 Fax: +1-949-856-4481, 4482

<Europe>
Mitsubishi Power Systems Europe, Ltd. (MPSE)
20 North Audley Street London W1K 6WL, UK
Phone: +44-20-7647-0820 Fax: +44-20-7491-4558

Hamburg Office
Gustav-Mahler-Platz 1, 20354 Hamburg, Germany
Phone: +49-40-3770-7820 Fax: +49-40-3770-78298

Printed in Japan

GE Energy

1.5MW
Wind Turbine

imagination at work

a product of
ecomagination

The industry workhorse

The world needs a reliable, affordable and clean supply of electric power with zero greenhouse gas emissions, which is why GE continues to drive investment in cutting-edge wind turbine technology.

Building on a strong power generation heritage spanning more than a century, our 1.5 MW wind turbine—also known as the industry workhorse—delivers proven performance and reliability, creating more value for our customers.

Our product strategy is focused on results that contribute to our customers' success and wind farm return on investment. Every initiative we pursue bears our uncompromising commitment to quality and product innovation. Our reputation for excellence can be seen in everything we do. GE's commitment to customer value and technology evolution is demonstrated in our ongoing investment in product development. Since entering the wind business in 2002, GE has invested over $850 million in driving reliable and efficient wind technology.

GE 1.5 MW...the most widely used wind turbine in its class

- **12,000+** turbines are in operation worldwide
- **19** countries
- **170+** million operating hours
- **100,000+** GWh produced

Data as of March, 2009

Global footprint

GE Energy is one of the world's leading suppliers of power generation and energy delivery technologies—providing comprehensive solutions for coal, oil, natural gas and nuclear energy; renewable resources such as wind, solar and biogas, and other alternative fuels. As a part of GE Energy Infrastructure—which also includes the Water, Energy Services and Oil & Gas businesses—we have the worldwide resources and experience to help customers meet their needs for cleaner, more reliable and efficient energy.

GE has six wind manufacturing and assembly facilities in Germany, Spain, China and the United States. Our facilities are registered to both ISO 9001:2000 and our Quality Management System, providing our customers with quality assurance backed by the strength of GE. Our wind energy technology centers of excellence in Europe, Asia, and North America, as well as our teams of engineers and scientists, use Six Sigma methodology coupled with the latest computational modeling and power electronic analysis tools to manufacture wind turbines with the performance and reliability necessary to meet our customers' challenges.

As the cornerstone of GE technology for more than 100 years, our four Global Research Centers are focused on developing breakthrough innovations in the energy industry. We believe wind power will be an integral part of the world energy mix throughout the 21st century and we are committed to helping our customers design and implement energy solutions for their unique energy needs.

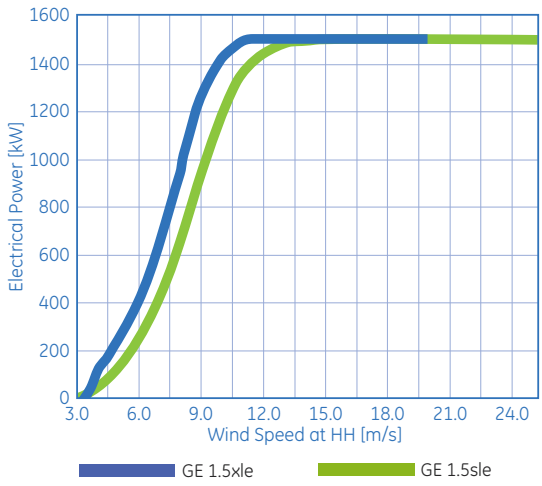
Advancing wind capture performance

As a leading global provider of energy products and services, GE continues to invest in advancing its 1.5 MW wind turbine product platform. With a core focus on enhancing efficiency, reliability, site flexibility and delivering multi-generational product advancements, GE's 1.5 MW wind turbine is the most widely used turbine in its class. Our commitment is to fully understand our customer's needs and respond with new technology enhancements aimed at capturing maximum wind energy to deliver additional return on investment.

Technical data

	1.5sle	1.5xle
Operating Data		
Rated Capacity:	1,500 kW	1,500 kW
Temperature Range: (with Cold Weather Extreme Package) Operation: / Survival:	-30°C – +40°C / -40°C – +50°C	-30°C – +40°C / -40°C – +50°C
Cut-in Wind Speed:	3.5 m/s	3.5 m/s
Cut-out Wind Speed (10 min avg.):	25 m/s	20 m/s
Rated Wind Speed:	14 m/s	11.5 m/s
Wind Class — IEC:	IIa (V_{e50} = 55 m/s V_{ave} = 8.5 m/s)	IIIb (V_{e50} = 52.5 m/s V_{ave} = 8.0 m/s)
Electrical Interface		
Frequency	50/60 Hz	50/60 Hz
Voltage	690V	690V
Rotor		
Rotor Diameter:	77 m	82.5 m
Swept Area:	4657 m^2	5346 m^2
Tower		
Hub Heights:	65/80 m	80 m
Power Control	Active Blade Pitch Control	Active Blade Pitch Control

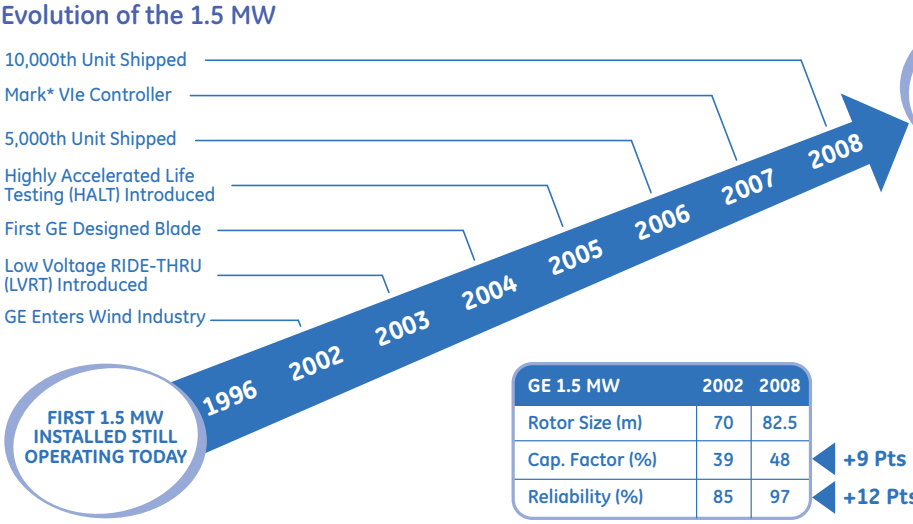
Power curve



1.5sle — *Classic workhorse, an efficient and reliable machine with proven technology*
1.5xle — *Built on the success of the 1.5sle platform, captures more wind energy with 15% greater swept area*

GE's 1.5 MW wind turbine is designed to maximize customer value by providing proven performance and reliability. GE's commitment to customer satisfaction drives our continuous investment in the evolution of the 1.5 MW wind turbine through technological enhancements.

Evolution of the 1.5 MW



GE 1.5 MW	2002	2008	
Rotor Size (m)	70	82.5	
Cap. Factor (%)	39	48	+9 Pts
Reliability (%)	85	97	+12 Pts

Commitment to continued investment

GE's commitment to investing in technology and increasing customer value is demonstrated with our exciting new customer options for increasing turbine performance, flexibility and reliability.

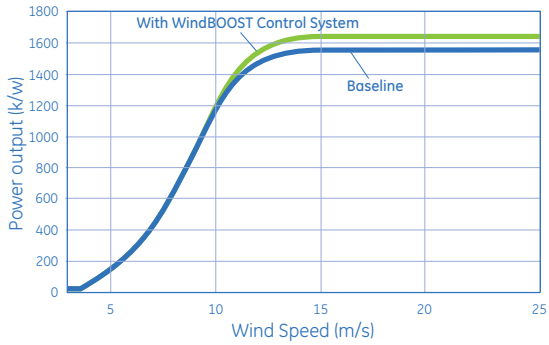
Enhanced performance

WindBOOST* Control System

This exciting new customer option for increasing performance, WindBOOST* control system, is a unique offering in the wind industry and the latest addition to the 1.5 MW product platform. This software upgrade provides:

- Up to 4% increased annual energy production (AEP), resulting in higher return on investment.
- Patent-pending control technology for optimum rotational speed, resulting in increased energy production.
- Remote capability to turn feature on and off at the turbine level.
- Increased power output while maintaining grid stability.

WindBOOST* Control System
Power Curve Density 1.2 (kg/m^3)



Improved flexibility

Reinforced Tower

GE's investment in a reinforced tower design opens up new potential wind sites for our customers, enabling us to deliver reliable and safe products that meet product and regulatory compliance expectations. GE's reinforced tower sections have the same length and external diameter as the standard GE North American modular system, but are specially built to handle seismic loads.

- Allows wind farms to be located in designated seismic prone areas with good wind resources.
- GE provides an evaluation to determine if the site requires reinforced tower due to seismic activity.

Increased reliability

Condition Based Maintenance (CBM)

GE Energy's integrated Condition Based Maintenance (CBM) system proactively detects impending drive train issues, enabling increased availability and decreased maintenance expenses. Factory or field installed and tested, the CBM solution can improve reliability on a single wind farm or multiple wind farms. GE's CBM allows operators to understand an issue weeks—or even months—in advance. This permits operators to:

- Continue to produce power while parts, crane, and labor are resourced.
- Plan multiple maintenance events with the same resources.
- Reduce or limit the extent of damage to the drivetrain and reduce repair costs.

Leading reliability and availability perform

GE's 1.5 MW wind turbine and services are designed to set the industry standard for product reliability and availability performance. GE's continual investments in technology, established infrastructure, research capabilities and globally recognized business processes allow GE to create and deliver customer value by maximizing energy capture and return on investment. This is evident through our model year performance trend where availability performance significantly improves each year.

GEARBOX

- HALT testing on every design
- Cylindrical roller bearings
- Improved oil filtration, heating and cooling

MAIN SHAFT

- Material upgrade
- Expanded operating range

MAIN BEARING

- Increased bearing robustness

SOFT BRAKE SYSTEM

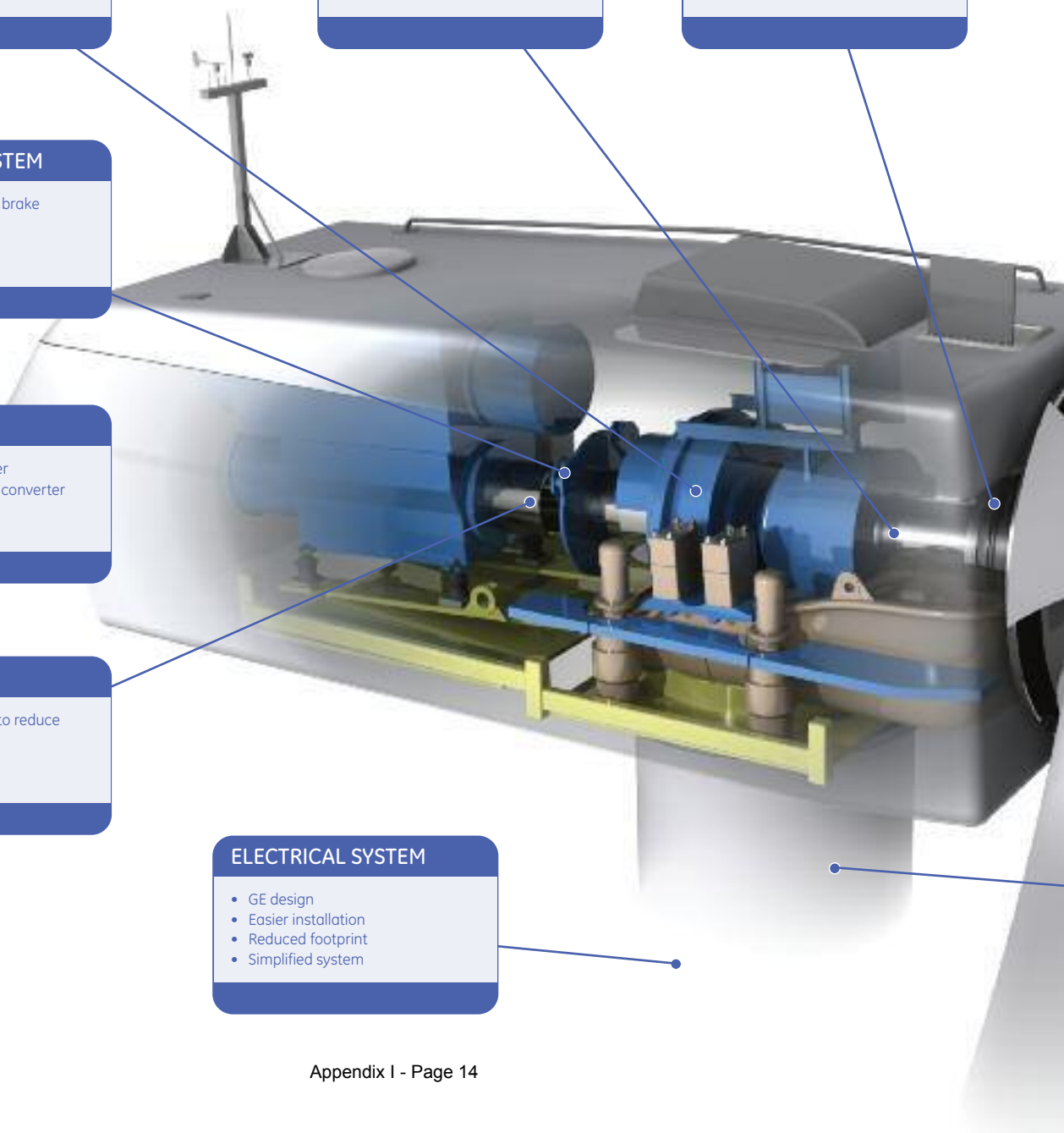
- Hydraulic secondary brake

CONTROL

- GE Mark VIe controller
- Integrated pitch and converter diagnostics

COUPLING

- Slip coupling design to reduce gearbox loads



ELECTRICAL SYSTEM

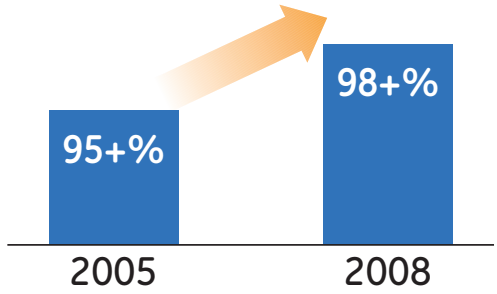
- GE design
- Easier installation
- Reduced footprint
- Simplified system

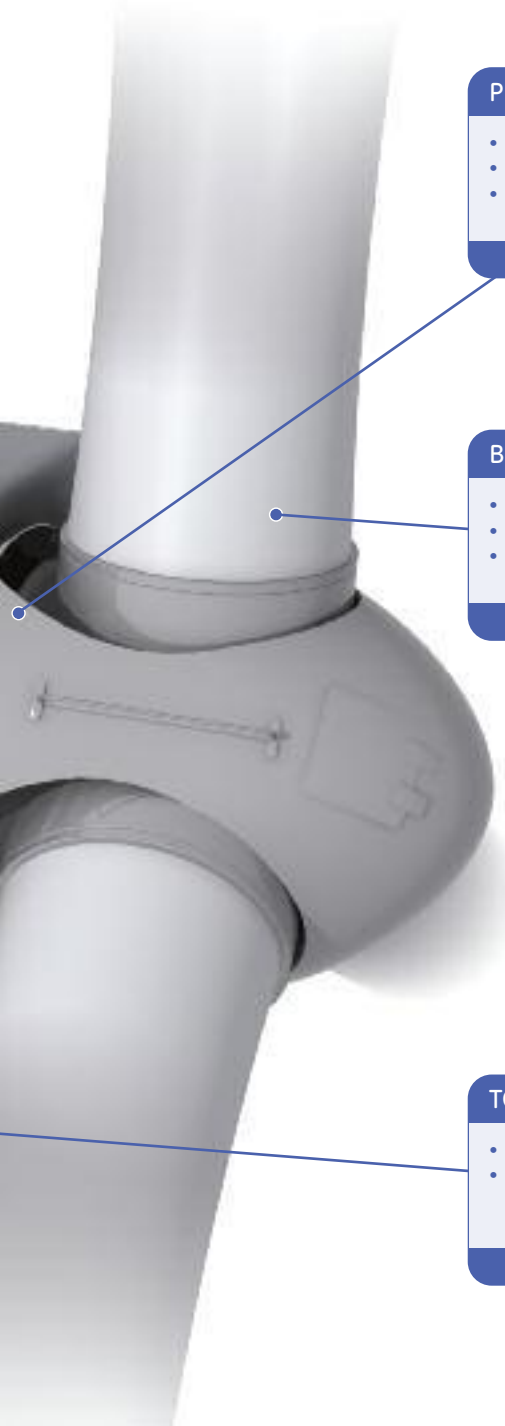
ance

Delivering reliability through advanced technology

To optimize turbine reliability and availability, GE focuses on reducing the number of downtime faults, and providing faster Return-to-Service (RTS). Our rigorous design and testing process—including specialized 20-year fatigue testing and Highly Accelerated Life Testing (HALT)—reflects our ongoing investment in key turbine components.

1.5 model year availability





PITCH

- GE designed pitch electronics
- Increased pitch drive robustness
- Greater torque

BLADES

- Includes GE designs
- Improved capacity factor
- HALT testing

TOWER

- Modular tower system
- Hub height flexibility

Technological expertise

GE Infrastructure

Energy

- Controls, materials, power electronics
- Fulfillment and logistics capability
- Efficient supply chain management

Aviation

Aerodynamic and aero-acoustic modeling expertise

Rail

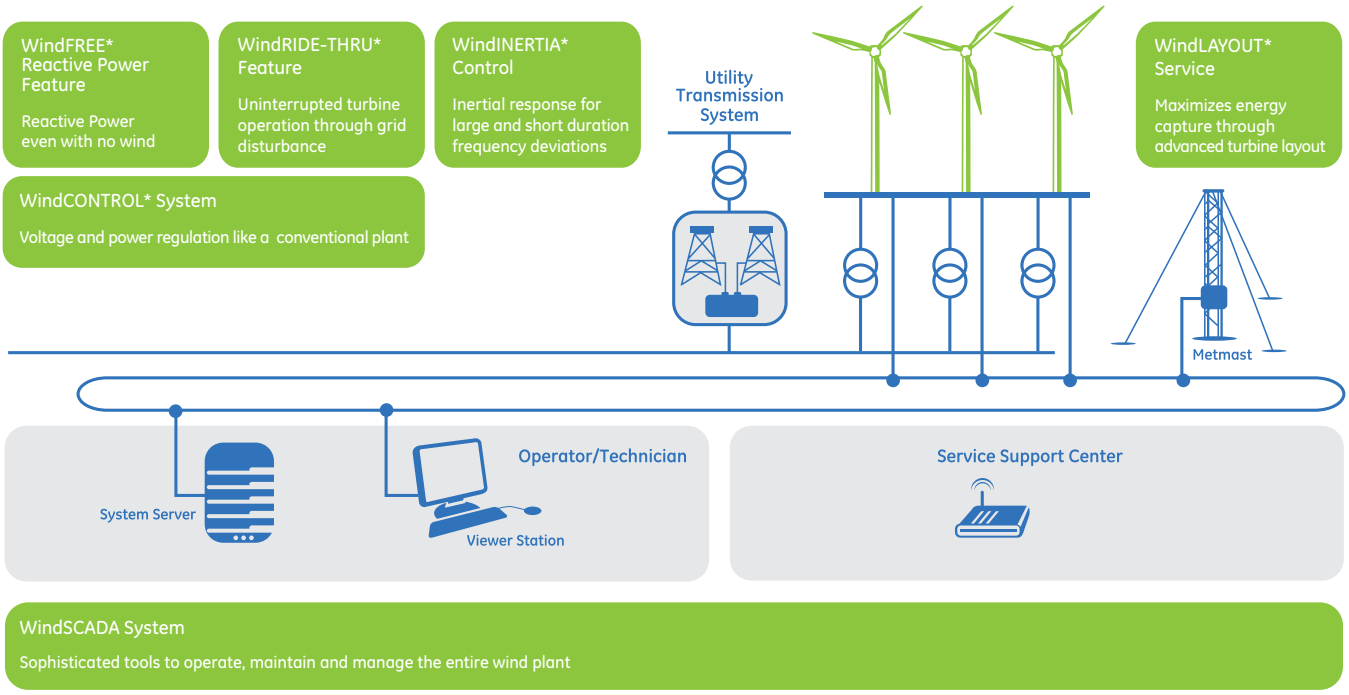
Gearbox and drive train technologies

GE Global Research

- Energy conversion
- Material sciences
- Smart grids

Optimized wind power plant performance

Wind turbine performance is a critical issue in light of increasingly stringent grid requirements. GE's unrivaled experience in power generation makes us the industry leader in grid connection. By providing a sophisticated set of grid-friendly benefits similar to conventional power plants, GE's patented integrated suite of controls and electronics take your wind power plant to the frontline of performance and seamless grid integration.



FEATURE	DESCRIPTION	BENEFITS
WindCONTROL* System	Voltage and power regulation like a conventional power plant	Ability to supply and regulate reactive and active power to the grid Additional features include power frequency droop, power ramp rate limiters and integrated capacitor/reactor bank control
WindFREE* Reactive Power Feature	Provides reactive power even with no wind	Provides smooth fast voltage regulation by delivering controlled reactive power through all operating conditions Eliminates the need for grid reinforcements specifically designed for no-wind conditions
WindRIDE-THRU* Feature	Low voltage, zero voltage and high voltage ride-through of grid disturbances	Uninterrupted turbine operation through grid disturbances Meets present and emerging transmission reliability standards
WindINERTIA* Control	Provides temporary boost in power for under-frequency grid events	Provides inertial response capability to wind turbines that is similar to conventional synchronous generators without additional hardware
WindLAYOUT* Service	Service to optimize turbine layout for a site	Opportunity to increase annual energy production for a site
WindSCADA System	Tools to operate, maintain and manage wind power plant	Real-time data visualization, reporting on historical data, alarm management and secure user access

Project execution

GE understands that grid compatibility, site flexibility, and on-time delivery are critical to the economics of a wind project. That's why the 1.5 MW wind turbine has been engineered for ease of integration and delivery to a wide range of locations, including those with challenging site conditions.

Our global project management and fulfillment expertise offer customers on-time delivery and schedule certainty. Regardless of where wind turbine components are delivered, GE's integrated logistics team retains ownership and responsibility for this critical step. Utilizing the GE Energy Power Answer Center, our engineering and supply chain teams are ready to respond to any technical, mechanical or electrical questions that may arise.

As one of the world's largest power plant system providers, GE is uniquely positioned to provide customers with full-service project management solutions. With offices in North America, Europe, and Asia, our world class Global Projects Organization utilizes decades of fulfillment expertise in project management, logistics, plant start-up and integration from Gas Turbine, Combined Cycle, Hydro, and Aero plants.

Here are some examples of how GE has worked with customers to solve project challenges and maximize their value through on-time delivery and advanced logistic capabilities:

Challenge:
Site with late grid availability due to project location change

GE's solution:
Pre-commissioning service: GE can bring portable generators on site and pre-commission turbines even without back feed power

Customer benefit:
Faster commissioning once grid became available

Challenge:
Project site with difficult geographic access

GE's solution:
Well-choreographed team with challenging terrain transportation expertise

Customer benefit:
More site flexibility; schedule target met

World-class customer service

GE's wind turbine fleet is one of the fastest growing and best-run fleets in the world. Utilizing our decades of experience in product services in the power generation industry, GE provides state-of-the-art solutions to ensure optimal performance for your wind plant.

24x7 Customer Support

GE's customer support centers in Europe and the Americas provide remote monitoring and troubleshooting for our installed fleet of wind turbines around the world, 24 hours a day, 365 days a year. The customer support centers are able to quickly perform remote resets for over 250 turbine faults. It is one of the most effective ways to ensure continuous monitoring and fault resets of your wind assets by qualified technology experts.

Technical Skills and In-depth Product Knowledge

GE's wind customer support centers have dedicated teams to dispatch for troubleshooting, repair and maintenance, available 24 hours a day, 365 days a year. This model ensures wide coverage of large wind turbine fleets without compromising technical skills or quality.

GE taps into our extensive product knowledge for timely resolution of many issues. All turbine faults are investigated using a structured technical process, which is then escalated as necessary. We also use feedback from this process in product development.

Operations and Maintenance Support

Driven by a highly skilled work force and the operating knowledge of over 12,000 1.5 MW wind turbines, GE offers a wide range of services tailored to the operation and maintenance needs of your wind assets. Our offerings range from technical advisory services, transactional services and remote operations to full on-site operations support including availability guarantees.

Parts Offerings

GE has utilized the extensive Parts and Refurbishment experience of its Energy Services business to establish a global center of excellence for wind parts operations. The wind parts resources are aligned to provide a full range of offerings for all types of parts and refurbishment needs, including routine maintenance kits, consumables and flow parts, and key capital parts such as gearboxes and blades.

With the launch of our 24/7 parts call center (877-956-3778), and the development of online ordering tools, we are increasing the channels that our wind plant operators can utilize to order required wind turbine parts, including emergency requests for down-turbine needs.

For wind plant operators looking for additional benefits that a contractual parts relationship with GE can offer, the wind parts team has developed tailored offerings that can provide ongoing inventory-level support and parts lead-time guarantees. One of the exciting advantages of a GE wind parts and refurbishment program is membership in the capital parts pool, with a priority access to often hard-to-source capital parts.

Conversions, Modifications and Uprates (CM&U)

Continuous technological improvements are key for GE to be a world leader in the wind industry. Our CM&U offerings utilize the new technology developments in the 1.5 MW platforms to improve the performance of existing assets. These offerings are designed to improve reliability and availability, and increase turbine output and improve grid integration.

Long-Term Asset Management Support

GE is your reliable partner as we strive to build long-term relationships with asset managers. Utilizing our strengths, we can provide parts solutions, field technician and customer training, and a wide range of specialized services to complement local on-site capabilities.

Environmental Health and Safety, a GE commitment

Maintaining high Environmental Health and Safety (EHS) standards is more than simply a good business practice; it is a fundamental responsibility to our employees, customers, contractors, and the environment we all share.

GE is committed to maintaining a safe work environment. We incorporate these values into every product, service and process, driving EHS processes to the highest standards.

Powering the world...responsibly.

For more information, please visit
www.ge-energy.com/wind

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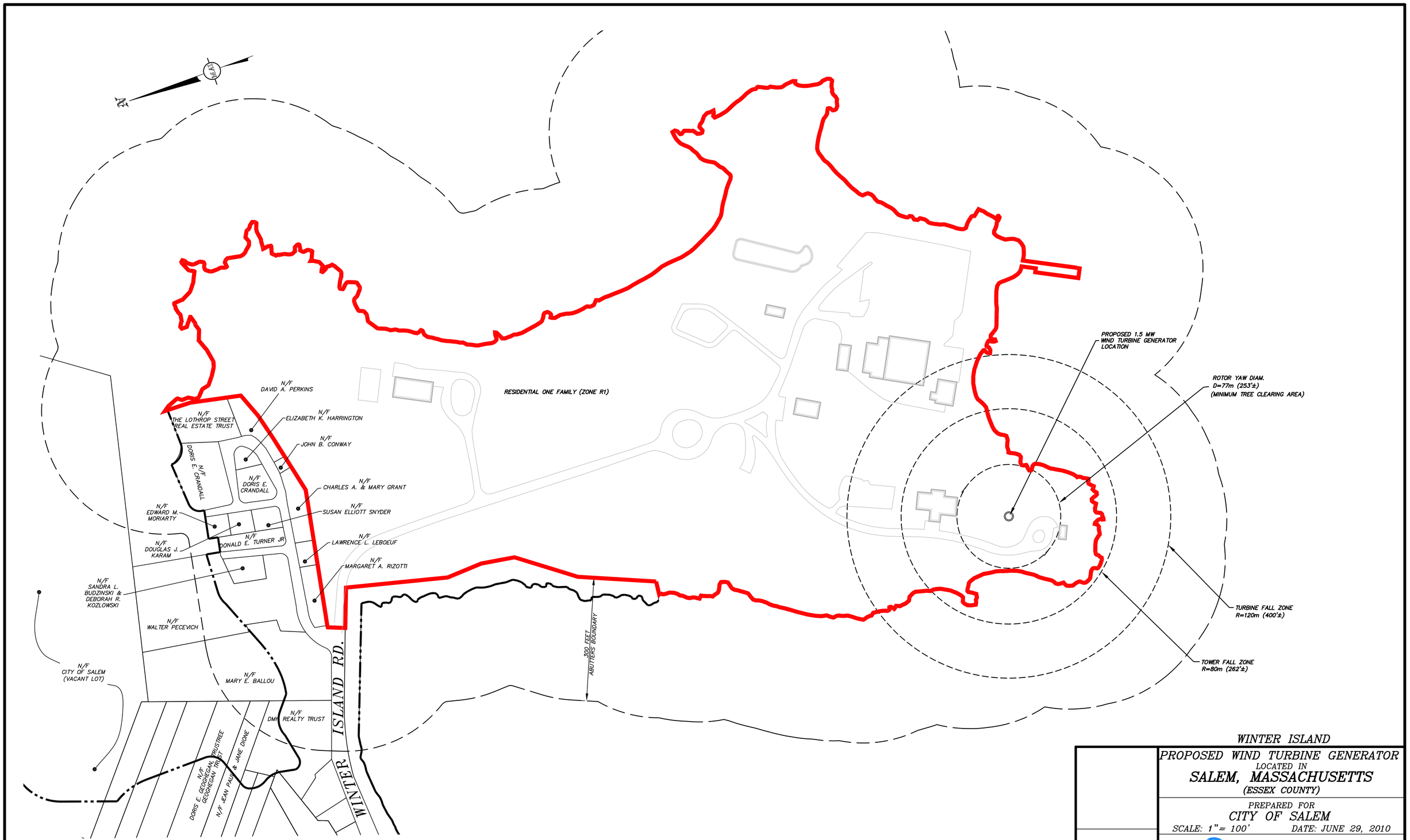
Appendix J

Site Plan



WINTER ISLAND

PROPOSED WIND TURBINE GENERATOR
LOCATED IN
SALEM, MASSACHUSETTS
(ESSEX COUNTY)

PREPARED FOR
CITY OF SALEM

SCALE: 1"= 100' DATE: JUNE 29, 2010

REVISIONS

NO.	DATE	DESCRIPTION	BY	CHK'D

DWG. No. 5209SITEBASE

MERIDIAN ASSOCIATES
152 CONANT STREET BEVERLY, MASSACHUSETTS 01915
TELEPHONE: (978) 299-0447
69 MILK STREET, SUITE 302 WESTBOROUGH, MASSACHUSETTS 01581
TELEPHONE: (508) 871-7030
WWW.MERIDIANASSOC.COM

SHEET No. 1 OF 1 PROJECT No. 5209

Appendix K

WindPro SHADOW Results

WindPRO version 2.7.486 Jan 2011

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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6/1/2011 2:37 PM / 1

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Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:29 PM/2.7.486

SHADOW - Main Result

Calculation: Winter Island - 600 kW

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

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

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
582	402	448	318	394	393	447	629	578	730	1,166	1,719	7,807

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: 253918_UPDATED.WPO (10)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10 m

Scale 1:20,000

New WTG Shadow receptor

WTGs

	UTM NAD83 Zone: 19 East	North	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	RPM
	UTM NAD83 Zone: 19		[m]					[kW]	[m]	[m]	[RPM]
1	346,356	4,709,927	8.5	ELECON1-600 ELECON1-600 6...	Yes	ELECON1-600	ELECON1-600-600	600	47.0	60.0	26.2

Shadow receptor-Input

No.	Name	UTM NAD83 Zone: 19 East	North	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
A	End of Larkin Lane	345,778	4,710,262	7.3	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
B	Winter Island Road	346,459	4,710,435	3.4	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
C	Memorial Drive @ Vicotry Road	345,605	4,710,048	2.9	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
D	Bayview Ave @ Cheval Ave	346,651	4,710,655	4.5	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
E	Naugus Ave, Marblehead	346,954	4,709,229	9.9	1.0	1.0	1.0	-180.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	End of Larkin Lane	2:06
B	Winter Island Road	0:00
C	Memorial Drive @ Vicotry Road	1:07
D	Bayview Ave @ Cheval Ave	0:00
E	Naugus Ave, Marblehead	0:00

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:29 PM/2.7.486

SHADOW - Main Result

Calculation: Winter Island - 600 kW

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	ELECON1-600 ELECON1-600 60Hz 600 47.0 !O! hub: 60.0 m (8)	10:09	3:14

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:29 PM/2.7.486

SHADOW - Calendar

Calculation: Winter Island - 600 kW **Shadow receptor:** A - End of Larkin Lane

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
582	402	448	318	394	393	447	629	578	730	1,166	1,719	7,807

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

	January		February		March	April	May	June	July	August	September	October	November		December
1	07:14		06:59	07:24 (1)	06:21	06:28	05:40	05:10	05:10	05:35	06:08	06:40	06:17		06:53
	16:21		16:57	17 07:41 (1)	17:33	19:09	19:43	20:14	20:25	20:06	19:20	18:27	16:38		16:12
2	07:14		06:58	07:24 (1)	06:19	06:26	05:39	05:09	05:10	05:36	06:09	06:41	06:18		06:54
	16:22		16:58	18 07:42 (1)	17:34	19:10	19:44	20:14	20:25	20:05	19:18	18:25	16:37		16:12
3	07:14		06:57	07:25 (1)	06:18	06:24	05:37	05:09	05:11	05:37	06:10	06:43	06:19	07:01 (1)	06:55
	16:23		17:00	17 07:42 (1)	17:35	19:11	19:45	20:15	20:25	20:04	19:16	18:23	16:35	3 07:04 (1)	16:12
4	07:14		06:56	07:25 (1)	06:16	06:23	05:36	05:08	05:12	05:38	06:11	06:44	06:21		06:56
	16:24		17:01	15 07:40 (1)	17:37	19:13	19:47	20:16	20:25	20:03	19:14	18:22	16:34	9 07:08 (1)	16:11
5	07:14		06:55	07:26 (1)	06:14	06:21	05:35	05:08	05:12	05:39	06:12	06:45	06:22		06:58
	16:25		17:02	14 07:40 (1)	17:38	19:14	19:48	20:17	20:25	20:01	19:13	18:20	16:33	12 07:09 (1)	16:11
6	07:14		06:53	07:27 (1)	06:13	06:19	05:33	05:07	05:13	05:40	06:13	06:46	06:23		06:58
	16:26		17:03	12 07:39 (1)	17:39	19:15	19:49	20:17	20:25	20:00	19:11	18:18	16:32	14 07:10 (1)	16:11
7	07:14		06:52	07:29 (1)	06:11	06:17	05:32	05:07	05:13	05:41	06:15	06:47	06:24		06:59
	16:27		17:05	9 07:38 (1)	17:40	19:16	19:50	20:18	20:24	19:58	19:09	18:16	16:31	15 07:11 (1)	16:11
8	07:14		06:51		07:09	06:16	05:31	05:07	05:14	05:43	06:16	06:48	06:26		07:00
	16:28		17:06		18:41	19:17	19:51	20:19	20:24	19:56	19:07	18:15	16:29	16 07:11 (1)	16:11
9	07:14		06:50		07:08	06:14	05:30	05:07	05:15	05:44	06:17	06:49	06:27		07:01
	16:29		17:07		18:43	19:18	19:52	20:19	20:24	19:55	19:06	18:13	16:28	17 07:11 (1)	16:11
10	07:13		06:49		07:06	06:12	05:28	05:06	05:15	05:45	06:18	06:50	06:28		07:02
	16:30		17:09		18:44	19:19	19:53	20:20	20:23	19:54	19:04	18:11	16:27	17 07:12 (1)	16:11
11	07:13		06:47		07:04	06:11	05:27	05:06	05:16	05:46	06:19	06:52	06:29		07:03
	16:31		17:10		18:45	19:21	19:54	20:20	20:23	19:52	19:02	18:10	16:26	17 07:12 (1)	16:11
12	07:13		06:46		07:03	06:09	05:26	05:06	05:17	05:47	06:20	06:53	06:31		07:04
	16:32		17:11		18:46	19:22	19:55	20:21	20:22	19:51	19:00	18:08	16:25	17 07:12 (1)	16:11
13	07:12		06:45		07:01	06:07	05:25	05:06	05:18	05:48	06:21	06:54	06:32		07:05
	16:33		17:13		18:47	19:23	19:56	20:22	20:22	19:49	18:59	18:06	16:24	16 07:12 (1)	16:11
14	07:12		06:43		06:59	06:06	05:24	05:06	05:19	05:49	06:22	06:55	06:33		07:06
	16:34		17:14		18:49	19:24	19:57	20:22	20:21	19:48	18:57	18:05	16:23	14 07:11 (1)	16:11
15	07:12		06:42		06:57	06:04	05:23	05:06	05:19	05:50	06:23	06:56	06:34		07:06
	16:35		17:15		18:50	19:25	19:58	20:23	20:21	19:47	18:55	18:03	16:22	13 07:10 (1)	16:11
16	07:11		06:41		06:56	06:03	05:22	05:06	05:20	05:51	06:24	06:57	06:36		07:07
	16:37		17:17		18:51	19:26	20:00	20:23	20:20	19:45	18:53	18:02	16:21	11 07:10 (1)	16:12
17	07:11		06:39		06:54	06:01	05:21	05:06	05:21	05:52	06:25	06:59	06:37	07:01 (1)	07:08
	16:38		17:18		18:52	19:27	20:00	20:23	20:19	19:44	18:52	18:00	16:21	7 07:08 (1)	16:12
18	07:10		06:38		06:52	05:59	05:20	05:06	05:22	05:53	06:26	07:00	06:38		07:08
	16:39		17:19		18:53	19:28	20:01	20:24	20:19	19:42	18:50	17:58	16:20		16:12
19	07:09		06:36		06:50	05:58	05:19	05:06	05:23	05:54	06:27	07:01	06:39		07:09
	16:40		17:20		18:54	19:30	20:02	20:24	20:18	19:41	18:48	17:57	16:19		16:13
20	07:09		06:35		06:49	05:56	05:18	05:06	05:24	05:55	06:28	07:02	06:41		07:10
	16:41		17:22		18:55	19:31	20:03	20:24	20:17	19:39	18:46	17:55	16:18		16:13
21	07:08		06:33		06:47	05:55	05:17	05:06	05:25	05:56	06:29	07:03	06:42		07:10
	16:43		17:23		18:57	19:32	20:04	20:25	20:17	19:37	18:44	17:54	16:17		16:14
22	07:08		06:32		06:45	05:53	05:16	05:07	05:25	05:57	06:30	07:04	06:43		07:11
	16:44		17:24		18:58	19:33	20:05	20:25	20:16	19:36	18:43	17:52	16:17		16:14
23	07:07		06:30		06:43	05:52	05:16	05:07	05:26	05:59	06:32	07:06	06:44		07:11
	16:45		17:25		18:59	19:34	20:06	20:25	20:15	19:34	18:41	17:51	16:16		16:15
24	07:06		06:29		06:42	05:50	05:15	05:07	05:27	06:00	06:33	07:07	06:45		07:12
	16:47		17:27		19:00	19:35	20:06	20:25	20:14	19:33	18:39	17:49	16:15		16:15
25	07:05	07:28 (1)	06:27		06:40	05:49	05:14	05:07	05:28	06:01	06:34	07:08	06:47		07:12
	16:48	7 07:35 (1)	17:28		19:01	19:36	20:07	20:25	20:13	19:31	18:37	17:48	16:15		16:16
26	07:04	07:26 (1)	06:26		06:38	05:47	05:13	05:08	05:29	06:02	06:35	07:09	06:48		07:12
	16:49	11 07:37 (1)	17:29		19:02	19:38	20:08	20:25	20:12	19:29	18:36	17:46	16:14		16:16
27	07:04	07:25 (1)	06:24		06:36	05:46	05:13	05:08	05:30	06:03	06:36	07:11	06:49		07:13
	16:50	13 07:38 (1)	17:30		19:04	19:39	20:09	20:26	20:11	19:28	18:34	17:45	16:14		16:17
28	07:03	07:25 (1)	06:22		06:35	05:44	05:12	05:09	05:31	06:04	06:37	07:12	06:50		07:13
	16:52	14 07:39 (1)	17:32		19:05	19:40	20:10	20:26	20:10	19:26	18:32	17:43	16:13		16:18
29	07:02	07:24 (1)			06:33	05:43	05:11	05:09	05:32	06:05	06:38	07:13	06:51		07:13
	16:53	16 07:40 (1)			19:06	19:41	20:11	20:26	20:09	19:25	18:30	17:42	16:13		16:18
30	07:01	07:24 (1)			06:31	05:41	05:11	05:09	05:33	06:06	06:39	07:14	06:52		07:14
	16:54	17 07:41 (1)			19:07	19:42	20:12	20:26	20:08	19:23	18:29	17:41	16:13		16:19
31	07:00	07:24 (1)			06:30		05:10		05:34	06:07		07:16			07:14
	16:56	17 07:41 (1)			19:08		20:13		20:07	19:21		17:39			16:20
Potential sun hours	293		295		370	401	452	457	464	431	375	343	294		283
Total, worst case		95		102										198	
Sun reduction		0.56		0.53										0.47	
Oper. time red.		0.89		0.89										0.89	
Wind dir. red.		0.71		0.71										0.71	
Total reduction		0.36		0.33										0.30	
Total, real		34		34										58	

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:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 2:37 PM / 4

Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:29 PM/2.7.486

SHADOW - Calendar

Calculation: Winter Island - 600 kW **Shadow receptor:** B - Winter Island Road

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
582	402	448	318	394	393	447	629	578	730	1,166	1,719	7,807

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:14	06:59	06:21	06:28	05:40	05:10	05:10	05:35	06:08	06:40	06:17	06:53
	16:21	16:57	17:33	19:09	19:43	20:14	20:25	20:06	19:19	18:27	16:38	16:12
2	07:14	06:58	06:19	06:26	05:39	05:09	05:10	05:36	06:09	06:41	06:18	06:54
	16:22	16:58	17:34	19:10	19:44	20:14	20:25	20:05	19:18	18:25	16:37	16:12
3	07:14	06:57	06:18	06:24	05:37	05:09	05:11	05:37	06:10	06:42	06:19	06:55
	16:23	16:59	17:35	19:11	19:45	20:15	20:25	20:04	19:16	18:23	16:35	16:12
4	07:14	06:56	06:16	06:23	05:36	05:08	05:12	05:38	06:11	06:44	06:20	06:56
	16:24	17:01	17:37	19:13	19:47	20:16	20:25	20:02	19:14	18:22	16:34	16:11
5	07:14	06:55	06:14	06:21	05:35	05:08	05:12	05:39	06:12	06:45	06:22	06:57
	16:25	17:02	17:38	19:14	19:48	20:17	20:25	20:01	19:13	18:20	16:33	16:11
6	07:14	06:53	06:13	06:19	05:33	05:07	05:13	05:40	06:13	06:46	06:23	06:58
	16:26	17:03	17:39	19:15	19:49	20:17	20:25	20:00	19:11	18:18	16:32	16:11
7	07:14	06:52	06:11	06:17	05:32	05:07	05:13	05:41	06:14	06:47	06:24	06:59
	16:27	17:05	17:40	19:16	19:50	20:18	20:24	19:58	19:09	18:16	16:31	16:11
8	07:14	06:51	07:09	06:16	05:31	05:07	05:14	05:43	06:16	06:48	06:26	07:00
	16:28	17:06	18:41	19:17	19:51	20:19	20:24	19:56	19:07	18:15	16:29	16:11
9	07:14	06:50	07:08	06:14	05:30	05:07	05:15	05:44	06:17	06:49	06:27	07:01
	16:29	17:07	18:43	19:18	19:52	20:19	20:24	19:55	19:06	18:13	16:28	16:11
10	07:13	06:48	07:06	06:12	05:28	05:06	05:15	05:45	06:18	06:50	06:28	07:02
	16:30	17:09	18:44	19:19	19:53	20:20	20:23	19:54	19:04	18:11	16:27	16:11
11	07:13	06:47	07:04	06:11	05:27	05:06	05:16	05:46	06:19	06:52	06:29	07:03
	16:31	17:10	18:45	19:21	19:54	20:20	20:23	19:52	19:02	18:10	16:26	16:11
12	07:13	06:46	07:03	06:09	05:26	05:06	05:17	05:47	06:20	06:53	06:31	07:04
	16:32	17:11	18:46	19:22	19:55	20:21	20:22	19:51	19:00	18:08	16:25	16:11
13	07:12	06:45	07:01	06:07	05:25	05:06	05:18	05:48	06:21	06:54	06:32	07:05
	16:33	17:13	18:47	19:23	19:56	20:22	20:22	19:49	18:59	18:06	16:24	16:11
14	07:12	06:43	06:59	06:06	05:24	05:06	05:18	05:49	06:22	06:55	06:33	07:06
	16:34	17:14	18:48	19:24	19:57	20:22	20:21	19:48	18:57	18:05	16:23	16:11
15	07:12	06:42	06:57	06:04	05:23	05:06	05:19	05:50	06:23	06:56	06:34	07:06
	16:35	17:15	18:50	19:25	19:58	20:22	20:21	19:46	18:55	18:03	16:22	16:11
16	07:11	06:40	06:56	06:03	05:22	05:06	05:20	05:51	06:24	06:57	06:36	07:07
	16:37	17:16	18:51	19:26	19:59	20:23	20:20	19:45	18:53	18:01	16:21	16:12
17	07:11	06:39	06:54	06:01	05:21	05:06	05:21	05:52	06:25	06:58	06:37	07:08
	16:38	17:18	18:52	19:27	20:01	20:23	20:19	19:44	18:52	18:00	16:21	16:12
18	07:10	06:38	06:52	05:59	05:20	05:06	05:22	05:53	06:26	07:00	06:38	07:08
	16:39	17:19	18:53	19:28	20:01	20:24	20:19	19:42	18:50	17:58	16:20	16:12
19	07:09	06:36	06:50	05:58	05:19	05:06	05:23	05:54	06:27	07:01	06:39	07:09
	16:40	17:20	18:54	19:30	20:02	20:24	20:18	19:41	18:48	17:57	16:19	16:13
20	07:09	06:35	06:49	05:56	05:18	05:06	05:24	05:55	06:28	07:02	06:40	07:10
	16:41	17:22	18:55	19:31	20:03	20:24	20:17	19:39	18:46	17:55	16:18	16:13
21	07:08	06:33	06:47	05:55	05:17	05:06	05:25	05:56	06:29	07:03	06:42	07:10
	16:43	17:23	18:57	19:32	20:04	20:25	20:16	19:37	18:44	17:54	16:17	16:14
22	07:08	06:32	06:45	05:53	05:16	05:07	05:25	05:57	06:30	07:04	06:43	07:11
	16:44	17:24	18:58	19:33	20:05	20:25	20:16	19:36	18:43	17:52	16:17	16:14
23	07:07	06:30	06:43	05:52	05:15	05:07	05:26	05:58	06:32	07:06	06:44	07:11
	16:45	17:25	18:59	19:34	20:05	20:25	20:15	19:34	18:41	17:51	16:16	16:15
24	07:06	06:29	06:42	05:50	05:15	05:07	05:27	06:00	06:33	07:07	06:45	07:12
	16:46	17:27	19:00	19:35	20:06	20:25	20:14	19:33	18:39	17:49	16:15	16:15
25	07:05	06:27	06:40	05:49	05:14	05:07	05:28	06:01	06:34	07:08	06:46	07:12
	16:48	17:28	19:01	19:36	20:07	20:25	20:13	19:31	18:37	17:48	16:15	16:16
26	07:04	06:26	06:38	05:47	05:13	05:08	05:29	06:02	06:35	07:09	06:48	07:12
	16:49	17:29	19:02	19:38	20:08	20:25	20:12	19:29	18:36	17:46	16:14	16:16
27	07:04	06:24	06:36	05:46	05:12	05:08	05:30	06:03	06:36	07:11	06:49	07:13
	16:50	17:30	19:03	19:39	20:09	20:26	20:11	19:28	18:34	17:45	16:14	16:17
28	07:03	06:22	06:35	05:44	05:12	05:09	05:31	06:04	06:37	07:12	06:50	07:13
	16:52	17:32	19:05	19:40	20:10	20:26	20:10	19:26	18:32	17:43	16:13	16:18
29	07:02		06:33	05:43	05:11	05:09	05:32	06:05	06:38	07:13	06:51	07:13
	16:53		19:06	19:41	20:11	20:26	20:09	19:25	18:30	17:42	16:13	16:18
30	07:01		06:31	05:41	05:11	05:09	05:33	06:06	06:39	07:14	06:52	07:13
	16:54		19:07	19:42	20:12	20:26	20:08	19:23	18:29	17:41	16:12	16:19
31	07:00		06:29		05:10		05:34	06:07		07:15		07:14
	16:56		19:08		20:13		20:07	19:21		17:39		16:20
Potential sun hours	293	295	370	401	452	457	464	431	375	343	294	283
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:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 2:37 PM / 5

Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:29 PM/2.7.486

SHADOW - Calendar

Calculation: Winter Island - 600 kW **Shadow receptor:** C - Memorial Drive @ Vicotry Road

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
582	402	448	318	394	393	447	629	578	730	1,166	1,719	7,807

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

	January	February	March		April	May	June	July	August	September		October		November	December
1	07:14	06:59	06:21		06:28	05:40	05:10	05:10	05:35	06:08		06:40	07:02 (1)	06:17	06:53
	16:21	16:57	17:33		19:09	19:43	20:14	20:25	20:06	19:20		18:27	13 07:15 (1)	16:38	16:12
2	07:14	06:58	06:19		06:26	05:39	05:09	05:10	05:36	06:09		06:41	07:02 (1)	06:18	06:54
	16:22	16:58	17:34		19:10	19:44	20:14	20:25	20:05	19:18		18:25	12 07:14 (1)	16:37	16:12
3	07:14	06:57	06:18		06:24	05:37	05:09	05:11	05:37	06:10		06:43	07:03 (1)	06:19	06:55
	16:23	17:00	17:35		19:11	19:45	20:15	20:25	20:04	19:16		18:23	9 07:12 (1)	16:35	16:12
4	07:14	06:56	06:16		06:23	05:36	05:08	05:12	05:38	06:11		06:44	07:06 (1)	06:21	06:56
	16:24	17:01	17:37		19:13	19:47	20:16	20:25	20:03	19:14		18:22	3 07:09 (1)	16:34	16:11
5	07:14	06:55	06:14		06:21	05:35	05:08	05:12	05:39	06:12		06:45		06:22	06:58
	16:25	17:02	17:38		19:14	19:48	20:17	20:25	20:01	19:13		18:20		16:33	16:11
6	07:14	06:53	06:13		06:19	05:33	05:08	05:13	05:40	06:13		06:46		06:23	06:58
	16:26	17:03	17:39		19:15	19:49	20:17	20:25	20:00	19:11		18:18		16:32	16:11
7	07:14	06:52	06:11		06:18	05:32	05:07	05:13	05:42	06:15		06:47		06:24	06:59
	16:27	17:05	17:40		19:16	19:50	20:18	20:24	19:58	19:09		18:16		16:31	16:11
8	07:14	06:51	07:09		06:16	05:31	05:07	05:14	05:43	06:16		06:48		06:26	07:00
	16:28	17:06	18:41		19:17	19:51	20:19	20:24	19:56	19:07		18:15		16:30	16:11
9	07:14	06:50	07:08		06:14	05:30	05:07	05:15	05:44	06:17		06:49		06:27	07:01
	16:29	17:07	18:43		19:18	19:52	20:19	20:24	19:55	19:06		18:13		16:28	16:11
10	07:13	06:49	07:06	07:26 (1)	06:12	05:28	05:06	05:15	05:45	06:18		06:50		06:28	07:02
	16:30	17:09	18:44	8 07:34 (1)	19:19	19:53	20:20	20:23	19:54	19:04		18:11		16:27	16:11
11	07:13	06:47	07:04	07:24 (1)	06:11	05:27	05:06	05:16	05:46	06:19		06:52		06:29	07:03
	16:31	17:10	18:45	11 07:35 (1)	19:21	19:54	20:20	20:23	19:52	19:02		18:10		16:26	16:11
12	07:13	06:46	07:03	07:22 (1)	06:09	05:26	05:06	05:17	05:47	06:20		06:53		06:31	07:04
	16:32	17:11	18:46	14 07:36 (1)	19:22	19:55	20:21	20:22	19:51	19:00		18:08		16:25	16:11
13	07:12	06:45	07:01	07:21 (1)	06:07	05:25	05:06	05:18	05:48	06:21		06:54		06:32	07:05
	16:33	17:13	18:47	15 07:36 (1)	19:23	19:56	20:22	20:22	19:49	18:59		18:06		16:24	16:11
14	07:12	06:43	06:59	07:22 (1)	06:06	05:24	05:06	05:19	05:49	06:22		06:55		06:33	07:06
	16:34	17:14	18:49	14 07:36 (1)	19:24	19:57	20:22	20:21	19:48	18:57		18:05		16:23	16:11
15	07:12	06:42	06:57	07:21 (1)	06:04	05:23	05:06	05:19	05:50	06:23		06:56		06:34	07:06
	16:35	17:15	18:50	14 07:35 (1)	19:25	19:58	20:23	20:21	19:47	18:55		18:03		16:22	16:11
16	07:11	06:41	06:56	07:21 (1)	06:03	05:22	05:06	05:20	05:51	06:24		06:57		06:36	07:07
	16:37	17:17	18:51	13 07:34 (1)	19:26	20:00	20:23	20:20	19:45	18:53		18:02		16:21	16:12
17	07:11	06:39	06:54	07:22 (1)	06:01	05:21	05:06	05:21	05:52	06:25		06:59		06:37	07:08
	16:38	17:18	18:52	11 07:33 (1)	19:27	20:00	20:23	20:19	19:44	18:52		18:00		16:21	16:12
18	07:10	06:38	06:52	07:24 (1)	05:59	05:20	05:06	05:22	05:53	06:26		07:00		06:38	07:08
	16:39	17:19	18:53	7 07:31 (1)	19:29	20:01	20:24	20:19	19:42	18:50		17:58		16:20	16:12
19	07:09	06:36	06:50		05:58	05:19	05:06	05:23	05:54	06:27		07:01		06:39	07:09
	16:40	17:20	18:54		19:30	20:02	20:24	20:18	19:41	18:48		17:57		16:19	16:13
20	07:09	06:35	06:49		05:56	05:18	05:06	05:24	05:55	06:28		07:02		06:41	07:10
	16:42	17:22	18:56		19:31	20:03	20:24	20:17	19:39	18:46		17:55		16:18	16:13
21	07:08	06:33	06:47		05:55	05:17	05:06	05:25	05:56	06:29		07:03		06:42	07:10
	16:43	17:23	18:57		19:32	20:04	20:25	20:17	19:37	18:44		17:54		16:17	16:14
22	07:08	06:32	06:45		05:53	05:16	05:07	05:25	05:57	06:30		07:04		06:43	07:11
	16:44	17:24	18:58		19:33	20:05	20:25	20:16	19:36	18:43		17:52		16:17	16:14
23	07:07	06:30	06:43		05:52	05:16	05:07	05:26	05:59	06:32		07:06		06:44	07:11
	16:45	17:25	18:59		19:34	20:06	20:25	20:15	19:34	18:41		17:51		16:16	16:15
24	07:06	06:29	06:42		05:50	05:15	05:07	05:27	06:00	06:33		07:07		06:45	07:12
	16:47	17:27	19:00		19:35	20:06	20:25	20:14	19:33	18:39		17:49		16:15	16:15
25	07:05	06:27	06:40		05:49	05:14	05:07	05:28	06:01	06:34	07:08 (1)	07:08		06:47	07:12
	16:48	17:28	19:01		19:36	20:07	20:25	20:13	19:31	18:37	5 07:13 (1)	17:48		16:15	16:16
26	07:04	06:26	06:38		05:47	05:13	05:08	05:29	06:02	06:35	07:05 (1)	07:09		06:48	07:12
	16:49	17:29	19:02		19:38	20:08	20:25	20:12	19:29	18:36	10 07:15 (1)	17:46		16:14	16:16
27	07:04	06:24	06:36		05:46	05:13	05:08	05:30	06:03	06:36	07:03 (1)	07:11		06:49	07:13
	16:50	17:30	19:04		19:39	20:09	20:26	20:11	19:28	18:34	12 07:15 (1)	17:45		16:14	16:17
28	07:03	06:22	06:35		05:44	05:12	05:09	05:31	06:04	06:37	07:02 (1)	07:12		06:50	07:13
	16:52	17:32	19:05		19:40	20:10	20:26	20:10	19:26	18:32	14 07:16 (1)	17:43		16:13	16:18
29	07:02		06:33		05:43	05:11	05:09	05:32	06:05	06:38	07:01 (1)	07:13		06:51	07:13
	16:53		19:06		19:41	20:11	20:26	20:09	19:25	18:30	15 07:16 (1)	17:42		16:13	16:18
30	07:01		06:31		05:41	05:11	05:09	05:33	06:06	06:39	07:02 (1)	07:14		06:52	07:14
	16:54		19:07		19:42	20:12	20:26	20:08	19:23	18:29	14 07:16 (1)	17:41		16:13	16:19
31	07:00		06:30			05:10		05:34	06:07			07:16			07:14
	16:56		19:08			20:13		20:07	19:21			17:39			16:20
Potential sun hours	293	295	370		401	452	457	464	431	375		343		294	283
Total, worst case				107							70		37		
Sun reduction				0.49							0.53		0.57		
Oper. time red.				0.89							0.89		0.89		
Wind dir. red.				0.68							0.68		0.68		
Total reduction				0.30							0.33		0.35		
Total, real				32							23		13		

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:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 2:37 PM / 6

Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:29 PM/2.7.486

SHADOW - Calendar

Calculation: Winter Island - 600 kW **Shadow receptor:** D - Bayview Ave @ Cheval Ave

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
582	402	448	318	394	393	447	629	578	730	1,166	1,719	7,807

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:14	06:59	06:21	06:28	05:40	05:10	05:10	05:35	06:08	06:40	06:17	06:53
	16:21	16:57	17:33	19:09	19:43	20:13	20:25	20:06	19:19	18:27	16:38	16:12
2	07:14	06:58	06:19	06:26	05:39	05:09	05:10	05:36	06:09	06:41	06:18	06:54
	16:22	16:58	17:34	19:10	19:44	20:14	20:25	20:05	19:18	18:25	16:37	16:12
3	07:14	06:57	06:18	06:24	05:37	05:09	05:11	05:37	06:10	06:42	06:19	06:55
	16:23	16:59	17:35	19:11	19:45	20:15	20:25	20:04	19:16	18:23	16:35	16:12
4	07:14	06:56	06:16	06:23	05:36	05:08	05:11	05:38	06:11	06:44	06:20	06:56
	16:24	17:01	17:37	19:13	19:47	20:16	20:25	20:02	19:14	18:22	16:34	16:11
5	07:14	06:54	06:14	06:21	05:35	05:08	05:12	05:39	06:12	06:45	06:22	06:57
	16:25	17:02	17:38	19:14	19:48	20:17	20:25	20:01	19:13	18:20	16:33	16:11
6	07:14	06:53	06:13	06:19	05:33	05:07	05:13	05:40	06:13	06:46	06:23	06:58
	16:26	17:03	17:39	19:15	19:49	20:17	20:25	20:00	19:11	18:18	16:32	16:11
7	07:14	06:52	06:11	06:17	05:32	05:07	05:13	05:41	06:14	06:47	06:24	06:59
	16:27	17:05	17:40	19:16	19:50	20:18	20:24	19:57	19:09	18:16	16:31	16:11
8	07:14	06:51	07:09	06:16	05:31	05:07	05:14	05:42	06:16	06:48	06:26	07:00
	16:28	17:06	18:41	19:17	19:51	20:19	20:24	19:56	19:07	18:15	16:29	16:11
9	07:14	06:50	07:08	06:14	05:30	05:07	05:15	05:44	06:17	06:49	06:27	07:01
	16:29	17:07	18:43	19:18	19:52	20:19	20:24	19:55	19:06	18:13	16:28	16:11
10	07:13	06:48	07:06	06:12	05:28	05:06	05:15	05:45	06:18	06:50	06:28	07:02
	16:30	17:09	18:44	19:19	19:53	20:20	20:23	19:54	19:04	18:11	16:27	16:11
11	07:13	06:47	07:04	06:11	05:27	05:06	05:16	05:46	06:19	06:51	06:29	07:03
	16:31	17:10	18:45	19:21	19:54	20:20	20:23	19:52	19:02	18:10	16:26	16:11
12	07:13	06:46	07:03	06:09	05:26	05:06	05:17	05:47	06:20	06:53	06:31	07:04
	16:32	17:11	18:46	19:22	19:55	20:21	20:22	19:51	19:00	18:08	16:25	16:11
13	07:12	06:45	07:01	06:07	05:25	05:06	05:18	05:48	06:21	06:54	06:32	07:05
	16:33	17:13	18:47	19:23	19:56	20:22	20:22	19:49	18:59	18:06	16:24	16:11
14	07:12	06:43	06:59	06:06	05:24	05:06	05:18	05:49	06:22	06:55	06:33	07:06
	16:34	17:14	18:48	19:24	19:57	20:22	20:21	19:48	18:57	18:05	16:23	16:11
15	07:12	06:42	06:57	06:04	05:23	05:06	05:19	05:50	06:23	06:56	06:34	07:06
	16:35	17:15	18:50	19:25	19:58	20:22	20:21	19:46	18:55	18:03	16:22	16:11
16	07:11	06:40	06:56	06:03	05:22	05:06	05:20	05:51	06:24	06:57	06:36	07:07
	16:37	17:16	18:51	19:26	19:59	20:23	20:20	19:45	18:53	18:01	16:21	16:12
17	07:11	06:39	06:54	06:01	05:21	05:06	05:21	05:52	06:25	06:58	06:37	07:08
	16:38	17:18	18:52	19:27	20:01	20:23	20:19	19:44	18:52	18:00	16:20	16:12
18	07:10	06:38	06:52	05:59	05:20	05:06	05:22	05:53	06:26	07:00	06:38	07:08
	16:39	17:19	18:53	19:28	20:01	20:24	20:19	19:42	18:50	17:58	16:20	16:12
19	07:09	06:36	06:50	05:58	05:19	05:06	05:23	05:54	06:27	07:01	06:39	07:09
	16:40	17:20	18:54	19:30	20:02	20:24	20:18	19:41	18:48	17:57	16:19	16:13
20	07:09	06:35	06:49	05:56	05:18	05:06	05:24	05:55	06:28	07:02	06:40	07:10
	16:41	17:22	18:55	19:31	20:03	20:24	20:17	19:39	18:46	17:55	16:18	16:13
21	07:08	06:33	06:47	05:55	05:17	05:06	05:24	05:56	06:29	07:03	06:42	07:10
	16:43	17:23	18:57	19:32	20:04	20:25	20:16	19:37	18:44	17:54	16:17	16:14
22	07:08	06:32	06:45	05:53	05:16	05:07	05:25	05:57	06:30	07:04	06:43	07:11
	16:44	17:24	18:58	19:33	20:05	20:25	20:16	19:36	18:43	17:52	16:17	16:14
23	07:07	06:30	06:43	05:52	05:15	05:07	05:26	05:58	06:32	07:06	06:44	07:11
	16:45	17:25	18:59	19:34	20:05	20:25	20:15	19:34	18:41	17:51	16:16	16:15
24	07:06	06:29	06:42	05:50	05:15	05:07	05:27	06:00	06:33	07:07	06:45	07:12
	16:46	17:27	19:00	19:35	20:06	20:25	20:14	19:33	18:39	17:49	16:15	16:15
25	07:05	06:27	06:40	05:49	05:14	05:07	05:28	06:01	06:34	07:08	06:46	07:12
	16:48	17:28	19:01	19:36	20:07	20:25	20:13	19:31	18:37	17:48	16:15	16:16
26	07:04	06:26	06:38	05:47	05:13	05:08	05:29	06:02	06:35	07:09	06:48	07:12
	16:49	17:29	19:02	19:38	20:08	20:25	20:12	19:29	18:36	17:46	16:14	16:16
27	07:04	06:24	06:36	05:46	05:12	05:08	05:30	06:03	06:36	07:11	06:49	07:13
	16:50	17:30	19:03	19:39	20:09	20:26	20:11	19:28	18:34	17:45	16:14	16:17
28	07:03	06:22	06:35	05:44	05:12	05:09	05:31	06:04	06:37	07:12	06:50	07:13
	16:52	17:32	19:05	19:40	20:10	20:26	20:10	19:26	18:32	17:43	16:13	16:18
29	07:02		06:33	05:43	05:11	05:09	05:32	06:05	06:38	07:13	06:51	07:13
	16:53		19:06	19:41	20:11	20:26	20:09	19:25	18:30	17:42	16:13	16:18
30	07:01		06:31	05:41	05:11	05:09	05:33	06:06	06:39	07:14	06:52	07:13
	16:54		19:07	19:42	20:12	20:26	20:08	19:23	18:28	17:41	16:12	16:19
31	07:00		06:29		05:10		05:34	06:07		07:15		07:14
	16:56		19:08		20:13		20:07	19:21		17:39		16:20
Potential sun hours	293	295	370	401	452	457	464	431	375	343	294	283
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:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 2:37 PM / 7

Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:29 PM/2.7.486

SHADOW - Calendar

Calculation: Winter Island - 600 kW **Shadow receptor:** E - Naugus Ave, Marblehead

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
582	402	448	318	394	393	447	629	578	730	1,166	1,719	7,807

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:14	06:59	06:21	06:28	05:40	05:10	05:10	05:35	06:08	06:40	06:17	06:53
	16:21	16:57	17:33	19:09	19:43	20:13	20:25	20:06	19:19	18:27	16:38	16:12
2	07:14	06:58	06:19	06:26	05:39	05:09	05:10	05:36	06:09	06:41	06:18	06:54
	16:22	16:58	17:34	19:10	19:44	20:14	20:25	20:05	19:18	18:25	16:37	16:12
3	07:14	06:57	06:18	06:24	05:37	05:09	05:11	05:37	06:10	06:42	06:19	06:55
	16:23	16:59	17:35	19:11	19:45	20:15	20:25	20:04	19:16	18:23	16:35	16:12
4	07:14	06:56	06:16	06:23	05:36	05:08	05:12	05:38	06:11	06:44	06:20	06:56
	16:24	17:01	17:37	19:13	19:46	20:16	20:25	20:02	19:14	18:22	16:34	16:11
5	07:14	06:54	06:14	06:21	05:35	05:08	05:12	05:39	06:12	06:45	06:22	06:57
	16:25	17:02	17:38	19:14	19:48	20:17	20:25	20:01	19:13	18:20	16:33	16:11
6	07:14	06:53	06:13	06:19	05:33	05:07	05:13	05:40	06:13	06:46	06:23	06:58
	16:26	17:03	17:39	19:15	19:49	20:17	20:24	20:00	19:11	18:18	16:32	16:11
7	07:14	06:52	06:11	06:17	05:32	05:07	05:13	05:41	06:14	06:47	06:24	06:59
	16:27	17:05	17:40	19:16	19:50	20:18	20:24	19:57	19:09	18:16	16:31	16:11
8	07:14	06:51	07:09	06:16	05:31	05:07	05:14	05:43	06:16	06:48	06:25	07:00
	16:28	17:06	18:41	19:17	19:51	20:19	20:24	19:56	19:07	18:15	16:29	16:11
9	07:13	06:50	07:08	06:14	05:30	05:07	05:15	05:44	06:17	06:49	06:27	07:01
	16:29	17:07	18:43	19:18	19:52	20:19	20:24	19:55	19:06	18:13	16:28	16:11
10	07:13	06:48	07:06	06:12	05:28	05:06	05:15	05:45	06:18	06:50	06:28	07:02
	16:30	17:09	18:44	19:19	19:53	20:20	20:23	19:53	19:04	18:11	16:27	16:11
11	07:13	06:47	07:04	06:11	05:27	05:06	05:16	05:46	06:19	06:51	06:29	07:03
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	16:32	17:11	18:46	19:22	19:55	20:21	20:22	19:51	19:00	18:08	16:25	16:11
13	07:12	06:45	07:01	06:07	05:25	05:06	05:18	05:48	06:21	06:54	06:32	07:05
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14	07:12	06:43	06:59	06:06	05:24	05:06	05:18	05:49	06:22	06:55	06:33	07:05
	16:34	17:14	18:48	19:24	19:57	20:22	20:21	19:48	18:57	18:05	16:23	16:11
15	07:11	06:42	06:57	06:04	05:23	05:06	05:19	05:50	06:23	06:56	06:34	07:06
	16:35	17:15	18:50	19:25	19:58	20:22	20:21	19:46	18:55	18:03	16:22	16:11
16	07:11	06:40	06:56	06:03	05:22	05:06	05:20	05:51	06:24	06:57	06:36	07:07
	16:37	17:16	18:51	19:26	19:59	20:23	20:20	19:45	18:53	18:01	16:21	16:12
17	07:11	06:39	06:54	06:01	05:21	05:06	05:21	05:52	06:25	06:58	06:37	07:08
	16:38	17:18	18:52	19:27	20:00	20:23	20:19	19:43	18:52	18:00	16:21	16:12
18	07:10	06:38	06:52	05:59	05:20	05:06	05:22	05:53	06:26	07:00	06:38	07:08
	16:39	17:19	18:53	19:28	20:00	20:24	20:19	19:42	18:50	17:58	16:20	16:12
19	07:09	06:36	06:50	05:58	05:19	05:06	05:23	05:54	06:27	07:01	06:39	07:09
	16:40	17:20	18:54	19:30	20:01	20:24	20:18	19:40	18:48	17:57	16:19	16:13
20	07:09	06:35	06:49	05:56	05:18	05:06	05:24	05:55	06:28	07:02	06:40	07:09
	16:41	17:22	18:55	19:31	20:02	20:24	20:17	19:39	18:46	17:55	16:18	16:13
21	07:08	06:33	06:47	05:55	05:17	05:06	05:25	05:56	06:29	07:03	06:42	07:10
	16:43	17:23	18:57	19:32	20:03	20:25	20:16	19:37	18:44	17:54	16:17	16:14
22	07:07	06:32	06:45	05:53	05:16	05:07	05:25	05:57	06:30	07:04	06:43	07:11
	16:44	17:24	18:58	19:33	20:04	20:25	20:16	19:36	18:43	17:52	16:17	16:14
23	07:07	06:30	06:43	05:52	05:15	05:07	05:26	05:58	06:32	07:06	06:44	07:11
	16:45	17:25	18:59	19:34	20:05	20:25	20:15	19:34	18:41	17:51	16:16	16:15
24	07:06	06:29	06:42	05:50	05:15	05:07	05:27	06:00	06:33	07:07	06:45	07:12
	16:46	17:27	19:00	19:35	20:06	20:25	20:14	19:33	18:39	17:49	16:15	16:15
25	07:05	06:27	06:40	05:49	05:14	05:07	05:28	06:01	06:34	07:08	06:46	07:12
	16:48	17:28	19:01	19:36	20:07	20:25	20:13	19:31	18:37	17:48	16:15	16:16
26	07:04	06:26	06:38	05:47	05:13	05:08	05:29	06:02	06:35	07:09	06:48	07:12
	16:49	17:29	19:02	19:37	20:08	20:25	20:12	19:29	18:36	17:46	16:14	16:16
27	07:04	06:24	06:36	05:46	05:13	05:08	05:30	06:03	06:36	07:10	06:49	07:13
	16:50	17:30	19:03	19:39	20:09	20:25	20:11	19:28	18:34	17:45	16:14	16:17
28	07:03	06:22	06:35	05:44	05:12	05:09	05:31	06:04	06:37	07:12	06:50	07:13
	16:52	17:32	19:05	19:40	20:10	20:25	20:10	19:26	18:32	17:43	16:13	16:18
29	07:02		06:33	05:43	05:11	05:09	05:32	06:05	06:38	07:13	06:51	07:13
	16:53		19:06	19:41	20:11	20:25	20:09	19:24	18:30	17:42	16:13	16:18
30	07:01		06:31	05:41	05:11	05:09	05:33	06:06	06:39	07:14	06:52	07:13
	16:54		19:07	19:42	20:12	20:25	20:08	19:23	18:28	17:41	16:12	16:19
31	07:00		06:29		05:10		05:34	06:07		07:15		07:14
	16:56		19:08		20:13		20:07	19:21		17:39		16:20
Potential sun hours	293	295	370	401	452	457	464	431	375	343	294	283
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:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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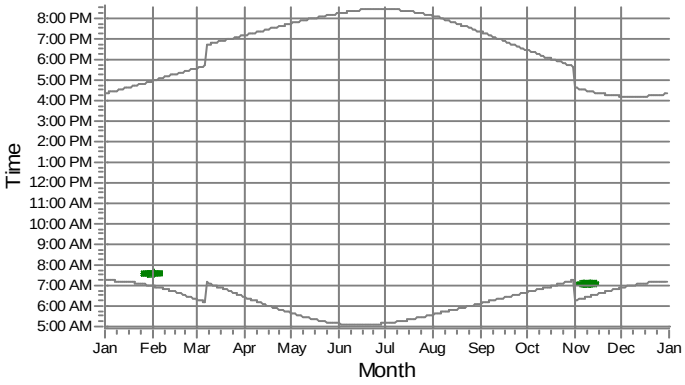
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:29 PM/2.7.486

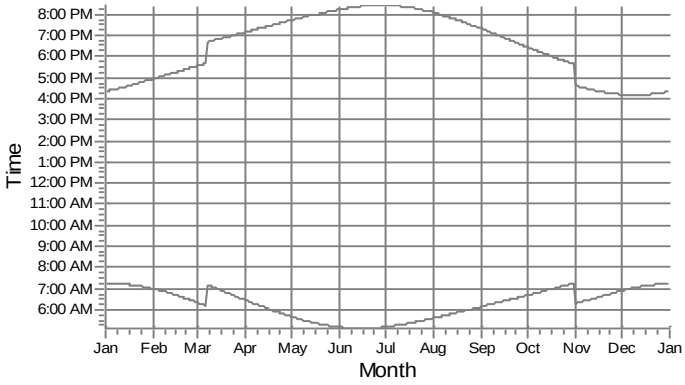
SHADOW - Calendar, graphical

Calculation: Winter Island - 600 kW

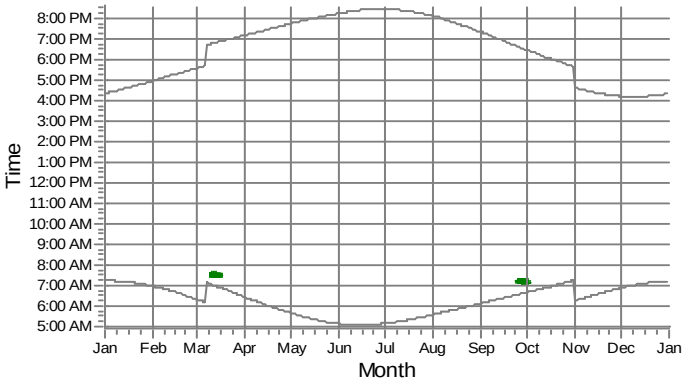
A: End of Larkin Lane



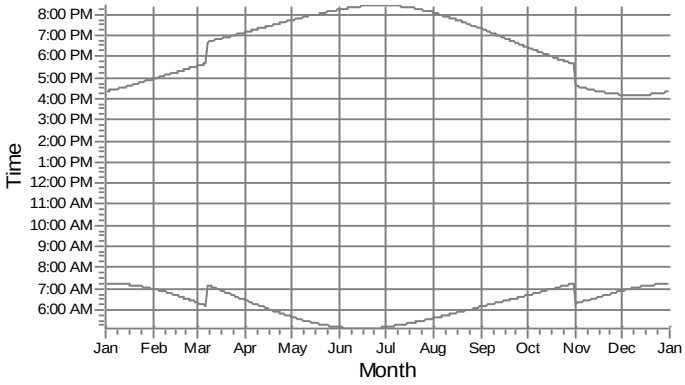
B: Winter Island Road



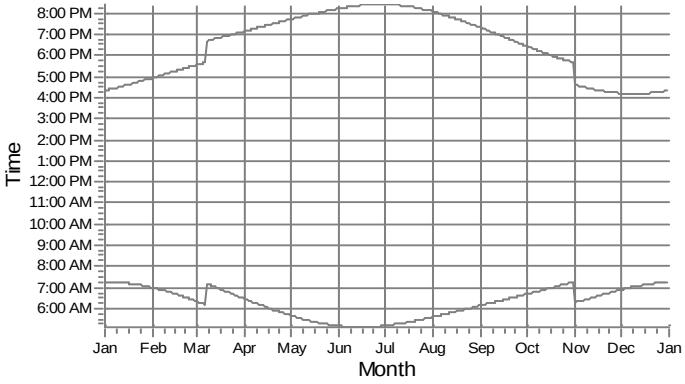
C: Memorial Drive @ Vicotry Road



D: Bayview Ave @ Cheval Ave



E: Naugus Ave, Marblehead



WTGs

1: ELECON1-600 ELECON1-600 60Hz 600 47.0 !O! hub: 60.0 m (8)

Project:
WI-Salem_WindPRO

Description:
Winter Island
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SHADOW - Calendar per WTG

Calculation: Winter Island - 600 kW**WTG:** 1 - ELECON1-600 ELECON1-600 60Hz 600 47.0 !O! hub: 60.0 m (8)

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
582	402	448	318	394	393	447	629	578	730	1,166	1,719	7,807

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:14	06:59 07:24-07:41/17	06:21	06:28	05:40	05:10	05:10	05:35	06:08	06:40 07:02-07:15/13	06:17	06:53
	16:21	16:57	17:33	19:09	19:43	20:13	20:25	20:06	19:19	18:27	16:38	16:12
2	07:14	06:58 07:24-07:42/18	06:19	06:26	05:39	05:09	05:10	05:36	06:09	06:41 07:02-07:14/12	06:18	06:54
	16:22	16:58	17:34	19:10	19:44	20:14	20:25	20:05	19:18	18:25	16:37	16:12
3	07:14	06:57 07:25-07:42/17	06:18	06:24	05:37	05:09	05:11	05:37	06:10	06:42 07:03-07:12/9	06:19 07:01-07:04/3	06:55
	16:23	16:59	17:35	19:11	19:45	20:15	20:25	20:04	19:16	18:23	16:35	16:12
4	07:14	06:56 07:25-07:40/15	06:16	06:23	05:36	05:08	05:12	05:38	06:11	06:44 07:06-07:09/3	06:20 06:59-07:08/9	06:56
	16:24	17:01	17:37	19:13	19:47	20:16	20:25	20:02	19:14	18:22	16:34	16:11
5	07:14	06:54 07:26-07:40/14	06:14	06:21	05:35	05:08	05:12	05:39	06:12	06:45	06:22 06:57-07:09/12	06:57
	16:25	17:02	17:38	19:14	19:48	20:17	20:25	20:01	19:13	18:20	16:33	16:11
6	07:14	06:53 07:27-07:39/12	06:13	06:19	05:33	05:07	05:13	05:40	06:13	06:46	06:23 06:56-07:10/14	06:58
	16:26	17:03	17:39	19:15	19:49	20:17	20:25	20:00	19:11	18:18	16:32	16:11
7	07:14	06:52 07:29-07:38/9	06:11	06:17	05:32	05:07	05:13	05:41	06:14	06:47	06:24 06:56-07:11/15	06:59
	16:27	17:05	17:40	19:16	19:50	20:18	20:24	19:57	19:09	18:16	16:31	16:11
8	07:14	06:51	07:09	06:16	05:31	05:07	05:14	05:43	06:16	06:48	06:26 06:55-07:11/16	07:00
	16:28	17:06	18:41	19:17	19:51	20:19	20:24	19:56	19:07	18:15	16:29	16:11
9	07:13	06:50	07:08	06:14	05:30	05:07	05:15	05:44	06:17	06:49	06:27 06:54-07:11/17	07:01
	16:29	17:07	18:43	19:18	19:52	20:19	20:24	19:55	19:06	18:13	16:28	16:11
10	07:13	06:48	07:06 07:26-07:34/8	06:12	05:28	05:06	05:15	05:45	06:18	06:50	06:28 06:55-07:12/17	07:02
	16:30	17:09	18:44	19:19	19:53	20:20	20:23	19:54	19:04	18:11	16:27	16:11
11	07:13	06:47	07:04 07:24-07:35/11	06:11	05:27	05:06	05:16	05:46	06:19	06:52	06:29 06:55-07:12/17	07:03
	16:31	17:10	18:45	19:21	19:54	20:20	20:23	19:52	19:02	18:10	16:26	16:11
12	07:13	06:46	07:03 07:22-07:36/14	06:09	05:26	05:06	05:17	05:47	06:20	06:53	06:31 06:55-07:12/17	07:04
	16:32	17:11	18:46	19:22	19:55	20:21	20:22	19:51	19:00	18:08	16:25	16:11
13	07:12	06:45	07:01 07:21-07:36/15	06:07	05:25	05:06	05:18	05:48	06:21	06:54	06:32 06:56-07:12/16	07:05
	16:33	17:13	18:47	19:23	19:56	20:22	20:22	19:49	18:59	18:06	16:24	16:11
14	07:12	06:43	06:59 07:22-07:36/14	06:06	05:24	05:06	05:19	05:49	06:22	06:55	06:33 06:57-07:11/14	07:05
	16:34	17:14	18:48	19:24	19:57	20:22	20:21	19:48	18:57	18:05	16:23	16:11
15	07:12	06:42	06:57 07:21-07:35/14	06:04	05:23	05:06	05:19	05:50	06:23	06:56	06:34 06:57-07:10/13	07:06
	16:35	17:15	18:50	19:25	19:58	20:22	20:21	19:46	18:55	18:03	16:22	16:11
16	07:11	06:40	06:56 07:21-07:34/13	06:03	05:22	05:06	05:20	05:51	06:24	06:57	06:36 06:59-07:10/11	07:07
	16:37	17:16	18:51	19:26	19:59	20:23	20:20	19:45	18:53	18:01	16:21	16:12
17	07:11	06:39	06:54 07:22-07:33/11	06:01	05:21	05:06	05:21	05:52	06:25	06:58	06:37 07:01-07:08/7	07:08
	16:38	17:18	18:52	19:27	20:00	20:23	20:19	19:44	18:52	18:00	16:21	16:12
18	07:10	06:38	06:52 07:24-07:31/7	05:59	05:20	05:06	05:22	05:53	06:26	07:00	06:38	07:08
	16:39	17:19	18:53	19:28	20:00	20:24	20:19	19:42	18:50	17:58	16:20	16:12
19	07:09	06:36	06:50	05:58	05:19	05:06	05:23	05:54	06:27	07:01	06:39	07:09
	16:40	17:20	18:54	19:30	20:02	20:24	20:18	19:41	18:48	17:57	16:19	16:13
20	07:09	06:35	06:49	05:56	05:18	05:06	05:24	05:55	06:28	07:02	06:40	07:10
	16:41	17:22	18:55	19:31	20:03	20:24	20:17	19:39	18:46	17:55	16:18	16:13
21	07:08	06:33	06:47	05:55	05:17	05:06	05:25	05:56	06:29	07:03	06:42	07:10
	16:43	17:23	18:57	19:32	20:04	20:25	20:16	19:37	18:44	17:54	16:17	16:14
22	07:08	06:32	06:45	05:53	05:16	05:07	05:25	05:57	06:30	07:04	06:43	07:11
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	16:45	17:25	18:59	19:34	20:05	20:25	20:15	19:34	18:41	17:51	16:16	16:15
24	07:06	06:29	06:42	05:50	05:15	05:07	05:27	06:00	06:33	07:07	06:45	07:12
	16:46	17:27	19:00	19:35	20:06	20:25	20:14	19:33	18:39	17:49	16:15	16:15
25	07:05 07:28-07:35/7	06:27	06:40	05:49	05:14	05:07	05:28	06:01	06:34 07:08-07:13/5	07:08	06:46	07:12
	16:48	17:28	19:01	19:36	20:07	20:25	20:13	19:31	18:37	17:48	16:15	16:16
26	07:04 07:26-07:37/11	06:26	06:38	05:47	05:13	05:08	05:29	06:02	06:35 07:05-07:15/10	07:09	06:48	07:12
	16:49	17:29	19:02	19:38	20:08	20:25	20:12	19:29	18:36	17:46	16:14	16:16
27	07:04 07:25-07:38/13	06:24	06:36	05:46	05:13	05:08	05:30	06:03	06:36 07:03-07:15/12	07:11	06:49	07:13
	16:50	17:30	19:03	19:39	20:09	20:26	20:11	19:28	18:34	17:45	16:14	16:17
28	07:03 07:25-07:39/14	06:22	06:35	05:44	05:12	05:09	05:31	06:04	06:37 07:02-07:16/14	07:12	06:50	07:13
	16:52	17:32	19:05	19:40	20:10	20:26	20:10	19:26	18:32	17:43	16:13	16:18
29	07:02 07:24-07:40/16		06:33	05:43	05:11	05:09	05:32	06:05	06:38 07:01-07:16/15	07:13	06:51	07:13
	16:53		19:06	19:41	20:11	20:26	20:09	19:25	18:30	17:42	16:13	16:18
30	07:01 07:24-07:41/17		06:31	05:41	05:11	05:09	05:33	06:06	06:39 07:02-07:16/14	07:14	06:52	07:13
	16:54		19:07	19:42	20:12	20:26	20:08	19:23	18:29	17:41	16:13	16:19
31	07:00 07:24-07:41/17		06:29		05:10		05:34	06:07		07:15		07:14
	16:56		19:08		20:13		20:07	19:21		17:39		16:20
Potential sun hours	293	295	370	401	452	457	464	431	375	343	294	283
Sum of minutes with flicker	95	102	107	0	0	0	0	0	70	37	198	0

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-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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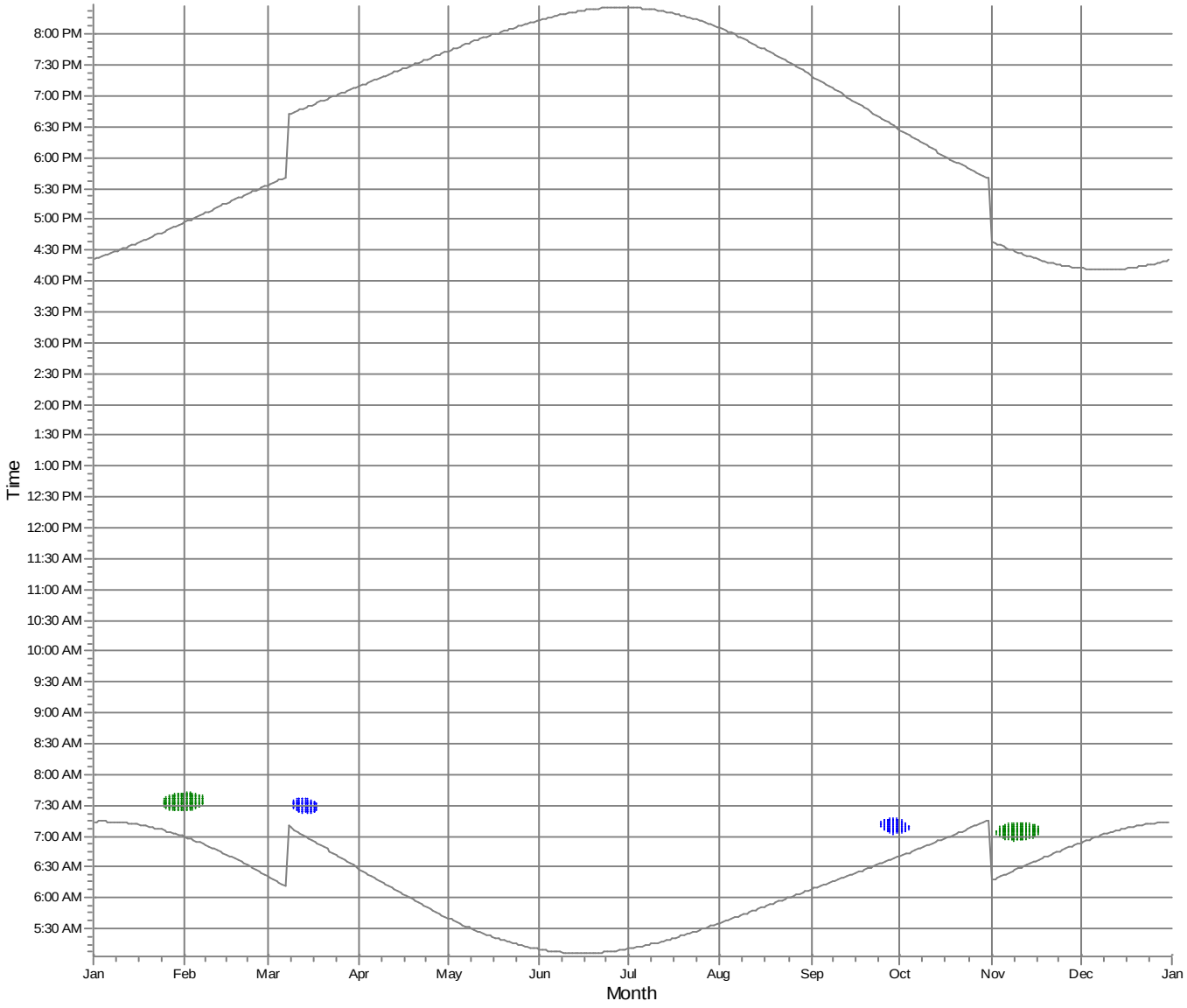
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:29 PM/2.7.486

SHADOW - Calendar per WTG, graphical

Calculation: Winter Island - 600 kW**WTG:** 1 - ELECON1-600 ELECON1-600 60Hz 600 47.0 !O! hub: 60.0 m (8)

1: ELECON1-600 ELECON1-600 60Hz 600 47.0 !O! hub: 60.0 m (8)



Shadow receptor

A: End of Larkin Lane

C: Memorial Drive @ Vicotry Road

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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Calculated:
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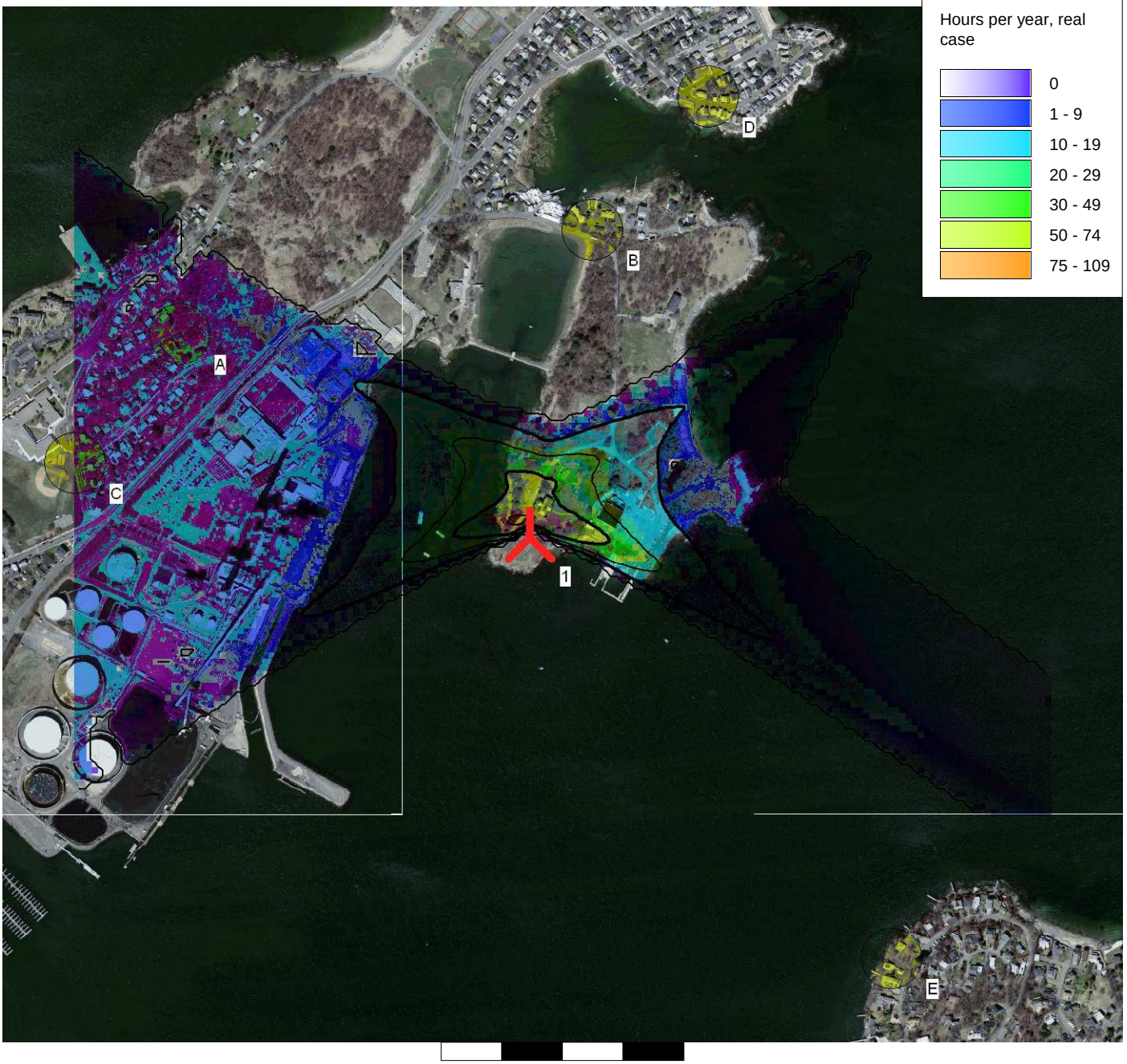
SHADOW - Map

Calculation: Winter Island - 600 kW**WTG:** 1 - ELECON1-600 ELECON1-600 60Hz 600 47.0 !O! hub: 60.0 m (8)



Map: 25229200_all , Print scale 1:10,000, Map center UTM NAD 83 Zone: 19 East: 346,407 North: 4,709,949

New WTG Shadow receptor

Isolines showing shadow in Hours per year, real case

0 10 25 50 100 200

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:49 PM/2.7.486

SHADOW - Main Result

Calculation: Winter Island - 1.0 MW

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

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

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	392	437	311	384	383	436	614	563	712	1,137	1,677	7,615

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: 253918_UPDATED.WPO (10)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10 m

Scale 1:20,000

New WTG Shadow receptor

WTGs

	UTM NAD83 Zone: 19 East	North	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	RPM
	UTM NAD83 Zone: 19		[m]					[kW]	[m]	[m]	[RPM]
1	346,356	4,709,927	8.5	MItsubishi MWT62/1.0 1000 61.4 !O! ...	No	MItsubishi	MWT62/1.0-1,000	1,000	61.4	70.0	19.8

Shadow receptor-Input

No.	Name	UTM NAD83 Zone: 19 East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
A	End of Larkin Lane	345,778	4,710,262	7.3	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
B	Winter Island Road	346,459	4,710,435	3.4	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
C	Memorial Drive @ Vicotry Road	345,605	4,710,048	2.9	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
D	Bayview Ave @ Cheval Ave	346,651	4,710,655	4.5	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
E	Naugus Ave, Marblehead	346,954	4,709,229	9.9	1.0	1.0	1.0	-180.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	End of Larkin Lane	3:20
B	Winter Island Road	0:00
C	Memorial Drive @ Vicotry Road	1:48
D	Bayview Ave @ Cheval Ave	0:00

To be continued on next page...

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SHADOW - Main Result

Calculation: Winter Island - 1.0 MW

...continued from previous page

		Shadow, expected values
No.	Name	Shadow hours per year [h/year]
E	Naugus Ave, Marblehead	0:00

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	MItsubishi MWT62/1.0 1000 61.4 !O! hub: 70.0 m (7)	16:35	5:09

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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Calculated:
6/1/2011 2:49 PM/2.7.486

SHADOW - Calendar

Calculation: Winter Island - 1.0 MW **Shadow receptor:** A - End of Larkin Lane

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	392	437	311	384	383	436	614	563	712	1,137	1,677	7,615

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:14	06:59	07:24 (1)	06:21	06:28	05:40	05:10	05:10	05:35	06:08	06:40	06:17	06:59 (1)	06:53
	16:21	16:57 22	07:46 (1)	17:33	19:09	19:43	20:14	20:25	20:06	19:20	18:27	16:38 14	07:13 (1)	16:12
2	07:14	06:58	07:24 (1)	06:19	06:26	05:39	05:09	05:10	05:36	06:09	06:41	06:18	06:57 (1)	06:54
	16:22	16:58 22	07:46 (1)	17:34	19:10	19:44	20:14	20:25	20:05	19:18	18:25	16:37 17	07:14 (1)	16:12
3	07:14	06:57	07:25 (1)	06:18	06:24	05:37	05:09	05:11	05:37	06:10	06:43	06:19	06:56 (1)	06:55
	16:23	17:00 22	07:47 (1)	17:35	19:11	19:45	20:15	20:25	20:04	19:16	18:23	16:35 18	07:14 (1)	16:12
4	07:14	06:56	07:24 (1)	06:16	06:23	05:36	05:08	05:12	05:38	06:11	06:44	06:21	06:56 (1)	06:56
	16:24	17:01 22	07:46 (1)	17:37	19:13	19:47	20:16	20:25	20:03	19:14	18:22	16:34 20	07:16 (1)	16:11
5	07:14	06:55	07:24 (1)	06:14	06:21	05:35	05:08	05:12	05:39	06:12	06:45	06:22	06:55 (1)	06:58
	16:25	17:02 22	07:46 (1)	17:38	19:14	19:48	20:17	20:25	20:01	19:13	18:20	16:33 21	07:16 (1)	16:11
6	07:14	06:53	07:25 (1)	06:13	06:19	05:33	05:07	05:13	05:40	06:13	06:46	06:23	06:54 (1)	06:58
	16:26	17:03 21	07:46 (1)	17:39	19:15	19:49	20:17	20:25	20:00	19:11	18:18	16:32 22	07:16 (1)	16:11
7	07:14	06:52	07:26 (1)	06:11	06:17	05:32	05:07	05:13	05:41	06:15	06:47	06:24	06:55 (1)	06:59
	16:27	17:05 20	07:46 (1)	17:40	19:16	19:50	20:18	20:24	19:58	19:09	18:16	16:31 22	07:17 (1)	16:11
8	07:14	06:51	07:27 (1)	07:09	06:16	05:31	05:07	05:14	05:43	06:16	06:48	06:26	06:54 (1)	07:00
	16:28	17:06 18	07:45 (1)	18:41	19:17	19:51	20:19	20:24	19:56	19:07	18:15	16:29 23	07:17 (1)	16:11
9	07:14	06:50	07:27 (1)	07:08	06:14	05:30	05:07	05:15	05:44	06:17	06:49	06:27	06:54 (1)	07:01
	16:29	17:07 17	07:44 (1)	18:43	19:18	19:52	20:19	20:24	19:55	19:06	18:13	16:28 22	07:16 (1)	16:11
10	07:13	06:49	07:29 (1)	07:06	06:12	05:28	05:06	05:15	05:45	06:18	06:50	06:28	06:55 (1)	07:02
	16:30	17:09 14	07:43 (1)	18:44	19:19	19:53	20:20	20:23	19:54	19:04	18:11	16:27 22	07:17 (1)	16:11
11	07:13	06:47	07:32 (1)	07:04	06:11	05:27	05:06	05:16	05:46	06:19	06:52	06:29	06:55 (1)	07:03
	16:31	17:10 9	07:41 (1)	18:45	19:21	19:54	20:20	20:23	19:52	19:02	18:10	16:26 21	07:16 (1)	16:11
12	07:13	06:46		07:03	06:09	05:26	05:06	05:17	05:47	06:20	06:53	06:31	06:56 (1)	07:04
	16:32	17:11		18:46	19:22	19:55	20:21	20:22	19:51	19:00	18:08	16:25 20	07:16 (1)	16:11
13	07:12	06:45		07:01	06:07	05:25	05:06	05:18	05:48	06:21	06:54	06:32	06:57 (1)	07:05
	16:33	17:13		18:47	19:23	19:56	20:22	20:22	19:49	18:59	18:06	16:24 19	07:16 (1)	16:11
14	07:12	06:43		06:59	06:06	05:24	05:06	05:19	05:49	06:22	06:55	06:33	06:58 (1)	07:06
	16:34	17:14		18:49	19:24	19:57	20:22	20:21	19:48	18:57	18:05	16:23 17	07:15 (1)	16:11
15	07:12	06:42		06:57	06:04	05:23	05:06	05:19	05:50	06:23	06:56	06:34	06:59 (1)	07:06
	16:35	17:15		18:50	19:25	19:58	20:23	20:21	19:47	18:55	18:03	16:22 14	07:13 (1)	16:11
16	07:11	06:41		06:56	06:03	05:22	05:06	05:20	05:51	06:24	06:57	06:36	07:01 (1)	07:07
	16:37	17:17		18:51	19:26	20:00	20:23	20:20	19:45	18:53	18:02	16:21 12	07:13 (1)	16:12
17	07:11	06:39		06:54	06:01	05:21	05:06	05:21	05:52	06:25	06:59	06:37	07:03 (1)	07:08
	16:38	17:18		18:52	19:27	20:00	20:23	20:19	19:44	18:52	18:00	16:21 8	07:11 (1)	16:12
18	07:10	06:38		06:52	05:59	05:20	05:06	05:22	05:53	06:26	07:00	06:38		07:08
	16:39	17:19		18:53	19:28	20:01	20:24	20:19	19:42	18:50	17:58	16:20		16:12
19	07:09	06:36		06:50	05:58	05:19	05:06	05:23	05:54	06:27	07:01	06:39		07:09
	16:40	17:20		18:54	19:30	20:02	20:24	20:18	19:41	18:48	17:57	16:19		16:13
20	07:09	06:35		06:49	05:56	05:18	05:06	05:24	05:55	06:28	07:02	06:41		07:10
	16:41	17:22		18:55	19:31	20:03	20:24	20:17	19:39	18:46	17:55	16:18		16:13
21	07:08	06:33		06:47	05:55	05:17	05:06	05:25	05:56	06:29	07:03	06:42		07:10
	16:43	17:23		18:57	19:32	20:04	20:25	20:17	19:37	18:44	17:54	16:17		16:14
22	07:08	06:32		06:45	05:53	05:16	05:07	05:25	05:57	06:30	07:04	06:43		07:11
	16:44	17:24		18:58	19:33	20:05	20:25	20:16	19:36	18:43	17:52	16:17		16:14
23	07:07	06:30		06:43	05:52	05:16	05:07	05:26	05:59	06:32	07:06	06:44		07:11
	16:45	17:25		18:59	19:34	20:06	20:25	20:15	19:34	18:41	17:51	16:16		16:15
24	07:06	06:29		06:42	05:50	05:15	05:07	05:27	06:00	06:33	07:07	06:45		07:12
	16:47	17:27		19:00	19:35	20:06	20:25	20:14	19:33	18:39	17:49	16:15		16:15
25	07:05	07:30 (1)	06:27	06:40	05:49	05:14	05:07	05:28	06:01	06:34	07:08	06:47		07:12
	16:48 8	07:38 (1)	17:28	19:01	19:36	20:07	20:25	20:13	19:31	18:37	17:48	16:15		16:16
26	07:04	07:28 (1)	06:26	06:38	05:47	05:13	05:08	05:29	06:02	06:35	07:09	06:48		07:12
	16:49 12	07:40 (1)	17:29	19:02	19:38	20:08	20:25	20:12	19:29	18:36	17:46	16:14		16:16
27	07:04	07:27 (1)	06:24	06:36	05:46	05:13	05:08	05:30	06:03	06:36	07:11	06:49		07:13
	16:50 15	07:42 (1)	17:30	19:04	19:39	20:09	20:26	20:11	19:28	18:34	17:45	16:14		16:17
28	07:03	07:26 (1)	06:22	06:35	05:44	05:12	05:09	05:31	06:04	06:37	07:12	06:50		07:13
	16:52 17	07:43 (1)	17:32	19:05	19:40	20:10	20:26	20:10	19:26	18:32	17:43	16:13		16:18
29	07:02	07:25 (1)		06:33	05:43	05:11	05:09	05:32	06:05	06:38	07:13	06:51		07:13
	16:53 19	07:44 (1)		19:06	19:41	20:11	20:26	20:09	19:25	18:30	17:42	16:13		16:18
30	07:01	07:25 (1)		06:31	05:41	05:11	05:09	05:33	06:06	06:39	07:14	06:52		07:14
	16:54 20	07:45 (1)		19:07	19:42	20:12	20:26	20:08	19:23	18:29	17:41	16:13		16:19
31	07:00	07:24 (1)		06:30		05:10		05:34	06:07		07:16 08:00 (1)			07:14
	16:56 21	07:45 (1)		19:08		20:13		20:07	19:21		17:39 10 08:10 (1)			16:20
Potential sun hours	293	295		370	401	452	457	464	431	375	343	294		283
Total, worst case	112	209									10	312		
Sun reduction	0.56	0.53									0.57	0.47		
Oper. time red.	0.87	0.87									0.87	0.87		
Wind dir. red.	0.71	0.71									0.71	0.71		
Total reduction	0.35	0.33									0.35	0.29		
Total, real	39	68									4	90		

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)

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WI-Salem_WindPRO

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SHADOW - Calendar

Calculation: Winter Island - 1.0 MW **Shadow receptor:** B - Winter Island Road

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

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

	January	February	March	April	May	June	July	August	September	October	November	December
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	16:21	16:57	17:33	19:09	19:43	20:14	20:25	20:06	19:19	18:27	16:38	16:12
2	07:14	06:58	06:19	06:26	05:39	05:09	05:10	05:36	06:09	06:41	06:18	06:54
	16:22	16:58	17:34	19:10	19:44	20:14	20:25	20:05	19:18	18:25	16:37	16:12
3	07:14	06:57	06:18	06:24	05:37	05:09	05:11	05:37	06:10	06:42	06:19	06:55
	16:23	16:59	17:35	19:11	19:45	20:15	20:25	20:04	19:16	18:23	16:35	16:12
4	07:14	06:56	06:16	06:23	05:36	05:08	05:12	05:38	06:11	06:44	06:20	06:56
	16:24	17:01	17:37	19:13	19:47	20:16	20:25	20:02	19:14	18:22	16:34	16:11
5	07:14	06:55	06:14	06:21	05:35	05:08	05:12	05:39	06:12	06:45	06:22	06:57
	16:25	17:02	17:38	19:14	19:48	20:17	20:25	20:01	19:13	18:20	16:33	16:11
6	07:14	06:53	06:13	06:19	05:33	05:07	05:13	05:40	06:13	06:46	06:23	06:58
	16:26	17:03	17:39	19:15	19:49	20:17	20:25	20:00	19:11	18:18	16:32	16:11
7	07:14	06:52	06:11	06:17	05:32	05:07	05:13	05:41	06:14	06:47	06:24	06:59
	16:27	17:05	17:40	19:16	19:50	20:18	20:24	19:58	19:09	18:16	16:31	16:11
8	07:14	06:51	07:09	06:16	05:31	05:07	05:14	05:43	06:16	06:48	06:26	07:00
	16:28	17:06	18:41	19:17	19:51	20:19	20:24	19:56	19:07	18:15	16:29	16:11
9	07:14	06:50	07:08	06:14	05:30	05:07	05:15	05:44	06:17	06:49	06:27	07:01
	16:29	17:07	18:43	19:18	19:52	20:19	20:24	19:55	19:06	18:13	16:28	16:11
10	07:13	06:48	07:06	06:12	05:28	05:06	05:15	05:45	06:18	06:50	06:28	07:02
	16:30	17:09	18:44	19:19	19:53	20:20	20:23	19:54	19:04	18:11	16:27	16:11
11	07:13	06:47	07:04	06:11	05:27	05:06	05:16	05:46	06:19	06:52	06:29	07:03
	16:31	17:10	18:45	19:21	19:54	20:20	20:23	19:52	19:02	18:10	16:26	16:11
12	07:13	06:46	07:03	06:09	05:26	05:06	05:17	05:47	06:20	06:53	06:31	07:04
	16:32	17:11	18:46	19:22	19:55	20:21	20:22	19:51	19:00	18:08	16:25	16:11
13	07:12	06:45	07:01	06:07	05:25	05:06	05:18	05:48	06:21	06:54	06:32	07:05
	16:33	17:13	18:47	19:23	19:56	20:22	20:22	19:49	18:59	18:06	16:24	16:11
14	07:12	06:43	06:59	06:06	05:24	05:06	05:18	05:49	06:22	06:55	06:33	07:06
	16:34	17:14	18:48	19:24	19:57	20:22	20:21	19:48	18:57	18:05	16:23	16:11
15	07:12	06:42	06:57	06:04	05:23	05:06	05:19	05:50	06:23	06:56	06:34	07:06
	16:35	17:15	18:50	19:25	19:58	20:22	20:21	19:46	18:55	18:03	16:22	16:11
16	07:11	06:40	06:56	06:03	05:22	05:06	05:20	05:51	06:24	06:57	06:36	07:07
	16:37	17:16	18:51	19:26	19:59	20:23	20:20	19:45	18:53	18:01	16:21	16:12
17	07:11	06:39	06:54	06:01	05:21	05:06	05:21	05:52	06:25	06:58	06:37	07:08
	16:38	17:18	18:52	19:27	20:01	20:23	20:19	19:44	18:52	18:00	16:21	16:12
18	07:10	06:38	06:52	05:59	05:20	05:06	05:22	05:53	06:26	07:00	06:38	07:08
	16:39	17:19	18:53	19:28	20:01	20:24	20:19	19:42	18:50	17:58	16:20	16:12
19	07:09	06:36	06:50	05:58	05:19	05:06	05:23	05:54	06:27	07:01	06:39	07:09
	16:40	17:20	18:54	19:30	20:02	20:24	20:18	19:41	18:48	17:57	16:19	16:13
20	07:09	06:35	06:49	05:56	05:18	05:06	05:24	05:55	06:28	07:02	06:40	07:10
	16:41	17:22	18:55	19:31	20:03	20:24	20:17	19:39	18:46	17:55	16:18	16:13
21	07:08	06:33	06:47	05:55	05:17	05:06	05:25	05:56	06:29	07:03	06:42	07:10
	16:43	17:23	18:57	19:32	20:04	20:25	20:16	19:37	18:44	17:54	16:17	16:14
22	07:08	06:32	06:45	05:53	05:16	05:07	05:25	05:57	06:30	07:04	06:43	07:11
	16:44	17:24	18:58	19:33	20:05	20:25	20:16	19:36	18:43	17:52	16:17	16:14
23	07:07	06:30	06:43	05:52	05:15	05:07	05:26	05:58	06:32	07:06	06:44	07:11
	16:45	17:25	18:59	19:34	20:05	20:25	20:15	19:34	18:41	17:51	16:16	16:15
24	07:06	06:29	06:42	05:50	05:15	05:07	05:27	06:00	06:33	07:07	06:45	07:12
	16:46	17:27	19:00	19:35	20:06	20:25	20:14	19:33	18:39	17:49	16:15	16:15
25	07:05	06:27	06:40	05:49	05:14	05:07	05:28	06:01	06:34	07:08	06:46	07:12
	16:48	17:28	19:01	19:36	20:07	20:25	20:13	19:31	18:37	17:48	16:15	16:16
26	07:04	06:26	06:38	05:47	05:13	05:08	05:29	06:02	06:35	07:09	06:48	07:12
	16:49	17:29	19:02	19:38	20:08	20:25	20:12	19:29	18:36	17:46	16:14	16:16
27	07:04	06:24	06:36	05:46	05:12	05:08	05:30	06:03	06:36	07:11	06:49	07:13
	16:50	17:30	19:03	19:39	20:09	20:26	20:11	19:28	18:34	17:45	16:14	16:17
28	07:03	06:22	06:35	05:44	05:12	05:09	05:31	06:04	06:37	07:12	06:50	07:13
	16:52	17:32	19:05	19:40	20:10	20:26	20:10	19:26	18:32	17:43	16:13	16:18
29	07:02		06:33	05:43	05:11	05:09	05:32	06:05	06:38	07:13	06:51	07:13
	16:53		19:06	19:41	20:11	20:26	20:09	19:25	18:30	17:42	16:13	16:18
30	07:01		06:31	05:41	05:11	05:09	05:33	06:06	06:39	07:14	06:52	07:13
	16:54		19:07	19:42	20:12	20:26	20:08	19:23	18:29	17:41	16:12	16:19
31	07:00		06:29		05:10		05:34	06:07		07:15		07:14
	16:56		19:08		20:13		20:07	19:21		17:39		16:20
Potential sun hours	293	295	370	401	452	457	464	431	375	343	294	283
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:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 2:55 PM / 5

Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:49 PM/2.7.486

SHADOW - Calendar

Calculation: Winter Island - 1.0 MW **Shadow receptor:** C - Memorial Drive @ Vicotry Road

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	392	437	311	384	383	436	614	563	712	1,137	1,677	7,615

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

	January	February	March		April	May	June	July	August	September		October		November	December
1	07:14	06:59	06:21		06:28	05:40	05:10	05:10	05:35	06:08		06:40	07:03 (1)	06:17	06:53
	16:21	16:57	17:33		19:09	19:43	20:14	20:25	20:06	19:20		18:27	16 07:19 (1)	16:38	16:12
2	07:14	06:58	06:19		06:26	05:39	05:09	05:10	05:36	06:09		06:41	07:03 (1)	06:18	06:54
	16:22	16:58	17:34		19:10	19:44	20:14	20:25	20:05	19:18		18:25	14 07:17 (1)	16:37	16:12
3	07:14	06:57	06:18		06:24	05:37	05:09	05:11	05:37	06:10		06:43	07:04 (1)	06:19	06:55
	16:23	17:00	17:35		19:11	19:45	20:15	20:25	20:04	19:16		18:23	11 07:15 (1)	16:35	16:12
4	07:14	06:56	06:16		06:23	05:36	05:08	05:12	05:38	06:11		06:44	07:07 (1)	06:21	06:56
	16:24	17:01	17:37		19:13	19:47	20:16	20:25	20:03	19:14		18:22	4 07:11 (1)	16:34	16:11
5	07:14	06:55	06:14		06:21	05:35	05:08	05:12	05:39	06:12		06:45		06:22	06:58
	16:25	17:02	17:38		19:14	19:48	20:17	20:25	20:01	19:13		18:20		16:33	16:11
6	07:14	06:53	06:13		06:19	05:33	05:08	05:13	05:40	06:13		06:46		06:23	06:58
	16:26	17:03	17:39		19:15	19:49	20:17	20:25	20:00	19:11		18:18		16:32	16:11
7	07:14	06:52	06:11		06:18	05:32	05:07	05:13	05:42	06:15		06:47		06:24	06:59
	16:27	17:05	17:40		19:16	19:50	20:18	20:24	19:58	19:09		18:16		16:31	16:11
8	07:14	06:51	07:09		06:16	05:31	05:07	05:14	05:43	06:16		06:48		06:26	07:00
	16:28	17:06	18:41		19:17	19:51	20:19	20:24	19:56	19:07		18:15		16:30	16:11
9	07:14	06:50	07:08		06:14	05:30	05:07	05:15	05:44	06:17		06:49		06:27	07:01
	16:29	17:07	18:43		19:18	19:52	20:19	20:24	19:55	19:06		18:13		16:28	16:11
10	07:13	06:49	07:06		07:28 (1)	06:12	05:28	05:06	05:15	05:45	06:18		06:50		06:28	07:02
	16:30	17:09	18:44	9	07:37 (1)	19:19	19:53	20:20	20:23	19:54	19:04		18:11		16:27	16:11
11	07:13	06:47	07:04		07:25 (1)	06:11	05:27	05:06	05:16	05:46	06:19		06:52		06:29	07:03
	16:31	17:10	18:45	13	07:38 (1)	19:21	19:54	20:20	20:23	19:52	19:02		18:10		16:26	16:11
12	07:13	06:46	07:03		07:23 (1)	06:09	05:26	05:06	05:17	05:47	06:20		06:53		06:31	07:04
	16:32	17:11	18:46	16	07:39 (1)	19:22	19:55	20:21	20:22	19:51	19:00		18:08		16:25	16:11
13	07:12	06:45	07:01		07:22 (1)	06:07	05:25	05:06	05:18	05:48	06:21		06:54		06:32	07:05
	16:33	17:13	18:47	17	07:39 (1)	19:23	19:56	20:22	20:22	19:49	18:59		18:06		16:24	16:11
14	07:12	06:43	06:59		07:22 (1)	06:06	05:24	05:06	05:19	05:49	06:22		06:55		06:33	07:06
	16:34	17:14	18:49	18	07:40 (1)	19:24	19:57	20:22	20:21	19:48	18:57		18:05		16:23	16:11
15	07:12	06:42	06:57		07:21 (1)	06:04	05:23	05:06	05:19	05:50	06:23		06:56		06:34	07:06
	16:35	17:15	18:50	19	07:40 (1)	19:25	19:58	20:23	20:21	19:47	18:55		18:03		16:22	16:11
16	07:11	06:41	06:56		07:21 (1)	06:03	05:22	05:06	05:20	05:51	06:24		06:57		06:36	07:07
	16:37	17:17	18:51	18	07:39 (1)	19:26	20:00	20:23	20:20	19:45	18:53		18:02		16:21	16:12
17	07:11	06:39	06:54		07:20 (1)	06:01	05:21	05:06	05:21	05:52	06:25		06:59		06:37	07:08
	16:38	17:18	18:52	18	07:38 (1)	19:27	20:00	20:23	20:19	19:44	18:52		18:00		16:21	16:12
18	07:10	06:38	06:52		07:22 (1)	05:59	05:20	05:06	05:22	05:53	06:26		07:00		06:38	07:08
	16:39	17:19	18:53	16	07:38 (1)	19:29	20:01	20:24	20:19	19:42	18:50		17:58		16:20	16:12
19	07:09	06:36	06:50		07:22 (1)	05:58	05:19	05:06	05:23	05:54	06:27		07:01		06:39	07:09
	16:40	17:20	18:54	15	07:37 (1)	19:30	20:02	20:24	20:18	19:41	18:48		17:57		16:19	16:13
20	07:09	06:35	06:49		07:23 (1)	05:56	05:18	05:06	05:24	05:55	06:28		07:02		06:41	07:10
	16:42	17:22	18:56	11	07:34 (1)	19:31	20:03	20:24	20:17	19:39	18:46		17:55		16:18	16:13
21	07:08	06:33	06:47		07:26 (1)	05:55	05:17	05:06	05:25	05:56	06:29		07:03		06:42	07:10
	16:43	17:23	18:57	5	07:31 (1)	19:32	20:04	20:25	20:17	19:37	18:44		17:54		16:17	16:14
22	07:08	06:32	06:45			05:53	05:16	05:07	05:25	05:57	06:30		07:04		06:43	07:11
	16:44	17:24	18:58			19:33	20:05	20:25	20:16	19:36	18:43		17:52		16:17	16:14
23	07:07	06:30	06:43			05:52	05:16	05:07	05:26	05:59	06:32	07:08 (1)	07:06		06:44	07:11
	16:45	17:25	18:59			19:34	20:06	20:25	20:15	19:34	18:41	10 07:18 (1)	17:51		16:16	16:15
24	07:06	06:29	06:42			05:50	05:15	05:07	05:27	06:00	06:33	07:06 (1)	07:07		06:45	07:12
	16:47	17:27	19:00			19:35	20:06	20:25	20:14	19:33	18:39	14 07:20 (1)	17:49		16:15	16:15
25	07:05	06:27	06:40			05:49	05:14	05:07	05:28	06:01	06:34	07:04 (1)	07:08		06:47	07:12
	16:48	17:28	19:01			19:36	20:07	20:25	20:13	19:31	18:37	16 07:20 (1)	17:48		16:15	16:16
26	07:04	06:26	06:38			05:47	05:13	05:08	05:29	06:02	06:35	07:03 (1)	07:09		06:48	07:12
	16:49	17:29	19:02			19:38	20:08	20:25	20:12	19:29	18:36	18 07:21 (1)	17:46		16:14	16:16
27	07:04	06:24	06:36			05:46	05:13	05:08	05:30	06:03	06:36	07:02 (1)	07:11		06:49	07:13
	16:50	17:30	19:04			19:39	20:09	20:26	20:11	19:28	18:34	19 07:21 (1)	17:45		16:14	16:17
28	07:03	06:22	06:35			05:44	05:12	05:09	05:31	06:04	06:37	07:02 (1)	07:12		06:50	07:13
	16:52	17:32	19:05			19:40	20:10	20:26	20:10	19:26	18:32	18 07:20 (1)	17:43		16:13	16:18
29	07:02		06:33			05:43	05:11	05:09	05:32	06:05	06:38	07:01 (1)	07:13		06:51	07:13
	16:53		19:06			19:41	20:11	20:26	20:09	19:25	18:30	19 07:20 (1)	17:42		16:13	16:18
30	07:01		06:31			05:41	05:11	05:09	05:33	06:06	06:39	07:02 (1)	07:14		06:52	07:14
	16:54		19:07			19:42	20:12	20:26	20:08	19:23	18:29	18 07:20 (1)	17:41		16:13	16:19
31	07:00		06:30				05:10		05:34	06:07			07:16			07:14
	16:56		19:08				20:13		20:07	19:21			17:39			16:20
Potential sun hours	293	295	370		401	452	457	464	431	375		343		294	283
Total, worst case				175							132		45		
Sun reduction				0.49							0.53		0.57		
Oper. time red.				0.87							0.87		0.87		
Wind dir. red.				0.68							0.68		0.68		
Total reduction				0.29							0.32		0.34		
Total, real				51							42		15		

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:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 2:55 PM / 6

Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:49 PM/2.7.486

SHADOW - Calendar

Calculation: Winter Island - 1.0 MW **Shadow receptor:** D - Bayview Ave @ Cheval Ave

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	392	437	311	384	383	436	614	563	712	1,137	1,677	7,615

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:14	06:59	06:21	06:28	05:40	05:10	05:10	05:35	06:08	06:40	06:17	06:53
	16:21	16:57	17:33	19:09	19:43	20:13	20:25	20:06	19:19	18:27	16:38	16:12
2	07:14	06:58	06:19	06:26	05:39	05:09	05:10	05:36	06:09	06:41	06:18	06:54
	16:22	16:58	17:34	19:10	19:44	20:14	20:25	20:05	19:18	18:25	16:37	16:12
3	07:14	06:57	06:18	06:24	05:37	05:09	05:11	05:37	06:10	06:42	06:19	06:55
	16:23	16:59	17:35	19:11	19:45	20:15	20:25	20:04	19:16	18:23	16:35	16:12
4	07:14	06:56	06:16	06:23	05:36	05:08	05:11	05:38	06:11	06:44	06:20	06:56
	16:24	17:01	17:37	19:13	19:47	20:16	20:25	20:02	19:14	18:22	16:34	16:11
5	07:14	06:54	06:14	06:21	05:35	05:08	05:12	05:39	06:12	06:45	06:22	06:57
	16:25	17:02	17:38	19:14	19:48	20:17	20:25	20:01	19:13	18:20	16:33	16:11
6	07:14	06:53	06:13	06:19	05:33	05:07	05:13	05:40	06:13	06:46	06:23	06:58
	16:26	17:03	17:39	19:15	19:49	20:17	20:25	20:00	19:11	18:18	16:32	16:11
7	07:14	06:52	06:11	06:17	05:32	05:07	05:13	05:41	06:14	06:47	06:24	06:59
	16:27	17:05	17:40	19:16	19:50	20:18	20:24	19:57	19:09	18:16	16:31	16:11
8	07:14	06:51	07:09	06:16	05:31	05:07	05:14	05:42	06:16	06:48	06:26	07:00
	16:28	17:06	18:41	19:17	19:51	20:19	20:24	19:56	19:07	18:15	16:29	16:11
9	07:14	06:50	07:08	06:14	05:30	05:07	05:15	05:44	06:17	06:49	06:27	07:01
	16:29	17:07	18:43	19:18	19:52	20:19	20:24	19:55	19:06	18:13	16:28	16:11
10	07:13	06:48	07:06	06:12	05:28	05:06	05:15	05:45	06:18	06:50	06:28	07:02
	16:30	17:09	18:44	19:19	19:53	20:20	20:23	19:54	19:04	18:11	16:27	16:11
11	07:13	06:47	07:04	06:11	05:27	05:06	05:16	05:46	06:19	06:51	06:29	07:03
	16:31	17:10	18:45	19:21	19:54	20:20	20:23	19:52	19:02	18:10	16:26	16:11
12	07:13	06:46	07:03	06:09	05:26	05:06	05:17	05:47	06:20	06:53	06:31	07:04
	16:32	17:11	18:46	19:22	19:55	20:21	20:22	19:51	19:00	18:08	16:25	16:11
13	07:12	06:45	07:01	06:07	05:25	05:06	05:18	05:48	06:21	06:54	06:32	07:05
	16:33	17:13	18:47	19:23	19:56	20:22	20:22	19:49	18:59	18:06	16:24	16:11
14	07:12	06:43	06:59	06:06	05:24	05:06	05:18	05:49	06:22	06:55	06:33	07:06
	16:34	17:14	18:48	19:24	19:57	20:22	20:21	19:48	18:57	18:05	16:23	16:11
15	07:12	06:42	06:57	06:04	05:23	05:06	05:19	05:50	06:23	06:56	06:34	07:06
	16:35	17:15	18:50	19:25	19:58	20:22	20:21	19:46	18:55	18:03	16:22	16:11
16	07:11	06:40	06:56	06:03	05:22	05:06	05:20	05:51	06:24	06:57	06:36	07:07
	16:37	17:16	18:51	19:26	19:59	20:23	20:20	19:45	18:53	18:01	16:21	16:12
17	07:11	06:39	06:54	06:01	05:21	05:06	05:21	05:52	06:25	06:58	06:37	07:08
	16:38	17:18	18:52	19:27	20:01	20:23	20:19	19:44	18:52	18:00	16:20	16:12
18	07:10	06:38	06:52	05:59	05:20	05:06	05:22	05:53	06:26	07:00	06:38	07:08
	16:39	17:19	18:53	19:28	20:01	20:24	20:19	19:42	18:50	17:58	16:20	16:12
19	07:09	06:36	06:50	05:58	05:19	05:06	05:23	05:54	06:27	07:01	06:39	07:09
	16:40	17:20	18:54	19:30	20:02	20:24	20:18	19:41	18:48	17:57	16:19	16:13
20	07:09	06:35	06:49	05:56	05:18	05:06	05:24	05:55	06:28	07:02	06:40	07:10
	16:41	17:22	18:55	19:31	20:03	20:24	20:17	19:39	18:46	17:55	16:18	16:13
21	07:08	06:33	06:47	05:55	05:17	05:06	05:24	05:56	06:29	07:03	06:42	07:10
	16:43	17:23	18:57	19:32	20:04	20:25	20:16	19:37	18:44	17:54	16:17	16:14
22	07:08	06:32	06:45	05:53	05:16	05:07	05:25	05:57	06:30	07:04	06:43	07:11
	16:44	17:24	18:58	19:33	20:05	20:25	20:16	19:36	18:43	17:52	16:17	16:14
23	07:07	06:30	06:43	05:52	05:15	05:07	05:26	05:58	06:32	07:06	06:44	07:11
	16:45	17:25	18:59	19:34	20:05	20:25	20:15	19:34	18:41	17:51	16:16	16:15
24	07:06	06:29	06:42	05:50	05:15	05:07	05:27	06:00	06:33	07:07	06:45	07:12
	16:46	17:27	19:00	19:35	20:06	20:25	20:14	19:33	18:39	17:49	16:15	16:15
25	07:05	06:27	06:40	05:49	05:14	05:07	05:28	06:01	06:34	07:08	06:46	07:12
	16:48	17:28	19:01	19:36	20:07	20:25	20:13	19:31	18:37	17:48	16:15	16:16
26	07:04	06:26	06:38	05:47	05:13	05:08	05:29	06:02	06:35	07:09	06:48	07:12
	16:49	17:29	19:02	19:38	20:08	20:25	20:12	19:29	18:36	17:46	16:14	16:16
27	07:04	06:24	06:36	05:46	05:12	05:08	05:30	06:03	06:36	07:11	06:49	07:13
	16:50	17:30	19:03	19:39	20:09	20:26	20:11	19:28	18:34	17:45	16:14	16:17
28	07:03	06:22	06:35	05:44	05:12	05:09	05:31	06:04	06:37	07:12	06:50	07:13
	16:52	17:32	19:05	19:40	20:10	20:26	20:10	19:26	18:32	17:43	16:13	16:18
29	07:02		06:33	05:43	05:11	05:09	05:32	06:05	06:38	07:13	06:51	07:13
	16:53		19:06	19:41	20:11	20:26	20:09	19:25	18:30	17:42	16:13	16:18
30	07:01		06:31	05:41	05:11	05:09	05:33	06:06	06:39	07:14	06:52	07:13
	16:54		19:07	19:42	20:12	20:26	20:08	19:23	18:28	17:41	16:12	16:19
31	07:00		06:29		05:10		05:34	06:07		07:15		07:14
	16:56		19:08		20:13		20:07	19:21		17:39		16:20
Potential sun hours	293	295	370	401	452	457	464	431	375	343	294	283
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:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 2:55 PM / 7

Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:49 PM/2.7.486

SHADOW - Calendar

Calculation: Winter Island - 1.0 MW **Shadow receptor:** E - Naugus Ave, Marblehead

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	392	437	311	384	383	436	614	563	712	1,137	1,677	7,615

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:14	06:59	06:21	06:28	05:40	05:10	05:10	05:35	06:08	06:40	06:17	06:53
	16:21	16:57	17:33	19:09	19:43	20:13	20:25	20:06	19:19	18:27	16:38	16:12
2	07:14	06:58	06:19	06:26	05:39	05:09	05:10	05:36	06:09	06:41	06:18	06:54
	16:22	16:58	17:34	19:10	19:44	20:14	20:25	20:05	19:18	18:25	16:37	16:12
3	07:14	06:57	06:18	06:24	05:37	05:09	05:11	05:37	06:10	06:42	06:19	06:55
	16:23	16:59	17:35	19:11	19:45	20:15	20:25	20:04	19:16	18:23	16:35	16:12
4	07:14	06:56	06:16	06:23	05:36	05:08	05:12	05:38	06:11	06:44	06:20	06:56
	16:24	17:01	17:37	19:13	19:46	20:16	20:25	20:02	19:14	18:22	16:34	16:11
5	07:14	06:54	06:14	06:21	05:35	05:08	05:12	05:39	06:12	06:45	06:22	06:57
	16:25	17:02	17:38	19:14	19:48	20:17	20:25	20:01	19:13	18:20	16:33	16:11
6	07:14	06:53	06:13	06:19	05:33	05:07	05:13	05:40	06:13	06:46	06:23	06:58
	16:26	17:03	17:39	19:15	19:49	20:17	20:24	20:00	19:11	18:18	16:32	16:11
7	07:14	06:52	06:11	06:17	05:32	05:07	05:13	05:41	06:14	06:47	06:24	06:59
	16:27	17:05	17:40	19:16	19:50	20:18	20:24	19:57	19:09	18:16	16:31	16:11
8	07:14	06:51	07:09	06:16	05:31	05:07	05:14	05:43	06:16	06:48	06:25	07:00
	16:28	17:06	18:41	19:17	19:51	20:19	20:24	19:56	19:07	18:15	16:29	16:11
9	07:13	06:50	07:08	06:14	05:30	05:07	05:15	05:44	06:17	06:49	06:27	07:01
	16:29	17:07	18:43	19:18	19:52	20:19	20:24	19:55	19:06	18:13	16:28	16:11
10	07:13	06:48	07:06	06:12	05:28	05:06	05:15	05:45	06:18	06:50	06:28	07:02
	16:30	17:09	18:44	19:19	19:53	20:20	20:23	19:53	19:04	18:11	16:27	16:11
11	07:13	06:47	07:04	06:11	05:27	05:06	05:16	05:46	06:19	06:51	06:29	07:03
	16:31	17:10	18:45	19:20	19:54	20:20	20:23	19:52	19:02	18:10	16:26	16:11
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	16:32	17:11	18:46	19:22	19:55	20:21	20:22	19:51	19:00	18:08	16:25	16:11
13	07:12	06:45	07:01	06:07	05:25	05:06	05:18	05:48	06:21	06:54	06:32	07:05
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	16:34	17:14	18:48	19:24	19:57	20:22	20:21	19:48	18:57	18:05	16:23	16:11
15	07:11	06:42	06:57	06:04	05:23	05:06	05:19	05:50	06:23	06:56	06:34	07:06
	16:35	17:15	18:50	19:25	19:58	20:22	20:21	19:46	18:55	18:03	16:22	16:11
16	07:11	06:40	06:56	06:03	05:22	05:06	05:20	05:51	06:24	06:57	06:36	07:07
	16:37	17:16	18:51	19:26	19:59	20:23	20:20	19:45	18:53	18:01	16:21	16:12
17	07:11	06:39	06:54	06:01	05:21	05:06	05:21	05:52	06:25	06:58	06:37	07:08
	16:38	17:18	18:52	19:27	20:00	20:23	20:19	19:43	18:52	18:00	16:21	16:12
18	07:10	06:38	06:52	05:59	05:20	05:06	05:22	05:53	06:26	07:00	06:38	07:08
	16:39	17:19	18:53	19:28	20:00	20:24	20:19	19:42	18:50	17:58	16:20	16:12
19	07:09	06:36	06:50	05:58	05:19	05:06	05:23	05:54	06:27	07:01	06:39	07:09
	16:40	17:20	18:54	19:30	20:01	20:24	20:18	19:40	18:48	17:57	16:19	16:13
20	07:09	06:35	06:49	05:56	05:18	05:06	05:24	05:55	06:28	07:02	06:40	07:09
	16:41	17:22	18:55	19:31	20:02	20:24	20:17	19:39	18:46	17:55	16:18	16:13
21	07:08	06:33	06:47	05:55	05:17	05:06	05:25	05:56	06:29	07:03	06:42	07:10
	16:43	17:23	18:57	19:32	20:03	20:25	20:16	19:37	18:44	17:54	16:17	16:14
22	07:07	06:32	06:45	05:53	05:16	05:07	05:25	05:57	06:30	07:04	06:43	07:11
	16:44	17:24	18:58	19:33	20:04	20:25	20:16	19:36	18:43	17:52	16:17	16:14
23	07:07	06:30	06:43	05:52	05:15	05:07	05:26	05:58	06:32	07:06	06:44	07:11
	16:45	17:25	18:59	19:34	20:05	20:25	20:15	19:34	18:41	17:51	16:16	16:15
24	07:06	06:29	06:42	05:50	05:15	05:07	05:27	06:00	06:33	07:07	06:45	07:12
	16:46	17:27	19:00	19:35	20:06	20:25	20:14	19:33	18:39	17:49	16:15	16:15
25	07:05	06:27	06:40	05:49	05:14	05:07	05:28	06:01	06:34	07:08	06:46	07:12
	16:48	17:28	19:01	19:36	20:07	20:25	20:13	19:31	18:37	17:48	16:15	16:16
26	07:04	06:26	06:38	05:47	05:13	05:08	05:29	06:02	06:35	07:09	06:48	07:12
	16:49	17:29	19:02	19:37	20:08	20:25	20:12	19:29	18:36	17:46	16:14	16:16
27	07:04	06:24	06:36	05:46	05:13	05:08	05:30	06:03	06:36	07:10	06:49	07:13
	16:50	17:30	19:03	19:39	20:09	20:25	20:11	19:28	18:34	17:45	16:14	16:17
28	07:03	06:22	06:35	05:44	05:12	05:09	05:31	06:04	06:37	07:12	06:50	07:13
	16:52	17:32	19:05	19:40	20:10	20:25	20:10	19:26	18:32	17:43	16:13	16:18
29	07:02		06:33	05:43	05:11	05:09	05:32	06:05	06:38	07:13	06:51	07:13
	16:53		19:06	19:41	20:11	20:25	20:09	19:24	18:30	17:42	16:13	16:18
30	07:01		06:31	05:41	05:11	05:09	05:33	06:06	06:39	07:14	06:52	07:13
	16:54		19:07	19:42	20:12	20:25	20:08	19:23	18:28	17:41	16:12	16:19
31	07:00		06:29		05:10		05:34	06:07		07:15		07:14
	16:56		19:08		20:13		20:07	19:21		17:39		16:20
Potential sun hours	293	295	370	401	452	457	464	431	375	343	294	283
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:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 2:55 PM / 8

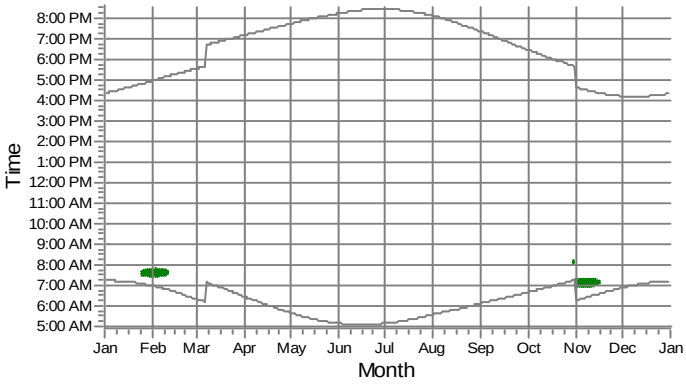
Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:49 PM/2.7.486

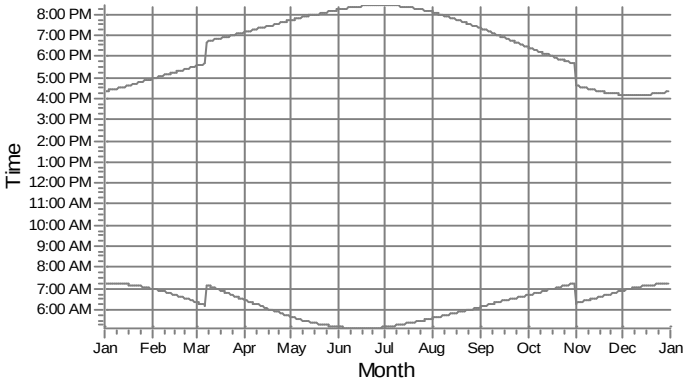
SHADOW - Calendar, graphical

Calculation: Winter Island - 1.0 MW

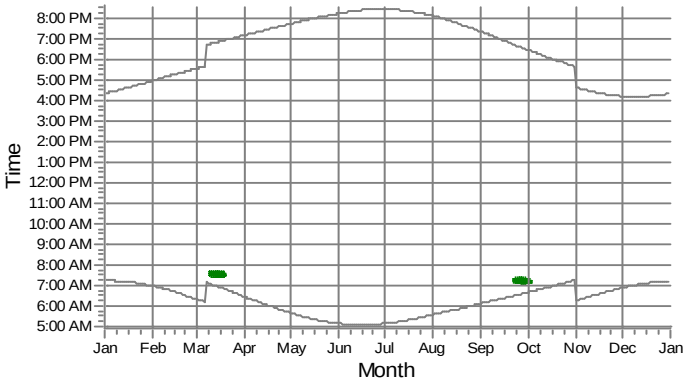
A: End of Larkin Lane



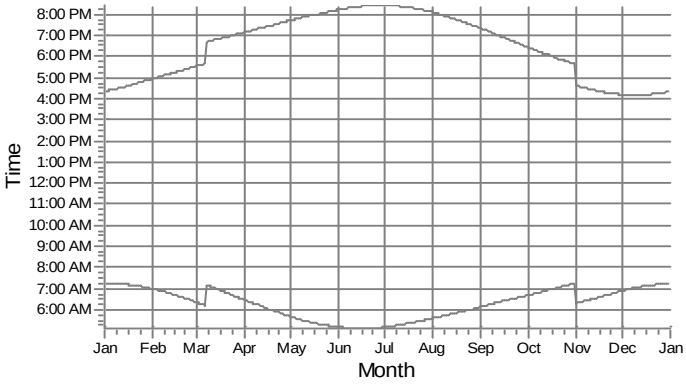
B: Winter Island Road



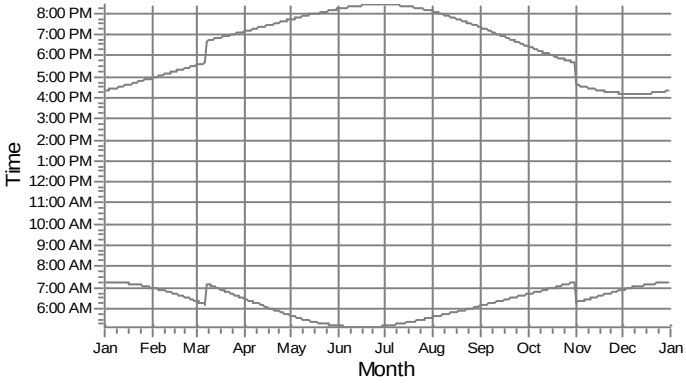
C: Memorial Drive @ Vicotry Road



D: Bayview Ave @ Cheval Ave



E: Naugus Ave, Marblehead



WTGs

1: MItsubishi MWT62/1.0 1000 61.4 !O! hub: 70.0 m (7)

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 2:55 PM / 9

Licensed user:
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152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:49 PM/2.7.486

SHADOW - Calendar per WTG

Calculation: Winter Island - 1.0 MW**WTG:** 1 - MItsubishi MWT62/1.0 1000 61.4 !O! hub: 70.0 m (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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	392	437	311	384	383	436	614	563	712	1,137	1,677	7,615

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:14 16:21	06:59 07:24-07:46/22 16:57	06:21 17:33	06:28 19:09	05:40 19:43	05:10 20:13	05:10 20:25	05:35 20:06	06:08 19:19	06:40 07:03-07:19/16 18:27	06:17 06:59-07:13/14 16:38	06:53 16:12
2	07:14 16:22	06:58 07:24-07:46/22 16:58	06:19 17:34	06:26 19:10	05:39 19:44	05:09 20:14	05:10 20:25	05:36 20:05	06:09 19:18	06:41 07:03-07:17/14 18:25	06:18 06:57-07:14/17 16:37	06:54 16:12
3	07:14 16:23	06:57 07:25-07:47/22 16:59	06:18 17:35	06:24 19:11	05:37 19:45	05:09 20:15	05:11 20:25	05:37 20:04	06:10 19:16	06:42 07:04-07:15/11 18:23	06:19 06:56-07:14/18 16:35	06:55 16:12
4	07:14 16:24	06:56 07:24-07:46/22 17:01	06:16 17:37	06:23 19:13	05:36 19:47	05:08 20:16	05:12 20:25	05:38 20:02	06:11 19:14	06:44 07:07-07:11/4 18:22	06:20 06:56-07:16/20 16:34	06:56 16:11
5	07:14 16:25	06:54 07:24-07:46/22 17:02	06:14 17:38	06:21 19:14	05:35 19:48	05:08 20:17	05:12 20:25	05:39 20:01	06:12 19:13	06:45 18:20	06:22 06:55-07:16/21 16:33	06:57 16:11
6	07:14 16:26	06:53 07:25-07:46/21 17:03	06:13 17:39	06:19 19:15	05:33 19:49	05:07 20:17	05:13 20:25	05:40 20:00	06:13 19:11	06:46 18:18	06:23 06:54-07:16/22 16:32	06:58 16:11
7	07:14 16:27	06:52 07:26-07:46/20 17:05	06:11 17:40	06:17 19:16	05:32 19:50	05:07 20:18	05:13 20:24	05:41 19:57	06:14 19:09	06:47 18:16	06:24 06:55-07:17/22 16:31	06:59 16:11
8	07:14 16:28	06:51 07:27-07:45/18 17:06	07:09 18:41	06:16 19:17	05:31 19:51	05:07 20:19	05:14 20:24	05:43 19:56	06:16 19:07	06:48 18:15	06:26 06:54-07:17/23 16:29	07:00 16:11
9	07:13 16:29	06:50 07:27-07:44/17 17:07	07:08 18:43	06:14 19:18	05:30 19:52	05:07 20:19	05:15 20:24	05:44 19:55	06:17 19:06	06:49 18:13	06:27 06:54-07:16/22 16:28	07:01 16:11
10	07:13 16:30	06:48 07:29-07:43/14 17:09	07:06 07:28-07:37/9 18:44	06:12 19:19	05:28 19:53	05:06 20:20	05:15 20:23	05:45 19:54	06:18 19:04	06:50 18:11	06:28 06:55-07:17/22 16:27	07:02 16:11
11	07:13 16:31	06:47 07:32-07:41/9 17:10	07:04 07:25-07:38/13 18:45	06:11 19:21	05:27 19:54	05:06 20:20	05:16 20:23	05:46 19:52	06:19 19:02	06:52 18:10	06:29 06:55-07:16/21 16:26	07:03 16:11
12	07:13 16:32	06:46 17:11	07:03 07:23-07:39/16 18:46	06:09 19:22	05:26 19:55	05:06 20:21	05:17 20:22	05:47 19:51	06:20 19:00	06:53 18:08	06:31 06:56-07:16/20 16:25	07:04 16:11
13	07:12 16:33	06:45 17:13	07:01 07:22-07:39/17 18:47	06:07 19:23	05:25 19:56	05:06 20:22	05:18 20:22	05:48 19:49	06:21 18:59	06:54 18:06	06:32 06:57-07:16/19 16:24	07:05 16:11
14	07:12 16:34	06:43 17:14	06:59 07:22-07:40/18 18:48	06:06 19:24	05:24 19:57	05:06 20:22	05:19 20:21	05:49 19:48	06:22 18:57	06:55 18:05	06:33 06:58-07:15/17 16:23	07:05 16:11
15	07:12 16:35	06:42 17:15	06:57 07:21-07:40/19 18:50	06:04 19:25	05:23 19:58	05:06 20:22	05:19 20:21	05:50 19:46	06:23 18:55	06:56 18:03	06:34 06:59-07:13/14 16:22	07:06 16:11
16	07:11 16:37	06:40 17:16	06:56 07:21-07:39/18 18:51	06:03 19:26	05:22 19:59	05:06 20:23	05:20 20:20	05:51 19:45	06:24 18:53	06:57 18:01	06:36 07:01-07:13/12 16:21	07:07 16:12
17	07:11 16:38	06:39 17:18	06:54 07:20-07:38/18 18:52	06:01 19:27	05:21 20:00	05:06 20:23	05:21 20:19	05:52 19:44	06:25 18:52	06:58 18:00	06:37 07:03-07:11/8 16:21	07:08 16:12
18	07:10 16:39	06:38 17:19	06:52 07:22-07:38/16 18:53	05:59 19:28	05:20 20:00	05:06 20:24	05:22 20:19	05:53 19:42	06:26 18:50	07:00 17:58	06:38 16:20	07:08 16:12
19	07:09 16:40	06:36 17:20	06:50 07:22-07:37/15 18:54	05:58 19:30	05:19 20:02	05:06 20:24	05:23 20:18	05:54 19:41	06:27 18:48	07:01 17:57	06:39 16:19	07:09 16:13
20	07:09 16:41	06:35 17:22	06:49 07:23-07:34/11 18:55	05:56 19:31	05:18 20:03	05:06 20:24	05:24 20:17	05:55 19:39	06:28 18:46	07:02 17:55	06:40 16:18	07:10 16:13
21	07:08 16:43	06:33 17:23	06:47 07:26-07:31/5 18:57	05:55 19:32	05:17 20:04	05:06 20:25	05:25 20:16	05:56 19:37	06:29 18:44	07:03 17:54	06:42 16:17	07:10 16:14
22	07:08 16:44	06:32 17:24	06:45 18:58	05:53 19:33	05:16 20:04	05:07 20:25	05:25 20:16	05:57 19:36	06:30 18:43	07:04 17:52	06:43 16:17	07:11 16:14
23	07:07 16:45	06:30 17:25	06:43 18:59	05:52 19:34	05:15 20:05	05:07 20:25	05:26 20:15	05:58 19:34	06:32 07:08-07:18/10 18:41	07:06 17:51	06:44 16:16	07:11 16:15
24	07:06 16:46	06:29 17:27	06:42 19:00	05:50 19:35	05:15 20:06	05:07 20:25	05:27 20:14	06:00 19:33	06:33 07:06-07:20/14 18:39	07:07 17:49	06:45 16:15	07:12 16:15
25	07:05 07:30-07:38/8 16:48	06:27 17:28	06:40 19:01	05:49 19:36	05:14 20:07	05:07 20:25	05:28 20:13	06:01 19:31	06:34 07:04-07:20/16 18:37	07:08 17:48	06:46 16:15	07:12 16:16
26	07:04 07:28-07:40/12 16:49	06:26 17:29	06:38 19:02	05:47 19:38	05:13 20:08	05:08 20:25	05:29 20:12	06:02 19:29	06:35 07:03-07:21/18 18:36	07:09 17:46	06:48 16:14	07:12 16:16
27	07:04 07:27-07:42/15 16:50	06:24 17:30	06:36 19:03	05:46 19:39	05:13 20:09	05:08 20:26	05:30 20:11	06:03 19:28	06:36 07:02-07:21/19 18:34	07:11 17:45	06:49 16:14	07:13 16:17
28	07:03 07:26-07:43/17 16:52	06:22 17:32	06:35 19:05	05:44 19:40	05:12 20:10	05:09 20:26	05:31 20:10	06:04 19:26	06:37 07:02-07:20/18 18:32	07:12 17:43	06:50 16:13	07:13 16:18
29	07:02 07:25-07:44/19 16:53		06:33 19:06	05:43 19:41	05:11 20:11	05:09 20:26	05:32 20:09	06:05 19:25	06:38 07:01-07:20/19 18:30	07:13 17:42	06:51 16:13	07:13 16:18
30	07:01 07:25-07:45/20 16:54		06:31 19:07	05:41 19:42	05:11 20:12	05:09 20:26	05:33 20:08	06:06 19:23	06:39 07:02-07:20/18 18:29	07:14 17:41	06:52 16:13	07:13 16:19
31	07:00 07:24-07:45/21 16:56		06:29 19:08		05:10 20:13		05:34 20:07	06:07 19:21		07:15 08:00-08:10/10 17:39		07:14 16:20
Potential sun hours	293	295	370	401	452	457	464	431	375	343	294	283
Sum of minutes with flicker	112	209	175	0	0	0	0	0	132	55	312	0

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

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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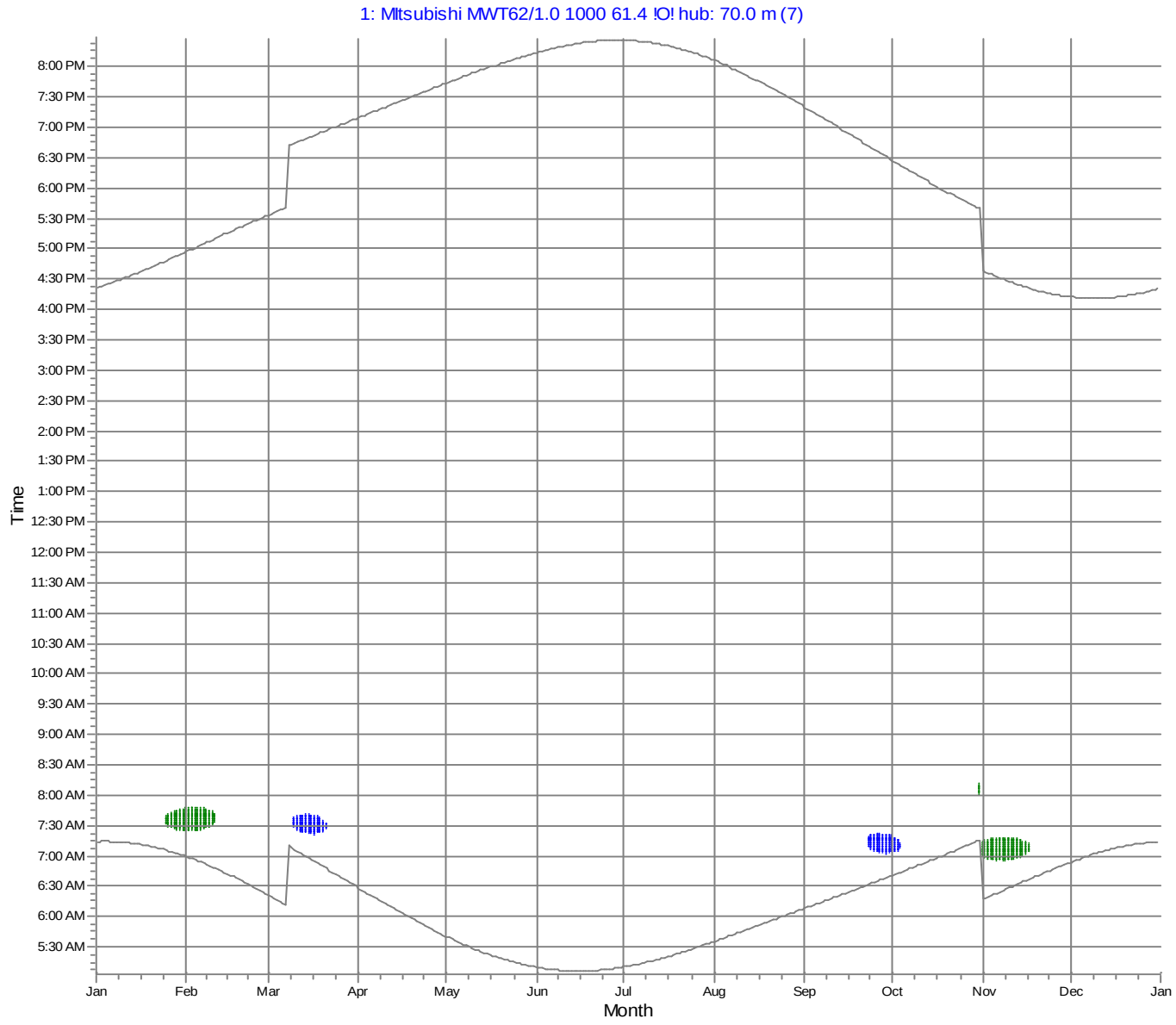
6/1/2011 2:55 PM / 10

Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 2:49 PM/2.7.486

SHADOW - Calendar per WTG, graphical

Calculation: Winter Island - 1.0 MW**WTG:** 1 - MItsubishi MWT62/1.0 1000 61.4 !O! hub: 70.0 m (7)



Shadow receptor

A: End of Larkin Lane

C: Memorial Drive @ Vicotry Road

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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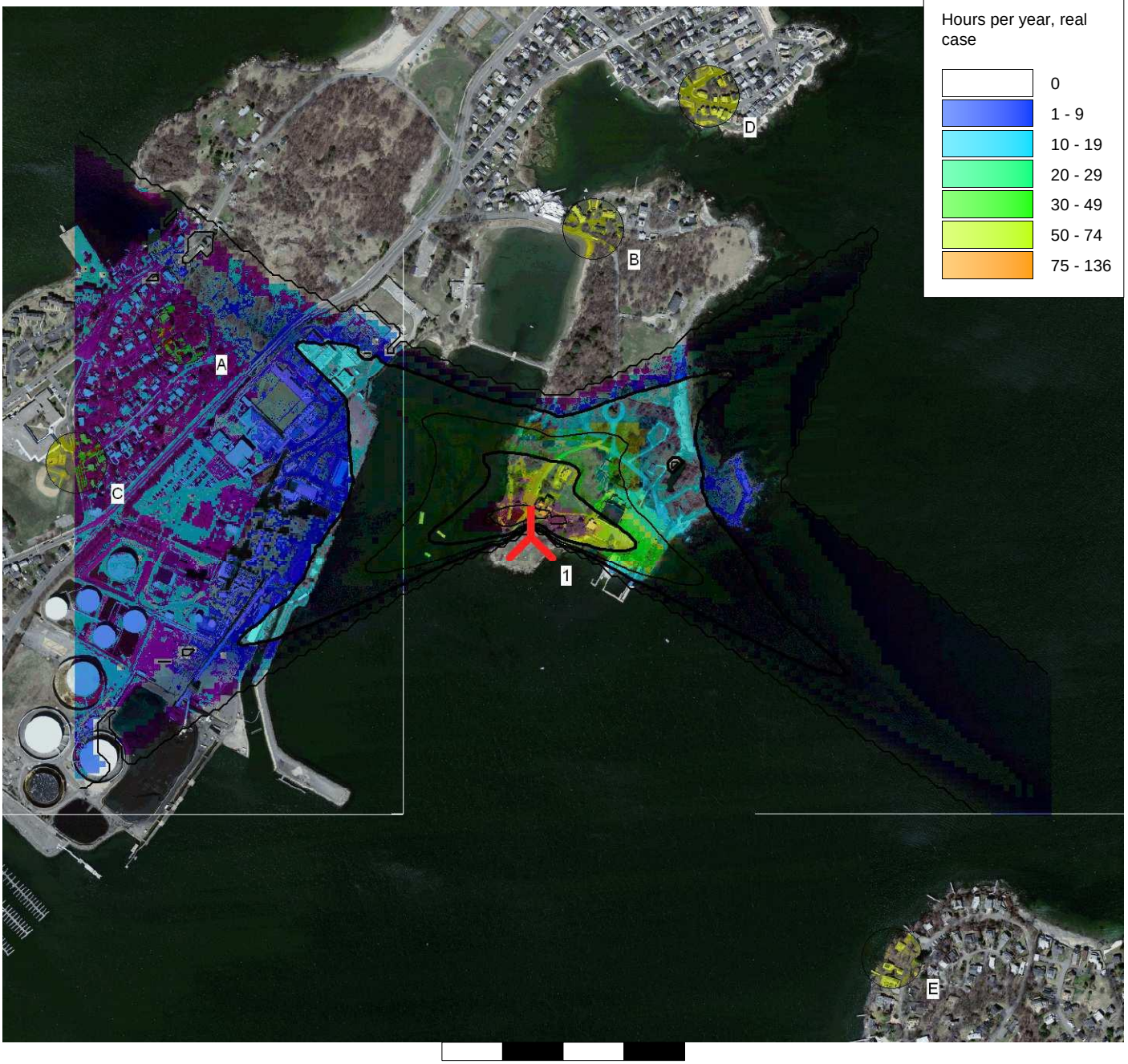
Calculated:
6/1/2011 2:49 PM/2.7.486

SHADOW - Map

Calculation: Winter Island - 1.0 MW**WTG:** 1 - MItsubishi MWT62/1.0 1000 61.4 !O! hub: 70.0 m (7)



Map: 25229200_all , Print scale 1:10,000, Map center UTM NAD 83 Zone: 19 East: 346,407 North: 4,709,949

New WTG Shadow receptor

Isolines showing shadow in Hours per year, real case

0 10 25 50 100 200

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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Calculated:
6/1/2011 3:03 PM/2.7.486

SHADOW - Main Result

Calculation: Winter Island - 1.5 MW

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

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

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
578	399	445	316	391	390	444	625	573	724	1,158	1,707	7,752

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: 253918_UPDATED.WPO (10)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10 m

Scale 1:20,000

New WTG Shadow receptor

WTGs

	UTM NAD83 Zone: 19 East	North	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	RPM
	UTM NAD83 Zone: 19		[m]					[kW]	[m]	[m]	[RPM]
1	346,356	4,709,927	8.4	GE 1.5 sle	Yes	GE WIND ENERGY	GE 1.5sle-1,500	1,500	77.0	80.0	20.0

Shadow receptor-Input

No.	Name	UTM NAD83 Zone: 19 East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
A	End of Larkin Lane	345,778	4,710,262	7.3	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
B	Winter Island Road	346,459	4,710,435	3.4	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
C	Memorial Drive @ Vicotry Road	345,605	4,710,048	2.9	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
D	Bayview Ave @ Cheval Ave	346,651	4,710,655	4.5	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
E	Naugus Ave, Marblehead	346,954	4,709,229	9.9	1.0	1.0	1.0	-180.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	End of Larkin Lane	5:10
B	Winter Island Road	0:00
C	Memorial Drive @ Vicotry Road	2:50
D	Bayview Ave @ Cheval Ave	0:00

To be continued on next page...

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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Calculated:
6/1/2011 3:03 PM/2.7.486

SHADOW - Main Result

Calculation: Winter Island - 1.5 MW

...continued from previous page

		Shadow, expected values
No.	Name	Shadow hours per year [h/year]
E	Naugus Ave, Marblehead	0:00

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	GE 1.5 sle	25:10	8:01

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 3:03 PM/2.7.486

SHADOW - Calendar

Calculation: Winter Island - 1.5 MW **Shadow receptor:** A - End of Larkin Lane

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
578	399	445	316	391	390	444	625	573	724	1,158	1,707	7,752

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

	January		February		March	April	May	June	July	August	September	October		November		December
1	07:14		06:59	07:25 (1)	06:21	06:28	05:40	05:10	05:10	05:35	06:08	06:40		06:17	06:56 (1)	06:53
	16:21		16:57 25	07:50 (1)	17:33	19:09	19:43	20:14	20:25	20:06	19:20	18:27		16:38 24	07:20 (1)	16:12
2	07:14		06:58	07:25 (1)	06:19	06:26	05:39	05:09	05:10	05:36	06:09	06:41		06:18	06:55 (1)	06:54
	16:22		16:58 26	07:51 (1)	17:34	19:10	19:44	20:14	20:25	20:05	19:18	18:25		16:37 26	07:21 (1)	16:12
3	07:14		06:57	07:25 (1)	06:18	06:24	05:37	05:09	05:11	05:37	06:10	06:43		06:19	06:54 (1)	06:55
	16:23		17:00 27	07:52 (1)	17:35	19:11	19:45	20:15	20:25	20:04	19:16	18:23		16:35 27	07:21 (1)	16:12
4	07:14		06:56	07:24 (1)	06:16	06:23	05:36	05:08	05:12	05:38	06:11	06:44		06:21	06:54 (1)	06:56
	16:24		17:01 27	07:51 (1)	17:37	19:13	19:47	20:16	20:25	20:03	19:14	18:22		16:34 28	07:22 (1)	16:11
5	07:14		06:55	07:24 (1)	06:14	06:21	05:35	05:08	05:12	05:39	06:12	06:45		06:22	06:54 (1)	06:58
	16:25		17:02 27	07:51 (1)	17:38	19:14	19:48	20:17	20:25	20:01	19:13	18:20		16:33 28	07:22 (1)	16:11
6	07:14		06:53	07:24 (1)	06:13	06:19	05:33	05:07	05:13	05:40	06:13	06:46		06:23	06:54 (1)	06:58
	16:26		17:03 28	07:52 (1)	17:39	19:15	19:49	20:17	20:25	20:00	19:11	18:18		16:32 27	07:21 (1)	16:11
7	07:14		06:52	07:25 (1)	06:11	06:17	05:32	05:07	05:13	05:41	06:15	06:47		06:24	06:54 (1)	06:59
	16:27		17:05 27	07:52 (1)	17:40	19:16	19:50	20:18	20:24	19:58	19:09	18:16		16:31 28	07:22 (1)	16:11
8	07:14		06:51	07:25 (1)	07:09	06:16	05:31	05:07	05:14	05:43	06:16	06:48		06:26	06:54 (1)	07:00
	16:28		17:06 27	07:52 (1)	18:41	19:17	19:51	20:19	20:24	19:56	19:07	18:15		16:29 28	07:22 (1)	16:11
9	07:14		06:50	07:25 (1)	07:08	06:14	05:30	05:07	05:15	05:44	06:17	06:49		06:27	06:54 (1)	07:01
	16:29		17:07 26	07:51 (1)	18:43	19:18	19:52	20:19	20:24	19:55	19:06	18:13		16:28 27	07:21 (1)	16:11
10	07:13		06:49	07:26 (1)	07:06	06:12	05:28	05:06	05:15	05:45	06:18	06:50		06:28	06:56 (1)	07:02
	16:30		17:09 25	07:51 (1)	18:44	19:19	19:53	20:20	20:23	19:54	19:04	18:11		16:27 25	07:21 (1)	16:11
11	07:13		06:47	07:27 (1)	07:04	06:11	05:27	05:06	05:16	05:46	06:19	06:52		06:29	06:56 (1)	07:03
	16:31		17:10 23	07:50 (1)	18:45	19:21	19:54	20:20	20:23	19:52	19:02	18:10		16:26 25	07:21 (1)	16:11
12	07:13		06:46	07:28 (1)	07:03	06:09	05:26	05:06	05:17	05:47	06:20	06:53		06:31	06:56 (1)	07:04
	16:32		17:11 20	07:48 (1)	18:46	19:22	19:55	20:21	20:22	19:51	19:00	18:08		16:25 24	07:20 (1)	16:11
13	07:12		06:45	07:29 (1)	07:01	06:07	05:25	05:06	05:18	05:48	06:21	06:54		06:32	06:58 (1)	07:05
	16:33		17:13 18	07:47 (1)	18:47	19:23	19:56	20:22	20:22	19:49	18:59	18:06		16:24 22	07:20 (1)	16:11
14	07:12		06:43	07:32 (1)	06:59	06:06	05:24	05:06	05:19	05:49	06:22	06:55		06:33	06:59 (1)	07:06
	16:34		17:14 14	07:46 (1)	18:49	19:24	19:57	20:22	20:21	19:48	18:57	18:05		16:23 19	07:18 (1)	16:11
15	07:12		06:42	07:34 (1)	06:57	06:04	05:23	05:06	05:19	05:50	06:23	06:56		06:34	07:00 (1)	07:06
	16:35		17:15 8	07:42 (1)	18:50	19:25	19:58	20:23	20:21	19:47	18:55	18:03		16:22 17	07:17 (1)	16:11
16	07:11		06:41		06:56	06:03	05:22	05:06	05:20	05:51	06:24	06:57		06:36	07:02 (1)	07:07
	16:37		17:17		18:51	19:26	20:00	20:23	20:20	19:45	18:53	18:02		16:21 14	07:16 (1)	16:12
17	07:11		06:39		06:54	06:01	05:21	05:06	05:21	05:52	06:25	06:59		06:37	07:04 (1)	07:08
	16:38		17:18		18:52	19:27	20:00	20:23	20:19	19:44	18:52	18:00		16:21 10	07:14 (1)	16:12
18	07:10		06:38		06:52	05:59	05:20	05:06	05:22	05:53	06:26	07:00		06:38		07:08
	16:39		17:19		18:53	19:28	20:01	20:24	20:19	19:42	18:50	17:58		16:20		16:12
19	07:09		06:36		06:50	05:58	05:19	05:06	05:23	05:54	06:27	07:01		06:39		07:09
	16:40		17:20		18:54	19:30	20:02	20:24	20:18	19:41	18:48	17:57		16:19		16:13
20	07:09		06:35		06:49	05:56	05:18	05:06	05:24	05:55	06:28	07:02		06:41		07:10
	16:41		17:22		18:55	19:31	20:03	20:24	20:17	19:39	18:46	17:55		16:18		16:13
21	07:08		06:33		06:47	05:55	05:17	05:06	05:25	05:56	06:29	07:03		06:42		07:10
	16:43		17:23		18:57	19:32	20:04	20:25	20:17	19:37	18:44	17:54		16:17		16:14
22	07:08		06:32		06:45	05:53	05:16	05:07	05:25	05:57	06:30	07:04		06:43		07:11
	16:44		17:24		18:58	19:33	20:05	20:25	20:16	19:36	18:43	17:52		16:17		16:14
23	07:07		06:30		06:43	05:52	05:16	05:07	05:26	05:59	06:32	07:06		06:44		07:11
	16:45		17:25		18:59	19:34	20:06	20:25	20:15	19:34	18:41	17:51		16:16		16:15
24	07:06		06:29		06:42	05:50	05:15	05:07	05:27	06:00	06:33	07:07		06:45		07:12
	16:47		17:27		19:00	19:35	20:06	20:25	20:14	19:33	18:39	17:49		16:15		16:15
25	07:05	07:31 (1)	06:27		06:40	05:49	05:14	05:07	05:28	06:01	06:34	07:08		06:47		07:12
	16:48 10	07:41 (1)	17:28		19:01	19:36	20:07	20:25	20:13	19:31	18:37	17:48		16:15		16:16
26	07:04	07:29 (1)	06:26		06:38	05:47	05:13	05:08	05:29	06:02	06:35	07:09		06:48		07:12
	16:49 14	07:43 (1)	17:29		19:02	19:38	20:08	20:25	20:12	19:29	18:36	17:46		16:14		16:16
27	07:04	07:28 (1)	06:24		06:36	05:46	05:13	05:08	05:30	06:03	06:36	07:11	08:03 (1)	06:49		07:13
	16:50 17	07:45 (1)	17:30		19:04	19:39	20:09	20:26	20:11	19:28	18:34	17:45 10	08:13 (1)	16:14		16:17
28	07:03	07:27 (1)	06:22		06:35	05:44	05:12	05:09	05:31	06:04	06:37	07:12	08:00 (1)	06:50		07:13
	16:52 20	07:47 (1)	17:32		19:05	19:40	20:10	20:26	20:10	19:26	18:32	17:43 15	08:15 (1)	16:13		16:18
29	07:02	07:26 (1)			06:33	05:43	05:11	05:09	05:32	06:05	06:38	07:13	07:59 (1)	06:51		07:13
	16:53 22	07:48 (1)			19:06	19:41	20:11	20:26	20:09	19:25	18:30	17:42 18	08:17 (1)	16:13		16:18
30	07:01	07:25 (1)			06:31	05:41	05:11	05:09	05:33	06:06	06:39	07:14	07:57 (1)	06:52		07:14
	16:54 24	07:49 (1)			19:07	19:42	20:12	20:26	20:08	19:23	18:29	17:41 21	08:18 (1)	16:13		16:19
31	07:00	07:25 (1)			06:30		05:10		05:34	06:07		07:16	07:56 (1)			07:14
	16:56 25	07:50 (1)			19:08		20:13		20:07	19:21		17:39 23	08:19 (1)			16:20
Potential sun hours	293		295		370	401	452	457	464	431	375	343		294		283
Total, worst case	132		348									87		399		
Sun reduction	0.56		0.53									0.57		0.47		
Oper. time red.	0.88		0.88									0.88		0.88		
Wind dir. red.	0.71		0.71									0.71		0.71		
Total reduction	0.35		0.33									0.36		0.29		
Total, real	47		115									31		117		

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:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 3:04 PM / 4

Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 3:03 PM/2.7.486

SHADOW - Calendar

Calculation: Winter Island - 1.5 MW **Shadow receptor:** B - Winter Island Road

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
578	399	445	316	391	390	444	625	573	724	1,158	1,707	7,752

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:14	06:59	06:21	06:28	05:40	05:10	05:10	05:35	06:08	06:40	06:17	06:53
	16:21	16:57	17:33	19:09	19:43	20:14	20:25	20:06	19:19	18:27	16:38	16:12
2	07:14	06:58	06:19	06:26	05:39	05:09	05:10	05:36	06:09	06:41	06:18	06:54
	16:22	16:58	17:34	19:10	19:44	20:14	20:25	20:05	19:18	18:25	16:37	16:12
3	07:14	06:57	06:18	06:24	05:37	05:09	05:11	05:37	06:10	06:42	06:19	06:55
	16:23	16:59	17:35	19:11	19:45	20:15	20:25	20:04	19:16	18:23	16:35	16:12
4	07:14	06:56	06:16	06:23	05:36	05:08	05:12	05:38	06:11	06:44	06:20	06:56
	16:24	17:01	17:37	19:13	19:47	20:16	20:25	20:02	19:14	18:22	16:34	16:11
5	07:14	06:55	06:14	06:21	05:35	05:08	05:12	05:39	06:12	06:45	06:22	06:57
	16:25	17:02	17:38	19:14	19:48	20:17	20:25	20:01	19:13	18:20	16:33	16:11
6	07:14	06:53	06:13	06:19	05:33	05:07	05:13	05:40	06:13	06:46	06:23	06:58
	16:26	17:03	17:39	19:15	19:49	20:17	20:25	20:00	19:11	18:18	16:32	16:11
7	07:14	06:52	06:11	06:17	05:32	05:07	05:13	05:41	06:14	06:47	06:24	06:59
	16:27	17:05	17:40	19:16	19:50	20:18	20:24	19:58	19:09	18:16	16:31	16:11
8	07:14	06:51	07:09	06:16	05:31	05:07	05:14	05:43	06:16	06:48	06:26	07:00
	16:28	17:06	18:41	19:17	19:51	20:19	20:24	19:56	19:07	18:15	16:29	16:11
9	07:14	06:50	07:08	06:14	05:30	05:07	05:15	05:44	06:17	06:49	06:27	07:01
	16:29	17:07	18:43	19:18	19:52	20:19	20:24	19:55	19:06	18:13	16:28	16:11
10	07:13	06:48	07:06	06:12	05:28	05:06	05:15	05:45	06:18	06:50	06:28	07:02
	16:30	17:09	18:44	19:19	19:53	20:20	20:23	19:54	19:04	18:11	16:27	16:11
11	07:13	06:47	07:04	06:11	05:27	05:06	05:16	05:46	06:19	06:52	06:29	07:03
	16:31	17:10	18:45	19:21	19:54	20:20	20:23	19:52	19:02	18:10	16:26	16:11
12	07:13	06:46	07:03	06:09	05:26	05:06	05:17	05:47	06:20	06:53	06:31	07:04
	16:32	17:11	18:46	19:22	19:55	20:21	20:22	19:51	19:00	18:08	16:25	16:11
13	07:12	06:45	07:01	06:07	05:25	05:06	05:18	05:48	06:21	06:54	06:32	07:05
	16:33	17:13	18:47	19:23	19:56	20:22	20:22	19:49	18:59	18:06	16:24	16:11
14	07:12	06:43	06:59	06:06	05:24	05:06	05:18	05:49	06:22	06:55	06:33	07:06
	16:34	17:14	18:48	19:24	19:57	20:22	20:21	19:48	18:57	18:05	16:23	16:11
15	07:12	06:42	06:57	06:04	05:23	05:06	05:19	05:50	06:23	06:56	06:34	07:06
	16:35	17:15	18:50	19:25	19:58	20:22	20:21	19:46	18:55	18:03	16:22	16:11
16	07:11	06:40	06:56	06:03	05:22	05:06	05:20	05:51	06:24	06:57	06:36	07:07
	16:37	17:16	18:51	19:26	19:59	20:23	20:20	19:45	18:53	18:01	16:21	16:12
17	07:11	06:39	06:54	06:01	05:21	05:06	05:21	05:52	06:25	06:58	06:37	07:08
	16:38	17:18	18:52	19:27	20:01	20:23	20:19	19:44	18:52	18:00	16:21	16:12
18	07:10	06:38	06:52	05:59	05:20	05:06	05:22	05:53	06:26	07:00	06:38	07:08
	16:39	17:19	18:53	19:28	20:01	20:24	20:19	19:42	18:50	17:58	16:20	16:12
19	07:09	06:36	06:50	05:58	05:19	05:06	05:23	05:54	06:27	07:01	06:39	07:09
	16:40	17:20	18:54	19:30	20:02	20:24	20:18	19:41	18:48	17:57	16:19	16:13
20	07:09	06:35	06:49	05:56	05:18	05:06	05:24	05:55	06:28	07:02	06:40	07:10
	16:41	17:22	18:55	19:31	20:03	20:24	20:17	19:39	18:46	17:55	16:18	16:13
21	07:08	06:33	06:47	05:55	05:17	05:06	05:25	05:56	06:29	07:03	06:42	07:10
	16:43	17:23	18:57	19:32	20:04	20:25	20:16	19:37	18:44	17:54	16:17	16:14
22	07:08	06:32	06:45	05:53	05:16	05:07	05:25	05:57	06:30	07:04	06:43	07:11
	16:44	17:24	18:58	19:33	20:05	20:25	20:16	19:36	18:43	17:52	16:17	16:14
23	07:07	06:30	06:43	05:52	05:15	05:07	05:26	05:58	06:32	07:06	06:44	07:11
	16:45	17:25	18:59	19:34	20:05	20:25	20:15	19:34	18:41	17:51	16:16	16:15
24	07:06	06:29	06:42	05:50	05:15	05:07	05:27	06:00	06:33	07:07	06:45	07:12
	16:46	17:27	19:00	19:35	20:06	20:25	20:14	19:33	18:39	17:49	16:15	16:15
25	07:05	06:27	06:40	05:49	05:14	05:07	05:28	06:01	06:34	07:08	06:46	07:12
	16:48	17:28	19:01	19:36	20:07	20:25	20:13	19:31	18:37	17:48	16:15	16:16
26	07:04	06:26	06:38	05:47	05:13	05:08	05:29	06:02	06:35	07:09	06:48	07:12
	16:49	17:29	19:02	19:38	20:08	20:25	20:12	19:29	18:36	17:46	16:14	16:16
27	07:04	06:24	06:36	05:46	05:12	05:08	05:30	06:03	06:36	07:11	06:49	07:13
	16:50	17:30	19:03	19:39	20:09	20:26	20:11	19:28	18:34	17:45	16:14	16:17
28	07:03	06:22	06:35	05:44	05:12	05:09	05:31	06:04	06:37	07:12	06:50	07:13
	16:52	17:32	19:05	19:40	20:10	20:26	20:10	19:26	18:32	17:43	16:13	16:18
29	07:02		06:33	05:43	05:11	05:09	05:32	06:05	06:38	07:13	06:51	07:13
	16:53		19:06	19:41	20:11	20:26	20:09	19:25	18:30	17:42	16:13	16:18
30	07:01		06:31	05:41	05:11	05:09	05:33	06:06	06:39	07:14	06:52	07:13
	16:54		19:07	19:42	20:12	20:26	20:08	19:23	18:29	17:41	16:12	16:19
31	07:00		06:29		05:10		05:34	06:07		07:15		07:14
	16:56		19:08		20:13		20:07	19:21		17:39		16:20
Potential sun hours	293	295	370	401	452	457	464	431	375	343	294	283
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:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 3:04 PM / 5

Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 3:03 PM/2.7.486

SHADOW - Calendar

Calculation: Winter Island - 1.5 MW **Shadow receptor:** C - Memorial Drive @ Vicotry Road

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
578	399	445	316	391	390	444	625	573	724	1,158	1,707	7,752

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

	January	February	March		April	May	June	July	August	September		October		November	December
1	07:14	06:59	06:21		06:28	05:40	05:10	05:10	05:35	06:08		06:40	07:03 (1)	06:17	06:53
	16:21	16:57	17:33		19:09	19:43	20:14	20:25	20:06	19:20		18:27	20 07:23 (1)	16:38	16:12
2	07:14	06:58	06:19		06:26	05:39	05:09	05:10	05:36	06:09		06:41	07:04 (1)	06:18	06:54
	16:22	16:58	17:34		19:10	19:44	20:14	20:25	20:05	19:18		18:25	17 07:21 (1)	16:37	16:12
3	07:14	06:57	06:18		06:24	05:37	05:09	05:11	05:37	06:10		06:43	07:05 (1)	06:19	06:55
	16:23	17:00	17:35		19:11	19:45	20:15	20:25	20:04	19:16		18:23	14 07:19 (1)	16:35	16:12
4	07:14	06:56	06:16		06:23	05:36	05:08	05:12	05:38	06:11		06:44	07:08 (1)	06:21	06:56
	16:24	17:01	17:37		19:13	19:47	20:16	20:25	20:03	19:14		18:22	7 07:15 (1)	16:34	16:11
5	07:14	06:55	06:14		06:21	05:35	05:08	05:12	05:39	06:12		06:45		06:22	06:58
	16:25	17:02	17:38		19:14	19:48	20:17	20:25	20:01	19:13		18:20		16:33	16:11
6	07:14	06:53	06:13		06:19	05:33	05:08	05:13	05:40	06:13		06:46		06:23	06:58
	16:26	17:03	17:39		19:15	19:49	20:17	20:25	20:00	19:11		18:18		16:32	16:11
7	07:14	06:52	06:11		06:18	05:32	05:07	05:13	05:42	06:15		06:47		06:24	06:59
	16:27	17:05	17:40		19:16	19:50	20:18	20:24	19:58	19:09		18:16		16:31	16:11
8	07:14	06:51	07:09		06:16	05:31	05:07	05:14	05:43	06:16		06:48		06:26	07:00
	16:28	17:06	18:41		19:17	19:51	20:19	20:24	19:56	19:07		18:15		16:30	16:11
9	07:14	06:50	07:08		06:14	05:30	05:07	05:15	05:44	06:17		06:49		06:27	07:01
	16:29	17:07	18:43		19:18	19:52	20:19	20:24	19:55	19:06		18:13		16:28	16:11
10	07:13	06:49	07:06		07:29 (1)	06:12	05:28	05:06	05:15	05:45	06:18		06:50		06:28	07:02
	16:30	17:09	18:44	11	07:40 (1)	19:19	19:53	20:20	20:23	19:54	19:04		18:11		16:27	16:11
11	07:13	06:47	07:04		07:26 (1)	06:11	05:27	05:06	05:16	05:46	06:19		06:52		06:29	07:03
	16:31	17:10	18:45	16	07:42 (1)	19:21	19:54	20:20	20:23	19:52	19:02		18:10		16:26	16:11
12	07:13	06:46	07:03		07:24 (1)	06:09	05:26	05:06	05:17	05:47	06:20		06:53		06:31	07:04
	16:32	17:11	18:46	19	07:43 (1)	19:22	19:55	20:21	20:22	19:51	19:00		18:08		16:25	16:11
13	07:12	06:45	07:01		07:23 (1)	06:07	05:25	05:06	05:18	05:48	06:21		06:54		06:32	07:05
	16:33	17:13	18:47	20	07:43 (1)	19:23	19:56	20:22	20:22	19:49	18:59		18:06		16:24	16:11
14	07:12	06:43	06:59		07:22 (1)	06:06	05:24	05:06	05:19	05:49	06:22		06:55		06:33	07:06
	16:34	17:14	18:49	22	07:44 (1)	19:24	19:57	20:22	20:21	19:48	18:57		18:05		16:23	16:11
15	07:12	06:42	06:57		07:21 (1)	06:04	05:23	05:06	05:19	05:50	06:23		06:56		06:34	07:06
	16:35	17:15	18:50	23	07:44 (1)	19:25	19:58	20:23	20:21	19:47	18:55		18:03		16:22	16:11
16	07:11	06:41	06:56		07:21 (1)	06:03	05:22	05:06	05:20	05:51	06:24		06:57		06:36	07:07
	16:37	17:17	18:51	23	07:44 (1)	19:26	20:00	20:23	20:20	19:45	18:53		18:02		16:21	16:12
17	07:11	06:39	06:54		07:20 (1)	06:01	05:21	05:06	05:21	05:52	06:25		06:59		06:37	07:08
	16:38	17:18	18:52	23	07:43 (1)	19:27	20:00	20:23	20:19	19:44	18:52		18:00		16:21	16:12
18	07:10	06:38	06:52		07:21 (1)	05:59	05:20	05:06	05:22	05:53	06:26		07:00		06:38	07:08
	16:39	17:19	18:53	23	07:44 (1)	19:29	20:01	20:24	20:19	19:42	18:50		17:58		16:20	16:12
19	07:09	06:36	06:50		07:21 (1)	05:58	05:19	05:06	05:23	05:54	06:27		07:01		06:39	07:09
	16:40	17:20	18:54	22	07:43 (1)	19:30	20:02	20:24	20:18	19:41	18:48		17:57		16:19	16:13
20	07:09	06:35	06:49		07:21 (1)	05:56	05:18	05:06	05:24	05:55	06:28	07:12 (1)	07:02		06:41	07:10
	16:42	17:22	18:56	20	07:41 (1)	19:31	20:03	20:24	20:17	19:39	18:46	9 07:21 (1)	17:55		16:18	16:13
21	07:08	06:33	06:47		07:21 (1)	05:55	05:17	05:06	05:25	05:56	06:29	07:09 (1)	07:03		06:42	07:10
	16:43	17:23	18:57	19	07:40 (1)	19:32	20:04	20:25	20:17	19:37	18:44	14 07:23 (1)	17:54		16:17	16:14
22	07:08	06:32	06:45		07:23 (1)	05:53	05:16	05:07	05:25	05:57	06:30	07:07 (1)	07:04		06:43	07:11
	16:44	17:24	18:58	16	07:39 (1)	19:33	20:05	20:25	20:16	19:36	18:43	18 07:25 (1)	17:52		16:17	16:14
23	07:07	06:30	06:43		07:25 (1)	05:52	05:16	05:07	05:26	05:59	06:32	07:05 (1)	07:06		06:44	07:11
	16:45	17:25	18:59	11	07:36 (1)	19:34	20:06	20:25	20:15	19:34	18:41	20 07:25 (1)	17:51		16:16	16:15
24	07:06	06:29	06:42			05:50	05:15	05:07	05:27	06:00	06:33	07:04 (1)	07:07		06:45	07:12
	16:47	17:27	19:00			19:35	20:06	20:25	20:14	19:33	18:39	22 07:26 (1)	17:49		16:15	16:15
25	07:05	06:27	06:40			05:49	05:14	05:07	05:28	06:01	06:34	07:03 (1)	07:08		06:47	07:12
	16:48	17:28	19:01			19:36	20:07	20:25	20:13	19:31	18:37	23 07:26 (1)	17:48		16:15	16:16
26	07:04	06:26	06:38			05:47	05:13	05:08	05:29	06:02	06:35	07:03 (1)	07:09		06:48	07:12
	16:49	17:29	19:02			19:38	20:08	20:25	20:12	19:29	18:36	23 07:26 (1)	17:46		16:14	16:16
27	07:04	06:24	06:36			05:46	05:13	05:08	05:30	06:03	06:36	07:02 (1)	07:11		06:49	07:13
	16:50	17:30	19:04			19:39	20:09	20:26	20:11	19:28	18:34	23 07:25 (1)	17:45		16:14	16:17
28	07:03	06:22	06:35			05:44	05:12	05:09	05:31	06:04	06:37	07:02 (1)	07:12		06:50	07:13
	16:52	17:32	19:05			19:40	20:10	20:26	20:10	19:26	18:32	23 07:25 (1)	17:43		16:13	16:18
29	07:02		06:33			05:43	05:11	05:09	05:32	06:05	06:38	07:02 (1)	07:13		06:51	07:13
	16:53		19:06			19:41	20:11	20:26	20:09	19:25	18:30	22 07:24 (1)	17:42		16:13	16:18
30	07:01		06:31			05:41	05:11	05:09	05:33	06:06	06:39	07:03 (1)	07:14		06:52	07:14
	16:54		19:07			19:42	20:12	20:26	20:08	19:23	18:29	21 07:24 (1)	17:41		16:13	16:19
31	07:00		06:30				05:10		05:34	06:07			07:16			07:14
	16:56		19:08				20:13		20:07	19:21			17:39			16:20
Potential sun hours	293	295	370		401	452	457	464	431	375		343		294	283
Total, worst case				268							218		58		
Sun reduction				0.49							0.53		0.57		
Oper. time red.				0.88							0.88		0.88		
Wind dir. red.				0.68							0.68		0.68		
Total reduction				0.30							0.32		0.35		
Total, real				80							70		20		

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:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 3:04 PM / 6

Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 3:03 PM/2.7.486

SHADOW - Calendar

Calculation: Winter Island - 1.5 MW **Shadow receptor:** D - Bayview Ave @ Cheval Ave

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
578	399	445	316	391	390	444	625	573	724	1,158	1,707	7,752

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:14	06:59	06:21	06:28	05:40	05:10	05:10	05:35	06:08	06:40	06:17	06:53
	16:21	16:57	17:33	19:09	19:43	20:13	20:25	20:06	19:19	18:27	16:38	16:12
2	07:14	06:58	06:19	06:26	05:39	05:09	05:10	05:36	06:09	06:41	06:18	06:54
	16:22	16:58	17:34	19:10	19:44	20:14	20:25	20:05	19:18	18:25	16:37	16:12
3	07:14	06:57	06:18	06:24	05:37	05:09	05:11	05:37	06:10	06:42	06:19	06:55
	16:23	16:59	17:35	19:11	19:45	20:15	20:25	20:04	19:16	18:23	16:35	16:12
4	07:14	06:56	06:16	06:23	05:36	05:08	05:11	05:38	06:11	06:44	06:20	06:56
	16:24	17:01	17:37	19:13	19:47	20:16	20:25	20:02	19:14	18:22	16:34	16:11
5	07:14	06:54	06:14	06:21	05:35	05:08	05:12	05:39	06:12	06:45	06:22	06:57
	16:25	17:02	17:38	19:14	19:48	20:17	20:25	20:01	19:13	18:20	16:33	16:11
6	07:14	06:53	06:13	06:19	05:33	05:07	05:13	05:40	06:13	06:46	06:23	06:58
	16:26	17:03	17:39	19:15	19:49	20:17	20:25	20:00	19:11	18:18	16:32	16:11
7	07:14	06:52	06:11	06:17	05:32	05:07	05:13	05:41	06:14	06:47	06:24	06:59
	16:27	17:05	17:40	19:16	19:50	20:18	20:24	19:57	19:09	18:16	16:31	16:11
8	07:14	06:51	07:09	06:16	05:31	05:07	05:14	05:42	06:16	06:48	06:26	07:00
	16:28	17:06	18:41	19:17	19:51	20:19	20:24	19:56	19:07	18:15	16:29	16:11
9	07:14	06:50	07:08	06:14	05:30	05:07	05:15	05:44	06:17	06:49	06:27	07:01
	16:29	17:07	18:43	19:18	19:52	20:19	20:24	19:55	19:06	18:13	16:28	16:11
10	07:13	06:48	07:06	06:12	05:28	05:06	05:15	05:45	06:18	06:50	06:28	07:02
	16:30	17:09	18:44	19:19	19:53	20:20	20:23	19:54	19:04	18:11	16:27	16:11
11	07:13	06:47	07:04	06:11	05:27	05:06	05:16	05:46	06:19	06:51	06:29	07:03
	16:31	17:10	18:45	19:21	19:54	20:20	20:23	19:52	19:02	18:10	16:26	16:11
12	07:13	06:46	07:03	06:09	05:26	05:06	05:17	05:47	06:20	06:53	06:31	07:04
	16:32	17:11	18:46	19:22	19:55	20:21	20:22	19:51	19:00	18:08	16:25	16:11
13	07:12	06:45	07:01	06:07	05:25	05:06	05:18	05:48	06:21	06:54	06:32	07:05
	16:33	17:13	18:47	19:23	19:56	20:22	20:22	19:49	18:59	18:06	16:24	16:11
14	07:12	06:43	06:59	06:06	05:24	05:06	05:18	05:49	06:22	06:55	06:33	07:06
	16:34	17:14	18:48	19:24	19:57	20:22	20:21	19:48	18:57	18:05	16:23	16:11
15	07:12	06:42	06:57	06:04	05:23	05:06	05:19	05:50	06:23	06:56	06:34	07:06
	16:35	17:15	18:50	19:25	19:58	20:22	20:21	19:46	18:55	18:03	16:22	16:11
16	07:11	06:40	06:56	06:03	05:22	05:06	05:20	05:51	06:24	06:57	06:36	07:07
	16:37	17:16	18:51	19:26	19:59	20:23	20:20	19:45	18:53	18:01	16:21	16:12
17	07:11	06:39	06:54	06:01	05:21	05:06	05:21	05:52	06:25	06:58	06:37	07:08
	16:38	17:18	18:52	19:27	20:01	20:23	20:19	19:44	18:52	18:00	16:20	16:12
18	07:10	06:38	06:52	05:59	05:20	05:06	05:22	05:53	06:26	07:00	06:38	07:08
	16:39	17:19	18:53	19:28	20:01	20:24	20:19	19:42	18:50	17:58	16:20	16:12
19	07:09	06:36	06:50	05:58	05:19	05:06	05:23	05:54	06:27	07:01	06:39	07:09
	16:40	17:20	18:54	19:30	20:02	20:24	20:18	19:41	18:48	17:57	16:19	16:13
20	07:09	06:35	06:49	05:56	05:18	05:06	05:24	05:55	06:28	07:02	06:40	07:10
	16:41	17:22	18:55	19:31	20:03	20:24	20:17	19:39	18:46	17:55	16:18	16:13
21	07:08	06:33	06:47	05:55	05:17	05:06	05:24	05:56	06:29	07:03	06:42	07:10
	16:43	17:23	18:57	19:32	20:04	20:25	20:16	19:37	18:44	17:54	16:17	16:14
22	07:08	06:32	06:45	05:53	05:16	05:07	05:25	05:57	06:30	07:04	06:43	07:11
	16:44	17:24	18:58	19:33	20:05	20:25	20:16	19:36	18:43	17:52	16:17	16:14
23	07:07	06:30	06:43	05:52	05:15	05:07	05:26	05:58	06:32	07:06	06:44	07:11
	16:45	17:25	18:59	19:34	20:05	20:25	20:15	19:34	18:41	17:51	16:16	16:15
24	07:06	06:29	06:42	05:50	05:15	05:07	05:27	06:00	06:33	07:07	06:45	07:12
	16:46	17:27	19:00	19:35	20:06	20:25	20:14	19:33	18:39	17:49	16:15	16:15
25	07:05	06:27	06:40	05:49	05:14	05:07	05:28	06:01	06:34	07:08	06:46	07:12
	16:48	17:28	19:01	19:36	20:07	20:25	20:13	19:31	18:37	17:48	16:15	16:16
26	07:04	06:26	06:38	05:47	05:13	05:08	05:29	06:02	06:35	07:09	06:48	07:12
	16:49	17:29	19:02	19:38	20:08	20:25	20:12	19:29	18:36	17:46	16:14	16:16
27	07:04	06:24	06:36	05:46	05:12	05:08	05:30	06:03	06:36	07:11	06:49	07:13
	16:50	17:30	19:03	19:39	20:09	20:26	20:11	19:28	18:34	17:45	16:14	16:17
28	07:03	06:22	06:35	05:44	05:12	05:09	05:31	06:04	06:37	07:12	06:50	07:13
	16:52	17:32	19:05	19:40	20:10	20:26	20:10	19:26	18:32	17:43	16:13	16:18
29	07:02		06:33	05:43	05:11	05:09	05:32	06:05	06:38	07:13	06:51	07:13
	16:53		19:06	19:41	20:11	20:26	20:09	19:25	18:30	17:42	16:13	16:18
30	07:01		06:31	05:41	05:11	05:09	05:33	06:06	06:39	07:14	06:52	07:13
	16:54		19:07	19:42	20:12	20:26	20:08	19:23	18:28	17:41	16:12	16:19
31	07:00		06:29		05:10		05:34	06:07		07:15		07:14
	16:56		19:08		20:13		20:07	19:21		17:39		16:20
Potential sun hours	293	295	370	401	452	457	464	431	375	343	294	283
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:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 3:04 PM / 7

Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 3:03 PM/2.7.486

SHADOW - Calendar

Calculation: Winter Island - 1.5 MW **Shadow receptor:** E - Naugus Ave, Marblehead

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
578	399	445	316	391	390	444	625	573	724	1,158	1,707	7,752

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:14	06:59	06:21	06:28	05:40	05:10	05:10	05:35	06:08	06:40	06:17	06:53
	16:21	16:57	17:33	19:09	19:43	20:13	20:25	20:06	19:19	18:27	16:38	16:12
2	07:14	06:58	06:19	06:26	05:39	05:09	05:10	05:36	06:09	06:41	06:18	06:54
	16:22	16:58	17:34	19:10	19:44	20:14	20:25	20:05	19:18	18:25	16:37	16:12
3	07:14	06:57	06:18	06:24	05:37	05:09	05:11	05:37	06:10	06:42	06:19	06:55
	16:23	16:59	17:35	19:11	19:45	20:15	20:25	20:04	19:16	18:23	16:35	16:12
4	07:14	06:56	06:16	06:23	05:36	05:08	05:12	05:38	06:11	06:44	06:20	06:56
	16:24	17:01	17:37	19:13	19:46	20:16	20:25	20:02	19:14	18:22	16:34	16:11
5	07:14	06:54	06:14	06:21	05:35	05:08	05:12	05:39	06:12	06:45	06:22	06:57
	16:25	17:02	17:38	19:14	19:48	20:17	20:25	20:01	19:13	18:20	16:33	16:11
6	07:14	06:53	06:13	06:19	05:33	05:07	05:13	05:40	06:13	06:46	06:23	06:58
	16:26	17:03	17:39	19:15	19:49	20:17	20:24	20:00	19:11	18:18	16:32	16:11
7	07:14	06:52	06:11	06:17	05:32	05:07	05:13	05:41	06:14	06:47	06:24	06:59
	16:27	17:05	17:40	19:16	19:50	20:18	20:24	19:57	19:09	18:16	16:31	16:11
8	07:14	06:51	07:09	06:16	05:31	05:07	05:14	05:43	06:16	06:48	06:25	07:00
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13	07:12	06:45	07:01	06:07	05:25	05:06	05:18	05:48	06:21	06:54	06:32	07:05
	16:33	17:13	18:47	19:23	19:56	20:21	20:22	19:49	18:59	18:06	16:24	16:11
14	07:12	06:43	06:59	06:06	05:24	05:06	05:18	05:49	06:22	06:55	06:33	07:05
	16:34	17:14	18:48	19:24	19:57	20:22	20:21	19:48	18:57	18:05	16:23	16:11
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16	07:11	06:40	06:56	06:03	05:22	05:06	05:20	05:51	06:24	06:57	06:36	07:07
	16:37	17:16	18:51	19:26	19:59	20:23	20:20	19:45	18:53	18:01	16:21	16:12
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18	07:10	06:38	06:52	05:59	05:20	05:06	05:22	05:53	06:26	07:00	06:38	07:08
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	16:44	17:24	18:58	19:33	20:04	20:25	20:16	19:36	18:43	17:52	16:17	16:14
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24	07:06	06:29	06:42	05:50	05:15	05:07	05:27	06:00	06:33	07:07	06:45	07:12
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27	07:04	06:24	06:36	05:46	05:13	05:08	05:30	06:03	06:36	07:10	06:49	07:13
	16:50	17:30	19:03	19:39	20:09	20:25	20:11	19:28	18:34	17:45	16:14	16:17
28	07:03	06:22	06:35	05:44	05:12	05:09	05:31	06:04	06:37	07:12	06:50	07:13
	16:52	17:32	19:05	19:40	20:10	20:25	20:10	19:26	18:32	17:43	16:13	16:18
29	07:02		06:33	05:43	05:11	05:09	05:32	06:05	06:38	07:13	06:51	07:13
	16:53		19:06	19:41	20:11	20:25	20:09	19:24	18:30	17:42	16:13	16:18
30	07:01		06:31	05:41	05:11	05:09	05:33	06:06	06:39	07:14	06:52	07:13
	16:54		19:07	19:42	20:12	20:25	20:08	19:23	18:28	17:41	16:12	16:19
31	07:00		06:29		05:10		05:34	06:07		07:15		07:14
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Potential sun hours	293	295	370	401	452	457	464	431	375	343	294	283
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:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 3:04 PM / 8

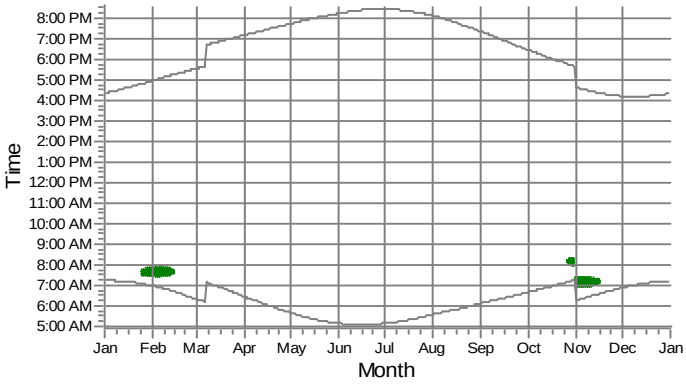
Licensed user:
Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 3:03 PM/2.7.486

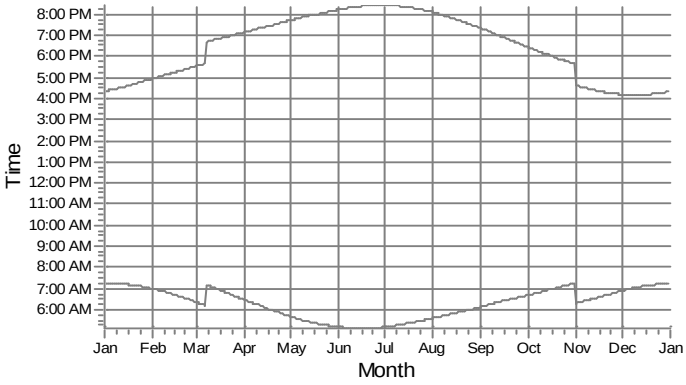
SHADOW - Calendar, graphical

Calculation: Winter Island - 1.5 MW

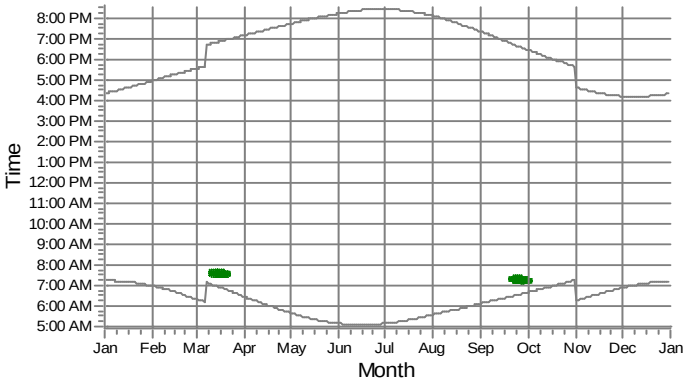
A: End of Larkin Lane



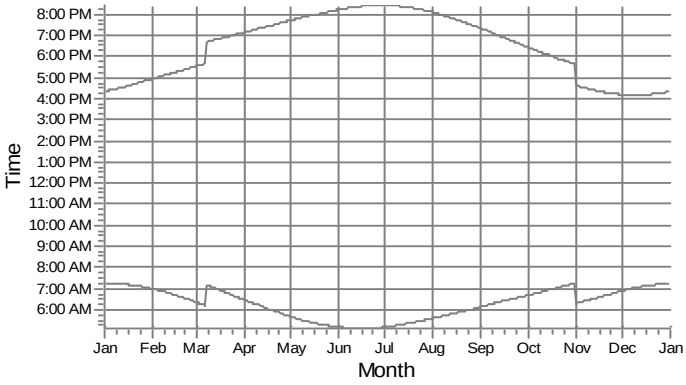
B: Winter Island Road



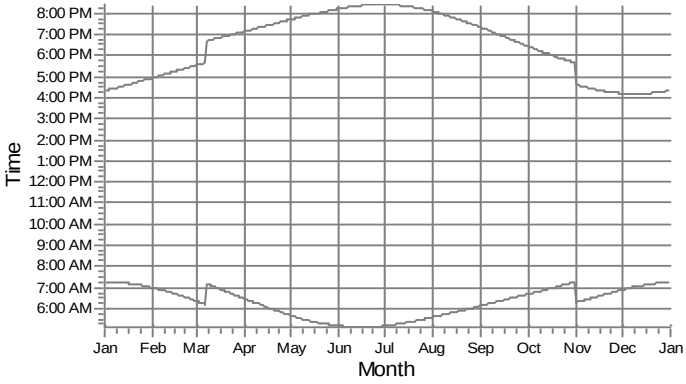
C: Memorial Drive @ Vicotry Road



D: Bayview Ave @ Cheval Ave



E: Naugus Ave, Marblehead



WTGs

1: GE 1.5 sle

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

Printed/Page
6/1/2011 3:04 PM / 9

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Meridian Associates, Inc.
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 3:03 PM/2.7.486

SHADOW - Calendar per WTG

Calculation: Winter Island - 1.5 MW**WTG:** 1 - GE 1.5 sle

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) [PORTLAND]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.33	5.56	5.86	7.36	7.36	8.60	8.76	9.21	6.67	6.36	4.57	4.07

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
578	399	445	316	391	390	444	625	573	724	1,158	1,707	7,752

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:14 16:21	06:59 07:25-07:50/25 16:57	06:21 17:33	06:28 19:09	05:40 19:43	05:10 20:13	05:10 20:25	05:35 20:06	06:08 19:19	06:40 07:03-07:23/20 18:27	06:17 06:56-07:20/24 16:38	06:53 16:12
2	07:14 16:22	06:58 07:25-07:51/26 16:58	06:19 17:34	06:26 19:10	05:39 19:44	05:09 20:14	05:10 20:25	05:36 20:05	06:09 19:18	06:41 07:04-07:21/17 18:25	06:18 06:55-07:21/26 16:37	06:54 16:12
3	07:14 16:23	06:57 07:25-07:52/27 16:59	06:18 17:35	06:24 19:11	05:37 19:45	05:09 20:15	05:11 20:25	05:37 20:04	06:10 19:16	06:42 07:05-07:19/14 18:23	06:19 06:54-07:21/27 16:35	06:55 16:12
4	07:14 16:24	06:56 07:24-07:51/27 17:01	06:16 17:37	06:23 19:13	05:36 19:47	05:08 20:16	05:12 20:25	05:38 20:02	06:11 19:14	06:44 07:08-07:15/7 18:22	06:20 06:54-07:22/28 16:34	06:56 16:11
5	07:14 16:25	06:54 07:24-07:51/27 17:02	06:14 17:38	06:21 19:14	05:35 19:48	05:08 20:17	05:12 20:25	05:39 20:01	06:12 19:13	06:45 18:20	06:22 06:54-07:22/28 16:33	06:57 16:11
6	07:14 16:26	06:53 07:24-07:52/28 17:03	06:13 17:39	06:19 19:15	05:33 19:49	05:07 20:17	05:13 20:25	05:40 20:00	06:13 19:11	06:46 18:18	06:23 06:54-07:21/27 16:32	06:58 16:11
7	07:14 16:27	06:52 07:25-07:52/27 17:05	06:11 17:40	06:17 19:16	05:32 19:50	05:07 20:18	05:13 20:24	05:41 19:57	06:14 19:09	06:47 18:16	06:24 06:54-07:22/28 16:31	06:59 16:11
8	07:14 16:28	06:51 07:25-07:52/27 17:06	07:09 18:41	06:16 19:17	05:31 19:51	05:07 20:19	05:14 20:24	05:43 19:56	06:16 19:07	06:48 18:15	06:26 06:54-07:22/28 16:29	07:00 16:11
9	07:13 16:29	06:50 07:25-07:51/26 17:07	07:08 18:43	06:14 19:18	05:30 19:52	05:07 20:19	05:15 20:24	05:44 19:55	06:17 19:06	06:49 18:13	06:27 06:54-07:21/27 16:28	07:01 16:11
10	07:13 16:30	06:48 07:26-07:51/25 17:09	07:06 07:29-07:40/11 18:44	06:12 19:19	05:28 19:53	05:06 20:20	05:15 20:23	05:45 19:54	06:18 19:04	06:50 18:11	06:28 06:56-07:21/25 16:27	07:02 16:11
11	07:13 16:31	06:47 07:27-07:50/23 17:10	07:04 07:26-07:42/16 18:45	06:11 19:21	05:27 19:54	05:06 20:20	05:16 20:23	05:46 19:52	06:19 19:02	06:52 18:10	06:29 06:56-07:21/25 16:26	07:03 16:11
12	07:13 16:32	06:46 07:28-07:48/20 17:11	07:03 07:24-07:43/19 18:46	06:09 19:22	05:26 19:55	05:06 20:21	05:17 20:22	05:47 19:51	06:20 19:00	06:53 18:08	06:31 06:56-07:20/24 16:25	07:04 16:11
13	07:12 16:33	06:45 07:29-07:47/18 17:13	07:01 07:23-07:43/20 18:47	06:07 19:23	05:25 19:56	05:06 20:22	05:18 20:22	05:48 19:49	06:21 18:59	06:54 18:06	06:32 06:58-07:20/22 16:24	07:05 16:11
14	07:12 16:34	06:43 07:32-07:46/14 17:14	06:59 07:22-07:44/22 18:48	06:06 19:24	05:24 19:57	05:06 20:22	05:19 20:21	05:49 19:48	06:22 18:57	06:55 18:05	06:33 06:59-07:18/19 16:23	07:05 16:11
15	07:12 16:35	06:42 07:34-07:42/8 17:15	06:57 07:21-07:44/23 18:50	06:04 19:25	05:23 19:58	05:06 20:22	05:19 20:21	05:50 19:46	06:23 18:55	06:56 18:03	06:34 07:00-07:17/17 16:22	07:06 16:11
16	07:11 16:37	06:40 17:16	06:56 07:21-07:44/23 18:51	06:03 19:26	05:22 19:59	05:06 20:23	05:20 20:20	05:51 19:45	06:24 18:53	06:57 18:01	06:36 07:02-07:16/14 16:21	07:07 16:12
17	07:11 16:38	06:39 17:18	06:54 07:20-07:43/23 18:52	06:01 19:27	05:21 20:00	05:06 20:23	05:21 20:19	05:52 19:44	06:25 18:52	06:58 18:00	06:37 07:04-07:14/10 16:21	07:08 16:12
18	07:10 16:39	06:38 17:19	06:52 07:21-07:44/23 18:53	05:59 19:28	05:20 20:00	05:06 20:24	05:22 20:19	05:53 19:42	06:26 18:50	07:00 17:58	06:38 16:20	07:08 16:12
19	07:09 16:40	06:36 17:20	06:50 07:21-07:43/22 18:54	05:58 19:30	05:19 20:02	05:06 20:24	05:23 20:18	05:54 19:41	06:27 18:48	07:01 17:57	06:39 16:19	07:09 16:13
20	07:09 16:41	06:35 17:22	06:49 07:21-07:41/20 18:55	05:56 19:31	05:18 20:03	05:06 20:24	05:24 20:17	05:55 19:39	06:28 07:12-07:21/9 18:46	07:02 17:55	06:40 16:18	07:10 16:13
21	07:08 16:43	06:33 17:23	06:47 07:21-07:40/19 18:57	05:55 19:32	05:17 20:04	05:06 20:25	05:25 20:16	05:56 19:37	06:29 07:09-07:23/14 18:44	07:03 17:54	06:42 16:17	07:10 16:14
22	07:08 16:44	06:32 17:24	06:45 07:23-07:39/16 18:58	05:53 19:33	05:16 20:04	05:07 20:25	05:25 20:16	05:57 19:36	06:30 07:07-07:25/18 18:43	07:04 17:52	06:43 16:17	07:11 16:14
23	07:07 16:45	06:30 17:25	06:43 07:25-07:36/11 18:59	05:52 19:34	05:15 20:05	05:07 20:25	05:26 20:15	05:58 19:34	06:32 07:05-07:25/20 18:41	07:06 17:51	06:44 16:16	07:11 16:15
24	07:06 16:46	06:29 17:27	06:42 19:00	05:50 19:35	05:15 20:06	05:07 20:25	05:27 20:14	06:00 19:33	06:33 07:04-07:26/22 18:39	07:07 17:49	06:45 16:15	07:12 16:15
25	07:05 07:31-07:41/10 16:48	06:27 17:28	06:40 19:01	05:49 19:36	05:14 20:07	05:07 20:25	05:28 20:13	06:01 19:31	06:34 07:03-07:26/23 18:37	07:08 17:48	06:46 16:15	07:12 16:16
26	07:04 07:29-07:43/14 16:49	06:26 17:29	06:38 19:02	05:47 19:38	05:13 20:08	05:08 20:25	05:29 20:12	06:02 19:29	06:35 07:03-07:26/23 18:36	07:09 17:46	06:48 16:14	07:12 16:16
27	07:04 07:28-07:45/17 16:50	06:24 17:30	06:36 19:03	05:46 19:39	05:13 20:09	05:08 20:26	05:30 20:11	06:03 19:28	06:36 07:02-07:25/23 18:34	07:11 08:03-08:13/10 17:45	06:49 16:14	07:13 16:17
28	07:03 07:27-07:47/20 16:52	06:22 17:32	06:35 19:05	05:44 19:40	05:12 20:10	05:09 20:26	05:31 20:10	06:04 19:26	06:37 07:02-07:25/23 18:32	07:12 08:00-08:15/15 17:43	06:50 16:13	07:13 16:18
29	07:02 07:26-07:48/22 16:53		06:33 19:06	05:43 19:41	05:11 20:11	05:09 20:26	05:32 20:09	06:05 19:25	06:38 07:02-07:24/22 18:30	07:13 07:59-08:17/18 17:42	06:51 16:13	07:13 16:18
30	07:01 07:25-07:49/24 16:54		06:31 19:07	05:41 19:42	05:11 20:12	05:09 20:26	05:33 20:08	06:06 19:23	06:39 07:03-07:24/21 18:29	07:14 07:57-08:18/21 17:41	06:52 16:13	07:13 16:19
31	07:00 07:25-07:50/25 16:56		06:29 19:08		05:10 20:13		05:34 20:07	06:07 19:21		07:15 07:56-08:19/23 17:39		07:14 16:20
Potential sun hours	293	295	370	401	452	457	464	431	375	343	294	283
Sum of minutes with flicker	132	348	268	0	0	0	0	0	218	145	399	0

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-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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6/1/2011 3:04 PM / 10

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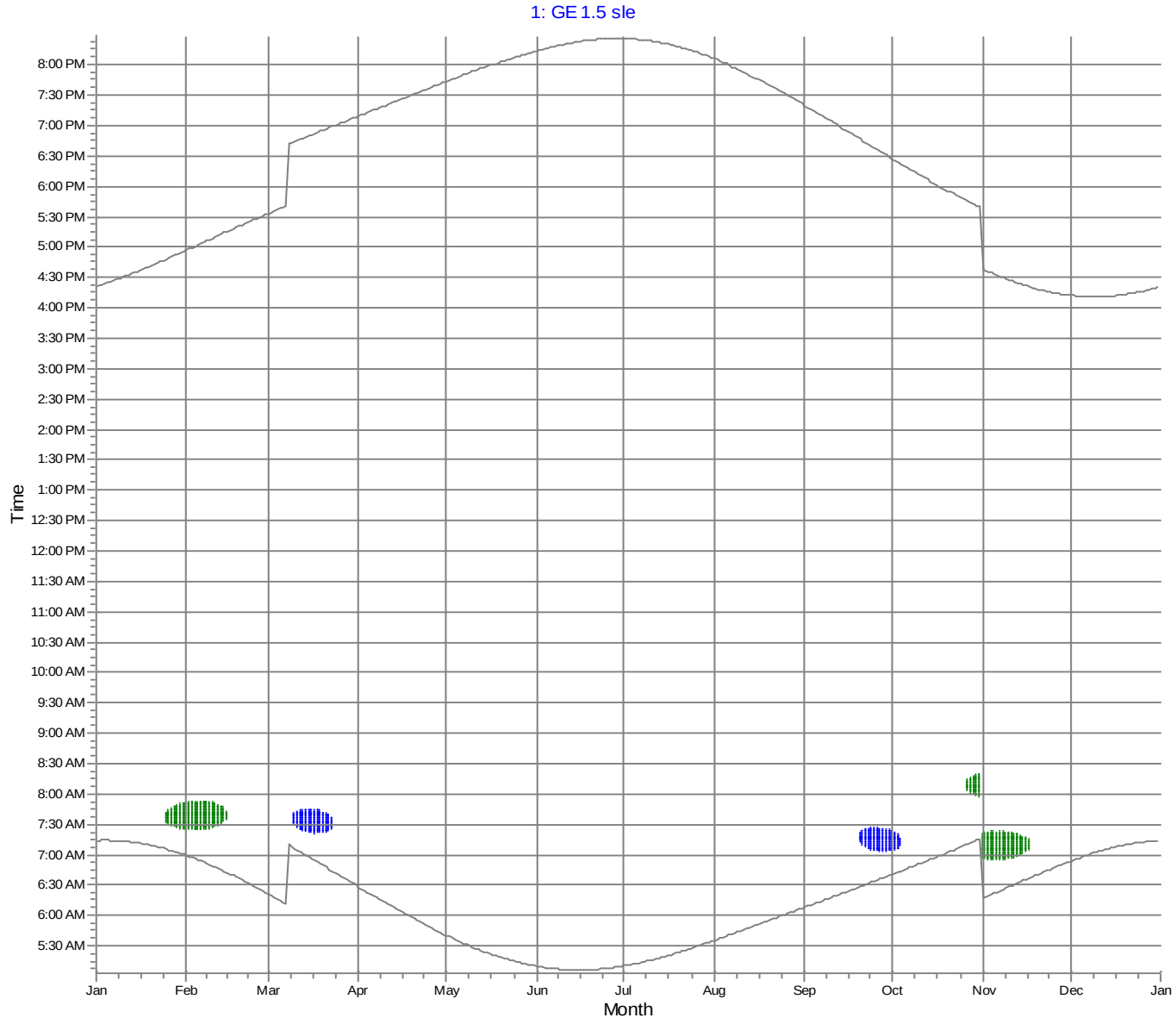
152 Conant Street
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 3:03 PM/2.7.486

SHADOW - Calendar per WTG, graphical

Calculation: Winter Island - 1.5 MW**WTG:** 1 - GE 1.5 sle



Shadow receptor

A: End of Larkin Lane

C: Memorial Drive @ Vicotry Road

Project:
WI-Salem_WindPRO

Description:
Winter Island
Salem, MA

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6/1/2011 3:04 PM / 11

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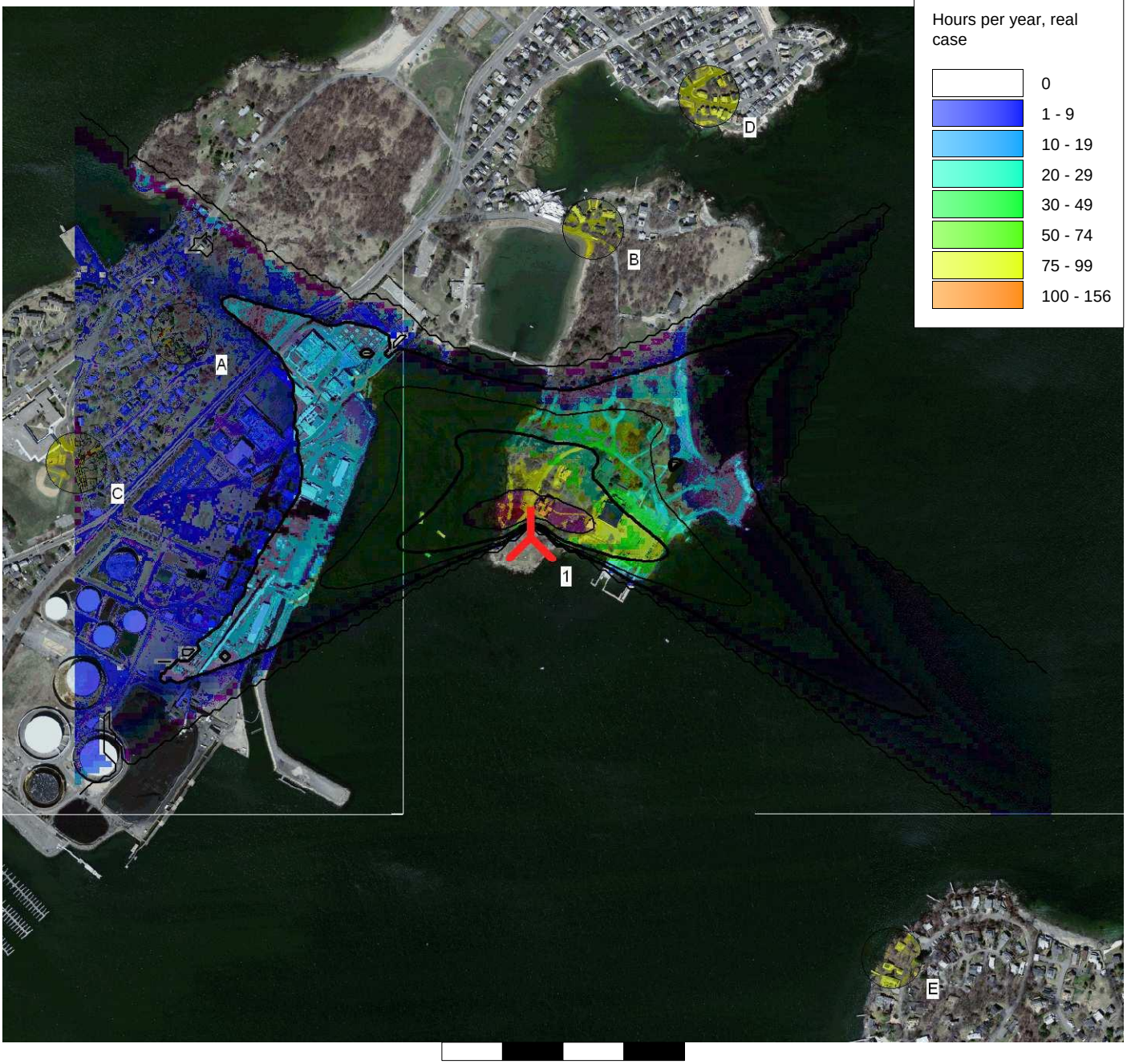
US-BEVERLY, MA 01845
(978) 299 0447 x 214
Diane Gagnon / dgagnon@meridianassoc.com

Calculated:
6/1/2011 3:03 PM/2.7.486

SHADOW - Map

Calculation: Winter Island - 1.5 MW**WTG:** 1 - GE 1.5 sle



Map: 25229200_all , Print scale 1:10,000, Map center UTM NAD 83 Zone: 19 East: 346,407 North: 4,709,949

New WTG Shadow receptor

Isolines showing shadow in Hours per year, real case

0 10 25 50 100 200

Appendix L

P50 and P90 Turbine Production

Probability of Exceedance for Wind Speed Calculation

Uncertainties

Inter-Annual Variability of Wind Speeds, U_I

10	Duration of Long Term Data Set (Years)
U_I=	1.90 %

Cup Anemometer (NRG #40), U_M

U_M= 1.48 %

Wind Shear Calculation, U_S

30	Lower Anemometer Height (m)
50	Upper Anemometer Height (m)
U_s=	2.3 %

MCP Algorithm Calculation, U_{MCP}

0.8486	R^2 Value
U_{MCP}=	1.43 %

Long Term Corrected Annual Average Wind Speeds

Height (m)	Wind Speed (m/s)
50	**5.75**
60	**6.05**
70	**6.28**
80	**6.48**
100	**6.84**

Wind Speed Probability Exceedence Calculation

Hub Height (m)	LTC Wind Speed (m/s)	Total Uncertainty (%)	Total Uncertainty (m/s)	P90 Wind Speed (m/s)	P50 Wind Speed (m/s)
50	5.75	7.105867	0.408587	5.23	5.75
60	6.05	7.105867	0.429905	5.50	6.05
70	6.28	7.105867	0.446248	5.71	6.28
80	6.48	7.105867	0.46046	5.89	6.48
100	6.84	7.105867	0.486041	6.22	6.84

600 kW

P50 Power Production Calculation

Site/Turbine Losses (%)	
Topography	0
Site Obstructions/Waking	0
Grid Availability	0.25
WTG Availability	2
Electrical Losses	2.5
Cold Temp Shut Down	0.5
Blade Contamination	0.5
Wind Farm Waking Effect	0
High Wind Hysteresis	0
Square Root Sum of Losses	**3.288237 %**

Hub Height (m)	Long Term Average (m/s)	P50 Wind Speed (m/s)	Wiebull Shape (α)	P50 Gross Annual Production	Total Uncertainty (%)	Total Uncertainty (kWh)	P50 Net Production (kWh)
50	5.75	5.75	3.2831	1057802.92	3.28823661	34783.06	1057803
60	6.05	6.05	3.2851	1226890.57	3.28823661	40343.06	1226891
70	6.28	6.28	3.2817	1363537.36	3.28823661	44836.33	1363537
80	6.48	6.48	3.2813	1485776.33	3.28823661	48855.84	1485776
100	6.84	6.84	3.2702	1712109.25	3.28823661	56298.2	1712109

600 kW

P90 Power Production Calculation

Site/Turbine Losses (%)

Topography	0
Site Obstructions/Waking	0
Grid Availability	0.25
WTG Availability	2
Electrical Losses	2.5
Cold Temp Shut Down	0.5
Blade Contamination	0.5
Wind Farm Waking Effect	0
High Wind Hysteresis	0
Square Root Sum of Losses	**3.288237 %**

Hub Height (m)	Long Term Av. Speed (m/s)	P90 Wind Speed (m/s)	Wiebull Shape (α)	P90 Gross Annual Production	Total Uncertainty (%)	Total Uncertainty (kWh)	P90 Net Production (kWh)
50	5.75	5.23	3.2831	790983.59	3.28823661	26009.41	757651
60	6.05	5.50	3.2851	923720.10	3.28823661	30374.1	884794
70	6.28	5.71	3.2817	1033168.85	3.28823661	33973.04	989631
80	6.48	5.89	3.2813	1132842.16	3.28823661	37250.53	1085104
100	6.84	6.22	3.2702	1322683.04	3.28823661	43492.95	1266945

1000 kW

P50 Power Production Calculation

Site/Turbine Losses (%)	
Topography	0
Site Obstructions/Waking	0
Grid Availability	0.25
WTG Availability	2
Electrical Losses	2.5
Cold Temp Shut Down	0.5
Blade Contamination	0.5
Wind Farm Waking Effect	0
High Wind Hysteresis	0
Square Root Sum of Losses	**3.288237 %**

Hub Height (m)	Long Term Average (m/s)	P50 Wind Speed (m/s)	Wiebull Shape (α)	P50 Gross Annual Production	Total Uncertainty (%)	Total Uncertainty (kWh)	P50 Net Production (kWh)
50	5.75	5.75	3.2831	1273793.68	3.28823661	41885.35	1273794
60	6.05	6.05	3.2851	1494158.00	3.28823661	49131.45	1494158
70	6.28	6.28	3.2817	1672388.66	3.28823661	54992.1	1672389
80	6.48	6.48	3.2813	1832149.67	3.28823661	60245.42	1832150
100	6.84	6.84	3.2702	2129987.30	3.28823661	70039.02	2129987

1000 kW

P90 Power Production Calculation

Site/Turbine Losses (%)

Topography	0
Site Obstructions/Waking	0
Grid Availability	0.25
WTG Availability	2
Electrical Losses	2.5
Cold Temp Shut Down	0.5
Blade Contamination	0.5
Wind Farm Waking Effect	0
High Wind Hysteresis	0
Square Root Sum of Losses	**3.288237 %**

Hub Height (m)	Long Term Av. Speed (m/s)	P90 Wind Speed (m/s)	Wiebull Shape (α)	P90 Gross Annual Production	Total Uncertainty (%)	Total Uncertainty (kWh)	P90 Net Production (kWh)
50	5.75	5.23	3.2831	926282.28	3.28823661	30458.35	887248
60	6.05	5.50	3.2851	1099142.16	3.28823661	36142.39	1052824
70	6.28	5.71	3.2817	1241900.83	3.28823661	40836.64	1189567
80	6.48	5.89	3.2813	1371860.89	3.28823661	45110.03	1314050
100	6.84	6.22	3.2702	1619486.53	3.28823661	53252.55	1551241

1500 kW

P50 Power Production Calculation

Site/Turbine Losses (%)	
Topography	0
Site Obstructions/Waking	0
Grid Availability	0.25
WTG Availability	2
Electrical Losses	2.5
Cold Temp Shut Down	0.5
Blade Contamination	0.5
Wind Farm Waking Effect	0
High Wind Hysteresis	0
Square Root Sum of Losses	**3.288237 %**

Hub Height (m)	Long Term Average (m/s)	P50 Wind Speed (m/s)	Wiebull Shape (α)	P50 Gross Annual Production	Total Uncertainty (%)	Total Uncertainty (kWh)	P50 Net Production (kWh)
50	5.75	5.75	3.2831	2486561.81	3.28823661	81764.04	2486562
60	6.05	6.05	3.2851	2929656.97	3.28823661	96334.05	2929657
70	6.28	6.28	3.2817	3287547.67	3.28823661	108102.3	3287548
80	6.48	6.48	3.2813	3607026.15	3.28823661	118607.6	3607026
100	6.84	6.84	3.2702	4196123.48	3.28823661	137978.5	4196123

1500 kW

P90 Power Production Calculation

Site/Turbine Losses (%)

Topography	0
Site Obstructions/Waking	0
Grid Availability	0.25
WTG Availability	2
Electrical Losses	2.5
Cold Temp Shut Down	0.5
Blade Contamination	0.5
Wind Farm Waking Effect	0
High Wind Hysteresis	0
Square Root Sum of Losses	**3.288237 %**

Hub Height (m)	Long Term Av. Speed (m/s)	P90 Wind Speed (m/s)	Wiebull Shape (α)	P90 Gross Annual Production	Total Uncertainty (%)	Total Uncertainty (kWh)	P90 Net Production (kWh)
50	5.75	5.23	3.2831	1789866.22	3.28823661	58855.04	1714440
60	6.05	5.50	3.2851	2135952.42	3.28823661	70235.17	2045942
70	6.28	5.71	3.2817	2422624.66	3.28823661	79661.63	2320534
80	6.48	5.89	3.2813	2683938.73	3.28823661	88254.26	2570836
100	6.84	6.22	3.2702	3181665.39	3.28823661	104620.7	3047589

Hub Height (m)	Wind Speed		Elecon 600 kW		Mitsubishi 1.0MW		GE Energy 1.5MW	
	P50 Wind Speed (m/s)	P90 Wind Speed (m/s)	P50 Net Production (kWh)	P90 Net Production (kWh)	P50 Net Production (kWh)	P90 Net Production (kWh)	P50 Net Production (kWh)	P90 Net Production (kWh)
50	5.75	5.23	1,057,803	757,651	1,273,794	887,248	2,486,562	1,714,440
60	6.05	5.50	1,226,891	884,794	1,494,158	1,052,824	2,929,657	2,045,942
70	6.28	5.71	1,363,537	989,631	1,672,389	1,189,567	3,287,548	2,320,534
80	6.48	5.89	1,485,776	1,085,104	1,832,150	1,314,050	3,607,026	2,570,836
100	6.84	6.22	1,712,109	1,266,945	2,129,987	1,551,241	4,196,123	3,047,589

Appendix M

Financial Pro-Forma

Financial Pro-Forma @ P50 (w/out MassCEC Grant)

Project Information:

Name	Winer Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Elecon	Total Project Cost	$2,500,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	600	Down Payment (%)	0	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	60	Down Payment	$0	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	48	Loan Amount	-$2,500,000	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	1,226,891	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.23	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

	Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	$0	$ -	$0	$0		-$197,986.72	-$197,986.72	-$197,986.72	-$197,987
2	2012	$ 0.1324	1,226,891		$ 162,403.56	$36,807	$0	-$29,233	-$197,986.72	-$28,009.07	-$225,995.79	-$24,928
3	2013	$ 0.1357	1,226,891		$ 166,463.65	$36,807	$0	-$29,963	-$197,986.72	-$24,679.80	-$250,675.59	-$20,722
4	2014	$ 0.1391	1,226,891		$ 170,625.24	$36,807	$0	-$30,713	-$197,986.72	-$21,267.29	-$271,942.88	-$16,846
5	2015	$ 0.1425	1,226,891		$ 174,890.87	$36,807	$0	-$31,480	-$197,986.72	-$17,769.48	-$289,712.36	-$13,278
6	2016	$ 0.1461	1,226,891		$ 179,263.14	$36,807	$0	-$32,267	-$197,986.72	-$14,184.21	-$303,896.57	-$9,999
7	2017	$ 0.1498	1,226,891		$ 183,744.72	$36,807		-$33,074	-$197,986.72	-$10,509.32	-$314,405.89	-$6,989
8	2018	$ 0.1535	1,226,891		$ 188,338.34	$36,807		-$33,901	-$197,986.72	-$6,742.55	-$321,148.44	-$4,230
9	2019	$ 0.1573	1,226,891		$ 193,046.80	$36,807		-$34,748	-$197,986.72	-$2,881.62	-$324,030.06	-$1,706
10	2020	$ 0.1613	1,226,891		$ 197,872.97	$36,807		-$35,617	-$197,986.72	$1,075.84	-$322,954.22	$601
11	2021	$ 0.1653	1,226,891		$ 202,819.79	$36,807		-$36,508	-$197,986.72	$5,132.24	-$317,821.98	$2,704
12	2022	$ 0.1694	1,226,891		$ 207,890.29	$36,807		-$37,420	-$197,986.72	$9,290.05	-$308,531.93	$4,617
13	2023	$ 0.1737	1,226,891		$ 213,087.55	$36,807		-$38,356	-$197,986.72	$13,551.80	-$294,980.13	$6,354
14	2024	$ 0.1780	1,226,891		$ 218,414.74	$36,807		-$39,315	-$197,986.72	$17,920.09	-$277,060.04	$7,926
15	2025	$ 0.1825	1,226,891		$ 223,875.10	$36,807		-$40,298	-$197,986.72	$22,397.59	-$254,662.45	$9,346
16	2026	$ 0.1870	1,226,891		$ 229,471.98	$36,807		-$41,305	-$197,986.72	$26,987.03	-$227,675.42	$10,623
17	2027	$ 0.1917	1,226,891		$ 235,208.78	$36,807		-$42,338	-$197,986.72	$31,691.21	-$195,984.21	$11,769
18	2028	$ 0.1965	1,226,891		$ 241,089.00	$36,807		-$43,396	-$197,986.72	$36,512.99	-$159,471.22	$12,792
19	2029	$ 0.2014	1,226,891		$ 247,116.23	$36,807		-$44,481	-$197,986.72	$41,455.31	-$118,015.91	$13,702
20	2030	$ 0.2065	1,226,891		$ 253,294.13	$36,807		-$45,593	-$197,986.72	$46,521.20	-$71,494.71	$14,506
21	2031	$ 0.2116	1,226,891		$ 259,626.48	$36,807		-$46,733	0	$249,700.45	$178,205.73	$73,451
22	2032	$ 0.2169	1,226,891		$ 266,117.15	$36,807		-$47,901	0	$255,022.79	$433,228.52	$70,770
23	2033	$ 0.2223	1,226,891		$ 272,770.07	$36,807		-$49,099	0	$260,478.19	$693,706.72	$68,192
24	2034	$ 0.2279	1,226,891		$ 279,589.33	$36,807		-$50,326	0	$266,069.98	$959,776.69	$65,714
25	2035	$ 0.2336	1,226,891		$ 286,579.06	$36,807		-$51,584	0	$271,801.56	$1,231,578.25	$63,329
26	2036	$ 0.2394	1,226,891		$ 293,743.54	$36,807		-$52,874	0	$277,676.43	$1,509,254.68	$61,036
27	2037	$ 0.2454	1,226,891		$ 301,087.12	$36,807		-$54,196	0	$283,698.17	$1,792,952.85	$58,830
28	2038	$ 0.2515	1,226,891		$ 308,614.30	$36,807		-$55,551	0	$289,870.46	$2,082,823.31	$56,707
29	2039	$ 0.2578	1,226,891		$ 316,329.66	$36,807		-$56,939	0	$296,197.05	$2,379,020.36	$54,665
30	2040	$ 0.2643	1,226,891		$ 324,237.90	$36,807		-$58,363	0	$302,681.81	$2,681,702.17	$52,700

Financial Calulations

	IRR	NPV
5 Years		-$273,760
10 Years	#NUM!	-$296,084
15 Years	#DIV/0!	-$265,138
20 Years	-2%	-$201,747

Years to Postive Return 20

Financial Pro-Forma @ P50 (w/ MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Elecon	Total Project Cost	$2,500,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	600	Down Payment (%)	0	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	60	Down Payment	$320,500	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	48	Loan Amount	-$2,179,500	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	1,226,891	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.23	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

	Project Revenues					Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	$320,500	$ -	$0	$0		-$172,604.82	$147,895.18	$147,895.18	$147,895
2	2012	$ 0.1324	1,226,891		$ 162,403.56	$36,807	$0	-$29,233	-$172,604.82	-$2,627.17	$145,268.00	-$2,338
3	2013	$ 0.1357	1,226,891		$ 166,463.65	$36,807	$0	-$29,963	-$172,604.82	$702.10	$145,970.10	$589
4	2014	$ 0.1391	1,226,891		$ 170,625.24	$36,807	$0	-$30,713	-$172,604.82	$4,114.60	$150,084.71	$3,259
5	2015	$ 0.1425	1,226,891		$ 174,890.87	$36,807	$0	-$31,480	-$172,604.82	$7,612.42	$157,697.13	$5,688
6	2016	$ 0.1461	1,226,891		$ 179,263.14	$36,807	$0	-$32,267	-$172,604.82	$11,197.68	$168,894.81	$7,894
7	2017	$ 0.1498	1,226,891		$ 183,744.72	$36,807		-$33,074	-$172,604.82	$14,872.58	$183,767.39	$9,891
8	2018	$ 0.1535	1,226,891		$ 188,338.34	$36,807		-$33,901	-$172,604.82	$18,639.35	$202,406.74	$11,695
9	2019	$ 0.1573	1,226,891		$ 193,046.80	$36,807		-$34,748	-$172,604.82	$22,500.28	$224,907.02	$13,318
10	2020	$ 0.1613	1,226,891		$ 197,872.97	$36,807		-$35,617	-$172,604.82	$26,457.74	$251,364.76	$14,774
11	2021	$ 0.1653	1,226,891		$ 202,819.79	$36,807		-$36,508	-$172,604.82	$30,514.14	$281,878.90	$16,074
12	2022	$ 0.1694	1,226,891		$ 207,890.29	$36,807		-$37,420	-$172,604.82	$34,671.94	$316,550.84	$17,231
13	2023	$ 0.1737	1,226,891		$ 213,087.55	$36,807		-$38,356	-$172,604.82	$38,933.69	$355,484.54	$18,254
14	2024	$ 0.1780	1,226,891		$ 218,414.74	$36,807		-$39,315	-$172,604.82	$43,301.99	$398,786.53	$19,153
15	2025	$ 0.1825	1,226,891		$ 223,875.10	$36,807		-$40,298	-$172,604.82	$47,779.49	$446,566.02	$19,937
16	2026	$ 0.1870	1,226,891		$ 229,471.98	$36,807		-$41,305	-$172,604.82	$52,368.93	$498,934.95	$20,615
17	2027	$ 0.1917	1,226,891		$ 235,208.78	$36,807		-$42,338	-$172,604.82	$57,073.11	$556,008.05	$21,195
18	2028	$ 0.1965	1,226,891		$ 241,089.00	$36,807		-$43,396	-$172,604.82	$61,894.89	$617,902.94	$21,684
19	2029	$ 0.2014	1,226,891		$ 247,116.23	$36,807		-$44,481	-$172,604.82	$66,837.21	$684,740.15	$22,091
20	2030	$ 0.2065	1,226,891		$ 253,294.13	$36,807		-$45,593	-$172,604.82	$71,903.09	$756,643.24	$22,420
21	2031	$ 0.2116	1,226,891		$ 259,626.48	$36,807		-$46,733	0	$249,700.45	$1,006,343.69	$73,451
22	2032	$ 0.2169	1,226,891		$ 266,117.15	$36,807		-$47,901	0	$255,022.79	$1,261,366.48	$70,770
23	2033	$ 0.2223	1,226,891		$ 272,770.07	$36,807		-$49,099	0	$260,478.19	$1,521,844.67	$68,192
24	2034	$ 0.2279	1,226,891		$ 279,589.33	$36,807		-$50,326	0	$266,069.98	$1,787,914.65	$65,714
25	2035	$ 0.2336	1,226,891		$ 286,579.06	$36,807		-$51,584	0	$271,801.56	$2,059,716.21	$63,329
26	2036	$ 0.2394	1,226,891		$ 293,743.54	$36,807		-$52,874	0	$277,676.43	$2,337,392.64	$61,036
27	2037	$ 0.2454	1,226,891		$ 301,087.12	$36,807		-$54,196	0	$283,698.17	$2,621,090.81	$58,830
28	2038	$ 0.2515	1,226,891		$ 308,614.30	$36,807		-$55,551	0	$289,870.46	$2,910,961.27	$56,707
29	2039	$ 0.2578	1,226,891		$ 316,329.66	$36,807		-$56,939	0	$296,197.05	$3,207,158.32	$54,665
30	2040	$ 0.2643	1,226,891		$ 324,237.90	$36,807		-$58,363	0	$302,681.81	$3,509,840.13	$52,700

Financial Calulations

	IRR	NPV
5 Years		$155,094
10 Years	#DIV/0!	$212,665
15 Years	#DIV/0!	$303,314
20 Years	#DIV/0!	$411,318

Years to Postive Return 18

Financial Pro-Forma @ P50 (w/out MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Mitsubishi	Total Project Cost	$3,400,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1000	Down Payment (%)	0	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	70	Down Payment	$0	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	61	Loan Amount	-$3,400,000	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	1,672,389	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.19	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

	Project Revenues					Project Costs			Project Cash Flows		
Project Year	Fiscal Year	Average Rates ($/kWh)	Annual Energy Production	Capital Payment	Annual Revenue from Production	REC Revenue	Depreciation	Total O+M Cost per Year	Annual Loan Principal and Interest	Cash Flow	Cumulative Cash Flow	Net Present Value for Current Year
1	2011		0	$0	$ -	$0	$0		-$269,261.94	-$269,261.94	-$269,261.94	-$269,262
2	2012	$ 0.1324	1,672,389		$ 221,374.13	$50,172	$0	-$39,847	-$269,261.94	-$37,563.48	-$306,825.43	-$33,431
3	2013	$ 0.1357	1,672,389		$ 226,908.49	$50,172	$0	-$40,844	-$269,261.94	-$33,025.31	-$339,850.74	-$27,729
4	2014	$ 0.1391	1,672,389		$ 232,581.20	$50,172	$0	-$41,865	-$269,261.94	-$28,373.69	-$368,224.43	-$22,475
5	2015	$ 0.1425	1,672,389		$ 238,395.73	$50,172	$0	-$42,911	-$269,261.94	-$23,605.78	-$391,830.20	-$17,640
6	2016	$ 0.1461	1,672,389		$ 244,355.62	$50,172	$0	-$43,984	-$269,261.94	-$18,718.66	-$410,548.87	-$13,196
7	2017	$ 0.1498	1,672,389		$ 250,464.51	$50,172		-$45,084	-$269,261.94	-$13,709.37	-$424,258.24	-$9,118
8	2018	$ 0.1535	1,672,389		$ 256,726.12	$50,172		-$46,211	-$269,261.94	-$8,574.85	-$432,833.09	-$5,380
9	2019	$ 0.1573	1,672,389		$ 263,144.28	$50,172		-$47,366	-$269,261.94	-$3,311.96	-$436,145.05	-$1,960
10	2020	$ 0.1613	1,672,389		$ 269,722.88	$50,172		-$48,550	-$269,261.94	$2,082.49	-$434,062.56	$1,163
11	2021	$ 0.1653	1,672,389		$ 276,465.96	$50,172		-$49,764	-$269,261.94	$7,611.81	-$426,450.75	$4,010
12	2022	$ 0.1694	1,672,389		$ 283,377.60	$50,172		-$51,008	-$269,261.94	$13,279.36	-$413,171.38	$6,599
13	2023	$ 0.1737	1,672,389		$ 290,462.04	$50,172		-$52,283	-$269,261.94	$19,088.61	-$394,082.78	$8,949
14	2024	$ 0.1780	1,672,389		$ 297,723.60	$50,172		-$53,590	-$269,261.94	$25,043.08	-$369,039.70	$11,077
15	2025	$ 0.1825	1,672,389		$ 305,166.69	$50,172		-$54,930	-$269,261.94	$31,146.41	-$337,893.29	$12,996
16	2026	$ 0.1870	1,672,389		$ 312,795.85	$50,172		-$56,303	-$269,261.94	$37,402.33	-$300,490.96	$14,723
17	2027	$ 0.1917	1,672,389		$ 320,615.75	$50,172		-$57,711	-$269,261.94	$43,814.64	-$256,676.32	$16,271
18	2028	$ 0.1965	1,672,389		$ 328,631.14	$50,172		-$59,154	-$269,261.94	$50,387.27	-$206,289.05	$17,653
19	2029	$ 0.2014	1,672,389		$ 336,846.92	$50,172		-$60,632	-$269,261.94	$57,124.20	-$149,164.85	$18,880
20	2030	$ 0.2065	1,672,389		$ 345,268.09	$50,172		-$62,148	-$269,261.94	$64,029.57	-$85,135.28	$19,965
21	2031	$ 0.2116	1,672,389		$ 353,899.80	$50,172		-$63,702	0	$340,369.50	$255,234.22	$100,122
22	2032	$ 0.2169	1,672,389		$ 362,747.29	$50,172		-$65,295	0	$347,624.45	$602,858.67	$96,468
23	2033	$ 0.2223	1,672,389		$ 371,815.97	$50,172		-$66,927	0	$355,060.77	$957,919.44	$92,954
24	2034	$ 0.2279	1,672,389		$ 381,111.37	$50,172		-$68,600	0	$362,683.00	$1,320,602.43	$89,575
25	2035	$ 0.2336	1,672,389		$ 390,639.16	$50,172		-$70,315	0	$370,495.78	$1,691,098.21	$86,325
26	2036	$ 0.2394	1,672,389		$ 400,405.14	$50,172		-$72,073	0	$378,503.88	$2,069,602.10	$83,199
27	2037	$ 0.2454	1,672,389		$ 410,415.27	$50,172		-$73,875	0	$386,712.19	$2,456,314.28	$80,192
28	2038	$ 0.2515	1,672,389		$ 420,675.65	$50,172		-$75,722	0	$395,125.70	$2,851,439.98	$77,298
29	2039	$ 0.2578	1,672,389		$ 431,192.54	$50,172		-$77,615	0	$403,749.55	$3,255,189.54	$74,515
30	2040	$ 0.2643	1,672,389		$ 441,972.35	$50,172		-$79,555	0	$412,589.00	$3,667,778.53	$71,836

Financial Calulations

	IRR	NPV
5 Years	#NUM!	-$370,536
10 Years	#NUM!	-$399,027
15 Years	#DIV/0!	-$355,396
20 Years	-1%	-$267,903

Years to Postive Return 20

Financial Pro-Forma @ P50 (w/ MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Mitsubishi	Total Project Cost	$3,400,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1000	Down Payment (%)	0	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	70	Down Payment	$364,820	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	61	Loan Amount	-$3,035,180	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	1,672,389	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.19	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

					Project Revenues			**Project Costs**		**Project Cash Flows**			
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	$364,820	$ -	$0	$0		-$240,370.14	$124,449.86	$124,449.86	$124,450
2	2012	$ 0.1324	1,672,389		$ 221,374.13	$50,172	$0	-$39,847	-$240,370.14	-$8,671.68	$115,778.19	-$7,718
3	2013	$ 0.1357	1,672,389		$ 226,908.49	$50,172	$0	-$40,844	-$240,370.14	-$4,133.51	$111,644.68	-$3,471
4	2014	$ 0.1391	1,672,389		$ 232,581.20	$50,172	$0	-$41,865	-$240,370.14	$518.12	$112,162.80	$410
5	2015	$ 0.1425	1,672,389		$ 238,395.73	$50,172	$0	-$42,911	-$240,370.14	$5,286.03	$117,448.83	$3,950
6	2016	$ 0.1461	1,672,389		$ 244,355.62	$50,172	$0	-$43,984	-$240,370.14	$10,173.14	$127,621.97	$7,172
7	2017	$ 0.1498	1,672,389		$ 250,464.51	$50,172		-$45,084	-$240,370.14	$15,182.43	$142,804.41	$10,097
8	2018	$ 0.1535	1,672,389		$ 256,726.12	$50,172		-$46,211	-$240,370.14	$20,316.96	$163,121.36	$12,747
9	2019	$ 0.1573	1,672,389		$ 263,144.28	$50,172		-$47,366	-$240,370.14	$25,579.84	$188,701.20	$15,141
10	2020	$ 0.1613	1,672,389		$ 269,722.88	$50,172		-$48,550	-$240,370.14	$30,974.30	$219,675.50	$17,296
11	2021	$ 0.1653	1,672,389		$ 276,465.96	$50,172		-$49,764	-$240,370.14	$36,503.62	$256,179.12	$19,230
12	2022	$ 0.1694	1,672,389		$ 283,377.60	$50,172		-$51,008	-$240,370.14	$42,171.17	$298,350.29	$20,958
13	2023	$ 0.1737	1,672,389		$ 290,462.04	$50,172		-$52,283	-$240,370.14	$47,980.41	$346,330.70	$22,495
14	2024	$ 0.1780	1,672,389		$ 297,723.60	$50,172		-$53,590	-$240,370.14	$53,934.88	$400,265.59	$23,855
15	2025	$ 0.1825	1,672,389		$ 305,166.69	$50,172		-$54,930	-$240,370.14	$60,038.22	$460,303.80	$25,052
16	2026	$ 0.1870	1,672,389		$ 312,795.85	$50,172		-$56,303	-$240,370.14	$66,294.13	$526,597.94	$26,096
17	2027	$ 0.1917	1,672,389		$ 320,615.75	$50,172		-$57,711	-$240,370.14	$72,706.45	$599,304.39	$27,001
18	2028	$ 0.1965	1,672,389		$ 328,631.14	$50,172		-$59,154	-$240,370.14	$79,279.07	$678,583.46	$27,775
19	2029	$ 0.2014	1,672,389		$ 336,846.92	$50,172		-$60,632	-$240,370.14	$86,016.01	$764,599.47	$28,429
20	2030	$ 0.2065	1,672,389		$ 345,268.09	$50,172		-$62,148	-$240,370.14	$92,921.37	$857,520.84	$28,973
21	2031	$ 0.2116	1,672,389		$ 353,899.80	$50,172		-$63,702	0	$340,369.50	$1,197,890.35	$100,122
22	2032	$ 0.2169	1,672,389		$ 362,747.29	$50,172		-$65,295	0	$347,624.45	$1,545,514.80	$96,468
23	2033	$ 0.2223	1,672,389		$ 371,815.97	$50,172		-$66,927	0	$355,060.77	$1,900,575.56	$92,954
24	2034	$ 0.2279	1,672,389		$ 381,111.37	$50,172		-$68,600	0	$362,683.00	$2,263,258.56	$89,575
25	2035	$ 0.2336	1,672,389		$ 390,639.16	$50,172		-$70,315	0	$370,495.78	$2,633,754.34	$86,325
26	2036	$ 0.2394	1,672,389		$ 400,405.14	$50,172		-$72,073	0	$378,503.88	$3,012,258.22	$83,199
27	2037	$ 0.2454	1,672,389		$ 410,415.27	$50,172		-$73,875	0	$386,712.19	$3,398,970.41	$80,192
28	2038	$ 0.2515	1,672,389		$ 420,675.65	$50,172		-$75,722	0	$395,125.70	$3,794,096.11	$77,298
29	2039	$ 0.2578	1,672,389		$ 431,192.54	$50,172		-$77,615	0	$403,749.55	$4,197,845.66	$74,515
30	2040	$ 0.2643	1,672,389		$ 441,972.35	$50,172		-$79,555	0	$412,589.00	$4,610,434.66	$71,836

Financial Calulations

	IRR	NPV
5 Years	#NUM!	$117,622
10 Years	#DIV/0!	$180,074
15 Years	#DIV/0!	$291,664
20 Years	#DIV/0!	$429,939

Years to Postive Return 18

Financial Pro-Forma @ P50 (w/out MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	GE Energy	Total Project Cost	$4,500,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1500	Down Payment (%)	0	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	80	Down Payment	$0	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	77	Loan Amount	-$4,500,000	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	3,607,026	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.27	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

	Project Revenues					Project Costs			Project Cash Flows		
Project Year	Fiscal Year	Average Rates ($/kWh)	Annual Energy Production	Capital Payment	Annual Revenue from Production	REC Revenue	Depreciation	Total O+M Cost per Year	Annual Loan Principal and Interest	Cash Flow	Cumulative Cash Flow	Net Present Value for Current Year
1	2011		0	$0	$ -	$0	$0		-$356,376.10	-$356,376.10	-$356,376.10	-$356,376
2	2012	$ 0.1324	3,607,026		$ 477,462.03	$108,211	$0	-$85,943	-$356,376.10	$143,353.55	-$213,022.55	$127,584
3	2013	$ 0.1357	3,607,026		$ 489,398.58	$108,211	$0	-$88,092	-$356,376.10	$153,141.52	-$59,881.03	$128,581
4	2014	$ 0.1391	3,607,026		$ 501,633.55	$108,211	$0	-$90,294	-$356,376.10	$163,174.19	$103,293.16	$129,249
5	2015	$ 0.1425	3,607,026		$ 514,174.39	$108,211	$0	-$92,551	-$356,376.10	$173,457.68	$276,750.83	$129,618
6	2016	$ 0.1461	3,607,026		$ 527,028.75	$108,211	$0	-$94,865	-$356,376.10	$183,998.25	$460,749.08	$129,712
7	2017	$ 0.1498	3,607,026		$ 540,204.46	$108,211		-$97,237	-$356,376.10	$194,802.34	$655,551.43	$129,555
8	2018	$ 0.1535	3,607,026		$ 553,709.58	$108,211		-$99,668	-$356,376.10	$205,876.53	$861,427.96	$129,169
9	2019	$ 0.1573	3,607,026		$ 567,552.31	$108,211		-$102,159	-$356,376.10	$217,227.58	$1,078,655.54	$128,577
10	2020	$ 0.1613	3,607,026		$ 581,741.12	$108,211		-$104,713	-$356,376.10	$228,862.40	$1,307,517.94	$127,796
11	2021	$ 0.1653	3,607,026		$ 596,284.65	$108,211		-$107,331	-$356,376.10	$240,788.09	$1,548,306.03	$126,844
12	2022	$ 0.1694	3,607,026		$ 611,191.77	$108,211		-$110,015	-$356,376.10	$253,011.93	$1,801,317.96	$125,739
13	2023	$ 0.1737	3,607,026		$ 626,471.56	$108,211		-$112,765	-$356,376.10	$265,541.36	$2,066,859.32	$124,496
14	2024	$ 0.1780	3,607,026		$ 642,133.35	$108,211		-$115,584	-$356,376.10	$278,384.03	$2,345,243.35	$123,130
15	2025	$ 0.1825	3,607,026		$ 658,186.68	$108,211		-$118,474	-$356,376.10	$291,547.76	$2,636,791.11	$121,653
16	2026	$ 0.1870	3,607,026		$ 674,641.35	$108,211		-$121,435	-$356,376.10	$305,040.59	$2,941,831.70	$120,078
17	2027	$ 0.1917	3,607,026		$ 691,507.38	$108,211		-$124,471	-$356,376.10	$318,870.74	$3,260,702.44	$118,417
18	2028	$ 0.1965	3,607,026		$ 708,795.07	$108,211		-$127,583	-$356,376.10	$333,046.64	$3,593,749.08	$116,681
19	2029	$ 0.2014	3,607,026		$ 726,514.95	$108,211		-$130,773	-$356,376.10	$347,576.94	$3,941,326.01	$114,879
20	2030	$ 0.2065	3,607,026		$ 744,677.82	$108,211		-$134,042	-$356,376.10	$362,470.49	$4,303,796.51	$113,020
21	2031	$ 0.2116	3,607,026		$ 763,294.77	$108,211		-$137,393	0	$734,112.49	$5,037,909.00	$215,943
22	2032	$ 0.2169	3,607,026		$ 782,377.13	$108,211		-$140,828	0	$749,760.03	$5,787,669.03	$208,062
23	2033	$ 0.2223	3,607,026		$ 801,936.56	$108,211		-$144,349	0	$765,798.76	$6,553,467.79	$200,484
24	2034	$ 0.2279	3,607,026		$ 821,984.98	$108,211		-$147,957	0	$782,238.46	$7,335,706.25	$193,196
25	2035	$ 0.2336	3,607,026		$ 842,534.60	$108,211		-$151,656	0	$799,089.15	$8,134,795.40	$186,187
26	2036	$ 0.2394	3,607,026		$ 863,597.97	$108,211		-$155,448	0	$816,361.11	$8,951,156.51	$179,444
27	2037	$ 0.2454	3,607,026		$ 885,187.92	$108,211		-$159,334	0	$834,064.87	$9,785,221.38	$172,958
28	2038	$ 0.2515	3,607,026		$ 907,317.61	$108,211		-$163,317	0	$852,211.22	$10,637,432.61	$166,718
29	2039	$ 0.2578	3,607,026		$ 930,000.55	$108,211		-$167,400	0	$870,811.23	$11,508,243.84	$160,714
30	2040	$ 0.2643	3,607,026		$ 953,250.57	$108,211		-$171,585	0	$889,876.25	$12,398,120.09	$154,936

Financial Calulations

	IRR	NPV
5 Years	27%	$158,656
10 Years	44%	$803,463
15 Years	46%	$1,425,325
20 Years	46%	$2,008,400

Years to Postive Return 13

Financial Pro-Forma @ P50 (w/ MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	GE Energy	Total Project Cost	$4,500,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1500	Down Payment (%)	0	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	80	Down Payment	$400,000	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	77	Loan Amount	-$4,100,000	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	3,607,026	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.27	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

	Project Revenues					Project Costs			Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	$400,000	$ -	$0	$0		-$324,698.22	$75,301.78	$75,301.78	$75,302
2	2012	$ 0.1324	3,607,026		$ 477,462.03	$108,211	$0	-$85,943	-$324,698.22	$175,031.42	$250,333.20	$155,777
3	2013	$ 0.1357	3,607,026		$ 489,398.58	$108,211	$0	-$88,092	-$324,698.22	$184,819.39	$435,152.59	$155,178
4	2014	$ 0.1391	3,607,026		$ 501,633.55	$108,211	$0	-$90,294	-$324,698.22	$194,852.06	$630,004.66	$154,341
5	2015	$ 0.1425	3,607,026		$ 514,174.39	$108,211	$0	-$92,551	-$324,698.22	$205,135.55	$835,140.21	$153,289
6	2016	$ 0.1461	3,607,026		$ 527,028.75	$108,211	$0	-$94,865	-$324,698.22	$215,676.13	$1,050,816.34	$152,043
7	2017	$ 0.1498	3,607,026		$ 540,204.46	$108,211		-$97,237	-$324,698.22	$226,480.22	$1,277,296.55	$150,622
8	2018	$ 0.1535	3,607,026		$ 553,709.58	$108,211		-$99,668	-$324,698.22	$237,554.41	$1,514,850.96	$149,045
9	2019	$ 0.1573	3,607,026		$ 567,552.31	$108,211		-$102,159	-$324,698.22	$248,905.45	$1,763,756.42	$147,327
10	2020	$ 0.1613	3,607,026		$ 581,741.12	$108,211		-$104,713	-$324,698.22	$260,540.28	$2,024,296.69	$145,484
11	2021	$ 0.1653	3,607,026		$ 596,284.65	$108,211		-$107,331	-$324,698.22	$272,465.97	$2,296,762.66	$143,532
12	2022	$ 0.1694	3,607,026		$ 611,191.77	$108,211		-$110,015	-$324,698.22	$284,689.81	$2,581,452.47	$141,482
13	2023	$ 0.1737	3,607,026		$ 626,471.56	$108,211		-$112,765	-$324,698.22	$297,219.24	$2,878,671.71	$139,348
14	2024	$ 0.1780	3,607,026		$ 642,133.35	$108,211		-$115,584	-$324,698.22	$310,061.90	$3,188,733.61	$137,141
15	2025	$ 0.1825	3,607,026		$ 658,186.68	$108,211		-$118,474	-$324,698.22	$323,225.64	$3,511,959.25	$134,871
16	2026	$ 0.1870	3,607,026		$ 674,641.35	$108,211		-$121,435	-$324,698.22	$336,718.46	$3,848,677.71	$132,548
17	2027	$ 0.1917	3,607,026		$ 691,507.38	$108,211		-$124,471	-$324,698.22	$350,548.61	$4,199,226.32	$130,181
18	2028	$ 0.1965	3,607,026		$ 708,795.07	$108,211		-$127,583	-$324,698.22	$364,724.51	$4,563,950.84	$127,779
19	2029	$ 0.2014	3,607,026		$ 726,514.95	$108,211		-$130,773	-$324,698.22	$379,254.81	$4,943,205.65	$125,349
20	2030	$ 0.2065	3,607,026		$ 744,677.82	$108,211		-$134,042	-$324,698.22	$394,148.37	$5,337,354.02	$122,897
21	2031	$ 0.2116	3,607,026		$ 763,294.77	$108,211		-$137,393	0	$734,112.49	$6,071,466.50	$215,943
22	2032	$ 0.2169	3,607,026		$ 782,377.13	$108,211		-$140,828	0	$749,760.03	$6,821,226.54	$208,062
23	2033	$ 0.2223	3,607,026		$ 801,936.56	$108,211		-$144,349	0	$765,798.76	$7,587,025.30	$200,484
24	2034	$ 0.2279	3,607,026		$ 821,984.98	$108,211		-$147,957	0	$782,238.46	$8,369,263.76	$193,196
25	2035	$ 0.2336	3,607,026		$ 842,534.60	$108,211		-$151,656	0	$799,089.15	$9,168,352.91	$186,187
26	2036	$ 0.2394	3,607,026		$ 863,597.97	$108,211		-$155,448	0	$816,361.11	$9,984,714.02	$179,444
27	2037	$ 0.2454	3,607,026		$ 885,187.92	$108,211		-$159,334	0	$834,064.87	$10,818,778.89	$172,958
28	2038	$ 0.2515	3,607,026		$ 907,317.61	$108,211		-$163,317	0	$852,211.22	$11,670,990.12	$166,718
29	2039	$ 0.2578	3,607,026		$ 930,000.55	$108,211		-$167,400	0	$870,811.23	$12,541,801.35	$160,714
30	2040	$ 0.2643	3,607,026		$ 953,250.57	$108,211		-$171,585	0	$889,876.25	$13,431,677.60	$154,936

Financial Calulations

	IRR	NPV
5 Years	#NUM!	$693,887
10 Years	#NUM!	$1,438,408
15 Years	#DIV/0!	$2,134,782
20 Years	#DIV/0!	$2,773,536

Years to Postive Return 12

Financial Pro-Forma @ P50 (w/out MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Elecon	Total Project Cost	$2,500,000	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	600	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	60	Down Payment	-$2,500,000	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	48	Loan Amount	$0	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	1,226,891	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.23	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

					Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	-$2,500,000	$ -	$0	$0		$0.00	-$2,500,000.00	-$2,500,000.00	-$2,500,000
2	2012	$ 0.1324	1,226,891		$ 162,403.56	$36,807	$0	-$29,233	$0.00	$169,977.65	-$2,330,022.35	$151,280
3	2013	$ 0.1357	1,226,891		$ 166,463.65	$36,807	$0	-$29,963	$0.00	$173,306.92	-$2,156,715.43	$145,512
4	2014	$ 0.1391	1,226,891		$ 170,625.24	$36,807	$0	-$30,713	$0.00	$176,719.43	-$1,979,996.00	$139,978
5	2015	$ 0.1425	1,226,891		$ 174,890.87	$36,807	$0	-$31,480	$0.00	$180,217.25	-$1,799,778.75	$134,669
6	2016	$ 0.1461	1,226,891		$ 179,263.14	$36,807	$0	-$32,267	$0.00	$183,802.51	-$1,615,976.24	$129,574
7	2017	$ 0.1498	1,226,891		$ 183,744.72	$36,807		-$33,074	$0.00	$187,477.40	-$1,428,498.84	$124,683
8	2018	$ 0.1535	1,226,891		$ 188,338.34	$36,807		-$33,901	$0.00	$191,244.17	-$1,237,254.67	$119,989
9	2019	$ 0.1573	1,226,891		$ 193,046.80	$36,807		-$34,748	$0.00	$195,105.11	-$1,042,149.56	$115,482
10	2020	$ 0.1613	1,226,891		$ 197,872.97	$36,807		-$35,617	$0.00	$199,062.57	-$843,087.00	$111,155
11	2021	$ 0.1653	1,226,891		$ 202,819.79	$36,807		-$36,508	$0.00	$203,118.96	-$639,968.04	$107,001
12	2022	$ 0.1694	1,226,891		$ 207,890.29	$36,807		-$37,420	$0.00	$207,276.77	-$432,691.27	$103,010
13	2023	$ 0.1737	1,226,891		$ 213,087.55	$36,807		-$38,356	$0.00	$211,538.52	-$221,152.75	$99,178
14	2024	$ 0.1780	1,226,891		$ 218,414.74	$36,807		-$39,315	$0.00	$215,906.81	-$5,245.94	$95,496
15	2025	$ 0.1825	1,226,891		$ 223,875.10	$36,807		-$40,298	$0.00	$220,384.31	$215,138.38	$91,959
16	2026	$ 0.1870	1,226,891		$ 229,471.98	$36,807		-$41,305	$0.00	$224,973.75	$440,112.13	$88,560
17	2027	$ 0.1917	1,226,891		$ 235,208.78	$36,807		-$42,338	$0.00	$229,677.93	$669,790.06	$85,294
18	2028	$ 0.1965	1,226,891		$ 241,089.00	$36,807		-$43,396	$0.00	$234,499.71	$904,289.77	$82,156
19	2029	$ 0.2014	1,226,891		$ 247,116.23	$36,807		-$44,481	$0.00	$239,442.03	$1,143,731.81	$79,139
20	2030	$ 0.2065	1,226,891		$ 253,294.13	$36,807		-$45,593	$0.00	$244,507.92	$1,388,239.72	$76,239
21	2031	$ 0.2116	1,226,891		$ 259,626.48	$36,807		-$46,733	0	$249,700.45	$1,637,940.17	$73,451
22	2032	$ 0.2169	1,226,891		$ 266,117.15	$36,807		-$47,901	0	$255,022.79	$1,892,962.96	$70,770
23	2033	$ 0.2223	1,226,891		$ 272,770.07	$36,807		-$49,099	0	$260,478.19	$2,153,441.15	$68,192
24	2034	$ 0.2279	1,226,891		$ 279,589.33	$36,807		-$50,326	0	$266,069.98	$2,419,511.13	$65,714
25	2035	$ 0.2336	1,226,891		$ 286,579.06	$36,807		-$51,584	0	$271,801.56	$2,691,312.69	$63,329
26	2036	$ 0.2394	1,226,891		$ 293,743.54	$36,807		-$52,874	0	$277,676.43	$2,968,989.12	$61,036
27	2037	$ 0.2454	1,226,891		$ 301,087.12	$36,807		-$54,196	0	$283,698.17	$3,252,687.29	$58,830
28	2038	$ 0.2515	1,226,891		$ 308,614.30	$36,807		-$55,551	0	$289,870.46	$3,542,557.75	$56,707
29	2039	$ 0.2578	1,226,891		$ 316,329.66	$36,807		-$56,939	0	$296,197.05	$3,838,754.80	$54,665
30	2040	$ 0.2643	1,226,891		$ 324,237.90	$36,807		-$58,363	0	$302,681.81	$4,141,436.61	$52,700

Financial Calulations

	IRR	NPV
5 Years		-$1,928,562
10 Years	-7%	-$1,327,678
15 Years	1%	-$831,035
20 Years	5%	-$419,648

Years to Postive Return 14

Financial Pro-Forma @ P50 (w/ MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Elecon	Total Project Cost	$2,500,000	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	600	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	60	Down Payment	-$2,179,500	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	48	Loan Amount	$0	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	1,226,891	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.23	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

					Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	-$2,179,500	$ -	$0	$0		$0.00	-$2,179,500.00	-$2,179,500.00	-$2,179,500
2	2012	$ 0.1324	1,226,891		$ 162,403.56	$36,807	$0	-$29,233	$0.00	$169,977.65	-$2,009,522.35	$151,280
3	2013	$ 0.1357	1,226,891		$ 166,463.65	$36,807	$0	-$29,963	$0.00	$173,306.92	-$1,836,215.43	$145,512
4	2014	$ 0.1391	1,226,891		$ 170,625.24	$36,807	$0	-$30,713	$0.00	$176,719.43	-$1,659,496.00	$139,978
5	2015	$ 0.1425	1,226,891		$ 174,890.87	$36,807	$0	-$31,480	$0.00	$180,217.25	-$1,479,278.75	$134,669
6	2016	$ 0.1461	1,226,891		$ 179,263.14	$36,807	$0	-$32,267	$0.00	$183,802.51	-$1,295,476.24	$129,574
7	2017	$ 0.1498	1,226,891		$ 183,744.72	$36,807		-$33,074	$0.00	$187,477.40	-$1,107,998.84	$124,683
8	2018	$ 0.1535	1,226,891		$ 188,338.34	$36,807		-$33,901	$0.00	$191,244.17	-$916,754.67	$119,989
9	2019	$ 0.1573	1,226,891		$ 193,046.80	$36,807		-$34,748	$0.00	$195,105.11	-$721,649.56	$115,482
10	2020	$ 0.1613	1,226,891		$ 197,872.97	$36,807		-$35,617	$0.00	$199,062.57	-$522,587.00	$111,155
11	2021	$ 0.1653	1,226,891		$ 202,819.79	$36,807		-$36,508	$0.00	$203,118.96	-$319,468.04	$107,001
12	2022	$ 0.1694	1,226,891		$ 207,890.29	$36,807		-$37,420	$0.00	$207,276.77	-$112,191.27	$103,010
13	2023	$ 0.1737	1,226,891		$ 213,087.55	$36,807		-$38,356	$0.00	$211,538.52	$99,347.25	$99,178
14	2024	$ 0.1780	1,226,891		$ 218,414.74	$36,807		-$39,315	$0.00	$215,906.81	$315,254.06	$95,496
15	2025	$ 0.1825	1,226,891		$ 223,875.10	$36,807		-$40,298	$0.00	$220,384.31	$535,638.38	$91,959
16	2026	$ 0.1870	1,226,891		$ 229,471.98	$36,807		-$41,305	$0.00	$224,973.75	$760,612.13	$88,560
17	2027	$ 0.1917	1,226,891		$ 235,208.78	$36,807		-$42,338	$0.00	$229,677.93	$990,290.06	$85,294
18	2028	$ 0.1965	1,226,891		$ 241,089.00	$36,807		-$43,396	$0.00	$234,499.71	$1,224,789.77	$82,156
19	2029	$ 0.2014	1,226,891		$ 247,116.23	$36,807		-$44,481	$0.00	$239,442.03	$1,464,231.81	$79,139
20	2030	$ 0.2065	1,226,891		$ 253,294.13	$36,807		-$45,593	$0.00	$244,507.92	$1,708,739.72	$76,239
21	2031	$ 0.2116	1,226,891		$ 259,626.48	$36,807		-$46,733	0	$249,700.45	$1,958,440.17	$73,451
22	2032	$ 0.2169	1,226,891		$ 266,117.15	$36,807		-$47,901	0	$255,022.79	$2,213,462.96	$70,770
23	2033	$ 0.2223	1,226,891		$ 272,770.07	$36,807		-$49,099	0	$260,478.19	$2,473,941.15	$68,192
24	2034	$ 0.2279	1,226,891		$ 279,589.33	$36,807		-$50,326	0	$266,069.98	$2,740,011.13	$65,714
25	2035	$ 0.2336	1,226,891		$ 286,579.06	$36,807		-$51,584	0	$271,801.56	$3,011,812.69	$63,329
26	2036	$ 0.2394	1,226,891		$ 293,743.54	$36,807		-$52,874	0	$277,676.43	$3,289,489.12	$61,036
27	2037	$ 0.2454	1,226,891		$ 301,087.12	$36,807		-$54,196	0	$283,698.17	$3,573,187.29	$58,830
28	2038	$ 0.2515	1,226,891		$ 308,614.30	$36,807		-$55,551	0	$289,870.46	$3,863,057.75	$56,707
29	2039	$ 0.2578	1,226,891		$ 316,329.66	$36,807		-$56,939	0	$296,197.05	$4,159,254.80	$54,665
30	2040	$ 0.2643	1,226,891		$ 324,237.90	$36,807		-$58,363	0	$302,681.81	$4,461,936.61	$52,700

Financial Calulations

	IRR	NPV
5 Years		-$1,608,062
10 Years	-5%	-$1,007,178
15 Years	3%	-$510,535
20 Years	6%	-$99,148

Years to Postive Return 12

PPA Financial Pro-Forma @ P50 (PPA)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Elecon	Total Project Cost	$0.00	Current Value of offset Electricity	$0.01
WTG Faceplate (kW)	600	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0
WTG Hub Height (m)	60	Down Payment	$0	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	48	Loan Amount	$0	Annual Inflation on Utility Rates:	0.00%
WTG Prod. (kWh/Year)	1,226,891	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.23	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

					Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	$0	$ -	$0	$0		$0.00	$0.00	$0.00	$0
2	2012	$ 0.0130	1,226,891		$ 15,949.58	$0	$0	-$2,871	$0.00	$13,078.66	$13,078.66	$11,640
3	2013	$ 0.0130	1,226,891		$ 15,949.58	$0	$0	-$2,943	$0.00	$13,006.88	$26,085.54	$10,921
4	2014	$ 0.0130	1,226,891		$ 15,949.58	$0	$0	-$3,016	$0.00	$12,933.32	$39,018.86	$10,244
5	2015	$ 0.0130	1,226,891		$ 15,949.58	$0	$0	-$3,092	$0.00	$12,857.91	$51,876.77	$9,608
6	2016	$ 0.0130	1,226,891		$ 15,949.58	$0	$0	-$3,169	$0.00	$12,780.62	$64,657.39	$9,010
7	2017	$ 0.0130	1,226,891		$ 15,949.58	$0		-$3,248	$0.00	$12,701.39	$77,358.79	$8,447
8	2018	$ 0.0130	1,226,891		$ 15,949.58	$0		-$3,329	$0.00	$12,620.19	$89,978.98	$7,918
9	2019	$ 0.0130	1,226,891		$ 15,949.58	$0		-$3,413	$0.00	$12,536.96	$102,515.93	$7,421
10	2020	$ 0.0130	1,226,891		$ 15,949.58	$0		-$3,498	$0.00	$12,451.64	$114,967.57	$6,953
11	2021	$ 0.0130	1,226,891		$ 15,949.58	$0		-$3,585	$0.00	$12,364.19	$127,331.76	$6,513
12	2022	$ 0.0130	1,226,891		$ 15,949.58	$0		-$3,675	$0.00	$12,274.56	$139,606.32	$6,100
13	2023	$ 0.0130	1,226,891		$ 15,949.58	$0		-$3,767	$0.00	$12,182.68	$151,789.00	$5,712
14	2024	$ 0.0130	1,226,891		$ 15,949.58	$0		-$3,861	$0.00	$12,088.51	$163,877.51	$5,347
15	2025	$ 0.0130	1,226,891		$ 15,949.58	$0		-$3,958	$0.00	$11,991.98	$175,869.49	$5,004
16	2026	$ 0.0130	1,226,891		$ 15,949.58	$0		-$4,057	$0.00	$11,893.04	$187,762.53	$4,682
17	2027	$ 0.0130	1,226,891		$ 15,949.58	$0		-$4,158	$0.00	$11,791.63	$199,554.16	$4,379
18	2028	$ 0.0130	1,226,891		$ 15,949.58	$0		-$4,262	$0.00	$11,687.68	$211,241.84	$4,095
19	2029	$ 0.0130	1,226,891		$ 15,949.58	$0		-$4,368	$0.00	$11,581.13	$222,822.97	$3,828
20	2030	$ 0.0130	1,226,891		$ 15,949.58	$0		-$4,478	$0.00	$11,471.92	$234,294.89	$3,577
21	2031	$ 0.0130	1,226,891		$ 15,949.58	$0		-$4,590	0	$11,359.98	$245,654.87	$3,342
22	2032	$ 0.0130	1,226,891		$ 15,949.58	$0		-$4,704	0	$11,245.24	$256,900.10	$3,121
23	2033	$ 0.0130	1,226,891		$ 15,949.58	$0		-$4,822	0	$11,127.63	$268,027.73	$2,913
24	2034	$ 0.0130	1,226,891		$ 15,949.58	$0		-$4,943	0	$11,007.08	$279,034.81	$2,719
25	2035	$ 0.0130	1,226,891		$ 15,949.58	$0		-$5,066	0	$10,883.52	$289,918.33	$2,536
26	2036	$ 0.0130	1,226,891		$ 15,949.58	$0		-$5,193	0	$10,756.87	$300,675.20	$2,364
27	2037	$ 0.0130	1,226,891		$ 15,949.58	$0		-$5,323	0	$10,627.05	$311,302.25	$2,204
28	2038	$ 0.0130	1,226,891		$ 15,949.58	$0		-$5,456	0	$10,493.99	$321,796.23	$2,053
29	2039	$ 0.0130	1,226,891		$ 15,949.58	$0		-$5,592	0	$10,357.60	$332,153.83	$1,912
30	2040	$ 0.0130	1,226,891		$ 15,949.58	$0		-$5,732	0	$10,217.80	$342,371.62	$1,779

Financial Calulations

	IRR	NPV
5 Years		$42,413
10 Years	#DIV/0!	$82,162
15 Years	#DIV/0!	$110,838
20 Years	#DIV/0!	$131,398

Years to Postive Return 0

Financial Pro-Forma @ P50 (w/out MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Mitsubishi	Total Project Cost	$3,400,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1000	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	70	Down Payment	-$3,400,000	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	61	Loan Amount	$0	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	1,672,389	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.19	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

					Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	-$3,400,000	$ -	$0	$0		$0.00	-$3,400,000.00	-$3,400,000.00	-$3,400,000
2	2012	$ 0.1324	1,672,389		$ 221,374.13	$50,172	$0	-$39,847	$0.00	$231,698.46	-$3,168,301.54	$206,211
3	2013	$ 0.1357	1,672,389		$ 226,908.49	$50,172	$0	-$40,844	$0.00	$236,236.63	-$2,932,064.91	$198,349
4	2014	$ 0.1391	1,672,389		$ 232,581.20	$50,172	$0	-$41,865	$0.00	$240,888.25	-$2,691,176.66	$190,806
5	2015	$ 0.1425	1,672,389		$ 238,395.73	$50,172	$0	-$42,911	$0.00	$245,656.17	-$2,445,520.50	$183,569
6	2016	$ 0.1461	1,672,389		$ 244,355.62	$50,172	$0	-$43,984	$0.00	$250,543.28	-$2,194,977.22	$176,623
7	2017	$ 0.1498	1,672,389		$ 250,464.51	$50,172		-$45,084	$0.00	$255,552.57	-$1,939,424.65	$169,957
8	2018	$ 0.1535	1,672,389		$ 256,726.12	$50,172		-$46,211	$0.00	$260,687.09	-$1,678,737.56	$163,558
9	2019	$ 0.1573	1,672,389		$ 263,144.28	$50,172		-$47,366	$0.00	$265,949.98	-$1,412,787.58	$157,415
10	2020	$ 0.1613	1,672,389		$ 269,722.88	$50,172		-$48,550	$0.00	$271,344.43	-$1,141,443.14	$151,517
11	2021	$ 0.1653	1,672,389		$ 276,465.96	$50,172		-$49,764	$0.00	$276,873.75	-$864,569.39	$145,854
12	2022	$ 0.1694	1,672,389		$ 283,377.60	$50,172		-$51,008	$0.00	$282,541.31	-$582,028.08	$140,414
13	2023	$ 0.1737	1,672,389		$ 290,462.04	$50,172		-$52,283	$0.00	$288,350.55	-$293,677.54	$135,190
14	2024	$ 0.1780	1,672,389		$ 297,723.60	$50,172		-$53,590	$0.00	$294,305.02	$627.48	$130,171
15	2025	$ 0.1825	1,672,389		$ 305,166.69	$50,172		-$54,930	$0.00	$300,408.35	$301,035.83	$125,350
16	2026	$ 0.1870	1,672,389		$ 312,795.85	$50,172		-$56,303	$0.00	$306,664.27	$607,700.10	$120,717
17	2027	$ 0.1917	1,672,389		$ 320,615.75	$50,172		-$57,711	$0.00	$313,076.58	$920,776.69	$116,266
18	2028	$ 0.1965	1,672,389		$ 328,631.14	$50,172		-$59,154	$0.00	$319,649.21	$1,240,425.89	$111,987
19	2029	$ 0.2014	1,672,389		$ 336,846.92	$50,172		-$60,632	$0.00	$326,386.15	$1,566,812.04	$107,875
20	2030	$ 0.2065	1,672,389		$ 345,268.09	$50,172		-$62,148	$0.00	$333,291.51	$1,900,103.55	$103,922
21	2031	$ 0.2116	1,672,389		$ 353,899.80	$50,172		-$63,702	0	$340,369.50	$2,240,473.05	$100,122
22	2032	$ 0.2169	1,672,389		$ 362,747.29	$50,172		-$65,295	0	$347,624.45	$2,588,097.50	$96,468
23	2033	$ 0.2223	1,672,389		$ 371,815.97	$50,172		-$66,927	0	$355,060.77	$2,943,158.27	$92,954
24	2034	$ 0.2279	1,672,389		$ 381,111.37	$50,172		-$68,600	0	$362,683.00	$3,305,841.27	$89,575
25	2035	$ 0.2336	1,672,389		$ 390,639.16	$50,172		-$70,315	0	$370,495.78	$3,676,337.05	$86,325
26	2036	$ 0.2394	1,672,389		$ 400,405.14	$50,172		-$72,073	0	$378,503.88	$4,054,840.93	$83,199
27	2037	$ 0.2454	1,672,389		$ 410,415.27	$50,172		-$73,875	0	$386,712.19	$4,441,553.12	$80,192
28	2038	$ 0.2515	1,672,389		$ 420,675.65	$50,172		-$75,722	0	$395,125.70	$4,836,678.82	$77,298
29	2039	$ 0.2578	1,672,389		$ 431,192.54	$50,172		-$77,615	0	$403,749.55	$5,240,428.37	$74,515
30	2040	$ 0.2643	1,672,389		$ 441,972.35	$50,172		-$79,555	0	$412,589.00	$5,653,017.37	$71,836

Financial Calulations

	IRR	**NPV**
5 Years	#NUM!	-$2,621,066
10 Years	-7%	-$1,801,995
15 Years	1%	-$1,125,015
20 Years	5%	-$564,249

Years to Postive Return 13

Financial Pro-Forma @ P50 (w/ MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Mitsubishi	Total Project Cost	$3,400,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1000	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	70	Down Payment	-$3,035,180	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	61	Loan Amount	$0	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	1,672,389	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.19	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

				Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	-$3,035,180	$ -	$0	$0		$0.00	-$3,035,180.00	-$3,035,180.00	-$3,035,180
2	2012	$ 0.1324	1,672,389		$ 221,374.13	$50,172	$0	-$39,847	$0.00	$231,698.46	-$2,803,481.54	$206,211
3	2013	$ 0.1357	1,672,389		$ 226,908.49	$50,172	$0	-$40,844	$0.00	$236,236.63	-$2,567,244.91	$198,349
4	2014	$ 0.1391	1,672,389		$ 232,581.20	$50,172	$0	-$41,865	$0.00	$240,888.25	-$2,326,356.66	$190,806
5	2015	$ 0.1425	1,672,389		$ 238,395.73	$50,172	$0	-$42,911	$0.00	$245,656.17	-$2,080,700.50	$183,569
6	2016	$ 0.1461	1,672,389		$ 244,355.62	$50,172	$0	-$43,984	$0.00	$250,543.28	-$1,830,157.22	$176,623
7	2017	$ 0.1498	1,672,389		$ 250,464.51	$50,172		-$45,084	$0.00	$255,552.57	-$1,574,604.65	$169,957
8	2018	$ 0.1535	1,672,389		$ 256,726.12	$50,172		-$46,211	$0.00	$260,687.09	-$1,313,917.56	$163,558
9	2019	$ 0.1573	1,672,389		$ 263,144.28	$50,172		-$47,366	$0.00	$265,949.98	-$1,047,967.58	$157,415
10	2020	$ 0.1613	1,672,389		$ 269,722.88	$50,172		-$48,550	$0.00	$271,344.43	-$776,623.14	$151,517
11	2021	$ 0.1653	1,672,389		$ 276,465.96	$50,172		-$49,764	$0.00	$276,873.75	-$499,749.39	$145,854
12	2022	$ 0.1694	1,672,389		$ 283,377.60	$50,172		-$51,008	$0.00	$282,541.31	-$217,208.08	$140,414
13	2023	$ 0.1737	1,672,389		$ 290,462.04	$50,172		-$52,283	$0.00	$288,350.55	$71,142.46	$135,190
14	2024	$ 0.1780	1,672,389		$ 297,723.60	$50,172		-$53,590	$0.00	$294,305.02	$365,447.48	$130,171
15	2025	$ 0.1825	1,672,389		$ 305,166.69	$50,172		-$54,930	$0.00	$300,408.35	$665,855.83	$125,350
16	2026	$ 0.1870	1,672,389		$ 312,795.85	$50,172		-$56,303	$0.00	$306,664.27	$972,520.10	$120,717
17	2027	$ 0.1917	1,672,389		$ 320,615.75	$50,172		-$57,711	$0.00	$313,076.58	$1,285,596.69	$116,266
18	2028	$ 0.1965	1,672,389		$ 328,631.14	$50,172		-$59,154	$0.00	$319,649.21	$1,605,245.89	$111,987
19	2029	$ 0.2014	1,672,389		$ 336,846.92	$50,172		-$60,632	$0.00	$326,386.15	$1,931,632.04	$107,875
20	2030	$ 0.2065	1,672,389		$ 345,268.09	$50,172		-$62,148	$0.00	$333,291.51	$2,264,923.55	$103,922
21	2031	$ 0.2116	1,672,389		$ 353,899.80	$50,172		-$63,702	0	$340,369.50	$2,605,293.05	$100,122
22	2032	$ 0.2169	1,672,389		$ 362,747.29	$50,172		-$65,295	0	$347,624.45	$2,952,917.50	$96,468
23	2033	$ 0.2223	1,672,389		$ 371,815.97	$50,172		-$66,927	0	$355,060.77	$3,307,978.27	$92,954
24	2034	$ 0.2279	1,672,389		$ 381,111.37	$50,172		-$68,600	0	$362,683.00	$3,670,661.27	$89,575
25	2035	$ 0.2336	1,672,389		$ 390,639.16	$50,172		-$70,315	0	$370,495.78	$4,041,157.05	$86,325
26	2036	$ 0.2394	1,672,389		$ 400,405.14	$50,172		-$72,073	0	$378,503.88	$4,419,660.93	$83,199
27	2037	$ 0.2454	1,672,389		$ 410,415.27	$50,172		-$73,875	0	$386,712.19	$4,806,373.12	$80,192
28	2038	$ 0.2515	1,672,389		$ 420,675.65	$50,172		-$75,722	0	$395,125.70	$5,201,498.82	$77,298
29	2039	$ 0.2578	1,672,389		$ 431,192.54	$50,172		-$77,615	0	$403,749.55	$5,605,248.37	$74,515
30	2040	$ 0.2643	1,672,389		$ 441,972.35	$50,172		-$79,555	0	$412,589.00	$6,017,837.37	$71,836

Financial Calulations

	IRR	NPV
5 Years	-34%	-$2,256,246
10 Years	-5%	-$1,437,175
15 Years	3%	-$760,195
20 Years	6%	-$199,429

Years to Postive Return 12

PPA Financial Pro-Forma @ P50 (PPA)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Mitsubishi	Total Project Cost	$0.00	Current Value of offset Electricity	$0.01
WTG Faceplate (kW)	1000	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0
WTG Hub Height (m)	70	Down Payment	$0	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	61	Loan Amount	$0	Annual Inflation on Utility Rates:	0.00%
WTG Prod. (kWh/Year)	1,672,389	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.19	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

					Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	$0	$ -	$0	$0		$0.00	$0.00	$0.00	$0
2	2012	$ 0.0130	1,672,389		$ 21,741.06	$0	$0	-$3,913	$0.00	$17,827.67	$17,827.67	$15,867
3	2013	$ 0.0130	1,672,389		$ 21,741.06	$0	$0	-$4,011	$0.00	$17,729.83	$35,557.50	$14,886
4	2014	$ 0.0130	1,672,389		$ 21,741.06	$0	$0	-$4,112	$0.00	$17,629.55	$53,187.05	$13,964
5	2015	$ 0.0130	1,672,389		$ 21,741.06	$0	$0	-$4,214	$0.00	$17,526.76	$70,713.81	$13,097
6	2016	$ 0.0130	1,672,389		$ 21,741.06	$0	$0	-$4,320	$0.00	$17,421.41	$88,135.22	$12,281
7	2017	$ 0.0130	1,672,389		$ 21,741.06	$0		-$4,428	$0.00	$17,313.42	$105,448.64	$11,514
8	2018	$ 0.0130	1,672,389		$ 21,741.06	$0		-$4,538	$0.00	$17,202.72	$122,651.36	$10,793
9	2019	$ 0.0130	1,672,389		$ 21,741.06	$0		-$4,652	$0.00	$17,089.27	$139,740.63	$10,115
10	2020	$ 0.0130	1,672,389		$ 21,741.06	$0		-$4,768	$0.00	$16,972.97	$156,713.60	$9,478
11	2021	$ 0.0130	1,672,389		$ 21,741.06	$0		-$4,887	$0.00	$16,853.77	$173,567.36	$8,878
12	2022	$ 0.0130	1,672,389		$ 21,741.06	$0		-$5,009	$0.00	$16,731.59	$190,298.95	$8,315
13	2023	$ 0.0130	1,672,389		$ 21,741.06	$0		-$5,135	$0.00	$16,606.35	$206,905.30	$7,786
14	2024	$ 0.0130	1,672,389		$ 21,741.06	$0		-$5,263	$0.00	$16,477.98	$223,383.28	$7,288
15	2025	$ 0.0130	1,672,389		$ 21,741.06	$0		-$5,395	$0.00	$16,346.41	$239,729.69	$6,821
16	2026	$ 0.0130	1,672,389		$ 21,741.06	$0		-$5,530	$0.00	$16,211.54	$255,941.23	$6,382
17	2027	$ 0.0130	1,672,389		$ 21,741.06	$0		-$5,668	$0.00	$16,073.30	$272,014.53	$5,969
18	2028	$ 0.0130	1,672,389		$ 21,741.06	$0		-$5,809	$0.00	$15,931.61	$287,946.14	$5,582
19	2029	$ 0.0130	1,672,389		$ 21,741.06	$0		-$5,955	$0.00	$15,786.37	$303,732.51	$5,218
20	2030	$ 0.0130	1,672,389		$ 21,741.06	$0		-$6,104	$0.00	$15,637.50	$319,370.01	$4,876
21	2031	$ 0.0130	1,672,389		$ 21,741.06	$0		-$6,256	0	$15,484.91	$334,854.93	$4,555
22	2032	$ 0.0130	1,672,389		$ 21,741.06	$0		-$6,413	0	$15,328.51	$350,183.44	$4,254
23	2033	$ 0.0130	1,672,389		$ 21,741.06	$0		-$6,573	0	$15,168.20	$365,351.63	$3,971
24	2034	$ 0.0130	1,672,389		$ 21,741.06	$0		-$6,737	0	$15,003.88	$380,355.51	$3,706
25	2035	$ 0.0130	1,672,389		$ 21,741.06	$0		-$6,906	0	$14,835.45	$395,190.96	$3,457
26	2036	$ 0.0130	1,672,389		$ 21,741.06	$0		-$7,078	0	$14,662.81	$409,853.76	$3,223
27	2037	$ 0.0130	1,672,389		$ 21,741.06	$0		-$7,255	0	$14,485.85	$424,339.61	$3,004
28	2038	$ 0.0130	1,672,389		$ 21,741.06	$0		-$7,437	0	$14,304.47	$438,644.08	$2,798
29	2039	$ 0.0130	1,672,389		$ 21,741.06	$0		-$7,623	0	$14,118.56	$452,762.64	$2,606
30	2040	$ 0.0130	1,672,389		$ 21,741.06	$0		-$7,813	0	$13,927.99	$466,690.63	$2,425

Financial Calulations

	IRR	NPV
5 Years	#NUM!	$57,814
10 Years	#DIV/0!	$111,996
15 Years	#DIV/0!	$151,084
20 Years	#DIV/0!	$179,110

Years to Postive Return 0

Financial Pro-Forma @ P50 (w/out MassCEC Grant)

Project Information:		**Key Assumptions:**					
Name	Winter Island	WTG Manufacturer:	GE Energy	Total Project Cost	$4,500,000.00	Current Value of offset Electricity	$0.13
Client	City of Salem	WTG Faceplate (kW)	1500	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0.03
Location	Salem	WTG Hub Height (m)	80	Down Payment	-$4,500,000	Net Present Value Based on Discount Rate of:	6.00%
	MA	Blade Diameter (m)	77	Loan Amount	$0	Annual Inflation on Utility Rates:	2.50%
MAI Job #	5209	WTG Prod. (kWh/Year)	3,607,026	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
Prepared By	DEG	WTG Capacity Factor	0.27	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

					Project Revenues			**Project Costs**		**Project Cash Flows**		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	-$4,500,000	$ -	$0	$0		$0.00	-$4,500,000.00	-$4,500,000.00	-$4,500,000
2	2012	$ 0.1324	3,607,026		$ 477,462.03	$108,211	$0	-$85,943	$0.00	$499,729.65	-$4,000,270.35	$444,758
3	2013	$ 0.1357	3,607,026		$ 489,398.58	$108,211	$0	-$88,092	$0.00	$509,517.62	-$3,490,752.74	$427,801
4	2014	$ 0.1391	3,607,026		$ 501,633.55	$108,211	$0	-$90,294	$0.00	$519,550.29	-$2,971,202.45	$411,532
5	2015	$ 0.1425	3,607,026		$ 514,174.39	$108,211	$0	-$92,551	$0.00	$529,833.78	-$2,441,368.67	$395,923
6	2016	$ 0.1461	3,607,026		$ 527,028.75	$108,211	$0	-$94,865	$0.00	$540,374.35	-$1,900,994.32	$380,943
7	2017	$ 0.1498	3,607,026		$ 540,204.46	$108,211		-$97,237	$0.00	$551,178.44	-$1,349,815.88	$366,565
8	2018	$ 0.1535	3,607,026		$ 553,709.58	$108,211		-$99,668	$0.00	$562,252.63	-$787,563.25	$352,764
9	2019	$ 0.1573	3,607,026		$ 567,552.31	$108,211		-$102,159	$0.00	$573,603.68	-$213,959.57	$339,515
10	2020	$ 0.1613	3,607,026		$ 581,741.12	$108,211		-$104,713	$0.00	$585,238.50	$371,278.93	$326,794
11	2021	$ 0.1653	3,607,026		$ 596,284.65	$108,211		-$107,331	$0.00	$597,164.19	$968,443.12	$314,579
12	2022	$ 0.1694	3,607,026		$ 611,191.77	$108,211		-$110,015	$0.00	$609,388.03	$1,577,831.15	$302,847
13	2023	$ 0.1737	3,607,026		$ 626,471.56	$108,211		-$112,765	$0.00	$621,917.46	$2,199,748.61	$291,579
14	2024	$ 0.1780	3,607,026		$ 642,133.35	$108,211		-$115,584	$0.00	$634,760.13	$2,834,508.74	$280,755
15	2025	$ 0.1825	3,607,026		$ 658,186.68	$108,211		-$118,474	$0.00	$647,923.86	$3,482,432.60	$270,356
16	2026	$ 0.1870	3,607,026		$ 674,641.35	$108,211		-$121,435	$0.00	$661,416.69	$4,143,849.29	$260,364
17	2027	$ 0.1917	3,607,026		$ 691,507.38	$108,211		-$124,471	$0.00	$675,246.84	$4,819,096.13	$250,763
18	2028	$ 0.1965	3,607,026		$ 708,795.07	$108,211		-$127,583	$0.00	$689,422.74	$5,508,518.86	$241,535
19	2029	$ 0.2014	3,607,026		$ 726,514.95	$108,211		-$130,773	$0.00	$703,953.04	$6,212,471.90	$232,666
20	2030	$ 0.2065	3,607,026		$ 744,677.82	$108,211		-$134,042	$0.00	$718,846.59	$6,931,318.49	$224,140
21	2031	$ 0.2116	3,607,026		$ 763,294.77	$108,211		-$137,393	0	$734,112.49	$7,665,430.98	$215,943
22	2032	$ 0.2169	3,607,026		$ 782,377.13	$108,211		-$140,828	0	$749,760.03	$8,415,191.01	$208,062
23	2033	$ 0.2223	3,607,026		$ 801,936.56	$108,211		-$144,349	0	$765,798.76	$9,180,989.77	$200,484
24	2034	$ 0.2279	3,607,026		$ 821,984.98	$108,211		-$147,957	0	$782,238.46	$9,963,228.23	$193,196
25	2035	$ 0.2336	3,607,026		$ 842,534.60	$108,211		-$151,656	0	$799,089.15	$10,762,317.39	$186,187
26	2036	$ 0.2394	3,607,026		$ 863,597.97	$108,211		-$155,448	0	$816,361.11	$11,578,678.50	$179,444
27	2037	$ 0.2454	3,607,026		$ 885,187.92	$108,211		-$159,334	0	$834,064.87	$12,412,743.37	$172,958
28	2038	$ 0.2515	3,607,026		$ 907,317.61	$108,211		-$163,317	0	$852,211.22	$13,264,954.59	$166,718
29	2039	$ 0.2578	3,607,026		$ 930,000.55	$108,211		-$167,400	0	$870,811.23	$14,135,765.83	$160,714
30	2040	$ 0.2643	3,607,026		$ 953,250.57	$108,211		-$171,585	0	$889,876.25	$15,025,642.07	$154,936

Financial Calulations

	IRR	**NPV**
5 Years	-25%	-$2,819,986
10 Years	2%	-$1,053,405
15 Years	8%	$406,711
20 Years	11%	$1,616,178

Years to Postive Return 9

Financial Pro-Forma @ P50 (w/ MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	GE Energy	Total Project Cost	$4,500,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1500	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	80	Down Payment	-$4,100,000	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	77	Loan Amount	$0	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	3,607,026	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.27	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

					Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	-$4,100,000	$ -	$0	$0		$0.00	-$4,100,000.00	-$4,100,000.00	-$4,100,000
2	2012	$ 0.1324	3,607,026		$ 477,462.03	$108,211	$0	-$85,943	$0.00	$499,729.65	-$3,600,270.35	$444,758
3	2013	$ 0.1357	3,607,026		$ 489,398.58	$108,211	$0	-$88,092	$0.00	$509,517.62	-$3,090,752.74	$427,801
4	2014	$ 0.1391	3,607,026		$ 501,633.55	$108,211	$0	-$90,294	$0.00	$519,550.29	-$2,571,202.45	$411,532
5	2015	$ 0.1425	3,607,026		$ 514,174.39	$108,211	$0	-$92,551	$0.00	$529,833.78	-$2,041,368.67	$395,923
6	2016	$ 0.1461	3,607,026		$ 527,028.75	$108,211	$0	-$94,865	$0.00	$540,374.35	-$1,500,994.32	$380,943
7	2017	$ 0.1498	3,607,026		$ 540,204.46	$108,211		-$97,237	$0.00	$551,178.44	-$949,815.88	$366,565
8	2018	$ 0.1535	3,607,026		$ 553,709.58	$108,211		-$99,668	$0.00	$562,252.63	-$387,563.25	$352,764
9	2019	$ 0.1573	3,607,026		$ 567,552.31	$108,211		-$102,159	$0.00	$573,603.68	$186,040.43	$339,515
10	2020	$ 0.1613	3,607,026		$ 581,741.12	$108,211		-$104,713	$0.00	$585,238.50	$771,278.93	$326,794
11	2021	$ 0.1653	3,607,026		$ 596,284.65	$108,211		-$107,331	$0.00	$597,164.19	$1,368,443.12	$314,579
12	2022	$ 0.1694	3,607,026		$ 611,191.77	$108,211		-$110,015	$0.00	$609,388.03	$1,977,831.15	$302,847
13	2023	$ 0.1737	3,607,026		$ 626,471.56	$108,211		-$112,765	$0.00	$621,917.46	$2,599,748.61	$291,579
14	2024	$ 0.1780	3,607,026		$ 642,133.35	$108,211		-$115,584	$0.00	$634,760.13	$3,234,508.74	$280,755
15	2025	$ 0.1825	3,607,026		$ 658,186.68	$108,211		-$118,474	$0.00	$647,923.86	$3,882,432.60	$270,356
16	2026	$ 0.1870	3,607,026		$ 674,641.35	$108,211		-$121,435	$0.00	$661,416.69	$4,543,849.29	$260,364
17	2027	$ 0.1917	3,607,026		$ 691,507.38	$108,211		-$124,471	$0.00	$675,246.84	$5,219,096.13	$250,763
18	2028	$ 0.1965	3,607,026		$ 708,795.07	$108,211		-$127,583	$0.00	$689,422.74	$5,908,518.86	$241,535
19	2029	$ 0.2014	3,607,026		$ 726,514.95	$108,211		-$130,773	$0.00	$703,953.04	$6,612,471.90	$232,666
20	2030	$ 0.2065	3,607,026		$ 744,677.82	$108,211		-$134,042	$0.00	$718,846.59	$7,331,318.49	$224,140
21	2031	$ 0.2116	3,607,026		$ 763,294.77	$108,211		-$137,393	0	$734,112.49	$8,065,430.98	$215,943
22	2032	$ 0.2169	3,607,026		$ 782,377.13	$108,211		-$140,828	0	$749,760.03	$8,815,191.01	$208,062
23	2033	$ 0.2223	3,607,026		$ 801,936.56	$108,211		-$144,349	0	$765,798.76	$9,580,989.77	$200,484
24	2034	$ 0.2279	3,607,026		$ 821,984.98	$108,211		-$147,957	0	$782,238.46	$10,363,228.23	$193,196
25	2035	$ 0.2336	3,607,026		$ 842,534.60	$108,211		-$151,656	0	$799,089.15	$11,162,317.39	$186,187
26	2036	$ 0.2394	3,607,026		$ 863,597.97	$108,211		-$155,448	0	$816,361.11	$11,978,678.50	$179,444
27	2037	$ 0.2454	3,607,026		$ 885,187.92	$108,211		-$159,334	0	$834,064.87	$12,812,743.37	$172,958
28	2038	$ 0.2515	3,607,026		$ 907,317.61	$108,211		-$163,317	0	$852,211.22	$13,664,954.59	$166,718
29	2039	$ 0.2578	3,607,026		$ 930,000.55	$108,211		-$167,400	0	$870,811.23	$14,535,765.83	$160,714
30	2040	$ 0.2643	3,607,026		$ 953,250.57	$108,211		-$171,585	0	$889,876.25	$15,425,642.07	$154,936

Financial Calulations

	IRR	NPV
5 Years	-23%	-$2,419,986
10 Years	3%	-$653,405
15 Years	10%	$806,711
20 Years	12%	$2,016,178

Years to Postive Return 8

PPA Financial Pro-Forma @ P50 (PPA)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	GE Energy	Total Project Cost	$0.00	Current Value of offset Electricity	$0.01
WTG Faceplate (kW)	1500	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0
WTG Hub Height (m)	80	Down Payment	$0	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	77	Loan Amount	$0	Annual Inflation on Utility Rates:	0.00%
WTG Prod. (kWh/Year)	3,607,026	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.27	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

					Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	$0	$ -	$0	$0		$0.00	$0.00	$0.00	$0
2	2012	$ 0.0130	3,607,026		$ 46,891.34	$0	$0	-$8,440	$0.00	$38,450.90	$38,450.90	$34,221
3	2013	$ 0.0130	3,607,026		$ 46,891.34	$0	$0	-$8,651	$0.00	$38,239.89	$76,690.78	$32,107
4	2014	$ 0.0130	3,607,026		$ 46,891.34	$0	$0	-$8,868	$0.00	$38,023.60	$114,714.38	$30,118
5	2015	$ 0.0130	3,607,026		$ 46,891.34	$0	$0	-$9,089	$0.00	$37,801.91	$152,516.29	$28,248
6	2016	$ 0.0130	3,607,026		$ 46,891.34	$0	$0	-$9,317	$0.00	$37,574.67	$190,090.96	$26,489
7	2017	$ 0.0130	3,607,026		$ 46,891.34	$0		-$9,550	$0.00	$37,341.75	$227,432.71	$24,834
8	2018	$ 0.0130	3,607,026		$ 46,891.34	$0		-$9,788	$0.00	$37,103.01	$264,535.73	$23,279
9	2019	$ 0.0130	3,607,026		$ 46,891.34	$0		-$10,033	$0.00	$36,858.31	$301,394.03	$21,816
10	2020	$ 0.0130	3,607,026		$ 46,891.34	$0		-$10,284	$0.00	$36,607.48	$338,001.51	$20,441
11	2021	$ 0.0130	3,607,026		$ 46,891.34	$0		-$10,541	$0.00	$36,350.38	$374,351.90	$19,149
12	2022	$ 0.0130	3,607,026		$ 46,891.34	$0		-$10,804	$0.00	$36,086.86	$410,438.76	$17,934
13	2023	$ 0.0130	3,607,026		$ 46,891.34	$0		-$11,075	$0.00	$35,816.75	$446,255.51	$16,792
14	2024	$ 0.0130	3,607,026		$ 46,891.34	$0		-$11,351	$0.00	$35,539.88	$481,795.39	$15,719
15	2025	$ 0.0130	3,607,026		$ 46,891.34	$0		-$11,635	$0.00	$35,256.10	$517,051.49	$14,711
16	2026	$ 0.0130	3,607,026		$ 46,891.34	$0		-$11,926	$0.00	$34,965.22	$552,016.70	$13,764
17	2027	$ 0.0130	3,607,026		$ 46,891.34	$0		-$12,224	$0.00	$34,667.06	$586,683.77	$12,874
18	2028	$ 0.0130	3,607,026		$ 46,891.34	$0		-$12,530	$0.00	$34,361.46	$621,045.22	$12,038
19	2029	$ 0.0130	3,607,026		$ 46,891.34	$0		-$12,843	$0.00	$34,048.21	$655,093.43	$11,253
20	2030	$ 0.0130	3,607,026		$ 46,891.34	$0		-$13,164	$0.00	$33,727.13	$688,820.56	$10,516
21	2031	$ 0.0130	3,607,026		$ 46,891.34	$0		-$13,493	0	$33,398.03	$722,218.59	$9,824
22	2032	$ 0.0130	3,607,026		$ 46,891.34	$0		-$13,831	0	$33,060.69	$755,279.28	$9,175
23	2033	$ 0.0130	3,607,026		$ 46,891.34	$0		-$14,176	0	$32,714.93	$787,994.21	$8,565
24	2034	$ 0.0130	3,607,026		$ 46,891.34	$0		-$14,531	0	$32,360.52	$820,354.72	$7,992
25	2035	$ 0.0130	3,607,026		$ 46,891.34	$0		-$14,894	0	$31,997.25	$852,351.97	$7,455
26	2036	$ 0.0130	3,607,026		$ 46,891.34	$0		-$15,266	0	$31,624.89	$883,976.86	$6,951
27	2037	$ 0.0130	3,607,026		$ 46,891.34	$0		-$15,648	0	$31,243.23	$915,220.10	$6,479
28	2038	$ 0.0130	3,607,026		$ 46,891.34	$0		-$16,039	0	$30,852.03	$946,072.13	$6,036
29	2039	$ 0.0130	3,607,026		$ 46,891.34	$0		-$16,440	0	$30,451.05	$976,523.17	$5,620
30	2040	$ 0.0130	3,607,026		$ 46,891.34	$0		-$16,851	0	$30,040.04	$1,006,563.21	$5,230

Financial Calulations

	IRR	NPV
5 Years	#NUM!	$124,694
10 Years	#DIV/0!	$241,554
15 Years	#DIV/0!	$325,860
20 Years	#DIV/0!	$386,306

Years to Postive Return 0

Financial Pro-Forma @ P90 (w/out MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Elecon	Total Project Cost	$2,500,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	600	Down Payment (%)	0	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	60	Down Payment	$0	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	48	Loan Amount	-$2,500,000	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	884,794	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.17	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

	Project Revenues					Project Costs		Project Cash Flows		
Project Year	Fiscal Year	Average Rates ($/kWh)	Annual Energy Production	Capital Payment	Annual Revenue from Production	REC Revenue	Depreciation	Total O+M Cost per Year	Annual Loan Principal and Interest	Cash Flow	Cumulative Cash Flow	Net Present Value for Current Year
1	2011		0	$0	$ -	$0	$0		-$197,986.72	-$197,986.72	-$197,986.72	-$197,987
2	2012	$ 0.1324	884,794		$ 117,120.18	$26,544	$0	-$21,082	-$197,986.72	-$75,404.35	-$273,391.07	-$67,110
3	2013	$ 0.1357	884,794		$ 120,048.19	$26,544	$0	-$21,609	-$197,986.72	-$73,003.39	-$346,394.46	-$61,295
4	2014	$ 0.1391	884,794		$ 123,049.39	$26,544	$0	-$22,149	-$197,986.72	-$70,542.40	-$416,936.86	-$55,876
5	2015	$ 0.1425	884,794		$ 126,125.63	$26,544	$0	-$22,703	-$197,986.72	-$68,019.89	-$484,956.75	-$50,828
6	2016	$ 0.1461	884,794		$ 129,278.77	$26,544	$0	-$23,270	-$197,986.72	-$65,434.31	-$550,391.07	-$46,129
7	2017	$ 0.1498	884,794		$ 132,510.74	$26,544		-$23,852	-$197,986.72	-$62,784.10	-$613,175.17	-$41,755
8	2018	$ 0.1535	884,794		$ 135,823.50	$26,544		-$24,448	-$197,986.72	-$60,067.63	-$673,242.79	-$37,687
9	2019	$ 0.1573	884,794		$ 139,219.09	$26,544		-$25,059	-$197,986.72	-$57,283.25	-$730,526.04	-$33,906
10	2020	$ 0.1613	884,794		$ 142,699.57	$26,544		-$25,686	-$197,986.72	-$54,429.26	-$784,955.30	-$30,393
11	2021	$ 0.1653	884,794		$ 146,267.06	$26,544		-$26,328	-$197,986.72	-$51,503.91	-$836,459.21	-$27,132
12	2022	$ 0.1694	884,794		$ 149,923.73	$26,544		-$26,986	-$197,986.72	-$48,505.44	-$884,964.65	-$24,106
13	2023	$ 0.1737	884,794		$ 153,671.83	$26,544		-$27,661	-$197,986.72	-$45,432.00	-$930,396.65	-$21,300
14	2024	$ 0.1780	884,794		$ 157,513.62	$26,544		-$28,352	-$197,986.72	-$42,281.73	-$972,678.38	-$18,701
15	2025	$ 0.1825	884,794		$ 161,451.46	$26,544		-$29,061	-$197,986.72	-$39,052.70	-$1,011,731.08	-$16,295
16	2026	$ 0.1870	884,794		$ 165,487.75	$26,544		-$29,788	-$197,986.72	-$35,742.95	-$1,047,474.03	-$14,070
17	2027	$ 0.1917	884,794		$ 169,624.94	$26,544		-$30,532	-$197,986.72	-$32,350.45	-$1,079,824.48	-$12,014
18	2028	$ 0.1965	884,794		$ 173,865.57	$26,544		-$31,296	-$197,986.72	-$28,873.14	-$1,108,697.61	-$10,116
19	2029	$ 0.2014	884,794		$ 178,212.21	$26,544		-$32,078	-$197,986.72	-$25,308.89	-$1,134,006.50	-$8,365
20	2030	$ 0.2065	884,794		$ 182,667.51	$26,544		-$32,880	-$197,986.72	-$21,655.54	-$1,155,662.05	-$6,752
21	2031	$ 0.2116	884,794		$ 187,234.20	$26,544		-$33,702	0	$180,075.86	-$975,586.18	$52,970
22	2032	$ 0.2169	884,794		$ 191,915.06	$26,544		-$34,545	0	$183,914.17	-$791,672.02	$51,037
23	2033	$ 0.2223	884,794		$ 196,712.93	$26,544		-$35,408	0	$187,848.42	-$603,823.59	$49,178
24	2034	$ 0.2279	884,794		$ 201,630.76	$26,544		-$36,294	0	$191,881.04	-$411,942.55	$47,391
25	2035	$ 0.2336	884,794		$ 206,671.52	$26,544		-$37,201	0	$196,014.47	-$215,928.08	$45,671
26	2036	$ 0.2394	884,794		$ 211,838.31	$26,544		-$38,131	0	$200,251.24	-$15,676.85	$44,017
27	2037	$ 0.2454	884,794		$ 217,134.27	$26,544		-$39,084	0	$204,593.92	$188,917.07	$42,426
28	2038	$ 0.2515	884,794		$ 222,562.63	$26,544		-$40,061	0	$209,045.17	$397,962.25	$40,896
29	2039	$ 0.2578	884,794		$ 228,126.69	$26,544		-$41,063	0	$213,607.71	$611,569.95	$39,423
30	2040	$ 0.2643	884,794		$ 233,829.86	$26,544		-$42,089	0	$218,284.30	$829,854.26	$38,006

Financial Calulations

	IRR	NPV
5 Years		-$433,096
10 Years	#NUM!	-$622,966
15 Years	#DIV/0!	-$730,500
20 Years	#DIV/0!	-$781,816

Years to Postive Return 26

Financial Pro-Forma @ P90 (w/ MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Elecon	Total Project Cost	$2,500,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	600	Down Payment (%)	0	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	60	Down Payment	$320,500	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	48	Loan Amount	-$2,179,500	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	884,794	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.17	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

	Project Revenues					Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	$320,500	$ -	$0	$0		-$172,604.82	$147,895.18	$147,895.18	$147,895
2	2012	$ 0.1324	884,794		$ 117,120.18	$26,544	$0	-$21,082	-$172,604.82	-$50,022.45	$97,872.72	-$44,520
3	2013	$ 0.1357	884,794		$ 120,048.19	$26,544	$0	-$21,609	-$172,604.82	-$47,621.49	$50,251.23	-$39,984
4	2014	$ 0.1391	884,794		$ 123,049.39	$26,544	$0	-$22,149	-$172,604.82	-$45,160.50	$5,090.73	-$35,771
5	2015	$ 0.1425	884,794		$ 126,125.63	$26,544	$0	-$22,703	-$172,604.82	-$42,637.99	-$37,547.26	-$31,862
6	2016	$ 0.1461	884,794		$ 129,278.77	$26,544	$0	-$23,270	-$172,604.82	-$40,052.42	-$77,599.68	-$28,235
7	2017	$ 0.1498	884,794		$ 132,510.74	$26,544		-$23,852	-$172,604.82	-$37,402.20	-$115,001.88	-$24,875
8	2018	$ 0.1535	884,794		$ 135,823.50	$26,544		-$24,448	-$172,604.82	-$34,685.73	-$149,687.61	-$21,762
9	2019	$ 0.1573	884,794		$ 139,219.09	$26,544		-$25,059	-$172,604.82	-$31,901.35	-$181,588.96	-$18,882
10	2020	$ 0.1613	884,794		$ 142,699.57	$26,544		-$25,686	-$172,604.82	-$29,047.36	-$210,636.32	-$16,220
11	2021	$ 0.1653	884,794		$ 146,267.06	$26,544		-$26,328	-$172,604.82	-$26,122.02	-$236,758.33	-$13,761
12	2022	$ 0.1694	884,794		$ 149,923.73	$26,544		-$26,986	-$172,604.82	-$23,123.54	-$259,881.88	-$11,492
13	2023	$ 0.1737	884,794		$ 153,671.83	$26,544		-$27,661	-$172,604.82	-$20,050.11	-$279,931.98	-$9,400
14	2024	$ 0.1780	884,794		$ 157,513.62	$26,544		-$28,352	-$172,604.82	-$16,899.83	-$296,831.81	-$7,475
15	2025	$ 0.1825	884,794		$ 161,451.46	$26,544		-$29,061	-$172,604.82	-$13,670.80	-$310,502.62	-$5,704
16	2026	$ 0.1870	884,794		$ 165,487.75	$26,544		-$29,788	-$172,604.82	-$10,361.05	-$320,863.67	-$4,079
17	2027	$ 0.1917	884,794		$ 169,624.94	$26,544		-$30,532	-$172,604.82	-$6,968.55	-$327,832.22	-$2,588
18	2028	$ 0.1965	884,794		$ 173,865.57	$26,544		-$31,296	-$172,604.82	-$3,491.24	-$331,323.45	-$1,223
19	2029	$ 0.2014	884,794		$ 178,212.21	$26,544		-$32,078	-$172,604.82	$73.01	-$331,250.45	$24
20	2030	$ 0.2065	884,794		$ 182,667.51	$26,544		-$32,880	-$172,604.82	$3,726.36	-$327,524.09	$1,162
21	2031	$ 0.2116	884,794		$ 187,234.20	$26,544		-$33,702	0	$180,075.86	-$147,448.23	$52,970
22	2032	$ 0.2169	884,794		$ 191,915.06	$26,544		-$34,545	0	$183,914.17	$36,465.94	$51,037
23	2033	$ 0.2223	884,794		$ 196,712.93	$26,544		-$35,408	0	$187,848.42	$224,314.36	$49,178
24	2034	$ 0.2279	884,794		$ 201,630.76	$26,544		-$36,294	0	$191,881.04	$416,195.40	$47,391
25	2035	$ 0.2336	884,794		$ 206,671.52	$26,544		-$37,201	0	$196,014.47	$612,209.87	$45,671
26	2036	$ 0.2394	884,794		$ 211,838.31	$26,544		-$38,131	0	$200,251.24	$812,461.11	$44,017
27	2037	$ 0.2454	884,794		$ 217,134.27	$26,544		-$39,084	0	$204,593.92	$1,017,055.03	$42,426
28	2038	$ 0.2515	884,794		$ 222,562.63	$26,544		-$40,061	0	$209,045.17	$1,226,100.20	$40,896
29	2039	$ 0.2578	884,794		$ 228,126.69	$26,544		-$41,063	0	$213,607.71	$1,439,707.91	$39,423
30	2040	$ 0.2643	884,794		$ 233,829.86	$26,544		-$42,089	0	$218,284.30	$1,657,992.21	$38,006

Financial Calulations

	IRR	NPV
5 Years		-$4,241
10 Years	26%	-$114,216
15 Years	27%	-$162,048
20 Years	27%	-$168,751

Years to Postive Return 23

Financial Pro-Forma @ P90 (w/out MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Mitsubishi	Total Project Cost	$3,400,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1000	Down Payment (%)	0	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	70	Down Payment	$0	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	61	Loan Amount	-$3,400,000	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	1,189,567	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.14	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

	Project Revenues					Project Costs			Project Cash Flows		
Project Year	Fiscal Year	Average Rates ($/kWh)	Annual Energy Production	Capital Payment	Annual Revenue from Production	REC Revenue	Depreciation	Total O+M Cost per Year	Annual Loan Principal and Interest	Cash Flow	Cumulative Cash Flow	Net Present Value for Current Year
1	2011		0	$0	$ -	$0	$0		-$269,261.94	-$269,261.94	-$269,261.94	-$269,262
2	2012	$ 0.1324	1,189,567		$ 157,462.98	$35,687	$0	-$28,343	-$269,261.94	-$104,455.28	-$373,717.23	-$92,965
3	2013	$ 0.1357	1,189,567		$ 161,399.56	$35,687	$0	-$29,052	-$269,261.94	-$101,227.29	-$474,944.52	-$84,992
4	2014	$ 0.1391	1,189,567		$ 165,434.55	$35,687	$0	-$29,778	-$269,261.94	-$97,918.60	-$572,863.12	-$77,561
5	2015	$ 0.1425	1,189,567		$ 169,570.41	$35,687	$0	-$30,523	-$269,261.94	-$94,527.19	-$667,390.32	-$70,636
6	2016	$ 0.1461	1,189,567		$ 173,809.67	$35,687	$0	-$31,286	-$269,261.94	-$91,051.00	-$758,441.32	-$64,187
7	2017	$ 0.1498	1,189,567		$ 178,154.91	$35,687		-$32,068	-$269,261.94	-$87,487.90	-$845,929.22	-$58,184
8	2018	$ 0.1535	1,189,567		$ 182,608.79	$35,687		-$32,870	-$269,261.94	-$83,835.73	-$929,764.95	-$52,600
9	2019	$ 0.1573	1,189,567		$ 187,174.01	$35,687		-$33,691	-$269,261.94	-$80,092.25	-$1,009,857.20	-$47,406
10	2020	$ 0.1613	1,189,567		$ 191,853.36	$35,687		-$34,534	-$269,261.94	-$76,255.18	-$1,086,112.38	-$42,580
11	2021	$ 0.1653	1,189,567		$ 196,649.69	$35,687		-$35,397	-$269,261.94	-$72,322.19	-$1,158,434.56	-$38,098
12	2022	$ 0.1694	1,189,567		$ 201,565.93	$35,687		-$36,282	-$269,261.94	-$68,290.87	-$1,226,725.43	-$33,938
13	2023	$ 0.1737	1,189,567		$ 206,605.08	$35,687		-$37,189	-$269,261.94	-$64,158.77	-$1,290,884.20	-$30,080
14	2024	$ 0.1780	1,189,567		$ 211,770.21	$35,687		-$38,119	-$269,261.94	-$59,923.36	-$1,350,807.56	-$26,504
15	2025	$ 0.1825	1,189,567		$ 217,064.46	$35,687		-$39,072	-$269,261.94	-$55,582.07	-$1,406,389.63	-$23,192
16	2026	$ 0.1870	1,189,567		$ 222,491.07	$35,687		-$40,048	-$269,261.94	-$51,132.25	-$1,457,521.88	-$20,128
17	2027	$ 0.1917	1,189,567		$ 228,053.35	$35,687		-$41,050	-$269,261.94	-$46,571.18	-$1,504,093.06	-$17,295
18	2028	$ 0.1965	1,189,567		$ 233,754.68	$35,687		-$42,076	-$269,261.94	-$41,896.09	-$1,545,989.15	-$14,678
19	2029	$ 0.2014	1,189,567		$ 239,598.55	$35,687		-$43,128	-$269,261.94	-$37,104.12	-$1,583,093.27	-$12,263
20	2030	$ 0.2065	1,189,567		$ 245,588.52	$35,687		-$44,206	-$269,261.94	-$32,192.35	-$1,615,285.62	-$10,038
21	2031	$ 0.2116	1,189,567		$ 251,728.23	$35,687		-$45,311	0	$242,104.16	-$1,373,181.47	$71,216
22	2032	$ 0.2169	1,189,567		$ 258,021.43	$35,687		-$46,444	0	$247,264.59	-$1,125,916.88	$68,617
23	2033	$ 0.2223	1,189,567		$ 264,471.97	$35,687		-$47,605	0	$252,554.03	-$873,362.85	$66,118
24	2034	$ 0.2279	1,189,567		$ 271,083.77	$35,687		-$48,795	0	$257,975.70	-$615,387.15	$63,714
25	2035	$ 0.2336	1,189,567		$ 277,860.86	$35,687		-$50,015	0	$263,532.92	-$351,854.24	$61,403
26	2036	$ 0.2394	1,189,567		$ 284,807.38	$35,687		-$51,265	0	$269,229.07	-$82,625.17	$59,179
27	2037	$ 0.2454	1,189,567		$ 291,927.57	$35,687		-$52,547	0	$275,067.62	$192,442.45	$57,040
28	2038	$ 0.2515	1,189,567		$ 299,225.76	$35,687		-$53,861	0	$281,052.13	$473,494.58	$54,982
29	2039	$ 0.2578	1,189,567		$ 306,706.40	$35,687		-$55,207	0	$287,186.26	$760,680.84	$53,002
30	2040	$ 0.2643	1,189,567		$ 314,374.06	$35,687		-$56,587	0	$293,473.74	$1,054,154.58	$51,097

Financial Calulations

	IRR	NPV
5 Years	#NUM!	-$595,416
10 Years	#NUM!	-$860,374
15 Years	#DIV/0!	-$1,012,188
20 Years	#DIV/0!	-$1,086,590

Years to Postive Return 26

Financial Pro-Forma @ P90 (w/ MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Mitsubishi	Total Project Cost	$3,400,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1000	Down Payment (%)	0	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	70	Down Payment	$364,820	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	61	Loan Amount	-$3,035,180	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	1,189,567	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.14	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

	Project Revenues					Project Costs			Project Cash Flows		
Project Year	Fiscal Year	Average Rates ($/kWh)	Annual Energy Production	Capital Payment	Annual Revenue from Production	REC Revenue	Depreciation	Total O+M Cost per Year	Annual Loan Principal and Interest	Cash Flow	Cumulative Cash Flow	Net Present Value for Current Year
1	2011		0	$364,820	$ -	$0	$0		-$240,370.14	$124,449.86	$124,449.86	$124,450
2	2012	$ 0.1324	1,189,567		$ 157,462.98	$35,687	$0	-$28,343	-$240,370.14	-$75,563.48	$48,886.39	-$67,251
3	2013	$ 0.1357	1,189,567		$ 161,399.56	$35,687	$0	-$29,052	-$240,370.14	-$72,335.49	-$23,449.10	-$60,734
4	2014	$ 0.1391	1,189,567		$ 165,434.55	$35,687	$0	-$29,778	-$240,370.14	-$69,026.80	-$92,475.90	-$54,676
5	2015	$ 0.1425	1,189,567		$ 169,570.41	$35,687	$0	-$30,523	-$240,370.14	-$65,635.39	-$158,111.29	-$49,047
6	2016	$ 0.1461	1,189,567		$ 173,809.67	$35,687	$0	-$31,286	-$240,370.14	-$62,159.19	-$220,270.48	-$43,820
7	2017	$ 0.1498	1,189,567		$ 178,154.91	$35,687		-$32,068	-$240,370.14	-$58,596.10	-$278,866.58	-$38,970
8	2018	$ 0.1535	1,189,567		$ 182,608.79	$35,687		-$32,870	-$240,370.14	-$54,943.92	-$333,810.50	-$34,472
9	2019	$ 0.1573	1,189,567		$ 187,174.01	$35,687		-$33,691	-$240,370.14	-$51,200.44	-$385,010.94	-$30,305
10	2020	$ 0.1613	1,189,567		$ 191,853.36	$35,687		-$34,534	-$240,370.14	-$47,363.37	-$432,374.31	-$26,447
11	2021	$ 0.1653	1,189,567		$ 196,649.69	$35,687		-$35,397	-$240,370.14	-$43,430.38	-$475,804.69	-$22,879
12	2022	$ 0.1694	1,189,567		$ 201,565.93	$35,687		-$36,282	-$240,370.14	-$39,399.06	-$515,203.75	-$19,580
13	2023	$ 0.1737	1,189,567		$ 206,605.08	$35,687		-$37,189	-$240,370.14	-$35,266.96	-$550,470.71	-$16,535
14	2024	$ 0.1780	1,189,567		$ 211,770.21	$35,687		-$38,119	-$240,370.14	-$31,031.56	-$581,502.27	-$13,725
15	2025	$ 0.1825	1,189,567		$ 217,064.46	$35,687		-$39,072	-$240,370.14	-$26,690.27	-$608,192.53	-$11,137
16	2026	$ 0.1870	1,189,567		$ 222,491.07	$35,687		-$40,048	-$240,370.14	-$22,240.44	-$630,432.98	-$8,755
17	2027	$ 0.1917	1,189,567		$ 228,053.35	$35,687		-$41,050	-$240,370.14	-$17,679.38	-$648,112.36	-$6,565
18	2028	$ 0.1965	1,189,567		$ 233,754.68	$35,687		-$42,076	-$240,370.14	-$13,004.28	-$661,116.64	-$4,556
19	2029	$ 0.2014	1,189,567		$ 239,598.55	$35,687		-$43,128	-$240,370.14	-$8,212.31	-$669,328.95	-$2,714
20	2030	$ 0.2065	1,189,567		$ 245,588.52	$35,687		-$44,206	-$240,370.14	-$3,300.54	-$672,629.50	-$1,029
21	2031	$ 0.2116	1,189,567		$ 251,728.23	$35,687		-$45,311	0	$242,104.16	-$430,525.34	$71,216
22	2032	$ 0.2169	1,189,567		$ 258,021.43	$35,687		-$46,444	0	$247,264.59	-$183,260.75	$68,617
23	2033	$ 0.2223	1,189,567		$ 264,471.97	$35,687		-$47,605	0	$252,554.03	$69,293.27	$66,118
24	2034	$ 0.2279	1,189,567		$ 271,083.77	$35,687		-$48,795	0	$257,975.70	$327,268.97	$63,714
25	2035	$ 0.2336	1,189,567		$ 277,860.86	$35,687		-$50,015	0	$263,532.92	$590,801.89	$61,403
26	2036	$ 0.2394	1,189,567		$ 284,807.38	$35,687		-$51,265	0	$269,229.07	$860,030.96	$59,179
27	2037	$ 0.2454	1,189,567		$ 291,927.57	$35,687		-$52,547	0	$275,067.62	$1,135,098.57	$57,040
28	2038	$ 0.2515	1,189,567		$ 299,225.76	$35,687		-$53,861	0	$281,052.13	$1,416,150.71	$54,982
29	2039	$ 0.2578	1,189,567		$ 306,706.40	$35,687		-$55,207	0	$287,186.26	$1,703,336.97	$53,002
30	2040	$ 0.2643	1,189,567		$ 314,374.06	$35,687		-$56,587	0	$293,473.74	$1,996,810.71	$51,097

Financial Calulations

	IRR	NPV
5 Years	45%	-$107,258
10 Years	55%	-$281,273
15 Years	56%	-$365,128
20 Years	56%	-$388,748

Years to Postive Return 24

Financial Pro-Forma @ P90 (w/out MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	GE Energy	Total Project Cost	$4,500,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1500	Down Payment (%)	0	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	80	Down Payment	$0	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	77	Loan Amount	-$4,500,000	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	2,570,836	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.20	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

			Project Revenues				Project Costs		Project Cash Flows			
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	$0	$ -	$0	$0		-$356,376.10	-$356,376.10	-$356,376.10	-$356,376
2	2012	$ 0.1324	2,570,836		$ 340,301.56	$77,125	$0	-$61,254	-$356,376.10	-$203.74	-$356,579.84	-$181
3	2013	$ 0.1357	2,570,836		$ 348,809.10	$77,125	$0	-$62,786	-$356,376.10	$6,772.44	-$349,807.39	$5,686
4	2014	$ 0.1391	2,570,836		$ 357,529.33	$77,125	$0	-$64,355	-$356,376.10	$13,923.03	-$335,884.37	$11,028
5	2015	$ 0.1425	2,570,836		$ 366,467.56	$77,125	$0	-$65,964	-$356,376.10	$21,252.38	-$314,631.98	$15,881
6	2016	$ 0.1461	2,570,836		$ 375,629.25	$77,125	$0	-$67,613	-$356,376.10	$28,764.97	-$285,867.02	$20,278
7	2017	$ 0.1498	2,570,836		$ 385,019.98	$77,125		-$69,304	-$356,376.10	$36,465.37	-$249,401.65	$24,252
8	2018	$ 0.1535	2,570,836		$ 394,645.48	$77,125		-$71,036	-$356,376.10	$44,358.28	-$205,043.38	$27,831
9	2019	$ 0.1573	2,570,836		$ 404,511.62	$77,125		-$72,812	-$356,376.10	$52,448.51	-$152,594.87	$31,044
10	2020	$ 0.1613	2,570,836		$ 414,624.41	$77,125		-$74,632	-$356,376.10	$60,741.00	-$91,853.87	$33,917
11	2021	$ 0.1653	2,570,836		$ 424,990.02	$77,125		-$76,498	-$356,376.10	$69,240.80	-$22,613.08	$36,475
12	2022	$ 0.1694	2,570,836		$ 435,614.77	$77,125		-$78,411	-$356,376.10	$77,953.09	$55,340.01	$38,740
13	2023	$ 0.1737	2,570,836		$ 446,505.14	$77,125		-$80,371	-$356,376.10	$86,883.19	$142,223.21	$40,734
14	2024	$ 0.1780	2,570,836		$ 457,667.77	$77,125		-$82,380	-$356,376.10	$96,036.55	$238,259.76	$42,477
15	2025	$ 0.1825	2,570,836		$ 469,109.46	$77,125		-$84,440	-$356,376.10	$105,418.74	$343,678.50	$43,988
16	2026	$ 0.1870	2,570,836		$ 480,837.20	$77,125		-$86,551	-$356,376.10	$115,035.48	$458,713.98	$45,283
17	2027	$ 0.1917	2,570,836		$ 492,858.13	$77,125		-$88,714	-$356,376.10	$124,892.65	$583,606.62	$46,381
18	2028	$ 0.1965	2,570,836		$ 505,179.58	$77,125		-$90,932	-$356,376.10	$134,996.24	$718,602.86	$47,295
19	2029	$ 0.2014	2,570,836		$ 517,809.07	$77,125		-$93,206	-$356,376.10	$145,352.42	$863,955.28	$48,041
20	2030	$ 0.2065	2,570,836		$ 530,754.30	$77,125		-$95,536	-$356,376.10	$155,967.50	$1,019,922.78	$48,631
21	2031	$ 0.2116	2,570,836		$ 544,023.15	$77,125		-$97,924	0	$523,224.07	$1,543,146.85	$153,909
22	2032	$ 0.2169	2,570,836		$ 557,623.73	$77,125		-$100,372	0	$534,376.54	$2,077,523.39	$148,292
23	2033	$ 0.2223	2,570,836		$ 571,564.33	$77,125		-$102,882	0	$545,807.83	$2,623,331.22	$142,891
24	2034	$ 0.2279	2,570,836		$ 585,853.43	$77,125		-$105,454	0	$557,524.90	$3,180,856.11	$137,697
25	2035	$ 0.2336	2,570,836		$ 600,499.77	$77,125		-$108,090	0	$569,534.89	$3,750,391.01	$132,701
26	2036	$ 0.2394	2,570,836		$ 615,512.26	$77,125		-$110,792	0	$581,845.14	$4,332,236.14	$127,895
27	2037	$ 0.2454	2,570,836		$ 630,900.07	$77,125		-$113,562	0	$594,463.14	$4,926,699.28	$123,273
28	2038	$ 0.2515	2,570,836		$ 646,672.57	$77,125		-$116,401	0	$607,396.59	$5,534,095.87	$118,825
29	2039	$ 0.2578	2,570,836		$ 662,839.39	$77,125		-$119,311	0	$620,653.38	$6,154,749.25	$114,546
30	2040	$ 0.2643	2,570,836		$ 679,410.37	$77,125		-$122,294	0	$634,241.59	$6,788,990.83	$110,428

Financial Calulations

	IRR	NPV
5 Years	#NUM!	-$323,962
10 Years	-4%	-$186,640
15 Years	7%	$15,775
20 Years	11%	$251,406

Years to Postive Return 17

Financial Pro-Forma @ P90 (w/ MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	GE Energy	Total Project Cost	$4,500,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1500	Down Payment (%)	0	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	80	Down Payment	$400,000	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	77	Loan Amount	-$4,100,000	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	2,570,836	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.20	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

	Project Revenues					Project Costs			Project Cash Flows		
Project Year	Fiscal Year	Average Rates ($/kWh)	Annual Energy Production	Capital Payment	Annual Revenue from Production	REC Revenue	Depreciation	Total O+M Cost per Year	Annual Loan Principal and Interest	Cash Flow	Cumulative Cash Flow	Net Present Value for Current Year
1	2011		0	$400,000	$ -	$0	$0		-$324,698.22	$75,301.78	$75,301.78	$75,302
2	2012	$ 0.1324	2,570,836		$ 340,301.56	$77,125	$0	-$61,254	-$324,698.22	$31,474.14	$106,775.91	$28,012
3	2013	$ 0.1357	2,570,836		$ 348,809.10	$77,125	$0	-$62,786	-$324,698.22	$38,450.32	$145,226.23	$32,284
4	2014	$ 0.1391	2,570,836		$ 357,529.33	$77,125	$0	-$64,355	-$324,698.22	$45,600.91	$190,827.14	$36,120
5	2015	$ 0.1425	2,570,836		$ 366,467.56	$77,125	$0	-$65,964	-$324,698.22	$52,930.26	$243,757.39	$39,553
6	2016	$ 0.1461	2,570,836		$ 375,629.25	$77,125	$0	-$67,613	-$324,698.22	$60,442.84	$304,200.23	$42,610
7	2017	$ 0.1498	2,570,836		$ 385,019.98	$77,125		-$69,304	-$324,698.22	$68,143.24	$372,343.48	$45,319
8	2018	$ 0.1535	2,570,836		$ 394,645.48	$77,125		-$71,036	-$324,698.22	$76,036.15	$448,379.63	$47,706
9	2019	$ 0.1573	2,570,836		$ 404,511.62	$77,125		-$72,812	-$324,698.22	$84,126.38	$532,506.01	$49,794
10	2020	$ 0.1613	2,570,836		$ 414,624.41	$77,125		-$74,632	-$324,698.22	$92,418.87	$624,924.88	$51,606
11	2021	$ 0.1653	2,570,836		$ 424,990.02	$77,125		-$76,498	-$324,698.22	$100,918.67	$725,843.55	$53,163
12	2022	$ 0.1694	2,570,836		$ 435,614.77	$77,125		-$78,411	-$324,698.22	$109,630.97	$835,474.52	$54,483
13	2023	$ 0.1737	2,570,836		$ 446,505.14	$77,125		-$80,371	-$324,698.22	$118,561.07	$954,035.59	$55,586
14	2024	$ 0.1780	2,570,836		$ 457,667.77	$77,125		-$82,380	-$324,698.22	$127,714.42	$1,081,750.01	$56,488
15	2025	$ 0.1825	2,570,836		$ 469,109.46	$77,125		-$84,440	-$324,698.22	$137,096.61	$1,218,846.63	$57,206
16	2026	$ 0.1870	2,570,836		$ 480,837.20	$77,125		-$86,551	-$324,698.22	$146,713.36	$1,365,559.99	$57,753
17	2027	$ 0.1917	2,570,836		$ 492,858.13	$77,125		-$88,714	-$324,698.22	$156,570.52	$1,522,130.51	$58,145
18	2028	$ 0.1965	2,570,836		$ 505,179.58	$77,125		-$90,932	-$324,698.22	$166,674.11	$1,688,804.62	$58,393
19	2029	$ 0.2014	2,570,836		$ 517,809.07	$77,125		-$93,206	-$324,698.22	$177,030.29	$1,865,834.91	$58,511
20	2030	$ 0.2065	2,570,836		$ 530,754.30	$77,125		-$95,536	-$324,698.22	$187,645.38	$2,053,480.29	$58,509
21	2031	$ 0.2116	2,570,836		$ 544,023.15	$77,125		-$97,924	0	$523,224.07	$2,576,704.36	$153,909
22	2032	$ 0.2169	2,570,836		$ 557,623.73	$77,125		-$100,372	0	$534,376.54	$3,111,080.90	$148,292
23	2033	$ 0.2223	2,570,836		$ 571,564.33	$77,125		-$102,882	0	$545,807.83	$3,656,888.73	$142,891
24	2034	$ 0.2279	2,570,836		$ 585,853.43	$77,125		-$105,454	0	$557,524.90	$4,214,413.62	$137,697
25	2035	$ 0.2336	2,570,836		$ 600,499.77	$77,125		-$108,090	0	$569,534.89	$4,783,948.52	$132,701
26	2036	$ 0.2394	2,570,836		$ 615,512.26	$77,125		-$110,792	0	$581,845.14	$5,365,793.65	$127,895
27	2037	$ 0.2454	2,570,836		$ 630,900.07	$77,125		-$113,562	0	$594,463.14	$5,960,256.79	$123,273
28	2038	$ 0.2515	2,570,836		$ 646,672.57	$77,125		-$116,401	0	$607,396.59	$6,567,653.38	$118,825
29	2039	$ 0.2578	2,570,836		$ 662,839.39	$77,125		-$119,311	0	$620,653.38	$7,188,306.76	$114,546
30	2040	$ 0.2643	2,570,836		$ 679,410.37	$77,125		-$122,294	0	$634,241.59	$7,822,548.34	$110,428

Financial Calulations

	IRR	NPV
5 Years	#NUM!	$211,270
10 Years	#NUM!	$448,306
15 Years	#DIV/0!	$725,231
20 Years	#DIV/0!	$1,016,542

Years to Postive Return 16

Financial Pro-Forma @ P90 (w/out MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Elecon	Total Project Cost	$2,500,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	600	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	60	Down Payment	-$2,500,000	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	48	Loan Amount	$0	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	884,794	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.17	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

				Project Revenues				Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	-$2,500,000	$ -	$0	$0		$0.00	-$2,500,000.00	-$2,500,000.00	-$2,500,000
2	2012	$ 0.1324	884,794		$ 117,120.18	$26,544	$0	-$21,082	$0.00	$124,983.33	-$2,377,417.63	$109,098
3	2013	$ 0.1357	884,794		$ 120,048.19	$26,544	$0	-$21,609	$0.00	$124,983.33	-$2,252,434.30	$104,938
4	2014	$ 0.1391	884,794		$ 123,049.39	$26,544	$0	-$22,149	$0.00	$127,444.32	-$2,124,989.98	$100,948
5	2015	$ 0.1425	884,794		$ 126,125.63	$26,544	$0	-$22,703	$0.00	$129,966.83	-$1,995,023.14	$97,119
6	2016	$ 0.1461	884,794		$ 129,278.77	$26,544	$0	-$23,270	$0.00	$132,552.41	-$1,862,470.74	$93,444
7	2017	$ 0.1498	884,794		$ 132,510.74	$26,544		-$23,852	$0.00	$135,202.62	-$1,727,268.11	$89,917
8	2018	$ 0.1535	884,794		$ 135,823.50	$26,544		-$24,448	$0.00	$137,919.09	-$1,589,349.02	$86,532
9	2019	$ 0.1573	884,794		$ 139,219.09	$26,544		-$25,059	$0.00	$140,703.48	-$1,448,645.54	$83,282
10	2020	$ 0.1613	884,794		$ 142,699.57	$26,544		-$25,686	$0.00	$143,557.47	-$1,305,088.08	$80,162
11	2021	$ 0.1653	884,794		$ 146,267.06	$26,544		-$26,328	$0.00	$146,482.81	-$1,158,605.27	$77,165
12	2022	$ 0.1694	884,794		$ 149,923.73	$26,544		-$26,986	$0.00	$149,481.28	-$1,009,123.99	$74,288
13	2023	$ 0.1737	884,794		$ 153,671.83	$26,544		-$27,661	$0.00	$152,554.72	-$856,569.27	$71,524
14	2024	$ 0.1780	884,794		$ 157,513.62	$26,544		-$28,352	$0.00	$155,704.99	-$700,864.28	$68,868
15	2025	$ 0.1825	884,794		$ 161,451.46	$26,544		-$29,061	$0.00	$158,934.02	-$541,930.26	$66,318
16	2026	$ 0.1870	884,794		$ 165,487.75	$26,544		-$29,788	$0.00	$162,243.78	-$379,686.48	$63,867
17	2027	$ 0.1917	884,794		$ 169,624.94	$26,544		-$30,532	$0.00	$165,636.27	-$214,050.21	$61,511
18	2028	$ 0.1965	884,794		$ 173,865.57	$26,544		-$31,296	$0.00	$169,113.59	-$44,936.62	$59,248
19	2029	$ 0.2014	884,794		$ 178,212.21	$26,544		-$32,078	$0.00	$172,677.83	$127,741.21	$57,072
20	2030	$ 0.2065	884,794		$ 182,667.51	$26,544		-$32,880	$0.00	$176,331.18	$304,072.39	$54,981
21	2031	$ 0.2116	884,794		$ 187,234.20	$26,544		-$33,702	0	$180,075.86	$484,148.25	$52,970
22	2032	$ 0.2169	884,794		$ 191,915.06	$26,544		-$34,545	0	$183,914.17	$668,062.42	$51,037
23	2033	$ 0.2223	884,794		$ 196,712.93	$26,544		-$35,408	0	$187,848.42	$855,910.84	$49,178
24	2034	$ 0.2279	884,794		$ 201,630.76	$26,544		-$36,294	0	$191,881.04	$1,047,791.88	$47,391
25	2035	$ 0.2336	884,794		$ 206,671.52	$26,544		-$37,201	0	$196,014.47	$1,243,806.35	$45,671
26	2036	$ 0.2394	884,794		$ 211,838.31	$26,544		-$38,131	0	$200,251.24	$1,444,057.59	$44,017
27	2037	$ 0.2454	884,794		$ 217,134.27	$26,544		-$39,084	0	$204,593.92	$1,648,651.51	$42,426
28	2038	$ 0.2515	884,794		$ 222,562.63	$26,544		-$40,061	0	$209,045.17	$1,857,696.68	$40,896
29	2039	$ 0.2578	884,794		$ 228,126.69	$26,544		-$41,063	0	$213,607.71	$2,071,304.39	$39,423
30	2040	$ 0.2643	884,794		$ 233,829.86	$26,544		-$42,089	0	$218,284.30	$2,289,588.69	$38,006

Financial Calulations

	IRR	NPV
5 Years		-$2,087,897
10 Years	-12%	-$1,654,559
15 Years	-3%	-$1,296,397
20 Years	1%	-$999,718

Years to Postive Return 18

Financial Pro-Forma @ P90 (w/ MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Elecon	Total Project Cost	$2,500,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	600	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	60	Down Payment	-$2,179,500	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	48	Loan Amount	$0	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	884,794	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.17	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

				Project Revenues				Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	-$2,179,500	$ -	$0	$0		$0.00	-$2,179,500.00	-$2,179,500.00	-$2,179,500
2	2012	$ 0.1324	884,794		$ 117,120.18	$26,544	$0	-$21,082	$0.00	$124,983.33	-$2,056,917.63	$109,098
3	2013	$ 0.1357	884,794		$ 120,048.19	$26,544	$0	-$21,609	$0.00	$124,983.33	-$1,931,934.30	$104,938
4	2014	$ 0.1391	884,794		$ 123,049.39	$26,544	$0	-$22,149	$0.00	$127,444.32	-$1,804,489.98	$100,948
5	2015	$ 0.1425	884,794		$ 126,125.63	$26,544	$0	-$22,703	$0.00	$129,966.83	-$1,674,523.14	$97,119
6	2016	$ 0.1461	884,794		$ 129,278.77	$26,544	$0	-$23,270	$0.00	$132,552.41	-$1,541,970.74	$93,444
7	2017	$ 0.1498	884,794		$ 132,510.74	$26,544		-$23,852	$0.00	$135,202.62	-$1,406,768.11	$89,917
8	2018	$ 0.1535	884,794		$ 135,823.50	$26,544		-$24,448	$0.00	$137,919.09	-$1,268,849.02	$86,532
9	2019	$ 0.1573	884,794		$ 139,219.09	$26,544		-$25,059	$0.00	$140,703.48	-$1,128,145.54	$83,282
10	2020	$ 0.1613	884,794		$ 142,699.57	$26,544		-$25,686	$0.00	$143,557.47	-$984,588.08	$80,162
11	2021	$ 0.1653	884,794		$ 146,267.06	$26,544		-$26,328	$0.00	$146,482.81	-$838,105.27	$77,165
12	2022	$ 0.1694	884,794		$ 149,923.73	$26,544		-$26,986	$0.00	$149,481.28	-$688,623.99	$74,288
13	2023	$ 0.1737	884,794		$ 153,671.83	$26,544		-$27,661	$0.00	$152,554.72	-$536,069.27	$71,524
14	2024	$ 0.1780	884,794		$ 157,513.62	$26,544		-$28,352	$0.00	$155,704.99	-$380,364.28	$68,868
15	2025	$ 0.1825	884,794		$ 161,451.46	$26,544		-$29,061	$0.00	$158,934.02	-$221,430.26	$66,318
16	2026	$ 0.1870	884,794		$ 165,487.75	$26,544		-$29,788	$0.00	$162,243.78	-$59,186.48	$63,867
17	2027	$ 0.1917	884,794		$ 169,624.94	$26,544		-$30,532	$0.00	$165,636.27	$106,449.79	$61,511
18	2028	$ 0.1965	884,794		$ 173,865.57	$26,544		-$31,296	$0.00	$169,113.59	$275,563.38	$59,248
19	2029	$ 0.2014	884,794		$ 178,212.21	$26,544		-$32,078	$0.00	$172,677.83	$448,241.21	$57,072
20	2030	$ 0.2065	884,794		$ 182,667.51	$26,544		-$32,880	$0.00	$176,331.18	$624,572.39	$54,981
21	2031	$ 0.2116	884,794		$ 187,234.20	$26,544		-$33,702	0	$180,075.86	$804,648.25	$52,970
22	2032	$ 0.2169	884,794		$ 191,915.06	$26,544		-$34,545	0	$183,914.17	$988,562.42	$51,037
23	2033	$ 0.2223	884,794		$ 196,712.93	$26,544		-$35,408	0	$187,848.42	$1,176,410.84	$49,178
24	2034	$ 0.2279	884,794		$ 201,630.76	$26,544		-$36,294	0	$191,881.04	$1,368,291.88	$47,391
25	2035	$ 0.2336	884,794		$ 206,671.52	$26,544		-$37,201	0	$196,014.47	$1,564,306.35	$45,671
26	2036	$ 0.2394	884,794		$ 211,838.31	$26,544		-$38,131	0	$200,251.24	$1,764,557.59	$44,017
27	2037	$ 0.2454	884,794		$ 217,134.27	$26,544		-$39,084	0	$204,593.92	$1,969,151.51	$42,426
28	2038	$ 0.2515	884,794		$ 222,562.63	$26,544		-$40,061	0	$209,045.17	$2,178,196.68	$40,896
29	2039	$ 0.2578	884,794		$ 228,126.69	$26,544		-$41,063	0	$213,607.71	$2,391,804.39	$39,423
30	2040	$ 0.2643	884,794		$ 233,829.86	$26,544		-$42,089	0	$218,284.30	$2,610,088.69	$38,006

Financial Calulations

	IRR	NPV
5 Years		-$1,767,397
10 Years	-10%	-$1,334,059
15 Years	-1%	-$975,897
20 Years	2%	-$679,218

Years to Postive Return 16

PPA Financial Pro-Forma @ P90 (PPA)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Elecon	Total Project Cost	$0.00	Current Value of offset Electricity	$0.01
WTG Faceplate (kW)	600	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0
WTG Hub Height (m)	60	Down Payment	$0	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	48	Loan Amount	$0	Annual Inflation on Utility Rates:	0.00%
WTG Prod. (kWh/Year)	884,794	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.17	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

					Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	$0	$ -	$0	$0		$0.00	$0.00	$0.00	$0
2	2012	$ 0.0130	884,794		$ 11,502.32	$0	$0	-$2,070	$0.00	$9,431.90	$9,431.90	$8,394
3	2013	$ 0.0130	884,794		$ 11,502.32	$0	$0	-$2,122	$0.00	$9,380.14	$18,812.05	$7,876
4	2014	$ 0.0130	884,794		$ 11,502.32	$0	$0	-$2,175	$0.00	$9,327.09	$28,139.14	$7,388
5	2015	$ 0.0130	884,794		$ 11,502.32	$0	$0	-$2,230	$0.00	$9,272.71	$37,411.85	$6,929
6	2016	$ 0.0130	884,794		$ 11,502.32	$0	$0	-$2,285	$0.00	$9,216.97	$46,628.81	$6,498
7	2017	$ 0.0130	884,794		$ 11,502.32	$0		-$2,342	$0.00	$9,159.83	$55,788.65	$6,092
8	2018	$ 0.0130	884,794		$ 11,502.32	$0		-$2,401	$0.00	$9,101.27	$64,889.92	$5,710
9	2019	$ 0.0130	884,794		$ 11,502.32	$0		-$2,461	$0.00	$9,041.25	$73,931.16	$5,351
10	2020	$ 0.0130	884,794		$ 11,502.32	$0		-$2,523	$0.00	$8,979.72	$82,910.88	$5,014
11	2021	$ 0.0130	884,794		$ 11,502.32	$0		-$2,586	$0.00	$8,916.65	$91,827.54	$4,697
12	2022	$ 0.0130	884,794		$ 11,502.32	$0		-$2,650	$0.00	$8,852.01	$100,679.55	$4,399
13	2023	$ 0.0130	884,794		$ 11,502.32	$0		-$2,717	$0.00	$8,785.75	$109,465.30	$4,119
14	2024	$ 0.0130	884,794		$ 11,502.32	$0		-$2,784	$0.00	$8,717.84	$118,183.14	$3,856
15	2025	$ 0.0130	884,794		$ 11,502.32	$0		-$2,854	$0.00	$8,648.23	$126,831.37	$3,609
16	2026	$ 0.0130	884,794		$ 11,502.32	$0		-$2,925	$0.00	$8,576.88	$135,408.25	$3,376
17	2027	$ 0.0130	884,794		$ 11,502.32	$0		-$2,999	$0.00	$8,503.74	$143,911.99	$3,158
18	2028	$ 0.0130	884,794		$ 11,502.32	$0		-$3,074	$0.00	$8,428.77	$152,340.76	$2,953
19	2029	$ 0.0130	884,794		$ 11,502.32	$0		-$3,150	$0.00	$8,351.94	$160,692.70	$2,760
20	2030	$ 0.0130	884,794		$ 11,502.32	$0		-$3,229	$0.00	$8,273.18	$168,965.87	$2,580
21	2031	$ 0.0130	884,794		$ 11,502.32	$0		-$3,310	0	$8,192.45	$177,158.32	$2,410
22	2032	$ 0.0130	884,794		$ 11,502.32	$0		-$3,393	0	$8,109.70	$185,268.02	$2,250
23	2033	$ 0.0130	884,794		$ 11,502.32	$0		-$3,477	0	$8,024.89	$193,292.91	$2,101
24	2034	$ 0.0130	884,794		$ 11,502.32	$0		-$3,564	0	$7,937.95	$201,230.86	$1,961
25	2035	$ 0.0130	884,794		$ 11,502.32	$0		-$3,653	0	$7,848.84	$209,079.70	$1,829
26	2036	$ 0.0130	884,794		$ 11,502.32	$0		-$3,745	0	$7,757.50	$216,837.20	$1,705
27	2037	$ 0.0130	884,794		$ 11,502.32	$0		-$3,838	0	$7,663.88	$224,501.08	$1,589
28	2038	$ 0.0130	884,794		$ 11,502.32	$0		-$3,934	0	$7,567.92	$232,069.01	$1,481
29	2039	$ 0.0130	884,794		$ 11,502.32	$0		-$4,033	0	$7,469.56	$239,538.57	$1,379
30	2040	$ 0.0130	884,794		$ 11,502.32	$0		-$4,134	0	$7,368.74	$246,907.31	$1,283

Financial Calulations

	IRR	NPV
5 Years		$30,587
10 Years	#DIV/0!	$59,253
15 Years	#DIV/0!	$79,933
20 Years	#DIV/0!	$94,760

Years to Postive Return 0

Financial Pro-Forma @ P90 (w/out MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Mitsubishi	Total Project Cost	$3,400,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1000	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	70	Down Payment	-$3,400,000	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	61	Loan Amount	$0	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	1,189,567	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.14	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

					Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	-$3,400,000	$ -	$0	$0		$0.00	-$3,400,000.00	-$3,400,000.00	-$3,400,000
2	2012	$ 0.1324	1,189,567		$ 157,462.98	$35,687	$0	-$28,343	$0.00	$164,806.66	-$3,235,193.34	$146,677
3	2013	$ 0.1357	1,189,567		$ 161,399.56	$35,687	$0	-$29,052	$0.00	$168,034.65	-$3,067,158.70	$141,085
4	2014	$ 0.1391	1,189,567		$ 165,434.55	$35,687	$0	-$29,778	$0.00	$171,343.34	-$2,895,815.36	$135,720
5	2015	$ 0.1425	1,189,567		$ 169,570.41	$35,687	$0	-$30,523	$0.00	$174,734.75	-$2,721,080.61	$130,572
6	2016	$ 0.1461	1,189,567		$ 173,809.67	$35,687	$0	-$31,286	$0.00	$178,210.94	-$2,542,869.67	$125,632
7	2017	$ 0.1498	1,189,567		$ 178,154.91	$35,687		-$32,068	$0.00	$181,774.04	-$2,361,095.63	$120,890
8	2018	$ 0.1535	1,189,567		$ 182,608.79	$35,687		-$32,870	$0.00	$185,426.21	-$2,175,669.42	$116,339
9	2019	$ 0.1573	1,189,567		$ 187,174.01	$35,687		-$33,691	$0.00	$189,169.69	-$1,986,499.72	$111,969
10	2020	$ 0.1613	1,189,567		$ 191,853.36	$35,687		-$34,534	$0.00	$193,006.76	-$1,793,492.96	$107,774
11	2021	$ 0.1653	1,189,567		$ 196,649.69	$35,687		-$35,397	$0.00	$196,939.76	-$1,596,553.20	$103,745
12	2022	$ 0.1694	1,189,567		$ 201,565.93	$35,687		-$36,282	$0.00	$200,971.07	-$1,395,582.13	$99,876
13	2023	$ 0.1737	1,189,567		$ 206,605.08	$35,687		-$37,189	$0.00	$205,103.18	-$1,190,478.95	$96,160
14	2024	$ 0.1780	1,189,567		$ 211,770.21	$35,687		-$38,119	$0.00	$209,338.58	-$981,140.37	$92,591
15	2025	$ 0.1825	1,189,567		$ 217,064.46	$35,687		-$39,072	$0.00	$213,679.87	-$767,460.51	$89,161
16	2026	$ 0.1870	1,189,567		$ 222,491.07	$35,687		-$40,048	$0.00	$218,129.69	-$549,330.81	$85,866
17	2027	$ 0.1917	1,189,567		$ 228,053.35	$35,687		-$41,050	$0.00	$222,690.76	-$326,640.06	$82,699
18	2028	$ 0.1965	1,189,567		$ 233,754.68	$35,687		-$42,076	$0.00	$227,365.85	-$99,274.21	$79,656
19	2029	$ 0.2014	1,189,567		$ 239,598.55	$35,687		-$43,128	$0.00	$232,157.82	$132,883.62	$76,731
20	2030	$ 0.2065	1,189,567		$ 245,588.52	$35,687		-$44,206	$0.00	$237,069.59	$369,953.21	$73,919
21	2031	$ 0.2116	1,189,567		$ 251,728.23	$35,687		-$45,311	0	$242,104.16	$612,057.37	$71,216
22	2032	$ 0.2169	1,189,567		$ 258,021.43	$35,687		-$46,444	0	$247,264.59	$859,321.95	$68,617
23	2033	$ 0.2223	1,189,567		$ 264,471.97	$35,687		-$47,605	0	$252,554.03	$1,111,875.98	$66,118
24	2034	$ 0.2279	1,189,567		$ 271,083.77	$35,687		-$48,795	0	$257,975.70	$1,369,851.68	$63,714
25	2035	$ 0.2336	1,189,567		$ 277,860.86	$35,687		-$50,015	0	$263,532.92	$1,633,384.60	$61,403
26	2036	$ 0.2394	1,189,567		$ 284,807.38	$35,687		-$51,265	0	$269,229.07	$1,902,613.66	$59,179
27	2037	$ 0.2454	1,189,567		$ 291,927.57	$35,687		-$52,547	0	$275,067.62	$2,177,681.28	$57,040
28	2038	$ 0.2515	1,189,567		$ 299,225.76	$35,687		-$53,861	0	$281,052.13	$2,458,733.41	$54,982
29	2039	$ 0.2578	1,189,567		$ 306,706.40	$35,687		-$55,207	0	$287,186.26	$2,745,919.67	$53,002
30	2040	$ 0.2643	1,189,567		$ 314,374.06	$35,687		-$56,587	0	$293,473.74	$3,039,393.41	$51,097

Financial Calulations

	IRR	NPV
5 Years	#NUM!	-$2,845,946
10 Years	-13%	-$2,263,342
15 Years	-3%	-$1,781,808
20 Years	1%	-$1,382,936

Years to Postive Return 18

Financial Pro-Forma @ P90 (w/ MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	Mitsubishi	Total Project Cost	$3,400,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1000	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	70	Down Payment	-$3,035,180	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	61	Loan Amount	$0	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	1,189,567	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.14	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

					Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	-$3,035,180	$ -	$0	$0		$0.00	-$3,035,180.00	-$3,035,180.00	-$3,035,180
2	2012	$ 0.1324	1,189,567		$ 157,462.98	$35,687	$0	-$28,343	$0.00	$164,806.66	-$2,870,373.34	$146,677
3	2013	$ 0.1357	1,189,567		$ 161,399.56	$35,687	$0	-$29,052	$0.00	$168,034.65	-$2,702,338.70	$141,085
4	2014	$ 0.1391	1,189,567		$ 165,434.55	$35,687	$0	-$29,778	$0.00	$171,343.34	-$2,530,995.36	$135,720
5	2015	$ 0.1425	1,189,567		$ 169,570.41	$35,687	$0	-$30,523	$0.00	$174,734.75	-$2,356,260.61	$130,572
6	2016	$ 0.1461	1,189,567		$ 173,809.67	$35,687	$0	-$31,286	$0.00	$178,210.94	-$2,178,049.67	$125,632
7	2017	$ 0.1498	1,189,567		$ 178,154.91	$35,687		-$32,068	$0.00	$181,774.04	-$1,996,275.63	$120,890
8	2018	$ 0.1535	1,189,567		$ 182,608.79	$35,687		-$32,870	$0.00	$185,426.21	-$1,810,849.42	$116,339
9	2019	$ 0.1573	1,189,567		$ 187,174.01	$35,687		-$33,691	$0.00	$189,169.69	-$1,621,679.72	$111,969
10	2020	$ 0.1613	1,189,567		$ 191,853.36	$35,687		-$34,534	$0.00	$193,006.76	-$1,428,672.96	$107,774
11	2021	$ 0.1653	1,189,567		$ 196,649.69	$35,687		-$35,397	$0.00	$196,939.76	-$1,231,733.20	$103,745
12	2022	$ 0.1694	1,189,567		$ 201,565.93	$35,687		-$36,282	$0.00	$200,971.07	-$1,030,762.13	$99,876
13	2023	$ 0.1737	1,189,567		$ 206,605.08	$35,687		-$37,189	$0.00	$205,103.18	-$825,658.95	$96,160
14	2024	$ 0.1780	1,189,567		$ 211,770.21	$35,687		-$38,119	$0.00	$209,338.58	-$616,320.37	$92,591
15	2025	$ 0.1825	1,189,567		$ 217,064.46	$35,687		-$39,072	$0.00	$213,679.87	-$402,640.51	$89,161
16	2026	$ 0.1870	1,189,567		$ 222,491.07	$35,687		-$40,048	$0.00	$218,129.69	-$184,510.81	$85,866
17	2027	$ 0.1917	1,189,567		$ 228,053.35	$35,687		-$41,050	$0.00	$222,690.76	$38,179.94	$82,699
18	2028	$ 0.1965	1,189,567		$ 233,754.68	$35,687		-$42,076	$0.00	$227,365.85	$265,545.79	$79,656
19	2029	$ 0.2014	1,189,567		$ 239,598.55	$35,687		-$43,128	$0.00	$232,157.82	$497,703.62	$76,731
20	2030	$ 0.2065	1,189,567		$ 245,588.52	$35,687		-$44,206	$0.00	$237,069.59	$734,773.21	$73,919
21	2031	$ 0.2116	1,189,567		$ 251,728.23	$35,687		-$45,311	0	$242,104.16	$976,877.37	$71,216
22	2032	$ 0.2169	1,189,567		$ 258,021.43	$35,687		-$46,444	0	$247,264.59	$1,224,141.95	$68,617
23	2033	$ 0.2223	1,189,567		$ 264,471.97	$35,687		-$47,605	0	$252,554.03	$1,476,695.98	$66,118
24	2034	$ 0.2279	1,189,567		$ 271,083.77	$35,687		-$48,795	0	$257,975.70	$1,734,671.68	$63,714
25	2035	$ 0.2336	1,189,567		$ 277,860.86	$35,687		-$50,015	0	$263,532.92	$1,998,204.60	$61,403
26	2036	$ 0.2394	1,189,567		$ 284,807.38	$35,687		-$51,265	0	$269,229.07	$2,267,433.66	$59,179
27	2037	$ 0.2454	1,189,567		$ 291,927.57	$35,687		-$52,547	0	$275,067.62	$2,542,501.28	$57,040
28	2038	$ 0.2515	1,189,567		$ 299,225.76	$35,687		-$53,861	0	$281,052.13	$2,823,553.41	$54,982
29	2039	$ 0.2578	1,189,567		$ 306,706.40	$35,687		-$55,207	0	$287,186.26	$3,110,739.67	$53,002
30	2040	$ 0.2643	1,189,567		$ 314,374.06	$35,687		-$56,587	0	$293,473.74	$3,404,213.41	$51,097

Financial Calulations

	IRR	NPV
5 Years	#NUM!	-$2,481,126
10 Years	-11%	-$1,898,522
15 Years	-2%	-$1,416,988
20 Years	2%	-$1,018,116

Years to Postive Return 16

PPA Financial Pro-Forma @ P90 (PPA)

Project Information:		**Key Assumptions:**					
Name	Winter Island	WTG Manufacturer:	Mitsubishi	Total Project Cost	$0.00	Current Value of offset Electricity	$0.01
Client	City of Salem	WTG Faceplate (kW)	1000	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0
Location	Salem	WTG Hub Height (m)	70	Down Payment	$0	Net Present Value Based on Discount Rate of:	6.00%
	MA	Blade Diameter (m)	61	Loan Amount	$0	Annual Inflation on Utility Rates:	0.00%
MAI Job #	5209	WTG Prod. (kWh/Year)	1,189,567	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
Prepared By	DEG	WTG Capacity Factor	0.14	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

					Project Revenues			**Project Costs**		**Project Cash Flows**		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	$0	$ -	$0	$0		$0.00	$0.00	$0.00	$0
2	2012	$ 0.0130	1,189,567		$ 15,464.37	$0	$0	-$2,784	$0.00	$12,680.78	$12,680.78	$11,286
3	2013	$ 0.0130	1,189,567		$ 15,464.37	$0	$0	-$2,853	$0.00	$12,611.19	$25,291.98	$10,589
4	2014	$ 0.0130	1,189,567		$ 15,464.37	$0	$0	-$2,925	$0.00	$12,539.87	$37,831.84	$9,933
5	2015	$ 0.0130	1,189,567		$ 15,464.37	$0	$0	-$2,998	$0.00	$12,466.75	$50,298.60	$9,316
6	2016	$ 0.0130	1,189,567		$ 15,464.37	$0	$0	-$3,073	$0.00	$12,391.81	$62,690.41	$8,736
7	2017	$ 0.0130	1,189,567		$ 15,464.37	$0		-$3,149	$0.00	$12,315.00	$75,005.41	$8,190
8	2018	$ 0.0130	1,189,567		$ 15,464.37	$0		-$3,228	$0.00	$12,236.26	$87,241.67	$7,677
9	2019	$ 0.0130	1,189,567		$ 15,464.37	$0		-$3,309	$0.00	$12,155.56	$99,397.23	$7,195
10	2020	$ 0.0130	1,189,567		$ 15,464.37	$0		-$3,392	$0.00	$12,072.84	$111,470.07	$6,741
11	2021	$ 0.0130	1,189,567		$ 15,464.37	$0		-$3,476	$0.00	$11,988.05	$123,458.12	$6,315
12	2022	$ 0.0130	1,189,567		$ 15,464.37	$0		-$3,563	$0.00	$11,901.14	$135,359.27	$5,915
13	2023	$ 0.0130	1,189,567		$ 15,464.37	$0		-$3,652	$0.00	$11,812.06	$147,171.33	$5,538
14	2024	$ 0.0130	1,189,567		$ 15,464.37	$0		-$3,744	$0.00	$11,720.76	$158,892.09	$5,184
15	2025	$ 0.0130	1,189,567		$ 15,464.37	$0		-$3,837	$0.00	$11,627.17	$170,519.26	$4,852
16	2026	$ 0.0130	1,189,567		$ 15,464.37	$0		-$3,933	$0.00	$11,531.24	$182,050.49	$4,539
17	2027	$ 0.0130	1,189,567		$ 15,464.37	$0		-$4,031	$0.00	$11,432.91	$193,483.40	$4,246
18	2028	$ 0.0130	1,189,567		$ 15,464.37	$0		-$4,132	$0.00	$11,332.12	$204,815.52	$3,970
19	2029	$ 0.0130	1,189,567		$ 15,464.37	$0		-$4,236	$0.00	$11,228.81	$216,044.33	$3,711
20	2030	$ 0.0130	1,189,567		$ 15,464.37	$0		-$4,341	$0.00	$11,122.93	$227,167.26	$3,468
21	2031	$ 0.0130	1,189,567		$ 15,464.37	$0		-$4,450	0	$11,014.39	$238,181.65	$3,240
22	2032	$ 0.0130	1,189,567		$ 15,464.37	$0		-$4,561	0	$10,903.14	$249,084.79	$3,026
23	2033	$ 0.0130	1,189,567		$ 15,464.37	$0		-$4,675	0	$10,789.11	$259,873.90	$2,825
24	2034	$ 0.0130	1,189,567		$ 15,464.37	$0		-$4,792	0	$10,672.23	$270,546.13	$2,636
25	2035	$ 0.0130	1,189,567		$ 15,464.37	$0		-$4,912	0	$10,552.42	$281,098.55	$2,459
26	2036	$ 0.0130	1,189,567		$ 15,464.37	$0		-$5,035	0	$10,429.63	$291,528.17	$2,293
27	2037	$ 0.0130	1,189,567		$ 15,464.37	$0		-$5,161	0	$10,303.76	$301,831.93	$2,137
28	2038	$ 0.0130	1,189,567		$ 15,464.37	$0		-$5,290	0	$10,174.74	$312,006.67	$1,990
29	2039	$ 0.0130	1,189,567		$ 15,464.37	$0		-$5,422	0	$10,042.50	$322,049.17	$1,853
30	2040	$ 0.0130	1,189,567		$ 15,464.37	$0		-$5,557	0	$9,906.95	$331,956.13	$1,725

Financial Calulations

	IRR	**NPV**
5 Years	#NUM!	$41,123
10 Years	#DIV/0!	$79,662
15 Years	#DIV/0!	$107,466
20 Years	#DIV/0!	$127,400

Years to Postive Return 0

Financial Pro-Forma @ P90 (w/out MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	GE Energy	Total Project Cost	$4,500,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1500	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	80	Down Payment	-$4,500,000	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	77	Loan Amount	$0	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	2,570,836	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.20	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

				Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	-$4,500,000	$ -	$0	$0		$0.00	-$4,500,000.00	-$4,500,000.00	-$4,500,000
2	2012	$ 0.1324	2,570,836		$ 340,301.56	$77,125	$0	-$61,254	$0.00	$356,172.36	-$4,143,827.64	$316,992
3	2013	$ 0.1357	2,570,836		$ 348,809.10	$77,125	$0	-$62,786	$0.00	$363,148.54	-$3,780,679.10	$304,907
4	2014	$ 0.1391	2,570,836		$ 357,529.33	$77,125	$0	-$64,355	$0.00	$370,299.13	-$3,410,379.97	$293,312
5	2015	$ 0.1425	2,570,836		$ 366,467.56	$77,125	$0	-$65,964	$0.00	$377,628.48	-$3,032,751.49	$282,186
6	2016	$ 0.1461	2,570,836		$ 375,629.25	$77,125	$0	-$67,613	$0.00	$385,141.07	-$2,647,610.42	$271,509
7	2017	$ 0.1498	2,570,836		$ 385,019.98	$77,125		-$69,304	$0.00	$392,841.46	-$2,254,768.96	$261,262
8	2018	$ 0.1535	2,570,836		$ 394,645.48	$77,125		-$71,036	$0.00	$400,734.37	-$1,854,034.58	$251,426
9	2019	$ 0.1573	2,570,836		$ 404,511.62	$77,125		-$72,812	$0.00	$408,824.61	-$1,445,209.98	$241,983
10	2020	$ 0.1613	2,570,836		$ 414,624.41	$77,125		-$74,632	$0.00	$417,117.09	-$1,028,092.88	$232,916
11	2021	$ 0.1653	2,570,836		$ 424,990.02	$77,125		-$76,498	$0.00	$425,616.90	-$602,475.99	$224,210
12	2022	$ 0.1694	2,570,836		$ 435,614.77	$77,125		-$78,411	$0.00	$434,329.19	-$168,146.80	$215,848
13	2023	$ 0.1737	2,570,836		$ 446,505.14	$77,125		-$80,371	$0.00	$443,259.29	$275,112.50	$207,817
14	2024	$ 0.1780	2,570,836		$ 457,667.77	$77,125		-$82,380	$0.00	$452,412.65	$727,525.14	$200,103
15	2025	$ 0.1825	2,570,836		$ 469,109.46	$77,125		-$84,440	$0.00	$461,794.84	$1,189,319.98	$192,691
16	2026	$ 0.1870	2,570,836		$ 480,837.20	$77,125		-$86,551	$0.00	$471,411.58	$1,660,731.56	$185,569
17	2027	$ 0.1917	2,570,836		$ 492,858.13	$77,125		-$88,714	$0.00	$481,268.74	$2,142,000.31	$178,726
18	2028	$ 0.1965	2,570,836		$ 505,179.58	$77,125		-$90,932	$0.00	$491,372.34	$2,633,372.65	$172,149
19	2029	$ 0.2014	2,570,836		$ 517,809.07	$77,125		-$93,206	$0.00	$501,728.52	$3,135,101.16	$165,828
20	2030	$ 0.2065	2,570,836		$ 530,754.30	$77,125		-$95,536	$0.00	$512,343.60	$3,647,444.77	$159,751
21	2031	$ 0.2116	2,570,836		$ 544,023.15	$77,125		-$97,924	0	$523,224.07	$4,170,668.83	$153,909
22	2032	$ 0.2169	2,570,836		$ 557,623.73	$77,125		-$100,372	0	$534,376.54	$4,705,045.37	$148,292
23	2033	$ 0.2223	2,570,836		$ 571,564.33	$77,125		-$102,882	0	$545,807.83	$5,250,853.20	$142,891
24	2034	$ 0.2279	2,570,836		$ 585,853.43	$77,125		-$105,454	0	$557,524.90	$5,808,378.10	$137,697
25	2035	$ 0.2336	2,570,836		$ 600,499.77	$77,125		-$108,090	0	$569,534.89	$6,377,912.99	$132,701
26	2036	$ 0.2394	2,570,836		$ 615,512.26	$77,125		-$110,792	0	$581,845.14	$6,959,758.13	$127,895
27	2037	$ 0.2454	2,570,836		$ 630,900.07	$77,125		-$113,562	0	$594,463.14	$7,554,221.26	$123,273
28	2038	$ 0.2515	2,570,836		$ 646,672.57	$77,125		-$116,401	0	$607,396.59	$8,161,617.85	$118,825
29	2039	$ 0.2578	2,570,836		$ 662,839.39	$77,125		-$119,311	0	$620,653.38	$8,782,271.23	$114,546
30	2040	$ 0.2643	2,570,836		$ 679,410.37	$77,125		-$122,294	0	$634,241.59	$9,416,512.82	$110,428

Financial Calulations

	IRR	NPV
5 Years	#NUM!	-$3,302,604
10 Years	-5%	-$2,043,508
15 Years	3%	-$1,002,840
20 Years	6%	-$140,816

Years to Postive Return 12

Financial Pro-Forma @ P90 (w/ MassCEC Grant)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	GE Energy	Total Project Cost	$4,500,000.00	Current Value of offset Electricity	$0.13
WTG Faceplate (kW)	1500	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0.03
WTG Hub Height (m)	80	Down Payment	-$4,100,000	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	77	Loan Amount	$0	Annual Inflation on Utility Rates:	2.50%
WTG Prod. (kWh/Year)	2,570,836	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	5.00%
WTG Capacity Factor	0.20	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

				Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	-$4,100,000	$ -	$0	$0		$0.00	-$4,100,000.00	-$4,100,000.00	-$4,100,000
2	2012	$ 0.1324	2,570,836		$ 340,301.56	$77,125	$0	-$61,254	$0.00	$356,172.36	-$3,743,827.64	$316,992
3	2013	$ 0.1357	2,570,836		$ 348,809.10	$77,125	$0	-$62,786	$0.00	$363,148.54	-$3,380,679.10	$304,907
4	2014	$ 0.1391	2,570,836		$ 357,529.33	$77,125	$0	-$64,355	$0.00	$370,299.13	-$3,010,379.97	$293,312
5	2015	$ 0.1425	2,570,836		$ 366,467.56	$77,125	$0	-$65,964	$0.00	$377,628.48	-$2,632,751.49	$282,186
6	2016	$ 0.1461	2,570,836		$ 375,629.25	$77,125	$0	-$67,613	$0.00	$385,141.07	-$2,247,610.42	$271,509
7	2017	$ 0.1498	2,570,836		$ 385,019.98	$77,125		-$69,304	$0.00	$392,841.46	-$1,854,768.96	$261,262
8	2018	$ 0.1535	2,570,836		$ 394,645.48	$77,125		-$71,036	$0.00	$400,734.37	-$1,454,034.58	$251,426
9	2019	$ 0.1573	2,570,836		$ 404,511.62	$77,125		-$72,812	$0.00	$408,824.61	-$1,045,209.98	$241,983
10	2020	$ 0.1613	2,570,836		$ 414,624.41	$77,125		-$74,632	$0.00	$417,117.09	-$628,092.88	$232,916
11	2021	$ 0.1653	2,570,836		$ 424,990.02	$77,125		-$76,498	$0.00	$425,616.90	-$202,475.99	$224,210
12	2022	$ 0.1694	2,570,836		$ 435,614.77	$77,125		-$78,411	$0.00	$434,329.19	$231,853.20	$215,848
13	2023	$ 0.1737	2,570,836		$ 446,505.14	$77,125		-$80,371	$0.00	$443,259.29	$675,112.50	$207,817
14	2024	$ 0.1780	2,570,836		$ 457,667.77	$77,125		-$82,380	$0.00	$452,412.65	$1,127,525.14	$200,103
15	2025	$ 0.1825	2,570,836		$ 469,109.46	$77,125		-$84,440	$0.00	$461,794.84	$1,589,319.98	$192,691
16	2026	$ 0.1870	2,570,836		$ 480,837.20	$77,125		-$86,551	$0.00	$471,411.58	$2,060,731.56	$185,569
17	2027	$ 0.1917	2,570,836		$ 492,858.13	$77,125		-$88,714	$0.00	$481,268.74	$2,542,000.31	$178,726
18	2028	$ 0.1965	2,570,836		$ 505,179.58	$77,125		-$90,932	$0.00	$491,372.34	$3,033,372.65	$172,149
19	2029	$ 0.2014	2,570,836		$ 517,809.07	$77,125		-$93,206	$0.00	$501,728.52	$3,535,101.16	$165,828
20	2030	$ 0.2065	2,570,836		$ 530,754.30	$77,125		-$95,536	$0.00	$512,343.60	$4,047,444.77	$159,751
21	2031	$ 0.2116	2,570,836		$ 544,023.15	$77,125		-$97,924	0	$523,224.07	$4,570,668.83	$153,909
22	2032	$ 0.2169	2,570,836		$ 557,623.73	$77,125		-$100,372	0	$534,376.54	$5,105,045.37	$148,292
23	2033	$ 0.2223	2,570,836		$ 571,564.33	$77,125		-$102,882	0	$545,807.83	$5,650,853.20	$142,891
24	2034	$ 0.2279	2,570,836		$ 585,853.43	$77,125		-$105,454	0	$557,524.90	$6,208,378.10	$137,697
25	2035	$ 0.2336	2,570,836		$ 600,499.77	$77,125		-$108,090	0	$569,534.89	$6,777,912.99	$132,701
26	2036	$ 0.2394	2,570,836		$ 615,512.26	$77,125		-$110,792	0	$581,845.14	$7,359,758.13	$127,895
27	2037	$ 0.2454	2,570,836		$ 630,900.07	$77,125		-$113,562	0	$594,463.14	$7,954,221.26	$123,273
28	2038	$ 0.2515	2,570,836		$ 646,672.57	$77,125		-$116,401	0	$607,396.59	$8,561,617.85	$118,825
29	2039	$ 0.2578	2,570,836		$ 662,839.39	$77,125		-$119,311	0	$620,653.38	$9,182,271.23	$114,546
30	2040	$ 0.2643	2,570,836		$ 679,410.37	$77,125		-$122,294	0	$634,241.59	$9,816,512.82	$110,428

Financial Calulations

	IRR	NPV
5 Years	#NUM!	-$2,902,604
10 Years	-3%	-$1,643,508
15 Years	4%	-$602,840
20 Years	7%	$259,184

Years to Postive Return 11

PPA Financial Pro-Forma @ P90 (PPA)

Project Information:

Name	Winter Island
Client	City of Salem
Location	Salem
	MA
MAI Job #	5209
Prepared By	DEG

Key Assumptions:

WTG Manufacturer:	GE Energy	Total Project Cost	$0.00	Current Value of offset Electricity	$0.01
WTG Faceplate (kW)	1500	Down Payment (%)	100	Value of Renewable Energy Certificate, $/kWh	0
WTG Hub Height (m)	80	Down Payment	$0	Net Present Value Based on Discount Rate of:	6.00%
Blade Diameter (m)	77	Loan Amount	$0	Annual Inflation on Utility Rates:	0.00%
WTG Prod. (kWh/Year)	2,570,836	O+M Cost (%Energy Prod.)	18	Interest Rate on 20-yr Loan:	4.50%
WTG Capacity Factor	0.20	Fed Tax Rate (%)	0	Annual Inflation Rate on Operation and Maint.	2.50%

					Project Revenues			Project Costs		Project Cash Flows		
Project Year	**Fiscal Year**	**Average Rates ($/kWh)**	**Annual Energy Production**	**Capital Payment**	**Annual Revenue from Production**	**REC Revenue**	**Depreciation**	**Total O+M Cost per Year**	**Annual Loan Principal and Interest**	**Cash Flow**	**Cumulative Cash Flow**	**Net Present Value for Current Year**
1	2011		0	$0	$ -	$0	$0		$0.00	$0.00	$0.00	$0
2	2012	$ 0.0130	2,570,836		$ 33,420.87	$0	$0	-$6,016	$0.00	$27,405.11	$27,405.11	$24,390
3	2013	$ 0.0130	2,570,836		$ 33,420.87	$0	$0	-$6,166	$0.00	$27,254.72	$54,659.83	$22,884
4	2014	$ 0.0130	2,570,836		$ 33,420.87	$0	$0	-$6,320	$0.00	$27,100.56	$81,760.39	$21,466
5	2015	$ 0.0130	2,570,836		$ 33,420.87	$0	$0	-$6,478	$0.00	$26,942.56	$108,702.95	$20,133
6	2016	$ 0.0130	2,570,836		$ 33,420.87	$0	$0	-$6,640	$0.00	$26,780.60	$135,483.55	$18,879
7	2017	$ 0.0130	2,570,836		$ 33,420.87	$0		-$6,806	$0.00	$26,614.59	$162,098.14	$17,700
8	2018	$ 0.0130	2,570,836		$ 33,420.87	$0		-$6,976	$0.00	$26,444.44	$188,542.58	$16,592
9	2019	$ 0.0130	2,570,836		$ 33,420.87	$0		-$7,151	$0.00	$26,270.02	$214,812.60	$15,549
10	2020	$ 0.0130	2,570,836		$ 33,420.87	$0		-$7,330	$0.00	$26,091.25	$240,903.85	$14,569
11	2021	$ 0.0130	2,570,836		$ 33,420.87	$0		-$7,513	$0.00	$25,908.01	$266,811.87	$13,648
12	2022	$ 0.0130	2,570,836		$ 33,420.87	$0		-$7,701	$0.00	$25,720.19	$292,532.06	$12,782
13	2023	$ 0.0130	2,570,836		$ 33,420.87	$0		-$7,893	$0.00	$25,527.67	$318,059.73	$11,968
14	2024	$ 0.0130	2,570,836		$ 33,420.87	$0		-$8,091	$0.00	$25,330.34	$343,390.08	$11,204
15	2025	$ 0.0130	2,570,836		$ 33,420.87	$0		-$8,293	$0.00	$25,128.08	$368,518.16	$10,485
16	2026	$ 0.0130	2,570,836		$ 33,420.87	$0		-$8,500	$0.00	$24,920.76	$393,438.92	$9,810
17	2027	$ 0.0130	2,570,836		$ 33,420.87	$0		-$8,713	$0.00	$24,708.26	$418,147.18	$9,176
18	2028	$ 0.0130	2,570,836		$ 33,420.87	$0		-$8,930	$0.00	$24,490.44	$442,637.62	$8,580
19	2029	$ 0.0130	2,570,836		$ 33,420.87	$0		-$9,154	$0.00	$24,267.18	$466,904.81	$8,021
20	2030	$ 0.0130	2,570,836		$ 33,420.87	$0		-$9,383	$0.00	$24,038.34	$490,943.15	$7,495
21	2031	$ 0.0130	2,570,836		$ 33,420.87	$0		-$9,617	0	$23,803.78	$514,746.93	$7,002
22	2032	$ 0.0130	2,570,836		$ 33,420.87	$0		-$9,858	0	$23,563.35	$538,310.28	$6,539
23	2033	$ 0.0130	2,570,836		$ 33,420.87	$0		-$10,104	0	$23,316.91	$561,627.19	$6,104
24	2034	$ 0.0130	2,570,836		$ 33,420.87	$0		-$10,357	0	$23,064.31	$584,691.50	$5,696
25	2035	$ 0.0130	2,570,836		$ 33,420.87	$0		-$10,615	0	$22,805.40	$607,496.90	$5,314
26	2036	$ 0.0130	2,570,836		$ 33,420.87	$0		-$10,881	0	$22,540.01	$630,036.92	$4,955
27	2037	$ 0.0130	2,570,836		$ 33,420.87	$0		-$11,153	0	$22,267.99	$652,304.91	$4,618
28	2038	$ 0.0130	2,570,836		$ 33,420.87	$0		-$11,432	0	$21,989.17	$674,294.08	$4,302
29	2039	$ 0.0130	2,570,836		$ 33,420.87	$0		-$11,717	0	$21,703.38	$695,997.46	$4,006
30	2040	$ 0.0130	2,570,836		$ 33,420.87	$0		-$12,010	0	$21,410.44	$717,407.90	$3,728

Financial Calulations

	IRR	NPV
5 Years	#NUM!	$88,873
10 Years	#DIV/0!	$172,163
15 Years	#DIV/0!	$232,250
20 Years	#DIV/0!	$275,332

Years to Postive Return 0

Appendix N

Massachusetts Cultural Reference Information

Massachusetts Cultural Resource Information System

Scanned Record Cover Page

Inventory No:	SAL.HB
Historic Name:	United States Coast Guard Air & Sea Rescue Station
Common Name:	
Address:	
City/Town:	Salem
Village/Neighborhood:	Salem Willows
Local No:	
Year Constructed:	
Architect(s):	
Architectural Style(s):	
Use(s):	Other Recreational
Significance:	Architecture; Recreation
Area(s):	SAL.HB: United States Coast Guard Air & Sea Rescue Station
Designation(s):	

The Massachusetts Historical Commission (MHC) has converted this paper record to digital format as part of ongoing projects to scan records of the Inventory of Historic Assets of the Commonwealth and National Register of Historic Places nominations for Massachusetts. Efforts are ongoing and not all inventory or National Register records related to this resource may be available in digital format at this time.

The MACRIS database and scanned files are highly dynamic; new information is added daily and both database records and related scanned files may be updated as new information is incorporated into MHC files. Users should note that there may be a considerable lag time between the receipt of new or updated records by MHC and the appearance of related information in MACRIS. Users should also note that not all source materials for the MACRIS database are made available as scanned images. Users may consult the records, files and maps available in MHC's public research area at its offices at the State Archives Building, 220 Morrissey Boulevard, Boston, open M-F, 9-5.

Users of this digital material acknowledge that they have read and understood the MACRIS Information and Disclaimer (http://mhc-macris.net/macrisdisclaimer.htm)

Commonwealth of Massachusetts
Massachusetts Historical Commission
220 Morrissey Boulevard, Boston, Massachusetts 02125
www.sec.state.ma.us/mhc

This file was accessed on:

Friday, June 03, 2011 at 3:36: PM

SAL. HB (in Area 62) HI NRDIS 4/14/94

FORM A - AREA

MASSACHUSETTS HISTORICAL COMMISSION
80 BOYLSTON STREET, BOSTON, MA 02116

Area Letter	Form numbers in this Area
X	928, 927

3761, 3762

Town Salem

Name of Area (if any) U.S. Coast Guard Air and Sea Search Rescue Station

Present Use Park

General Date or Period c. 1933-4

General Condition Poor

Acreage Approximately 45 acres

Recorded by Northfields Preservation Assoc.

Organization Salem Planning Dept.

Date July, 1989

Photos (3"x3" or 3"x5" black & white). Indicate on back of each photo street addresses for buildings shown. Staple to left side of form.

Sketch Map. Draw a general map of the area indicating properties within it. Number each property for which individual inventory forms have been completed. Label streets including route numbers, if any. Indicate north. (Attach a separate sheet if space here is not sufficient).

PLEASE SEE CONTINUATION FORM

UTM REFERENCE

USGS QUADRANGLE

SCALE

SAL.HB

NATIONAL REGISTER CRITERIA STATEMENT (if applicable)

ARCHITECTURAL SIGNIFICANCE Describe important architectural features and evaluate in terms of other areas within the community.

The U.S. Coast Guard Training Station contains two buildings of architectural significance: the barracks and the airplane hangar. The barracks is a two-story Colonial Revival building, nine bays wide, four bays deep, with a hipped roof. The entrance is contained in a two-story projecting gable with ocular window. An integral entry porch is segmented by round arches. The airplane hangar is of the Art Deco style. Its low hipped roof has a segmental, stepped parapet flanked by panelled and banded corner towers. The entrances are located within these towers. Large doors, many now boarded over, opened the hangar to the planes.

HISTORICAL SIGNIFICANCE Explain historical importance of area and how the area relates to the development of other areas of the community.

Winter Island has a long history of military use dating to the 17th century. Fort Pickering, now abandoned but still in existence, was used in the Civil War and as late as 1898. The Coast Guard Air Training Station was established in 1934 but has been abandoned since the 1970s.

BIBLIOGRAPHY and/or REFERENCES

Maps and Atlases, 1851, 1874, 1897, and 1911
Essex Institute Photo Collection
Mrozowski, Stephen, et. al. Salem, Massachusetts: An Archaeological Survey of the City. June, 1988.
Pinkham, Harold A., jr. "Winter Island: Its Use and Abuse." Essex Institute Historical Collections, Vol 118, July 1982.
Interview with Gary Moore, Winter Island Park manager.

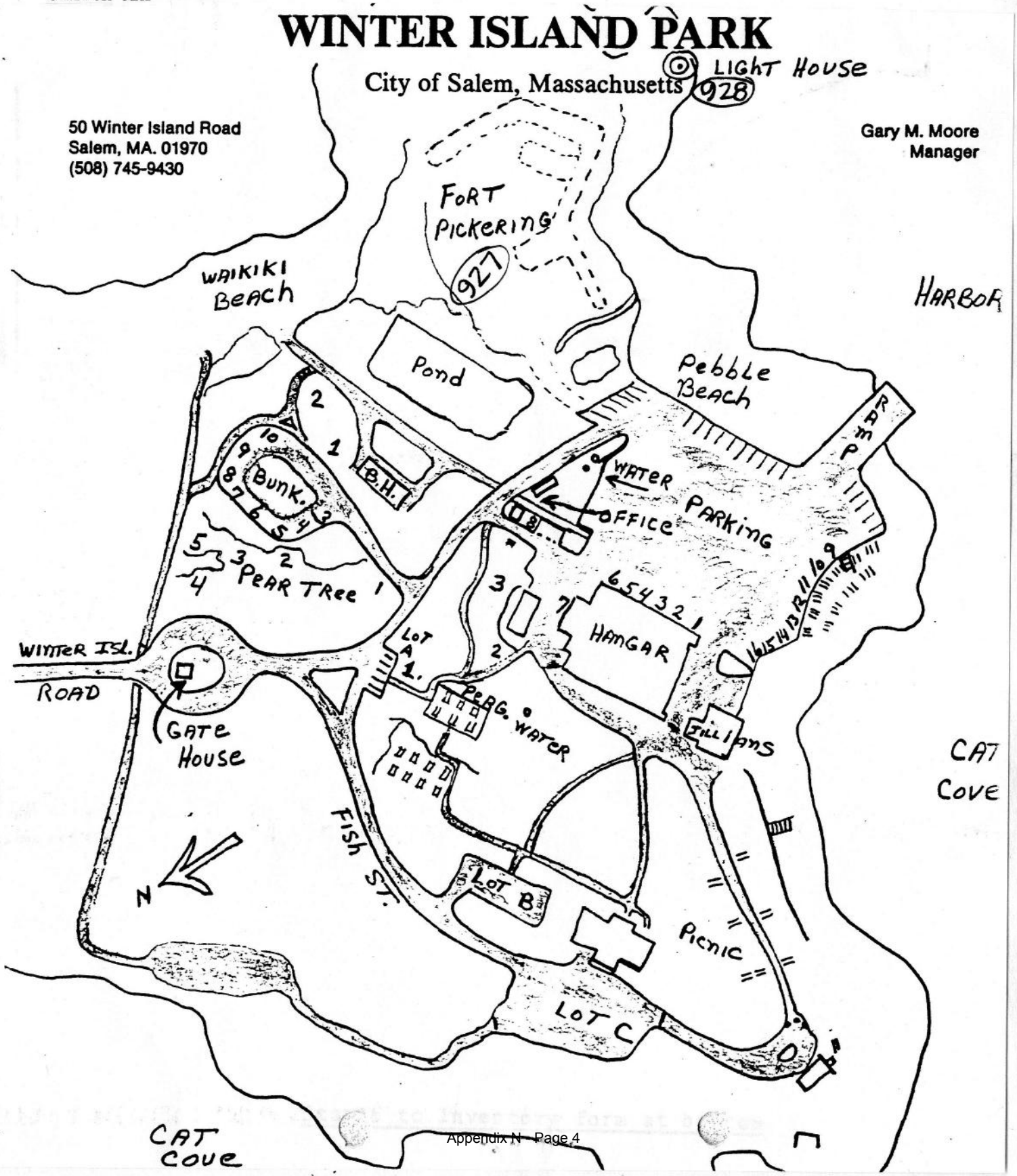
INVENTORY FORM CONTINUATION SHEET

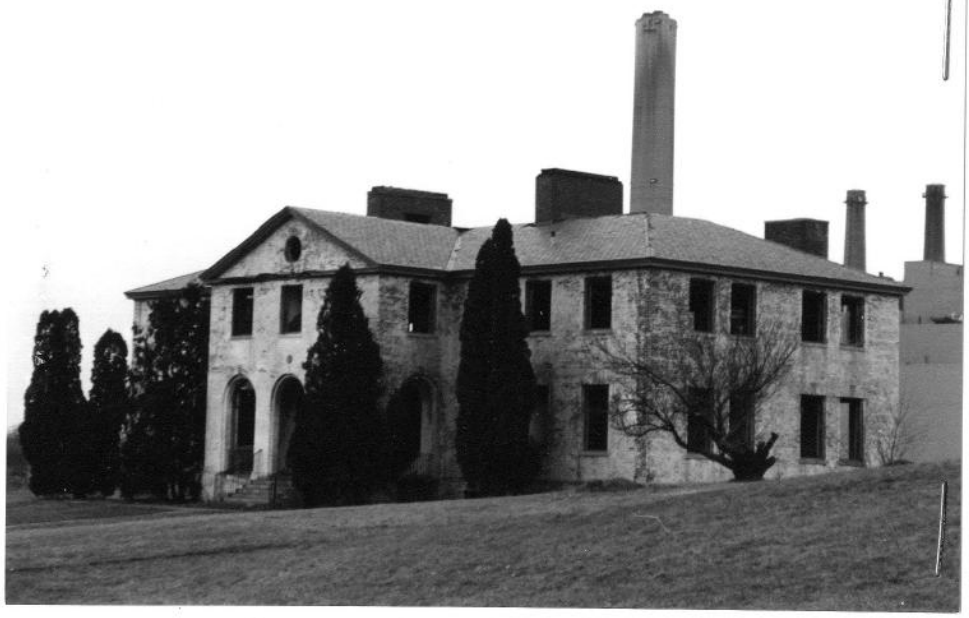
MASSACHUSETTS HISTORICAL COMMISSION
Office of the Secretary, Boston

Community: SAL.ITB	Form No: C
SALEM	
Property Name: U.S. Coast Guard Air and Sea Search Rescue Station	

Indicate each item on inventory form which is being continued below.

SKETCH MAP





U.S. COAST GUARD AIR & SEA SEARCH RESCUE
OFFICER'S QUARTERS & ADMINISTRATION BLDG
(SAL. 3761)

U.S. COAST GUARD AIR & SEA SEARCH RESCUE
HANGER (SAL.3762)

SAL.HB

PRP.....	Street No	Street Name.....	Loc Nbr.....	Ar	Code	NF
SAL.HB				HB		
SAL.3757		Winter Island Park	IH	IH		*
				GZ		
				HB		
SAL.3758		Winter Island Park	IH	IH		*
				GZ		
				HB		
SAL.3759		Winter Island Park	IH	IH		*
				GZ		
				HB		
SAL.3760		Winter Island Park	IH	IH		*
				GZ		
				HB		
SAL.3761		Winter Island Park	IH	IH		*
				GZ		
				HB		
SAL.3762		Winter Island Park	IH	IH		*
				GZ		
				HB		
SAL.3763		Winter Island Park	IH	IH		*
				GZ		
				HB		
SAL.973		Winter Island Park	IH	IH		*
				GZ		
				HB		
SAL.974		Winter Island Park	IH	IH		*
				GZ		
				HB		
SAL.975		Winter Island Park	IH	IH		*
				GZ		
				HB		
SAL.976		Winter Island Park	IH	IH		*
				GZ		
				HB		
SAL.977		Winter Island Park	IH	IH		*
				GZ		
				HB		
SAL.927	50	Winter Island Rd	43-1	HB		
				GZ		
				IH		
SAL.928	50	Winter Island Rd	43-1	HB		
				GZ		
				IH		

[405] 15 items listed out of 4303 items.

Appendix O

Article 97

Article 97

- Adopted in 1972 as the 97th Amendment to the Massachusetts Constitution.
- Guarantees Massachusetts residents basic environmental rights and protections.
- Lands and easements taken or acquired for such purposes shall not be used for other purposes or otherwise disposed of except by laws enacted by a 2/3 vote of the Massachusetts Legislature.

Language of Article 97:

"The people shall have the right to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and esthetic qualities of their environment; and the protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources is hereby declared to be a public purpose.

The general court shall have the power to enact legislation necessary or expedient to protect such rights.

In the furtherance of the foregoing powers, the general court shall have the power to provide for the taking, upon payment of just compensation therefore, or for the acquisition by purchase or otherwise, of lands and easements or such other interests therein as may be deemed necessary to accomplish these purposes.

Lands and easements taken or acquired for such purposes shall not be used for other purposes or otherwise disposed of except by laws enacted by a two thirds vote, taken by yeas and nays, of each branch of the general court."

Commonwealth of Massachusetts
Executive Office of Environmental Affairs

EOEA ARTICLE 97 LAND DISPOSITION POLICY - FEBRUARY 19, 1998

I. Statement of Policy

It is the policy of EOEA and its agencies to protect, preserve, and enhance all open space areas covered by Article 97 of the Article of Amendment to the Constitution of the Commonwealth of Massachusetts. Accordingly, as a general rule, EOEA and its agencies shall not sell, transfer, lease, relinquish, release, alienate, or change the control or use of any right or interest of the Commonwealth in and to Article 97 land. The goal of this policy is to ensure no net loss of Article 97 lands under the ownership and control of the Commonwealth and its political subdivisions. Exceptions shall be governed by the conditions included in this policy. This policy supersedes all previous EOEA Article 97 land disposition policies.

An Article 97 land disposition is defined as a) any transfer or conveyance of ownership or other interests; b) any change in physical or legal control; and c) any change in use, in and to Article 97 land or interests in Article 97 land owned or held by the Commonwealth or its political subdivisions, whether by deed, easement, lease or any other instrument effectuating such transfer, conveyance or change. A revocable permit or license is not considered a disposition as long as no interest in real property is transferred to the permittee or licensee, and no change in control or use that is in conflict with the controlling agency's mission, as determined by the controlling agency, occurs thereby.

II. Conditions for Disposition Exceptions

EOEA and its agencies shall not support an Article 97 land disposition unless EOEA and its agencies determine that exceptional circumstances exist. A determination of 'exceptional circumstances" is subject to all of the following conditions being met:

1. All other options to avoid the Article 97 disposition have been explored and no feasible and substantially equivalent alternatives exist (monetary considerations notwithstanding). Note: The purpose of evaluating alternatives is to avoid using/affecting Article 97 land to the extent feasible. To that end, the scope of alternatives under consideration shall be commensurate with the type and size of the proposed disposition of Article 97 land, and must be performed by the proponent of the disposition to the satisfaction of EOEA and its agencies. The scope of alternatives extends to any sits that were available at the time the proponent of the Article 97 disposition first notified the controlling agency of the Article 97 land, and which can be reasonably obtained: (a) within the appropriate market area for private proponents, state and/or regional entities; or (b) within the appropriate city/town for municipal proponents.

2. The disposition of the subject parcel and its proposed use do not destroy or threaten a unique or significant resource (e.g., significant habitat, rare or unusual terrain, or areas of significant public recreation), as determined by EOEA and its agencies;

3. As part of the disposition, real estate of equal or greater fair market value or value in use of proposed use, whichever is greater, and significantly greater resource value as determined by EOEA and its agencies, are granted to the disposing agency or its designee, so that the mission and legal mandate of EOEA and its agencies and the constitutional rights of the citizens of Massachusetts are protected and enhanced;

4. The minimum acreage necessary for the proposed use is proposed for disposition and, to the maximum extent possible, the resources of the parcel proposed for disposition continue to be protected;

5. The disposition serves an Article 97 purpose or another public purpose without detracting from the mission, plans, policies and mandates of EOEA and its appropriate department or division; and

6. The disposition of a parcel is not contrary to the express wishes of the person(s) who donated or sold the parcel or interests therein to the Commonwealth.

III. Procedures for Disposition

Although legislation can be enacted to dispose of Article 97 land without the consent of an EOEA agency, it is the policy of EOEA to minimize such occurrences. To that end, and to ensure coordination, EOEA agencies shall:

1. Develop an internal review process for any potential Article 97 land disposition to ensure that, at a minimum, the conditions in Section II above are met;

2. Develop, through the Interagency Lands Committee, a joint listing of all requests, regardless of their status, for the disposition of Article 97 land;

3. Notify the Interagency Lands Committee of any changes to the Article 97 land disposition list;

4. Monitor all legislation that disposes of Article 97 land, and communicate with legislative sponsors regarding their intent;

5. Recommend to the Secretary that the Governor veto any legislation that disposes of Article 97 land, the purchase, improvement, or maintenance of which involved state funds, on and for which the EOEA agency has not been consulted and received documentation (including information on title, survey, appraisal, and a MEPA review, all at the proponent's expense);

6. Obtain the concurrence of the Secretary of EOA for any proposed Article 97 land disposition decision prior to finalizing said decision;

7. If recommending an Article 97 disposition, attach to all Article 97 legislative recommendations and TR-1 forms a justification of the disposition and an explanation of how it complies with this policy, signed by the EOEA agency head;

8. Ensure that any conditions approved by EOEA and its agencies to any Article 97 land disposition are incorporated within the surplus declaration statement submitted to and published by DCPO as required by M.G.L. C. 7, §40F and 40F1/2 and throughout the disposition process, and if such conditions are not incorporated in said statement throughout the disposition process, the EOEA agency head shall recommend to the Secretary that the Governor veto any resulting legislation;

9. Recommend to the Secretary that the Governor veto legislation that disposes of Article 97 land of which the agency disapproves; and

10. Ensure that any Article 97 land disposition is authorized by enacted legislation and approved by all municipal, state and federal agencies, authorities, or other governmental bodies so required and empowered by law prior to conveyance.

IV. Applicability of the Policy to Municipalities

To comply with this policy, municipalities that seek to dispose of any Article 97 land must:

1. Obtain a unanimous vote of the municipal Conservation Commission that the Article 97 land is surplus to municipal, conservation and open space needs;

2. Obtain a unanimous vote of the municipal Park Commission if the land proposed for disposition is parkland;

3. Obtain a two-thirds Town Meeting or City Council vote in support of the disposition;

4. Obtain two-thirds vote of the legislature in support of the disposition, as required under the state constitution;

5. Comply with all requirements of the Self-Help, Urban Self-Help, Land and Water Conservation Fund, and any other applicable funding sources; and

6. Comply with EOEA Article 97 Land Disposition Policy [note: the municipality must also file an Environmental Notification Form with EOEA's MEPA office].

After the effective date of this policy, any municipality that proposes, advocates, supports or completes a disposition of Article 97 land without also following the terms of this policy, regardless of whether or not state funds were used in the acquisition of the Article 97 land, shall not be eligible for grants offered by EOEA or its agencies until the municipality has complied with this policy. Compliance with this policy by municipalities shall be determined by the EOEA Secretary, based on recommendations by the EOEA Interagency Lands Committee.

Trudy Coxe, Secretary
Executive Office of Environmental Affairs