WIND DATA REPORT

Tisbury, Martha Vineyard, MA

July 1, 2007 – June 30, 2008

Prepared for

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NOTICE AND ACKNOWLEDGEMENTS

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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 Tisbury, Martha's Vineyard, MA. Installed on June 21, 2007, the wind monitoring station has been in continuous operation to this day. Two sets of two anemometers and one wind vane are mounted each at 49 m (160.7ft) and 35 m (114.8ft). Reports are made on a quarterly basis; and this report is the final report for Tisbury.

The period covered by this report is July 2007-June2008. The mean recorded wind speed for this period which is one complete year was 5.39 m/s (12.1 mph)[1] and the prevailing wind direction was from the west south-west. The gross data recovery percentage (the actual percentage of expected data received) was 91.815% and the net data recovery percentage (the percentage of expected data which passed all of the quality assurance tests) was 87.36%. Both of these percentages are low because data between the middle of December and the middle of January was lost as the logger died.

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 Tisbury site is located Martha's Vineyard, MA. Latitude and Longitude are 41° 26.027'N and 70° 37.301'W, respectively, using the NAD 83 datum. Figure 1 shows the site on a topographic map.

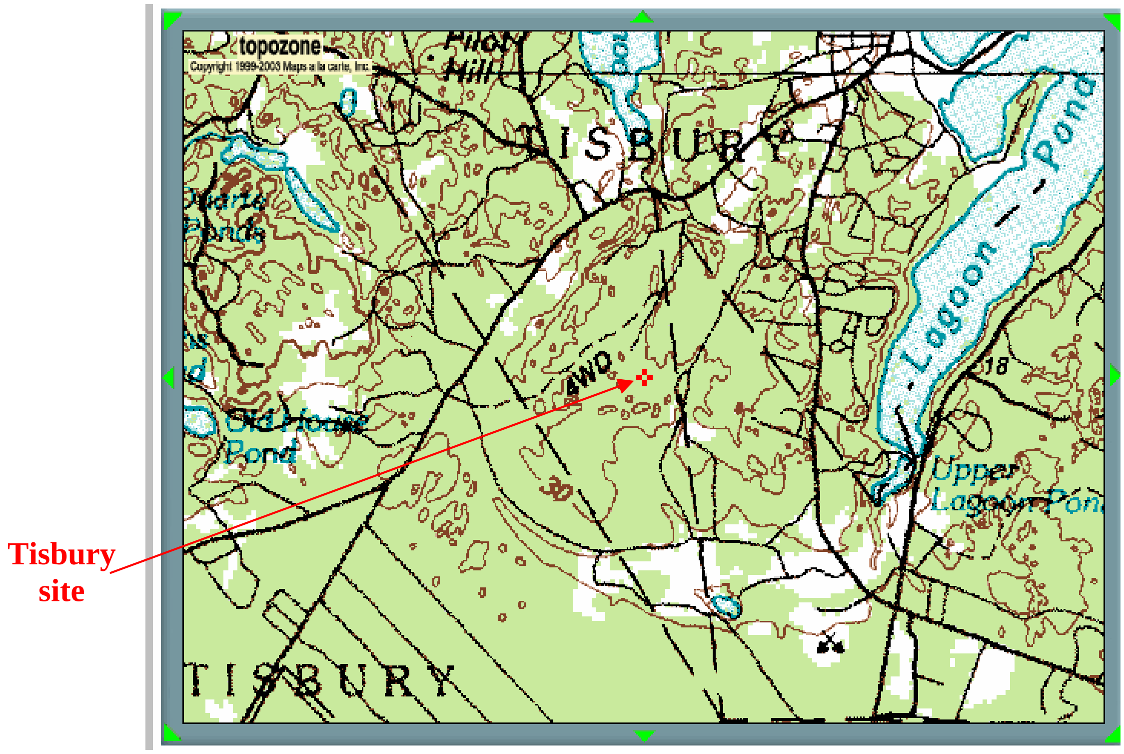

Figure 1 – Map Showing Tisbury Site Location--Source googlemaps.com

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
- 4 – #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 35 m(114.8 ft)
- 2 - #200P Wind direction vanes. They are located at heights of 49 m (160.7 ft) and 35m(124.6 ft)
- 4 – Sensor booms, 54" length
- Lightning rod and grounding cable
- 1 - #110S Temperature sensor mounted at approximately 3 m (9.8 ft)
- Shielded sensor wire

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	Data Good	Prevailing Wind Direction	Mean Wind Speed	Max Wind Speed	Data Good	Prevailing Wind Direction
Height Units	49 m [m/s]	49 m [m/s]	49m [%]	49 m [deg]	35 m [m/s]	35 m [m/s]	49m [%]	35 m [deg]
July'07	4.38	10.8	-	202.5	4.07	9.8	-	202.5
Aug'07	4.22	12.8	-	225	3.95	11.6	-	225
Sep'07	4.79	12.2	-	247.5	4.44	10.4	-	247.5
Oct'07	5.06	13.6	-	247.5	4.62	12.1	-	247.5
Nov'07	6.08	19.1	-	292.5	5.34	16.7	-	202.5
Dec'07	6.24	17.0	53.63	292.5	5.47	14.8	53.63	292.5
Jan'08	6.17	15.2	49.73	337.5	5.39	13.6	49.73	337.5
Feb'08	6.15	18.2	-	270	5.41	15.8	-	270
Mar'08	6.61	18.7	-	337.5	5.8	16.7	-	337.5
Apr'08	5.2	13.6	-	90	4.61	12.1	-	90
May'08	5.93	15.4	-	225	5.18	14.0	-	225
Jun'08	4.68	10.4	-	225	3.96	9.2	-	225
July'07–Jun'08	5.39	19.1		247.5	4.8	16.7		225

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 is missing, the percent of the available data that are used to determine the data statistics is noted, as in the month of December and January.

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	Mean Wind Shear Coefficient, α
Height Units	**49 m [-]**	**35 m [-]**	**Between 49 m and 35 m [-]**
July'07	0.23	0.23	0.22
Aug'07	0.23	0.22	0.20
Sep'07	0.23	0.23	0.23
Oct'07	0.24	0.23	0.27
Nov'07	0.22	0.24	0.39
Dec'07	0.22	0.25	0.39
Jan'08	0.22	0.23	0.40
Feb'08	0.21	0.23	0.34
Mar'08	0.21	0.23	0.39
Apr'08	0.21	0.23	0.36
May'08	0.21	0.24	0.40
Jun'08	0.2	0.24	0.49
July'07–Jun'08	**0.22**	**0.23**	**0.39**

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 Buzm3 buoy located in Buzzards Bay, MA between May 13th, 1997 and December 31st, 2007 is used as reference in the case of Tisbury. Correlation between the two sites is obtained from concurrent data between July 1st, 2007 and June 30th, 2008. The long term mean at Tisbury at 49 m is estimated to be 5.5 m/s with an uncertainty of 4.5% for the

MCP process. This estimate may also be used to calculate the long term mean at different heights by using the mean wind shear at site and the equation described in the previous section. The long term mean wind speed at 70 m height is estimated at 6.32 m/s.

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, which is 6.66m/s in this case. 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 0.33.

SECTION 5- Graphs

This report contains several types of wind data graphs. Unless otherwise noted, each graph represents data from one calendar year (July 2007 to June 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. [Add to this section and others below a description of what is in the graph]

- 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 2) it can be seen that the wind speed is generally below 14 m/s (31.3 mph). As can be seen in the plot, we lost data of about a month from middle of December to middle of January as the logger died during that period. Figure 3 shows that the wind speed was between 4 m/s and 5 m/s (8.9 mph 11.2 mph) about 19% of the time. Figure 4 shows that the monthly average wind speeds were generally always above 4 m/s (8.9 mph). Figure 5 shows that the wind speed was generally slightly higher during the afternoon hours. Figure 6 shows that the site turbulence intensity at 49 m was generally somewhat high. Figure 7 shows that though the average wind speeds were well distributed about the compass rose; and the wind blew primarily from the west-southwest and southwest (11.49% and 11.09% 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

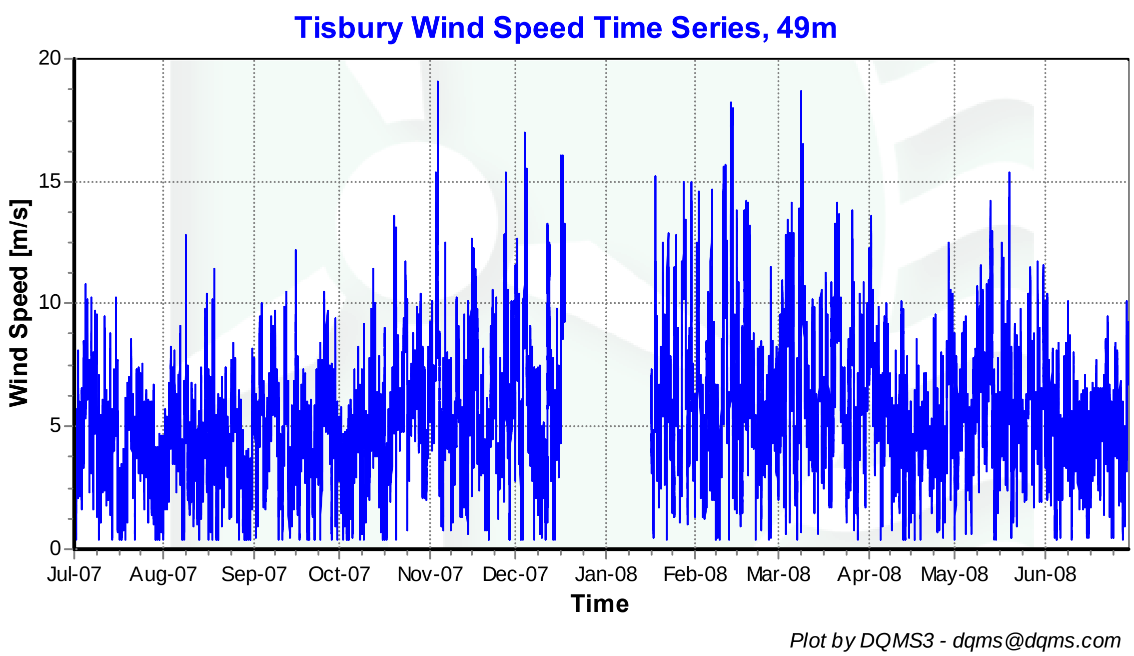

Figure 2 - Wind Speed Time Series, July 2007 – June 2008

Wind Speed Distributions

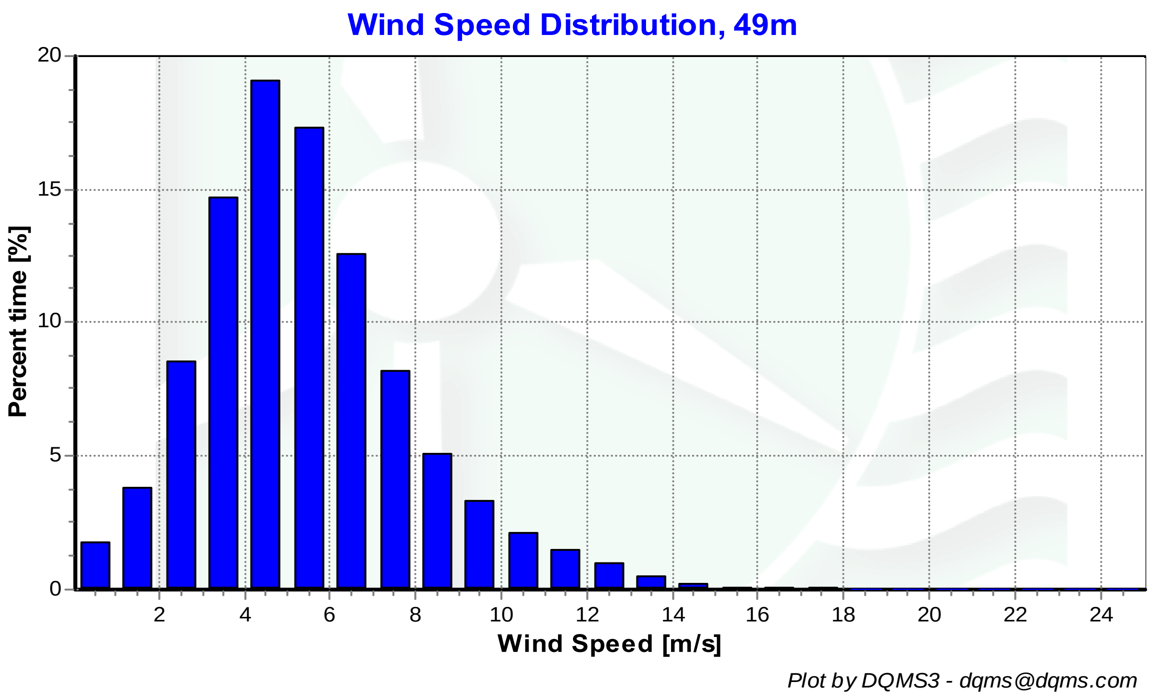

Figure 3 - Wind Speed Distribution, July 2007 – June 2008

Monthly Average Wind Speeds

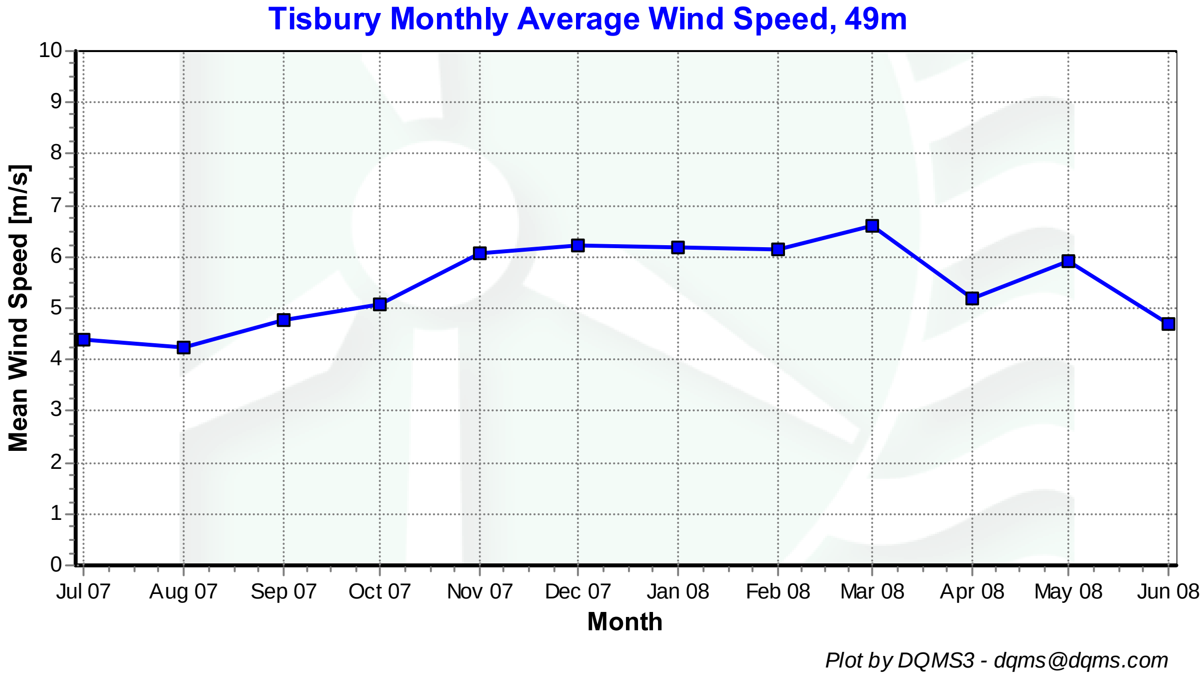

Figure 4 - Monthly Average Wind Speed

Diurnal Average Wind Speeds

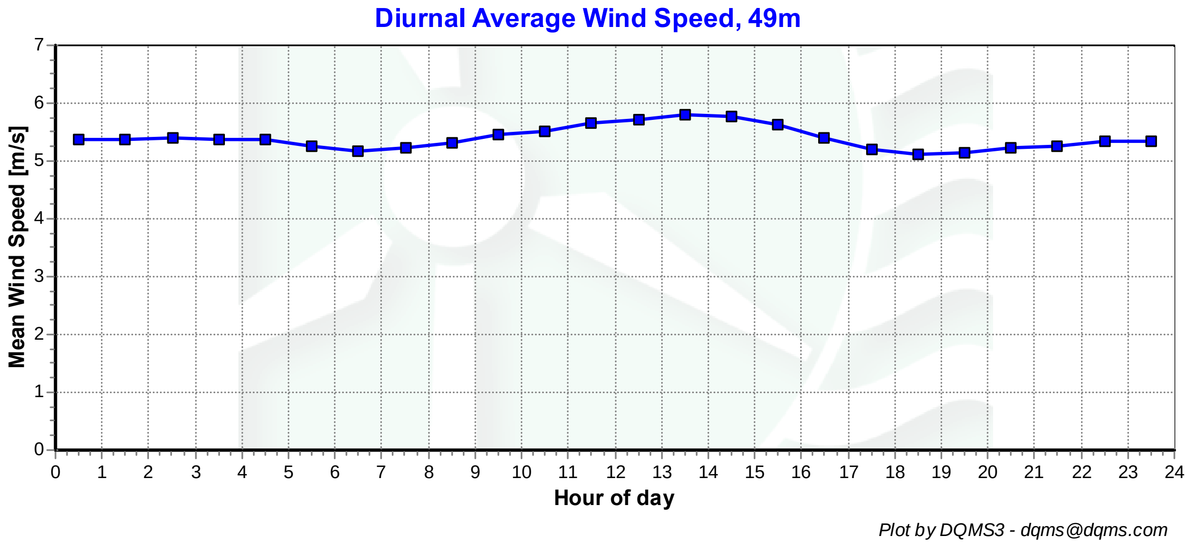

Figure 5 - Diurnal Average Wind Speed, July 2007 – June 2008

Turbulence Intensities

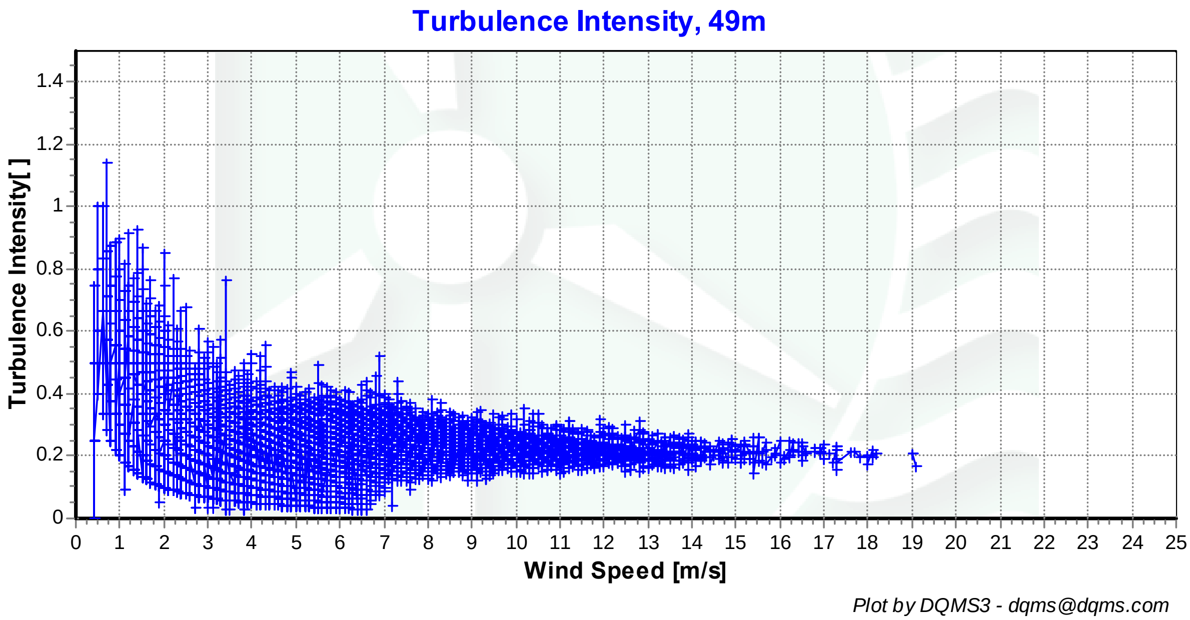

Figure 6 - Turbulence Intensity, July 2007 – June 2008

Wind Rose

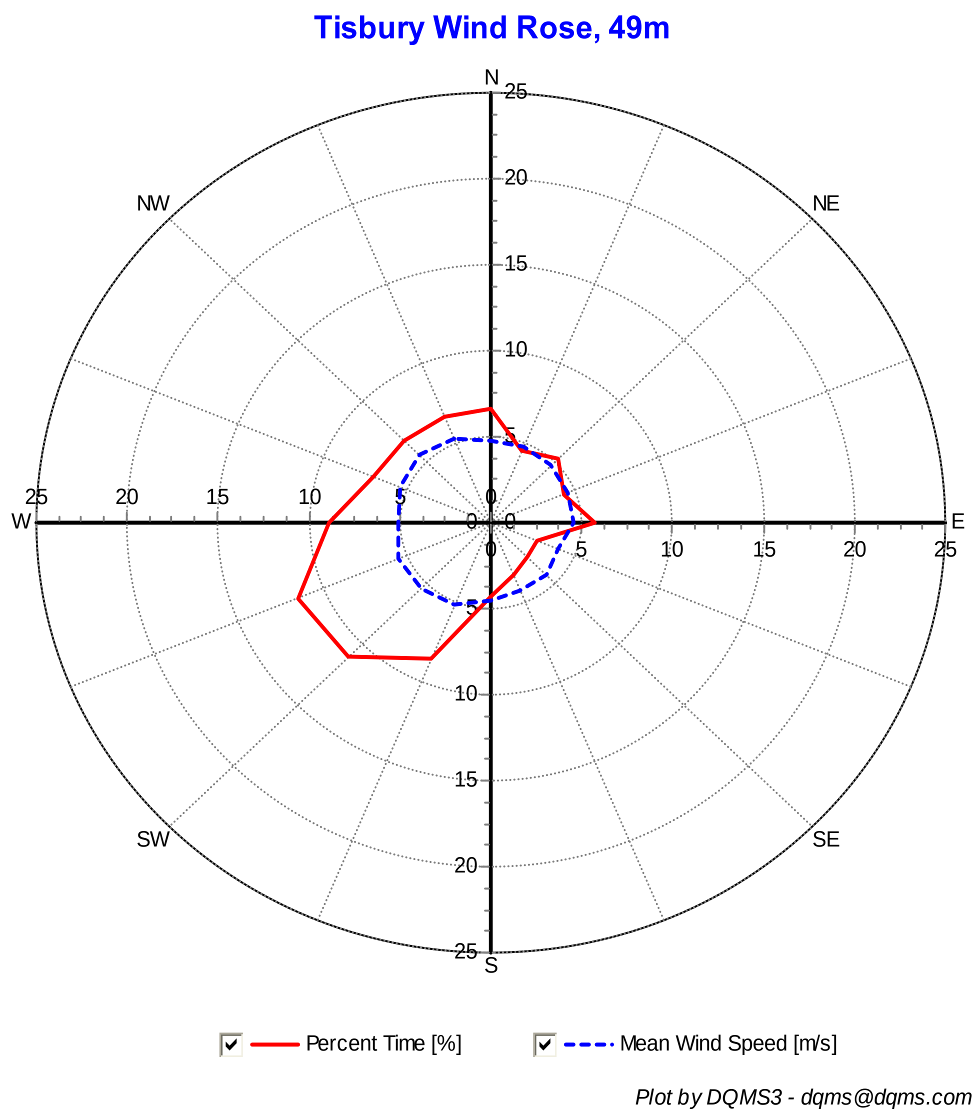

Figure 7 - Wind Rose, July 2007 – June 2008

SECTION 6 - Significant Meteorological Events

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

The data card that was sent in the middle of January contained no data (data between middle of December to middle of January was expected). The battery in the logger had run down and needed replacement. Data collection resumed on January 17th.

An anemometer at 49 m which malfunctioned early in the measurement period resumed providing viable data in the winter quarter.

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. [Statistics over whole period of data collection].

Gross Data Recovered [%]	91.815
Net Data Recovered [%]	87.36

<u>Test Definitions</u>

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.

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

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

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

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

TestOrder	TestField1	TestField2	TestField3	CalcField1	CalcField2	CalcField3	TestType	Factor1	Factor2	Factor3	Factor4
1							TimeTest Insert	0	0	0	0
2	Etmp2aDEGC						MinMax	-30	60		
3	EtmpSD2aDEGC						MinMax	-30	60		
4	EtmpMax2aDEGC						MinMax	-30	60		
5	EtmpMin2aDEGC						MinMax	-30	60		
10	Anem49aMS						MinMax	0	90	0	0
11	Anem49bMS						MinMax	0	90	0	0
12	Anem35aMS						MinMax	0	90	0	0
13	Anem35bMS						MinMax	0	90	0	0
14	Anem49yMS						MinMax	0	90	0	0
15	Anem35yMS						MinMax	0	90	0	0
20	AnemSD49aMS						MinMax	0	4	0	0
21	AnemSD49bMS						MinMax	0	4	0	0
22	AnemSD35aMS						MinMax	0	4	0	0
23	AnemSD35bMS						MinMax	0	4	0	0
24	AnemSD49yMS						MinMax	0	4	0	0
25	AnemSD35yMS						MinMax	0	4	0	0
30	Vane49aDEG						MinMax	0	359.9	0	0
31	Vane35aDEG						MinMax	0	359.9	0	0
50	Turb49zNONE						MinMax	0	2	0	0
51	Turb35zNONE						MinMax	0	2	0	0
60	Wshr0zNONE						MinMax	-100	100	0	0
70	Pwrd49zWMS						MinMax	0	1500	0	0
71	Pwrd35zWMS						MinMax	0	1500	0	0
200	VaneSD49aDEG	Anem49yMS					MinMaxT	0	100	10	10
201	VaneSD35aDEG	Anem35yMS					MinMaxT	0	100	10	10
300	Anem49aMS	AnemSD49aMS	Vane49aDEG	VaneSD49aDEG	Etmp2aDEGC		Icing	0.5	1	2	4
301	Anem49bMS	AnemSD49bMS	Vane49aDEG	VaneSD49aDEG	Etmp2aDEGC		Icing	0.5	1	2	4
302	Anem35aMS	AnemSD35aMS	Vane35aDEG	VaneSD35aDEG	Etmp2aDEGC		Icing	0.5	1	2	4
303	Anem35bMS	AnemSD35bMS	Vane35aDEG	VaneSD35aDEG	Etmp2aDEGC		Icing	0.5	1	2	4
400	Anem49aMS	Anem49bMS					CompareSensors	1	0.25	3	0
401	Anem35aMS	Anem35bMS					CompareSensors	1	0.25	3	0
500	AMax49aMS						MinMax	0	90	0	0
501	AMin49aMS						MinMax	0	90	0	0
502	AMax49bMS						MinMax	0	90	0	0
503	AMin49bMS						MinMax	0	90	0	0
504	AMax35aMS						MinMax	0	90	0	0
505	AMin35aMS						MinMax	0	90	0	0
506	AMax35bMS						MinMax	0	90	0	0
507	AMin35bMS						MinMax	0	90	0	0
520	VMax49aDEG						MinMax	0	359.9	0	0
521	VMin49aDEG						MinMax	0	359.9	0	0
522	VMax35aDEG						MinMax	0	359.9	0	0
523	VMin35aDEG						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
Etmp2aDEGC	52704	48390	91.815	0	0	0	91.815
EtmpSD2aDEGC	52704	48390	91.815	0	0	0	91.815
Anem49aMS	52704	48390	91.815	1.5	26.167	2030.333	68.386
AnemSD49aMS	52704	48390	91.815	1.5	26.167	2030.333	68.386
Anem49bMS	52704	48390	91.815	1.167	24.333	32.5	91.154
AnemSD49bMS	52704	48390	91.815	1.167	24.333	32.5	91.154
Anem35aMS	52704	48390	91.815	1.167	13.5	0.333	91.644
AnemSD35aMS	52704	48390	91.815	1.167	13.5	0.333	91.644
Anem35bMS	52704	48390	91.815	1	13.667	0.833	91.638
AnemSD35bMS	52704	48390	91.815	1	13.667	0.833	91.638
Vane49aDEG	52704	48390	91.815	435.333	26.167	0	86.561
VaneSD49aDEG	52704	48390	91.815	435.333	26.167	0	86.561
Vane35aDEG	52704	48390	91.815	0	13.667	0	91.659
VaneSD35aDEG	52704	48390	91.815	233.667	13.667	0	88.999
Total	**737856**	**677460**	**91.815**	**1114**	**235**	**4128**	**87.361**

APPENDIX B - Plot Data

Wind Speed Distribution Data

Bin Center Wind Speed [m/s]	Percent of Time [%]
0.5	1.78
1.5	3.81
2.5	8.54
3.5	14.69
4.5	19.1
5.5	17.33
6.5	12.56
7.5	8.21
8.5	5.11
9.5	3.32
10.5	2.11
11.5	1.49
12.5	1.02
13.5	0.51
14.5	0.18
15.5	0.1
16.5	0.06
17.5	0.04
18.5	0.01
19.5	0.01
20.5	0
21.5	0
22.5	0
23.5	0
24.5	0

Monthly Average Wind Speed Data

Date	10 min Mean [m/s]
July-07	4.38
Aug-07	4.22
Sept-07	4.79
Oct-07	5.06
Nov-07	6.08
Dec-07	6.26
Jan-08	6.17
Feb-08	6.15
Mar-08	6.61
Apr-08	5.2
May-08	5.93
Jun-08	4.68

Diurnal Average Wind Speed Data

Hour of Day	Average Wind Speed [m/s]
0.5	5.37
1.5	5.36
2.5	5.4
3.5	5.37
4.5	5.38
5.5	5.25
6.5	5.17
7.5	5.23
8.5	5.33
9.5	5.44
10.5	5.51
11.5	5.66
12.5	5.72
13.5	5.8
14.5	5.77
15.5	5.63
16.5	5.41
17.5	5.19
18.5	5.13
19.5	5.15
20.5	5.22
21.5	5.25
22.5	5.33
23.5	5.35

Wind Rose Data

Direction	Percent Time [%], 49m	Mean Wind Speed [m/s], 49m
N	6.63	4.82
NNE	4.53	4.84
NE	5.21	4.71
ENE	4.4	4.57
ENE	5.71	4.57
ESE	2.74	4.06
SE	2.79	4.36
SSE	3.26	4.22
S	4.26	4.54
SSW	8.5	5.2
SW	11.09	5.35
WSW	11.49	5.48
WSW	8.9	5.07
WNW	7	5.42
NW	6.8	5.6
NNW	6.68	5.29