WIND DATA FINAL REPORT

Truro, Massachusetts

March 24, 2006 to April 25, 2007

Prepared for

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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.

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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 final report covers the entire period of wind data measured at a meteorological tower installed in Truro, MA. The tower was installed and began collecting data on March 24th, 2006 at 13:10. On April 25th, 2007, the tower was lowered and disassembled. At 50 m (164.0 ft) and 38 m (124.7 ft), two sets of two anemometers and one wind vane were mounted. Also, there was one anemometer at 35 m (114.8 ft) and there is one wind vane at 30 m (98.4 ft).

More than one year of data was collected at this site. For purposes of site assessment, full years of data are required. For this reason, data collected from 1310 hrs March 24th, 2006 to 1310 hrs March 24th, 2007 was analyzed. During this time, the mean recorded wind speed was 7.63 m/s (17.07 mph)* at 50 m and the prevailing wind direction was from the southwest (SW) direction. The calculated capacity factor, based on this year's wind speed measurements, was estimated to be 0.483.

Over the entire data collection period (March 24th, 2006 to April 25th, 2007), the gross data recovery percentage (the actual percentage of expected data received) was 99.99 % and the net data recovery percentage (the percentage of expected data which passed all of the quality assurance tests) was 99.03 %.

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.

SECTION 1 - Station Location

The meteorological tower was located at the heliport at the former DEW (Distance Early Warning) radar location. The latitude and longitude of the tower location were N 042° 01.790' and W 070° 03.068' (NAD83). The elevation at the site was 39.3 m. Figure 1 shows the location of the wind monitoring tower.

Figure 1 - Location of Truro Wind Tower

SECTION 2 - Instrumentation and Equipment

The wind monitoring equipment was mounted on a 50 m (164.0 ft) Second Wind tower. All other monitoring equipment came from NRG Systems, and consisted 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 50 m (164.0 ft), two at 38 m (124.7 ft) and one at a height of 35 m (114.8 ft).
- 3 - #200P Wind direction vanes. They are located at heights of 50 m (164.0 ft.), 38 m (124.7 ft.) and 30m (98.4 ft) each.
- 5 – Sensor booms, 54" length
- Lightning rod and grounding cable
- Shielded sensor wire

The data from the Symphonie logger was mailed to the Renewable Energy Research Laboratory at the University of Massachusetts, Amherst on a regular basis. The logger sampled wind speed and direction once every two seconds. These data were then combined into 10-minute averages and, along with the standard deviation for those 10-minute periods, were put into a binary file. These binary files were converted to ASCII text files using the NRG software BaseStation®. These text files were then imported into a database software program where they were 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 over the entire period of data collection 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 one full year of data (1310 hrs March 24th, 2006 to 1300 hrs March 24th, 2007).

Table 1. Wind Speed and Direction Data Summary

Date Height Units	Mean Wind Speed 50 m [m/s]	Max Wind Speed 50 m [m/s]	Prevailing Wind Direction 50 m [m/s]	Mean Wind Speed 38 m [m/s]	Max Wind Speed 38m [m/s]	Prevailing Wind Direction 38 m [m/s]	Mean Wind Speed 35 m [m/s]	Max Wind Speed 35 m [m/s]	Prevailing Wind Direction 30 m [m/s]
April 2006	7.89	19	SW	7.26	17.3	SW	7.03	16.7	SSW
May 2006	7.66	19.1	SW	7.07	18.3	SW	6.83	17.9	SSW
June 2006	6.81	20.2	SW	6.29	18.4	SW	6.08	17.7	SW
July 2006	6.93	16.6	SW	6.36	15.6	SW	6.15	15.1	SSW
August 2006	5.87	11.9	SW	5.39	11	SW	5.22	10.7	SW
September 2006	6.44	13.8	SW	5.94	13.1	SW	5.71	12.8	SW
October 2006	8.12	19.8	SW	7.46	18.6	SW	7.21	17.7	SW
November 2006	7.41	28.4	SW	6.84	27.6	SW	6.56	27	SSW
December 2006	8.17	18.6	WNW	7.49	17	WNW	7.24	16.6	SW
January 2007	8.68	18.6	NW	8.02	17.3	NW	7.75	16.9	NW
February 2007	8.78	21.6	WNW	8.12	20.3	WNW	7.88	19.5	W
March 2007	9.14	20.9	SW	8.44	20.2	SW	8.17	19.7	SSW
April 2007	8.87	26.8	SE	8.33	25.4	SE	8.06	24.7	NNE
March 24, 2006 – March 24, 2007	**7.63**	**28.4**	**SW**	**7.03**	**27.6**	**SW**	**6.79**	**27**	**SW**

Wind data statistics in the table were reported when more than 90% of the data during the reporting period were valid. In cases when a larger amount of data was missing, the percent of the available data that was used to determine the data statistics was 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 10 and 11 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	**50 m [-]**	**38 m [-]**	**35 m [-]**	**Between 50 m and 40 m [-]**
April 2006	0.12	0.13	0.14	0.303
May 2006	0.13	0.16	0.17	0.292

Continued on next page

Table 2 – *Continued*

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	**50 m [-]**	**38 m [-]**	**35 m [-]**	**Between 50 m and 40 m [-]**
July 2006	0.14	0.17	0.19	0.313
August 2006	0.12	0.14	0.14	0.311
September 2006	0.12	0.15	0.15	0.294
October 2006	0.14	0.16	0.16	0.309
November 2006	0.13	0.16	0.17	0.292
December 2006	0.18	0.18	0.18	0.317
January 2007	0.16	0.18	0.18	0.288
February 2007	0.17	0.18	0.18	0.285
March 2007	0.15	0.17	0.18	0.290
April 2007	0.12	0.13	0.14	0.229
March 24, 2006 -March 24, 2007	**0.14**	**0.16**	**0.17**	**0.298**

SECTION 4- Capacity Factor

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 hub height of 80 m, a 1.8 MW wind turbine with a rotor diameter of 80 m and the mean wind speed at the highest measurement height and the mean wind shear at the site, in order to determine the mean hub height wind speed. Based on these assumptions, the mean hub height wind speed is 8.78 m/s. The capacity factor (CF) is then estimated from (see G.M. Masters, Renewable and Efficient Electric Power Systems, Wiley, 2004):

$$CF = (0.087) U_{hub} - \frac{P_{rated}}{D^2}$$

where U_{hub} is the mean annual hub height wind speed in m/s, P_{rated} is the rated power of the wind turbine in kW and D is the diameter of the rotor in meters. Based on this equation, the estimated capacity factor of a wind turbine at this site would be about 0.483.

SECTION 5- Graphs

This report contains several types of wind data graphs. Unless otherwise noted, each graph represents data from one calendar year (1310 hrs March 24, 2006 to 1300 hrs March 24, 2007). The following graphs are included:

- Time Series – 10-minute average wind speeds are plotted against time. This graph includes all of the collected data (March 24, 2006 to April 25, 2007). Figure 2 shows the time series of the wind speeds at 50 m.

- Wind Speed Distribution – A histogram plot giving the percentage of time that the wind is at a given wind speed. The wind blows most frequently between 7 m/s and 8 m/s, for approximately 12.89 % of the time. The wind speed distribution is shown in Figure 3.

- 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. Figure 4 shows the monthly average wind speeds at 50 m.

- Diurnal – A plot of the average wind speed for each hour of the day. During this calendar year, the wind speeds are highest between 10 pm and 11 pm at 7.98 m/s, and lowest between 4 pm and 5 pm at 7.18 m/s. The diurnal variation plot is shown in Figure 5.

- 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. In general, turbulence intensity range from 0.1 to 0.4; for Truro, the average turbulence intensity at 50 m between 10 and 11 m/s was 0.14 for this calendar year. The turbulence intensity plot is shown in Figure 6.

- 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. This wind rose shows the prevailing direction from the southwest and wind speeds are greatest from the northeast. The wind rose plot is shown in Figure 7.

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

Wind Speed Time Series

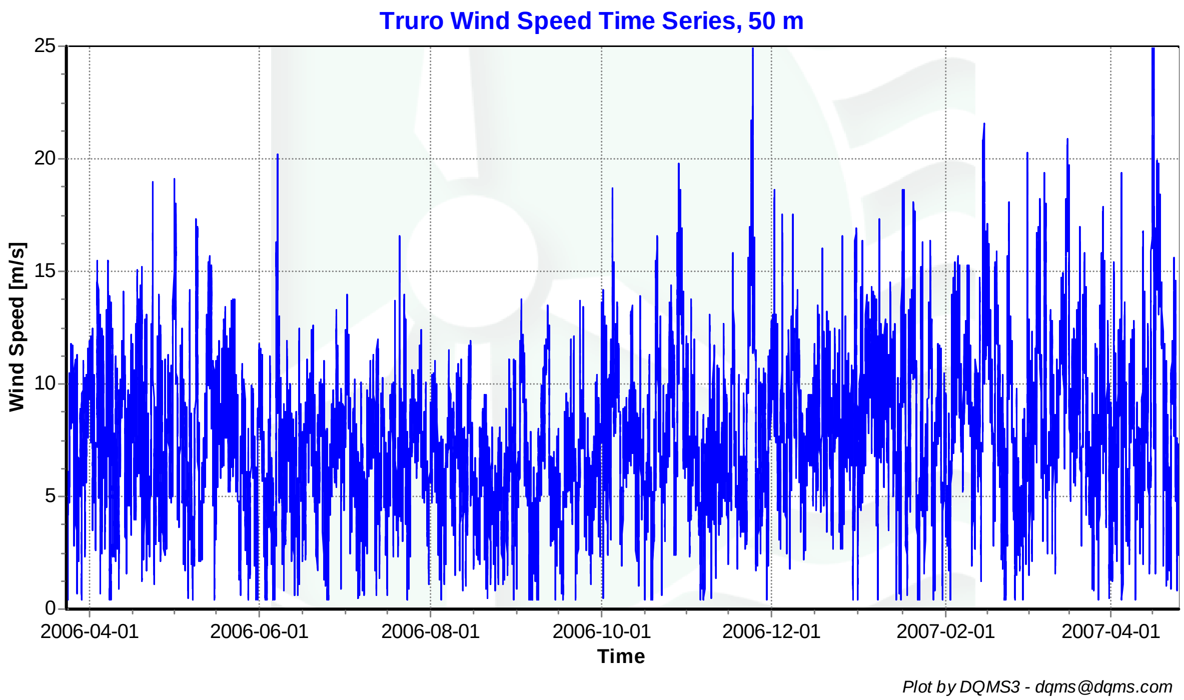

Figure 2 - Truro Wind Speed Time Series, March 24, 2006 – April 25, 2007

Wind Speed Distributions

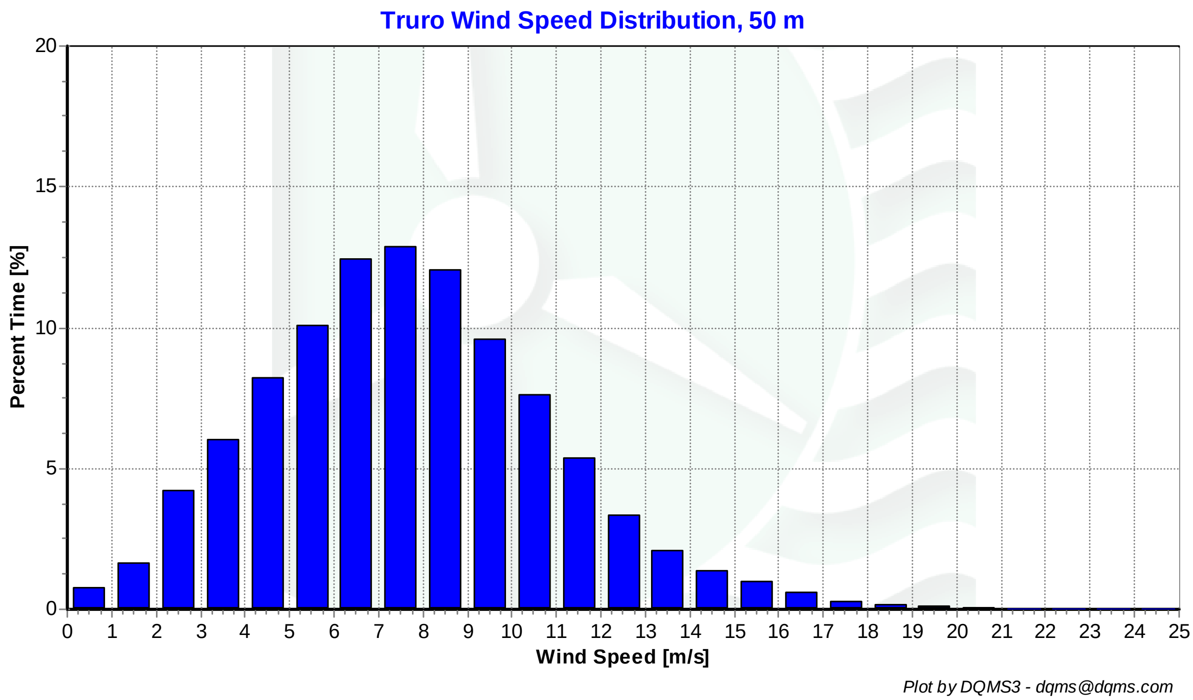

Figure 3 - Truro Wind Speed Distribution, March 24, 2006 – March 24, 2007

Monthly Average Wind Speeds

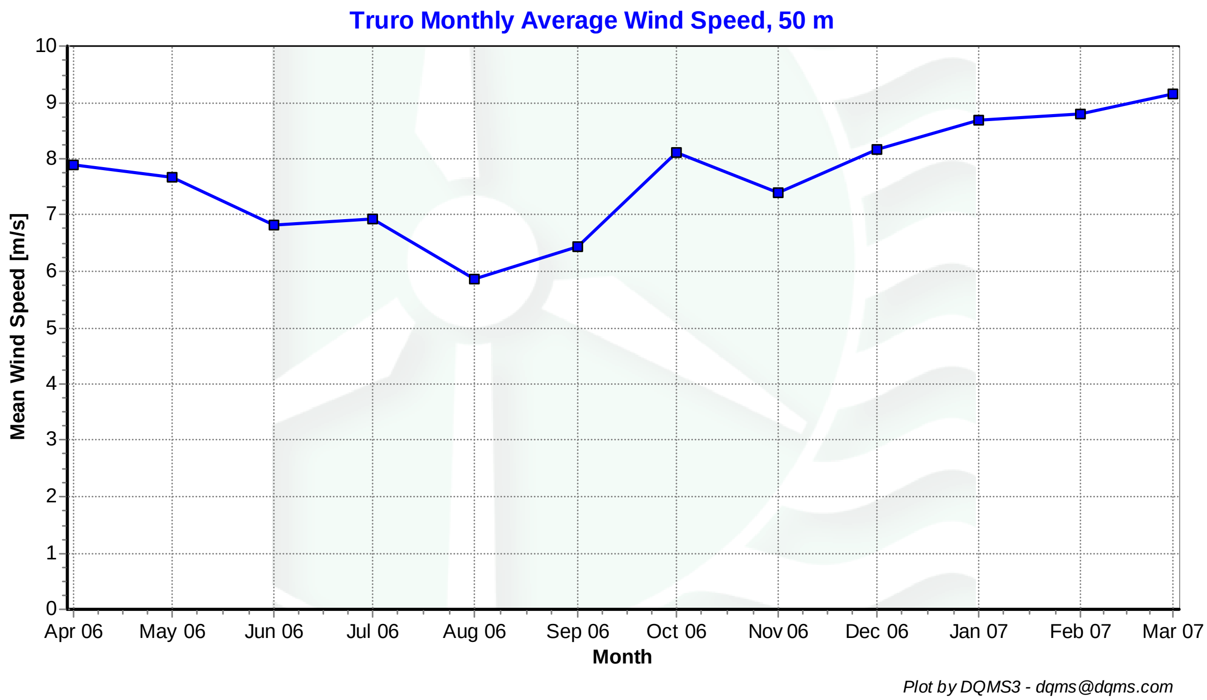

Figure 4 - Truro Monthly Average Wind Speed at 50 m, April 2006 – March 2007

Diurnal Average Wind Speeds

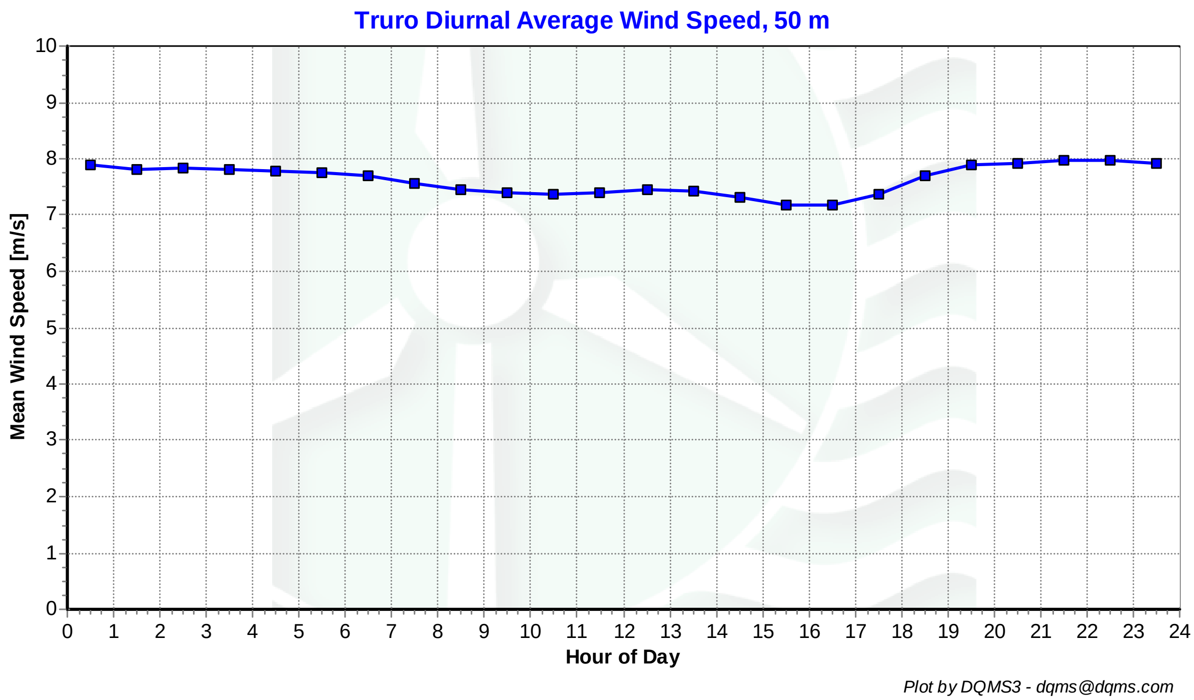

Figure 5 - Truro Diurnal Average Wind Speed at 50 m, March 24, 2006 – March 24, 2007

Turbulence Intensities

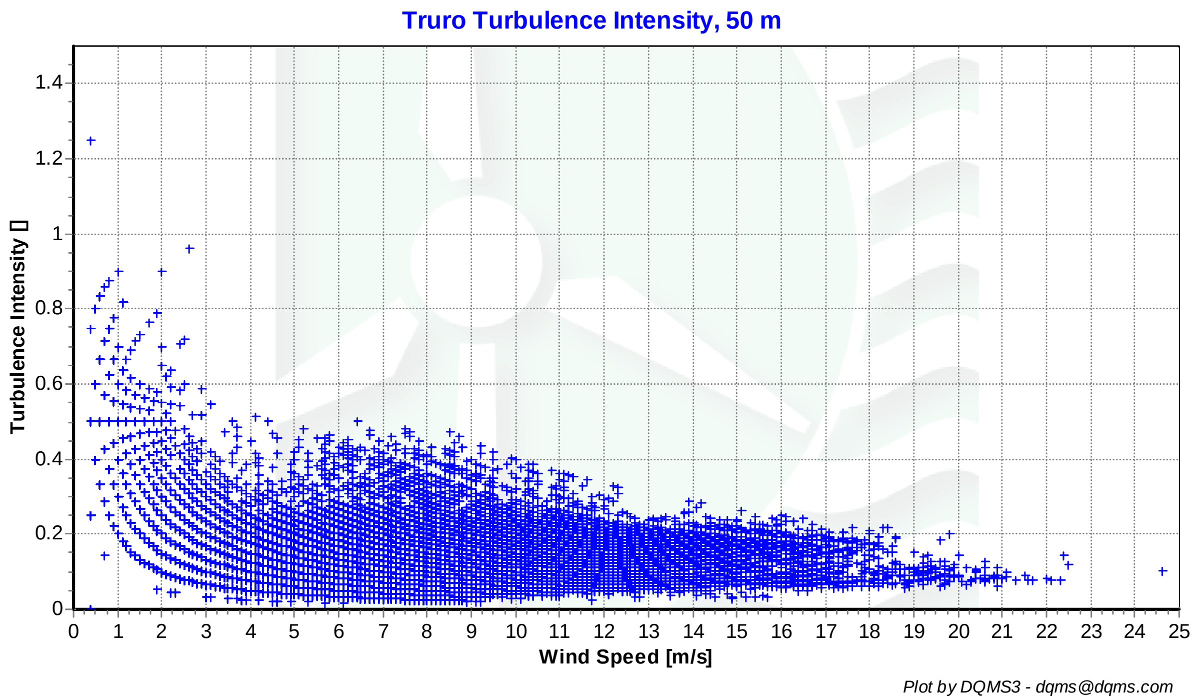

Figure 6 - Truro Turbulence Intensity at 50 m, March 24, 2006 – March 24, 2007

<u>**Wind Rose**</u>

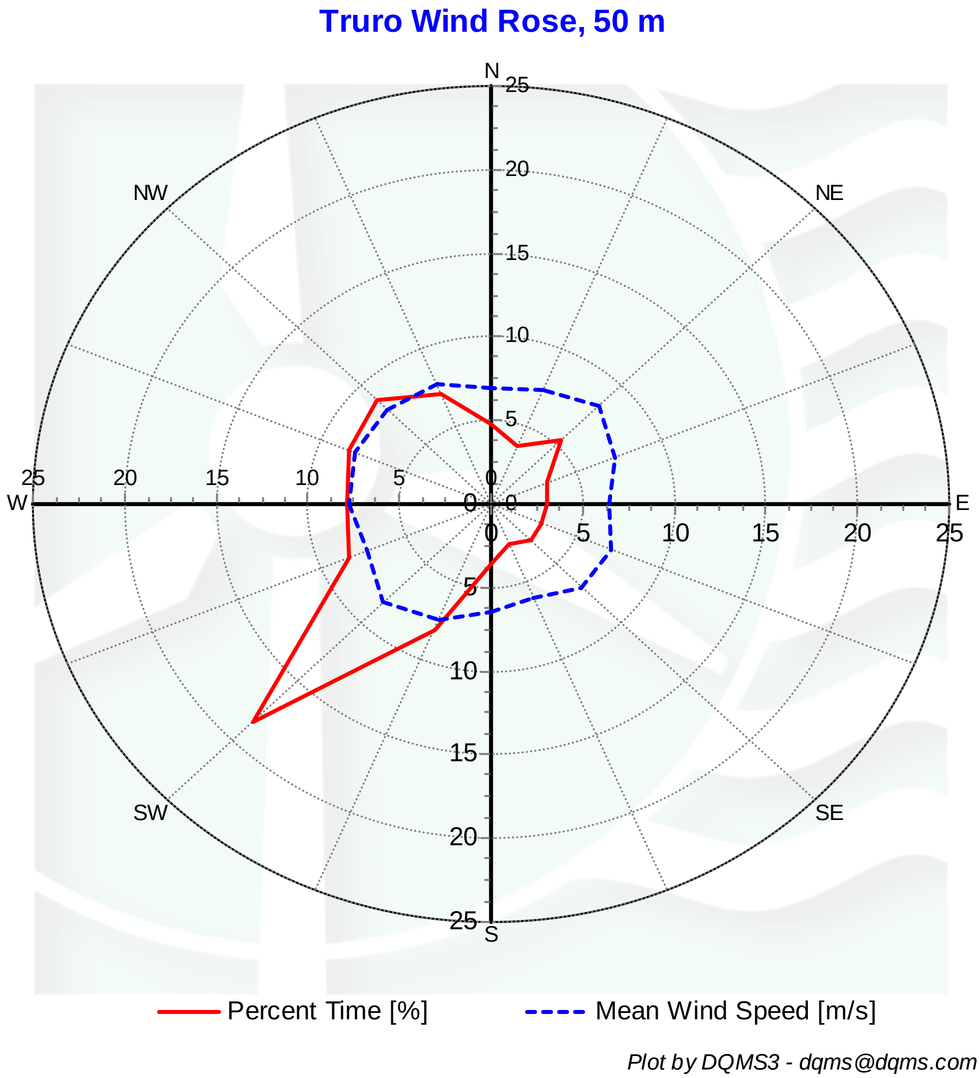

Figure 7 - Truro Wind Rose at 50 m, March 24, 2006 – March 24, 2007

SECTION 6 - Significant Meteorological Events

No significant meteorological events occurred during this data collection period.

SECTION 7 - Data Collection and Maintenance

No maintenance work was done and no equipment problems were encountered during this collection period.

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. The statistics are based on the whole period of data collection (March 24, 2006 to April 25, 2007).

Gross Data Recovered [%]	99.99 %
Net Data Recovered [%]	99.03 %

<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.

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

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				
4	Etmp2aDEGC						MinMax	-30	60		
5	EtmpSD2aDEGC						MinMax	-30	60		
10	Anem50aMS						MinMax	0	90		
11	Anem50bMS						MinMax	0	90		
12	Anem38aMS						MinMax	0	90		
13	Anem38bMS						MinMax	0	90		
14	Anem35aMS						MinMax	0	90		
20	AnemSD50aMS						MinMax	0	4		
21	AnemSD50bMS						MinMax	0	4		
22	AnemSD38aMS						MinMax	0	4		
23	AnemSD38bMS						MinMax	0	4		
24	AnemSD35aMS						MinMax	0	4		
30	Vane50aDEG						MinMax	0	359.9		
31	Vane38aDEG						MinMax	0	359.9		
32	Vane30aDEG						MinMax	0	359.9		
50	Turb50zNONE						MinMax	0	2		
51	Turb38zNONE						MinMax	0	2		
52	Turb35zNONE						MinMax	0	2		
60	Wshr0zNONE						MinMax	-100	100		
200	VaneSD50aDEG	Anem50yMS					MinMaxT	0	100	100	10
201	VaneSD38aDEG	Anem38yMS					MinMaxT	0	100	100	10
202	VaneSD30aDEG	Anem35aMS					MinMaxT	0	100	100	10
300	Anem50aMS	AnemSD50aMS	Vane50aDEG	VaneSD50aDEG	Etmp2aDEGC		Icing	0.5	1	2	4
301	Anem50bMS	AnemSD50bMS	Vane50aDEG	VaneSD50aDEG	Etmp2aDEGC		Icing	0.5	1	2	4
302	Anem38aMS	AnemSD38aMS	Vane38aDEG	VaneSD38aDEG	Etmp2aDEGC		Icing	0.5	1	2	4
303	Anem38bMS	AnemSD38bMS	Vane38aDEG	VaneSD38aDEG	Etmp2aDEGC		Icing	0.5	1	2	4
304	Anem35aMS	AnemSD35aMS	Vane30aDEG	VaneSD30aDEG	Etmp2aDEGC		Icing	0.5	1	2	4
400	Anem50aMS	Anem50bMS					CompareSensors	1	0.25	3	0
401	Anem38aMS	Anem38bMS					CompareSensors	1	0.25	3	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	57300	57295	99.991	27.5	0	0	99.703
EtmpSD2aDEGC	57300	57295	99.991	0	0	0	99.991
Anem50aMS	57300	57295	99.991	0.5	32.833	0.167	99.64
Anem50bMS	57300	57295	99.991	56.667	30.5	613.667	92.653
Anem38aMS	57300	57295	99.991	0.333	31.5	0.333	99.654
Anem38bMS	57300	57295	99.991	0.5	30.167	24.333	99.415
Anem35aMS	57300	57295	99.991	0.5	22	0	99.756
AnemSD50aMS	57300	57295	99.991	0.5	32.833	0.167	99.64
AnemSD50bMS	57300	57295	99.991	56.667	30.5	613.667	92.653
AnemSD38aMS	57300	57295	99.991	0.333	31.5	0.333	99.654
AnemSD38bMS	57300	57295	99.991	0.5	30.167	24.333	99.415
AnemSD35aMS	57300	57295	99.991	0.5	22	0	99.756
Vane50aDEG	57300	57295	99.991	0.5	33.333	0	99.637
VaneSD50aDEG	57300	57295	99.991	0.5	33.333	0	99.637
Vane38aDEG	57300	57295	99.991	1	31.5	0	99.651
VaneSD38aDEG	57300	57295	99.991	1	31.5	0	99.651
Vane30aDEG	57300	57295	99.991	1.5	22	0	99.745
VaneSD30aDEG	57300	57295	99.991	1.5	22	0	99.745
Total	**1260600**	**1260490**	**99.991**	**151.5**	**589.333**	**1277**	**99.031**

APPENDIX B - Plot Data

Wind Speed Distribution Data

Wind Speed [m/s]	Percent [%]
0.5	0.75
1.5	1.62
2.5	4.23
3.5	6.04
4.5	8.22
5.5	10.11
6.5	12.46
7.5	12.89
8.5	12.05
9.5	9.58
10.5	7.63
11.5	5.36
12.5	3.35
13.5	2.09
14.5	1.36
15.5	0.98
16.5	0.63
17.5	0.27
18.5	0.18
19.5	0.13
20.5	0.06
21.5	0.02
22.5	0.01
23.5	0.00
24.5	0.00

Monthly Average Wind Speed Data

Date	10 min Mean [m/s]
April 2006	7.89
May 2006	7.66
June 2006	6.81
July 2006	6.93
August 2006	5.87
September 2006	6.44
October 2006	8.12
November 2006	7.41
December 2006	8.17
January 2007	8.68
February 2007	8.78
March 2007	9.14

Wind Rose Data

Direction	Mean Wind Speed [m/s]	Percent Time [%]
N	6.93	4.83
NNE	7.33	3.8
NE	8.33	5.46
ENE	7.27	3.3
E	6.49	3.11
ESE	7.06	2.99
SE	7.02	3.05
SSE	6.13	2.64
S	6.48	3.59
SSW	7.45	8.11
SW	8.3	18.44
WSW	7.34	8.44
W	7.77	7.91
WNW	8.04	8.38
NW	8.02	8.81
NNW	7.71	7.15

Diurnal Average Wind Speed Data

hr	Wind Speed [m/s]
0.5	7.89
1.5	7.82
2.5	7.83
3.5	7.82
4.5	7.79
5.5	7.76
6.5	7.71
7.5	7.55
8.5	7.45
9.5	7.39
10.5	7.37
11.5	7.40
12.5	7.46
13.5	7.43
14.5	7.31
15.5	7.19
16.5	7.18
17.5	7.36
18.5	7.69
19.5	7.89
20.5	7.91
21.5	7.97
22.5	7.98
23.5	7.92