WIND DATA REPORT

Rockport School Complex
Rockport, Massachusetts

March 1st, 2007 – February 29th, 2008

Prepared for

Massachusetts Technology Collaborative
75 North Drive
Westborough, MA 01581

by

William L. W. Henson
James F. Manwell
Utama Abdulwahid
Anthony F. Ellis

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Renewable **E**nergy **R**esearch **L**aboratory
University of Massachusetts, Amherst
160 Governors Drive, Amherst, MA 01003
www.ceere.org/rerl • (413) 545-4359 • rerl@ecs.umass.edu

NOTICE AND ACKNOWLEDGEMENTS

This report was prepared by the Renewable Energy Research Laboratory (RERL) at the University of Massachusetts, Amherst in the course of performing work sponsored by the Renewable Energy Trust (RET), as administered by the Massachusetts Technology Collaborative (MTC). The opinions expressed in this report do not necessarily reflect those of MTC or the Commonwealth of Massachusetts, and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it.

TABLE OF CONTENTS

TABLE OF FIGURES

EXECUTIVE SUMMARY

All the work presented in this Wind Data Report including installation and decommissioning of the meteorological tower and instrumentation, and the data analysis and reporting was performed by the Renewable Energy Research Laboratory (RERL) at the University of Massachusetts, Amherst.

This report covers wind data measured at a meteorological tower installed at Rockport school complex in the town of Rockport, MA. Installed on October 27th, 2006, the wind monitoring station was in continuous operation until April 23rd, 2008. Two sets of two anemometers and one wind vane are mounted at 49 m (160.7 ft) and 38 m (124.6 ft), and an additional anemometer and vane are mounted at 20 m (65.6 ft). Reports are made on a quarterly basis; and this report is the final report for Rockport.

The data covered by this final report is one calendar year from March 1st, 2007 until February 29th, 2008. Typically, met towers are removed for reuse at other sites after a one year period; however, due to issues with missing data during the beginning of the collection period, additional data was gathered in an attempt to allow for a complete dataset. The gross data recovery percentage (the actual percentage of expected data received) was 100% and the net data recovery percentage (the percentage of expected data which passed all of the quality assurance tests) was 96.9% for all data collected. The gross data recovery percentage (the actual percentage of expected data received) was 100% and the net data recovery percentage (the percentage of expected data which passed all of the quality assurance tests) was 99.1% for the year covered in this report. The mean recorded wind speed for this year was 5.54 m/s (12.4 mph)[1] and the prevailing wind direction was from the south-southwest. Other nearby wind monitoring sites include Mattapoisett (5.74 m/s year 2006), and Thompson Island (6.1 m/s year 2007).

Additional information about interpreting the data presented in this report can be found in the Fact Sheet, "Interpreting Your Wind Resource Data," produced by RERL and the Massachusetts Technology Collaborative (MTC). This document is found through the RERL website:

http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_6_Wind_resource_interpretation.pdf

* 1 m/s = 2.237 mph.

[1] 1m/s=2.237 mph

SECTION 1 - Station Location

The Rockport site is located very near the Rockport school complex in Rockport, MA. Latitude and Longitude are 42° 39.090'N and 70° 36.566'W, respectively, using the NAD 83 datum. Figure 1 shows the site on a topographic map.

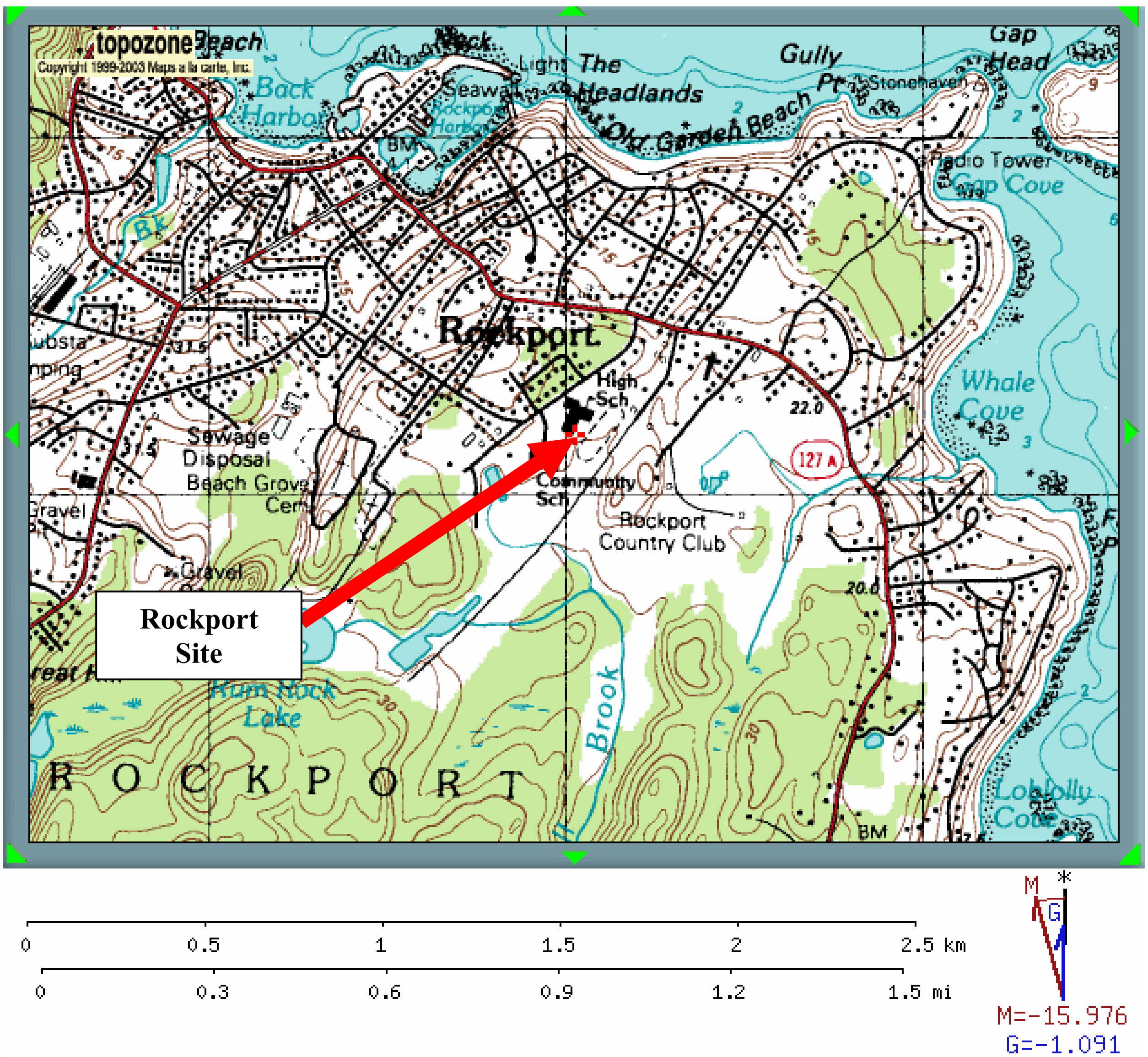

Figure 1 – Topographic Map Showing Rockport Site Location--Source Topozone.com

SECTION 2 - Instrumentation and Equipment

The wind monitoring equipment is mounted on a 50 m (164.0 ft) NRG tower. All other monitoring equipment comes from NRG Systems, and consists of the following items:

- Symphonie Data Logger
- Electrical enclosure box
- 5 – #40 Anemometers, standard calibration (Slope - 0.765 m/s, Offset – 0.350 m/s). Two anemometers are located at 49 m (160.7 ft), two at 38 m(124.6 ft) and one at 20 m (65.6 ft).
- 3 - #200P Wind direction vanes. They are located at heights of 49 m (160.7 ft), 38 m(124.6 ft) and 20 m (65.6 ft) each.
- 5 – Sensor booms, 54” length
- Lightning rod and grounding cable
- 1 - #110S Temperature sensor mounted at approximately 3 m (9.8 ft)
- Shielded sensor wire

Figure 2 – Preparation to raise the Met-tower at Rockport Site

The data from the Symphonie logger is mailed to the Renewable Energy Research Laboratory at the University of Massachusetts, Amherst on a regular basis. The logger samples wind speed and direction once every two seconds. These data are then combined into 10-minute averages and, along with the standard deviation for those 10-minute periods, are put into a binary file. These binary files are converted to ASCII text files using the NRG software BaseStation®. These text files are then imported into a database software program where they are subjected to quality assurance (QA) tests prior to using the data.

SECTION 3 - Data Summary

A summary of the wind speeds and wind directions measured during the reporting period is included in Table 1. Table 1 includes the mean wind speeds measured at each measurement height, the maximum instantaneous wind speed measured at each measurement height and the prevailing wind direction measured at each measurement height. These values are provided for each month of the reporting period and for the whole reporting period.

Table 1. Wind Speed and Direction Data Summary

Date	Mean Wind Speed	Max Wind Speed	Prevailing Wind Direction	Mean Wind Speed	Max Wind Speed	Prevailing Wind Direction	Mean Wind Speed	Max Wind Speed	Prevailing Wind Direction
Height Units	**49 m [m/s]**	**49 m [m/s]**	**49 m**	**38 m [m/s]**	**38 m [m/s]**	**38 m**	**20 m [m/s]**	**20 m [m/s]**	**20 m**
Nov-06	5.7	15.96	SW	4.95	13.96	SW	3.59	11.26	SW
Dec-06	6.05	15.21	NNW	5.39	13.95	NNW	2.98	11.73	WNW
Jan-07	--	16.89	--	--	15.06	--	--	9.94	--
Feb-07	--	15.64	--	--	13.64	--	1.63	11.42	WNW
Mar-07	7.08	17.55	NNW	6.42	15.86	WSW	4.19	12.17	SW
Apr-07	6.34	22.17	WNW	5.77	19.69	WNW	4.1	13.87	WNW
May-07	5.24	13.15	SW	4.8	11.2	SW	3.54	8.63	SW
Jun-07	4.85	10.26	SW	4.44	9.5	SW	3.13	7.60	SW
Jul-07	4.33	13.93	SW	3.86	11.96	SW	2.83	9.30	SW
Aug-07	4.66	11.31	SW	4.14	9.87	SW	3.08	7.56	SW
Sep-07	4.89	9.76	WSW	4.39	9.27	WSW	2.37	7.70	SW
Oct-07	5.02	12.93	SSW	4.49	11.98	SW	1.15	7.28	SW
Nov-07	6.04	21.03	NNW	5.39	18.3	SW	0.82	12.52	NW
Dec-07	6.11	17.86	WNW	5.48	16.19	NW	1.4	12.69	W
Jan-08	6.29	18.02	WNW	5.59	16.11	SW	1.17	10.32	SW
Feb-08	5.71	14.37	NW	5.16	12.99	SSW	1.32	9.28	SSW
Mar-08	6.47	14.61	SW	5.85	13.29	S	1.28	9.00	SSW
Mar 2007 – Feb 2008	**5.54**	**22.17**	**NNW**	**4.98**	**19.69**	**SW**	**2.43**	**13.87**	**SW**

Wind data statistics in the table are reported when more than 90% of the data during the reporting period are valid. In cases when a larger amount of data are missing, the percent of the available data that are used to determine the data statistics is noted.

No measurement of wind speed or direction can be perfectly accurate. Wind speed measurement errors occur due to anemometer manufacturing variability, anemometer calibration errors, the response of anemometers to turbulence and vertical air flow and due to air flows caused by the anemometer mounting system. Every effort is made to reduce the sources of these errors. Nevertheless, the values reported in this report have an expected uncertainty of about ± 2% or ± 0.2 m/s, whichever is greater. Wind direction measurement errors occur due to sensor measurement uncertainty, tower effects, boom alignment measurement errors and twisting of pipe sections during the raising of a pipe tower. Efforts are also made to reduce these errors, but the reported wind directions are estimated to have an uncertainty of +/- 5 degrees.

A summary of the turbulence intensity and mean wind shear measured at each measurement height during the reporting period is included in Table 2. These values are provided for each month of the reporting period and for the whole reporting period. Turbulence Intensity is calculated by dividing the standard deviation of the wind speed by the mean wind speed and is a measure of the gustiness of a wind resource. Lower turbulence results in lower mechanical loads on a wind turbine. Turbulence intensity varies with wind speed. The average turbulence intensity presented in Table 2 is the mean turbulence intensity when the wind speed at the highest measurement height is between 9.5 and 10.5 m/s.

Shear coefficients provide a measure of the change in wind speed with height. When data at multiple heights are available, shear coefficients, α, have been determined. They can be used in the following formula to estimate the average wind speed, $U(z)$, at height z, when the average wind speed, $U(z_r)$, at height z_r is known:

$$U(z)=U(z_r)\left(\frac{z}{z_r}\right)^{\alpha}$$

The change in wind speed with height is a very complicated relationship related to atmospheric conditions, wind speed, wind direction, time of day and time of year. This formula will not always provide the correct answer at any given site. Nevertheless the calculated shear coefficient, based on measurements at two heights, can be used to characterize the degree of increase in wind speed with height at a site.

The mean wind shear coefficient that is provided here is calculated based on the mean wind speeds in Table 1, where z_{high} and z_{low} are the heights of the higher and lower mean wind speeds used in the calculation and $U(z_{low})$ and $U(z_{high})$ are the mean wind speeds at the two heights.

$$\alpha = \log\left(\frac{U(z_{high})}{U(z_{low})}\right) \Big/ \log\left(\frac{z_{high}}{z_{low}}\right)$$

Table 2. Shear and Turbulence Intensity Data Summary

Date	Turbulence Intensity at 10 m/s	Turbulence Intensity at 10 m/s	Turbulence Intensity at 10 m/s	Mean Wind Shear Coefficient, α
Height Units	49 m [-]	38 m [-]	20 m [-]	Between 49 m and 38 m [-]
Nov-06	0.165	0.197	0.229	0.555
Dec-06	0.212	0.243	0.254	0.453
Jan-07	0.214	0.234	--	0.379
Feb-07	0.211	0.233	0.240	0.204
Mar-07	0.206	0.222	0.267	0.386
Apr-07	0.171	0.188	0.259	0.372
May-07	0.161	0.18	--	0.339
Jun-07	0.278	--	--	0.349
Jul-07	0.185	0.186	--	0.446
Aug-07	0.214	--	--	0.464
Sep-07	--	--	--	0.421
Oct-07	0.196	0.235	--	0.444
Nov-07	0.207	0.225	0.334	0.445
Dec-07	0.205	0.236	0.237	0.426
Jan-08	0.18	0.196	0.268	0.465
Feb-08	0.198	0.235	--	0.395
Mar-08	0.203	0.234	--	0.393
Mar 2007 -Feb 2008	**0.193**	**0.216**	**0.268**	**0.414**

SECTION 4- Long Term Estimate and Capacity Factor

Wind speed varies year by year and the mean obtained over the measurement period may be less or more compared to what is seen over a longer time period. Therefore, the use of the long term mean at the site is preferred when projecting the performance of a wind turbine. The long term mean at a site may be estimated by using the Measure-Correlate-Predict (MCP) method.

The MCP method correlates wind speed measurements at the target site to a reference site which collects data over the same period of time and has been collecting data for a much longer period. Based on this correlation, the reference wind speed data is used to predict long term mean at the site.

Long term data from Thompson Island between June 30th, 2002 and June 29th, 2008 is used as reference in the case of Rockport. Correlation between the two sites are obtained from concurrent data between October 27th, 2006 and April 23rd, 2008 . The long term mean at 49 m at Rockport is estimated to be 5.67 m/s with an uncertainty of 3.9% for the MCP process.

The capacity factor of a wind turbine at a given site depends on the hub height, wind speed distribution at the hub height, the wind turbine power curve and any assumptions about down time and losses due to wake effects from upwind wind turbines, etc. If the hub height wind speed is estimated from data at lower heights, then the capacity factor will also depend on the estimated wind shear and the wind speeds measured at lower heights. No simple estimate of capacity factor at a site could take all of these effects and choices into account. Nevertheless, an estimate of the capacity factor of a wind turbine at this site is provided here to help the reader understand the order of magnitude of the wind resource at this site.

The estimates assume a GE 1.5 sl turbine with a hub height of 80 m and the long term mean wind speed estimate at the highest measurement height and the mean wind shear at the site, in order to determine the mean hub height wind speed, in this case 6.94 m/s. The wind speed probability distribution is assumed to be given by a Rayleigh distribution. The average wind turbine power is then estimated from:

$$\overline{P_W} = \int_0^\infty P_W(U)p(U)dU$$

where $P_W(U)$ is the wind turbine power curve and $p(U)$ is the wind speed probability distribution. The capacity factor is then calculated from:

$$CF = \frac{\overline{P_W}}{P_{rated}}$$

where P_{rated} is the rated capacity of the turbine, i.e., 1500 kW. Based on this equation, the estimated capacity factor of a wind turbine at this site would be about 0.36.

SECTION 5- Graphs

This report contains several types of wind data graphs. Unless otherwise noted, each graph represents data from one calendar year (March, 2007 to February, 2008). The following graphs are included:

- Time Series – 10-minute average wind speeds are plotted against time. This graph includes all of the collected data.
- Wind Speed Distribution – A histogram plot giving the percentage of time that the wind is at a given wind speed.
- Monthly Average – A plot of the monthly average wind speed over a 12-month period. This graph shows the trends in the wind speed over the whole period of data collection.
- Diurnal – A plot of the average wind speed for each hour of the day.
- Turbulence Intensity – A plot of turbulence intensity as a function of wind speed. Turbulence Intensity is calculated as the standard deviation of the wind speed

divided by the wind speed and is a measure of the gustiness of a wind resource. Lower turbulence results in lower mechanical loads on a wind turbine.

- Wind Rose – A plot, by compass direction showing the percentage of time that the wind comes from a given direction and the average wind speed in that direction.

From the Wind Speed Time-Series graph (figure 3) it can be seen that the wind speed is generally below 10 m/s (22.4 mph). Figure 4 shows that the wind speed was between 5 m/s and 6 m/s (11.2 mph 13.4 mph) about 19% of the time. Figure 5 shows that the monthly average wind speeds were generally always above 4 m/s (08.9 mph), also visible in the figure is that the paucity of valid data collected during the months of January 2007 and February 2007 prevented calculation of monthly statistics. Figure 6 shows that the wind speed was generally slightly higher during the late evening and early morning hours. Figure 7 shows that the site turbulence intensity at 49 m was generally somewhat high presumably due to effects caused by nearby buildings. Figure 8 shows that though the average wind speeds were well distributed about the compass rose; and the wind blew primarily from the north-northwest and south-southwest (11.1% and 10.7% of the time, respectively).

Data for the wind speed histograms, monthly and diurnal average plots, and wind roses are included in APPENDIX B.

Wind Speed Time Series

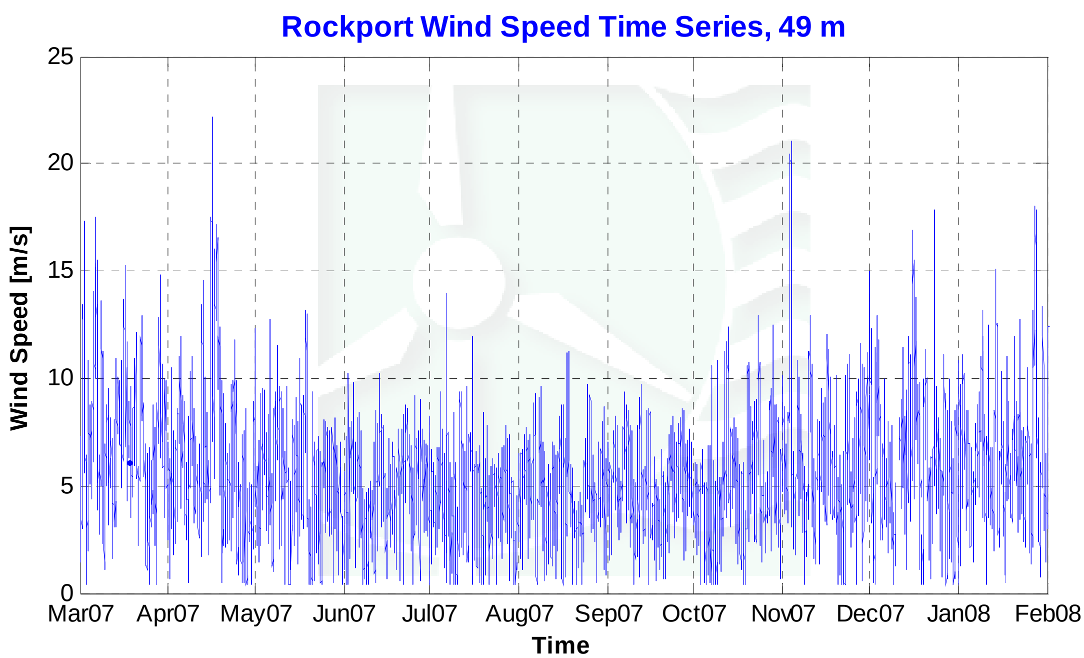

Figure 3 - Wind Speed Time Series, March 1, 2007 through February 29, 2008

Wind Speed Distributions

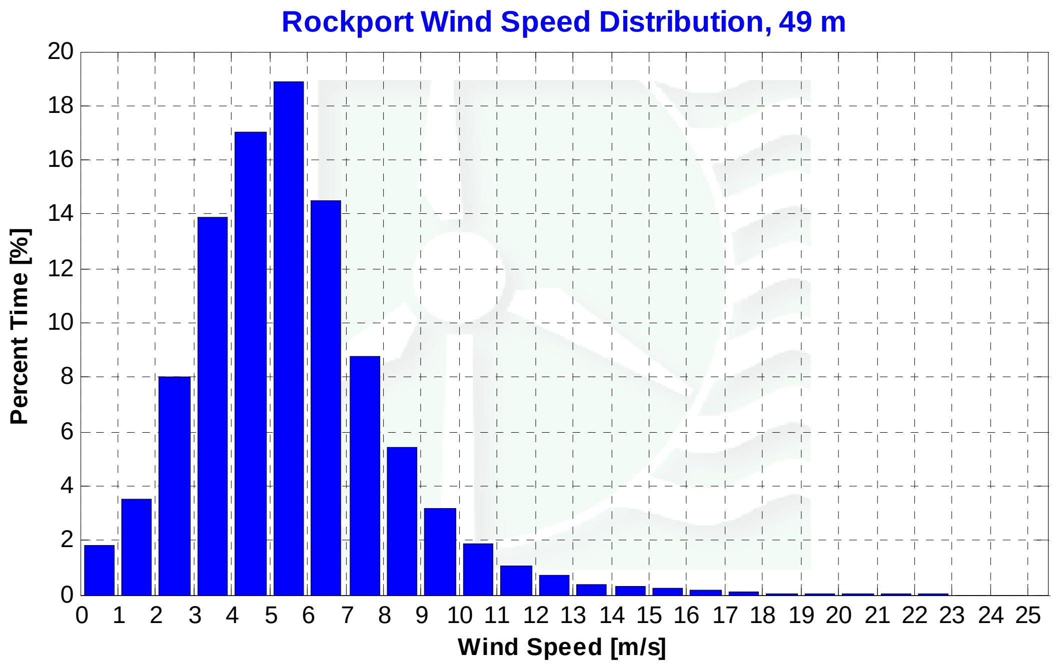

Figure 4 - Wind Speed Distribution, March 1, 2007 through February 29, 2008

Monthly Average Wind Speeds

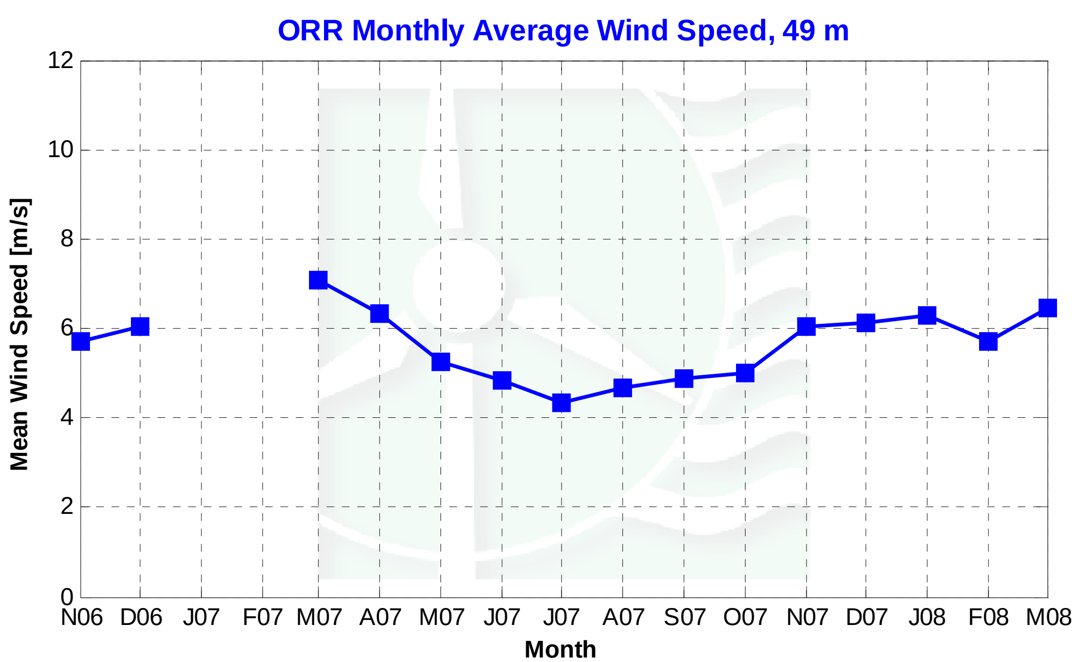

Figure 5 - Monthly Average Wind Speed

Diurnal Average Wind Speeds

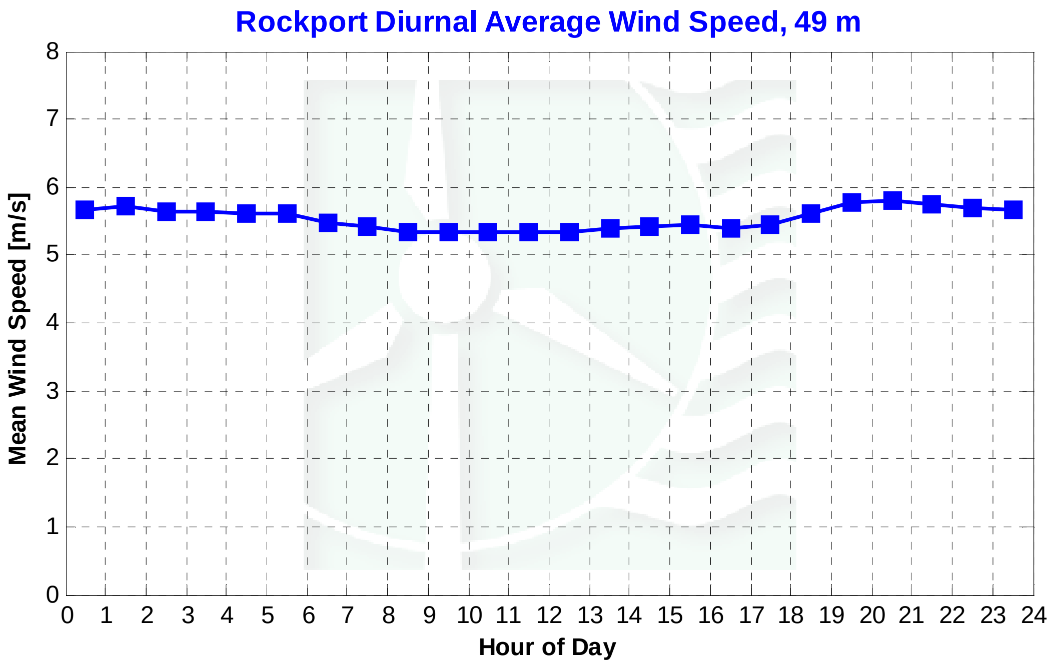

Figure 6 - Diurnal Average Wind Speed, March 1, 2007 through February 29, 2008

Turbulence Intensities

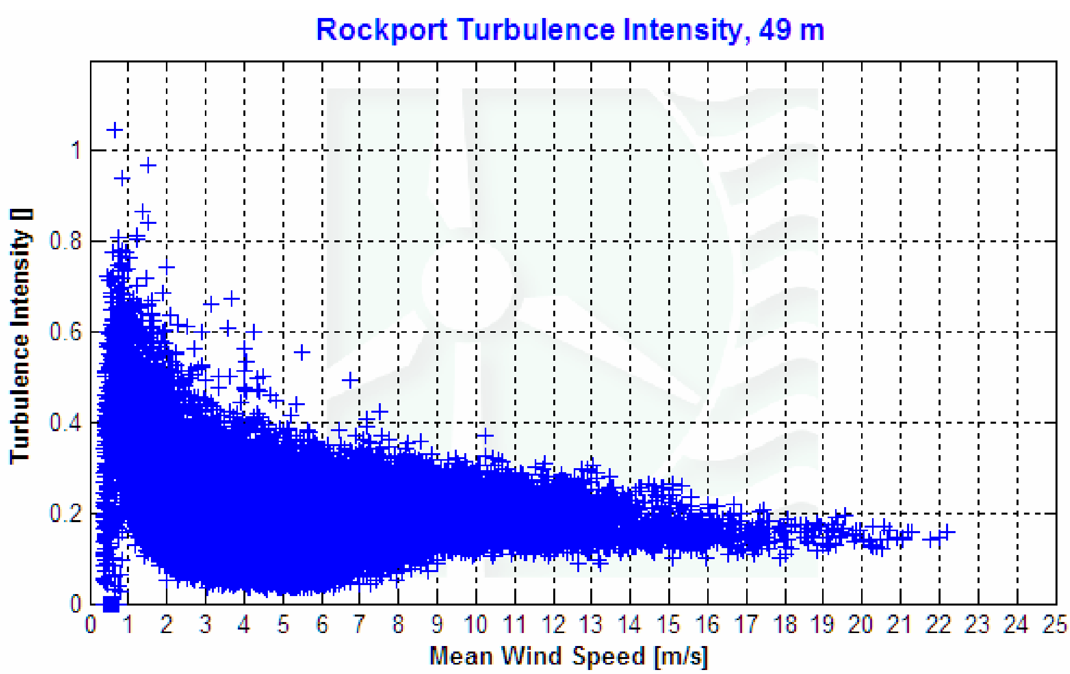

Figure 7 - Turbulence Intensity, March 1, 2007 through February 29, 2008

Wind Roses

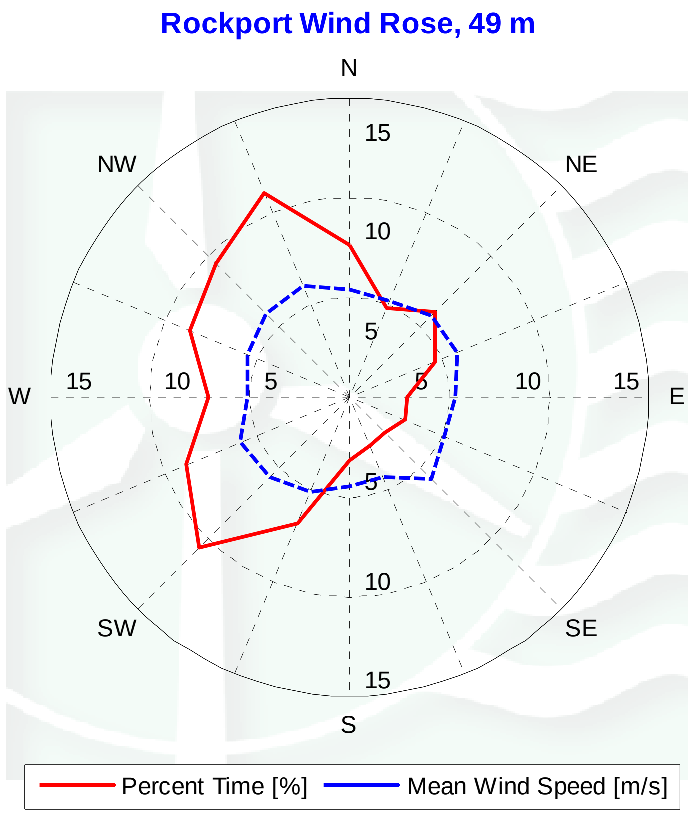

Figure 8 - Wind Rose, March 1, 2007 through February 29, 2008

SECTION 6 - Significant Meteorological Events

During this calendar year, there were no weather conditions that would have significantly affected wind speed or wind direction data.

Sources:
http://www.wunderground.com/, http://www.erh.noaa.gov/box/MonthlyClimate2.shtml

SECTION 7 - Data Collection and Maintenance

Problems with the wind speed data began to occur on about January 26 and lasted until the logger was replaced on February 21—though there is a brief period (Feb 2 until Feb 6) where valid data was also collected. The faulty logger was returned to NRG, and it was confirmed as the cause of the invalid data. The data collection period was extended in order to collect a full year of data and once the logger was replaced, all sensors appear to have functioned correctly except for the 20 m anemometer. From September 20th, 2007 until the end of data collection the 20 m anemometer data collected from the logger showed periods of "flatline" behavior for no apparent reason. The statistics reported for the 20 m anemometer should be viewed with caution, since it seems that they are biased low by the affected data. Because the 20 m height is not used in wind resource calculations, but more for correlation with nearby National Weather Service monitoring stations, and because the data from the 20 m anemometer does pass the filtering that the RERL currently uses, the data has not been marked as invalid and discounted from statistics processing. Although there have been a few short duration sensor-icing events, that have cause minor data loss, there has been no data loss large enough to substantially affect wind speed statistics during the calendar year covered in this report.

SECTION 8 - Data Recovery and Validation

All raw wind data are subjected to a series of tests and filters to weed out data that are faulty or corrupted. Definitions of these quality assurance (QA) controls are given below under Test Definitions and Sensor Statistics. These control filters were designed to automate the quality control process and used many of the previous hand-worked data sets made at UMass to affect a suitable emulation. The gross percentage of data recovered (ratio of the number 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.

Entire Data Collection Period	
Gross Data Recovered [%]	100
Net Data Recovered [%]	96.93
CY: 03/2007—02/2008	
Gross Data Recovered [%]	100
Net Data Recovered [%]	99.10

Test Definitions

All raw data were subjected to a series of validation tests, as described below. The sensors tested and the parameters specific to each sensor are given in the Sensor Performance Report which is included in APPENDIX A. Data which were flagged as invalid were not included in the statistics presented in this report.

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 is less than Factor 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 insolation.

$$F1 > TF1 > F2$$

MinMaxT Test: This is a MinMax test for wind direction standard deviation with different ranges applied for high and low wind speeds. 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.

$$\begin{gathered}(TF1 < F1) \\ \text{or } (TF2 < F4 \text{ and } TF1 > F2) \\ \text{or } (TF2 \geq F4 \text{ and } TF1 > F3)\end{gathered}$$

Icing Test: An icing event occurs when ice collects on a sensor and degrades its 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 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.

$$CF1 \leq F1 \text{ and } TF1 > F2 \text{ and } CF2 < F3$$

CompareSensors Test: Where primary and redundant sensors are used, it is possible to determine when one of the sensors is not 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 is 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 is greater than Factor 2.

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

Sensor Statistics

A summary of the results of the data collection and filtering are given in the Sensor Performance Report which is included in APPENDIX A. The following categories of information, tabulated for each sensor, are included in that report.

Expected Data Points: the total number of sample intervals between the start and end dates (inclusive).

Actual Data Points: the total number of data points recorded between the start and end dates.

% Data Recovered: the ratio of actual and expected data points (this is the *gross data recovered percentage*).

Hours Out of Range: total number of hours for which data were flagged according to MinMax and MinMaxT tests. These tests flag data which fall outside of an expected range.

Hours of Icing: total number of hours for which data were flagged according to Icing tests. This test uses the standard deviation of wind direction, air temperature, and wind speed to determine when sensor icing has occurred.

Hours of Fault: total number of hours for which data were flagged according to CompareSensors tests. These tests compare two sensors (e.g. primary and redundant anemometers installed at the same height) and flag data points where one sensor differs significantly from the other.

% Data Good: the filter results are subtracted from the gross data recovery percentage to yield the *net data recovered percentage*.

APPENDIX A - Sensor Performance Report

Test Definitions

Test Order	TestField1	TestField2	TestField3	CalcField1	Calc Field2	Calc Field3	TestType	Factor1	Factor2	Factor3	Factor4
1							TimeTest Insert	0	0	0	0
2	Etmp2aDEGC						MinMax	-30	60	0	0
3	Etmx2aDEGC						MinMax	-30	60	0	0
4	Etmn2aDEGC						MinMax	-30	60	0	0
5	EtmpSD2aDEGC						MinMax	-30	60	0	0
10	Anem49aMS						MinMax	0	90	0	0
11	Anem49bMS						MinMax	0	90	0	0
12	Anem38aMS						MinMax	0	90	0	0
13	Anem38bMS						MinMax	0	90	0	0
14	Anem20aMS						MinMax	0	90	0	0
20	AnemSD49aMS						MinMax	0	4	0	0
21	AnemSD49bMS						MinMax	0	4	0	0
22	AnemSD38aMS						MinMax	0	4	0	0
23	AnemSD38bMS						MinMax	0	4	0	0
24	AnemSD20aMS						MinMax	0	4	0	0
30	Vane49aDEG						MinMax	0	359.9	0	0
31	Vane38aDEG						MinMax	0	359.9	0	0
32	Vane20aDEG						MinMax	0	359.9	0	0
50	Turb49zNONE						MinMax	0	2	0	0
51	Turb38zNONE						MinMax	0	2	0	0
52	Turb20ZNONE						MinMax	0	2	0	0
60	Wshr0zNONE						MinMax	-100	100	0	0
200	VaneSD49aDEG	Anem49yMS					MinMaxT	0	100	100	10
201	VaneSD38aDEG	Anem38yMS					MinMaxT	0	100	100	10
202	VaneSD20aDEG	Anem20aMS					MinMax	0	100	100	10
300	Anem49aMS	AnemSD49aMS	Vane49aDEG	VaneSD49aDEG	Etmp2aDEGC		Icing	0.5	1	2	10
301	Anem49bMS	AnemSD49bMS	Vane49aDEG	VaneSD49aDEG	Etmp2aDEGC		Icing	0.5	1	2	10
302	Anem38aMS	AnemSD38aMS	Vane38aDEG	VaneSD38aDEG	Etmp2aDEGC		Icing	0.5	1	2	10
303	Anem38bMS	AnemSD38bMS	Vane38aDEG	VaneSD38aDEG	Etmp2aDEGC		Icing	0.5	1	2	10
304	Anem20aMS	AnemSD20aMS	Vane20aDEG	VaneSD20aDEG	Etmp2aDEGC		Icing	0.5	1	2	10
400	Anem49aMS	Anem49bMS					CompareSensors	1	0.25	3	0
401	Anem38aMS	Anem38bMS					CompareSensors	1	0.25	3	0
500	Amax49aMS						MinMax	0	90	0	0
501	Amax49bMS						MinMax	0	90	0	0
502	Amax38aMS						MinMax	0	90	0	0
503	Amax38bMS						MinMax	0	90	0	0

504	Amax20aMS						MinMax	0	90	0	0
510	Amin49aMS						MinMax	0	90	0	0
511	Amin49bMS						MinMax	0	90	0	0
512	Amin38aMS						MinMax	0	90	0	0
513	Amin38bMS						MinMax	0	90	0	0
514	Amin20aMS						MinMax	0	90	0	0
520	Vmax49aDEG						MinMax	0	359.9	0	0
521	Vmax38aDEG						MinMax	0	359.9	0	0
522	Vmax20aDEG						MinMax	0	359.9	0	0
530	Vmin49aDEG						MinMax	0	359.9	0	0
531	Vmin38aDEG						MinMax	0	359.9	0	0
532	Vmin20aDEG						MinMax	0	359.9	0	0

Sensor Statistics

Sensor	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	% Data Good
Anem49aMS	52704	52704	100	0.83	78.83	2.17	99.07
AnemSD49aMS	52704	52704	100	0.83	78.83	2.17	99.07
Anem49bMS	52704	52704	100	0.83	77.5	0.17	99.11
AnemSD49bMS	52704	52704	100	0.83	77.5	0.17	99.11
Anem38aMS	52704	52704	100	0.5	115	0.5	98.68
AnemSD38aMS	52704	52704	100	0.5	115	0.5	98.68
Anem38bMS	52704	52704	100	0.5	100.83	18.67	98.63
AnemSD38bMS	52704	52704	100	0.5	100.83	18.67	98.63
Anem20aMS	52704	52704	100	17.83	34.5	0	99.4
AnemSD20aMS	52704	52704	100	17.83	34.5	0	99.4
Vane49aDEG	52704	52704	100	1.83	78.83	0	99.08
VaneSD49aDEG	52704	52704	100	1.83	78.83	0	99.08
Vane38aDEG	52704	52704	100	17	116.17	0	98.48
VaneSD38aDEG	52704	52704	100	17	116.17	0	98.48
Vane20aDEG	52704	52704	100	17.83	34.5	0	99.4
VaneSD20aDEG	52704	52704	100	17.83	34.5	0	99.4
Etmp2aDEGC	52704	52704	100	0	0	0	100
EtmpSD2aDEGC	52704	52704	100	0	0	0	100
Total	**948672**	**948672**	**100**	**114.33**	**1272.33**	**43**	**99.1**

APPENDIX B - Plot Data

Wind Speed Distribution Data

Bin Center Wind Speed [m/s]	Percent of Time [%]
0.5	1.79
1.5	3.55
2.5	8.03
3.5	13.88
4.5	17
5.5	18.87
6.5	14.48
7.5	8.75
8.5	5.44
9.5	3.15
10.5	1.9
11.5	1.08
12.5	0.7
13.5	0.41
14.5	0.34
15.5	0.24
16.5	0.15
17.5	0.09
18.5	0.06
19.5	0.05
20.5	0.02
21.5	0.01
22.5	0
23.5	0
24.5	0

Monthly Average Wind Speed Data

Date	10 min Mean [m/s]
Nov-06	5.7
Dec-06	6.05
Jan-07	--
Feb-07	--
Mar-07	7.08
Apr-07	6.34
May-07	5.24
Jun-07	4.85
Jul-07	4.33
Aug-07	4.66
Sep-07	4.89
Oct-07	5.02
Nov-07	6.04
Dec-07	6.11
Jan-08	6.29
Feb-08	5.71
Mar-08	6.47

Diurnal Average Wind Speed Data

Hour of Day	Average Wind Speed [m/s]
0.5	5.67
1.5	5.72
2.5	5.65
3.5	5.65
4.5	5.61
5.5	5.62
6.5	5.49
7.5	5.41
8.5	5.33
9.5	5.34
10.5	5.35
11.5	5.34
12.5	5.34
13.5	5.4
14.5	5.43
15.5	5.43
16.5	5.39
17.5	5.46
18.5	5.6
19.5	5.76
20.5	5.8
21.5	5.75
22.5	5.7
23.5	5.68

Wind Rose Data

Direction	Percent Time [%], 49 m	Mean Wind Speed [m/s], 49 m
N	7.59	5.39
NNE	4.85	5.22
NE	6.07	5.78
ENE	4.62	5.83
E	2.91	5.31
ESE	3.01	5.1
SE	2.49	5.81
SSE	2.59	4.37
S	3.18	4.46
SSW	6.87	5.11
SW	10.65	5.61
WSW	8.84	5.94
W	7.09	5.16
WNW	8.68	5.57
NW	9.51	5.91
NNW	11.06	6.02