PRELIMINARY WIND DATA REPORT

Templeton, MA

July 1, 2011 – September 30, 2011

Prepared for

Massachusetts Division of Capital Asset Management
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NOTICE AND ACKNOWLEDGEMENTS

This report was prepared by the Wind Energy Center (WEC) at the University of Massachusetts, Amherst in the course of performing work sponsored by the Renewable Energy Trust (RET), as administered by the Massachusetts in the course of performing work sponsored by the Massachusetts Division of Capital Asset Management. The opinions expressed in this report do not necessarily reflect those of 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 Wind Energy Center (WEC) at the University of Massachusetts, Amherst.

This report covers wind data measured at Templeton, MA. It was installed in September but raised on October 7 2011. The raising was delayed due to problems with the installation of anchors. The site will be fully functional for the next quarter. Two cup anemometers are mounted at each height of 49m (161 ft), and 38m (125 ft). There is one wind vane at the height of 38 m and another wind vane at the height of 24 m.

There was no data recorded during the period covered by this report (July 2011 through September 2011).

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.umass.edu/windenergy/publications/published/communityWindFactSheets/RERL_Fact_Sheet_6_Wind_resource_interpretation.pdf

* 1 m/s = 2.237 mph.

SECTION 1 - Station Location

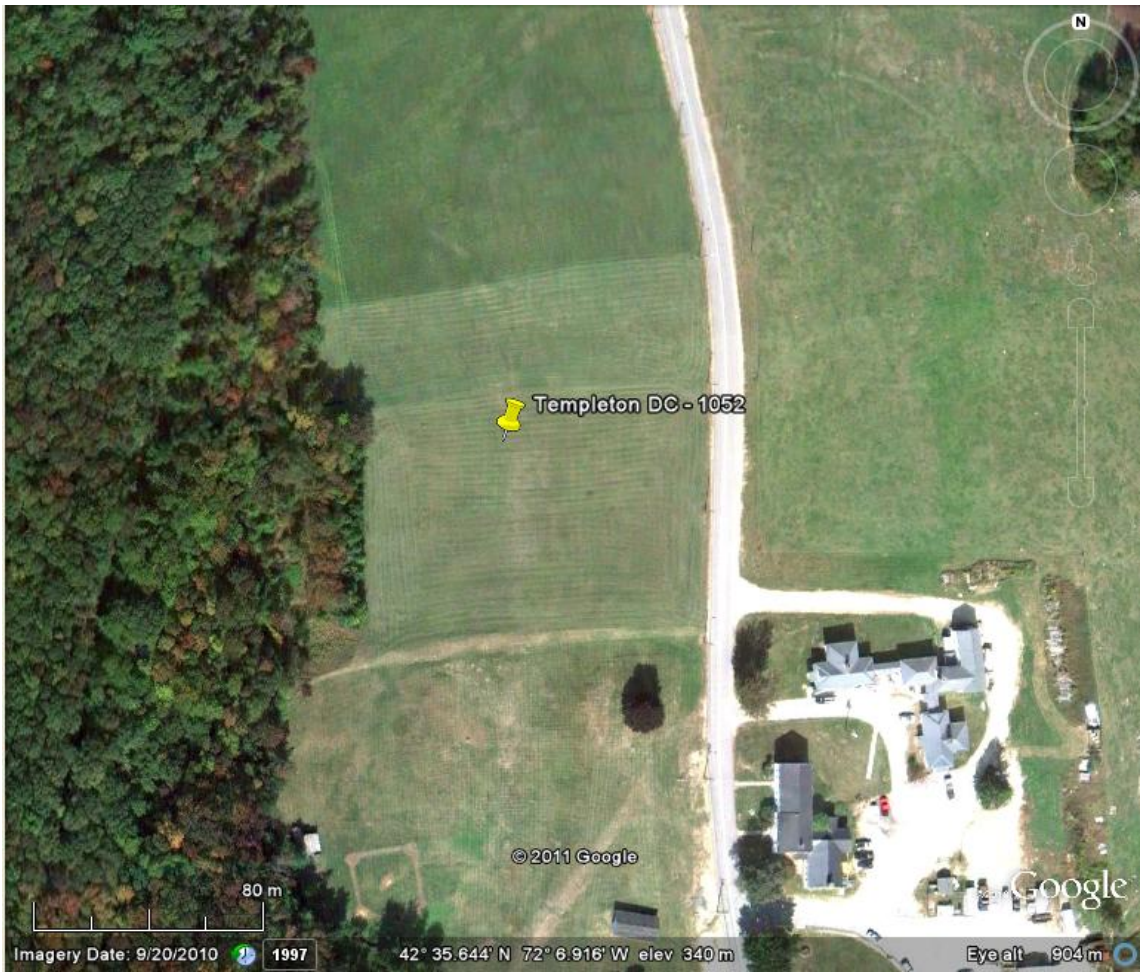

Figure 1 – Meteorological Tower location in Templeton, MA

The tower is located in Templeton, MA. The site coordinates are 42° 35.643' N, 72° 7.015' W. These coordinates correspond to the WGS84 datum.

SECTION 2 - Instrumentation and Equipment

The wind monitoring equipment is mounted on an NRG Systems 50 meter meteorological tower. The wind monitoring equipment includes:

- 1 – Calibrated MAX 40 Anemometer (slope - 0.755 m/s, offset – 0.39 m/s). The anemometer is located at a height of 49m (161 ft)
- 3 - Comptus A75-104 Anemometers (standard slope - 0.765 m/s, offset – 0.35 m/s). One anemometer is located at 49 m (161 ft) and the other two are located at 38 m (125 ft).

- 2 – Comptus A75-302 wind direction vanes. One vane is located at a height of 38 m (125 ft) and the other at a height of 24 m (79 ft).
- #110S Calibrated thermoster (temperature sensor). The sensor is located 1.5 m (5 ft) from the tower base.
- NRG Systems Symphonie Plus data logger

SECTION 3- Data Summary

Normally, a summary of the wind speeds and wind directions are included in this section which are measured during the reporting period These values are provided for each month of the reporting period and for the whole reporting period. There was no data recorded for the period of this report.

SECTION 4- Graphs

This report would normally contain several types of wind data graphs. Unless otherwise noted, each graph represents data from 1 quarter (3 months). The following graphs would be normally included:

- Time Series – 10-minute average wind speeds are plotted against time.
- 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 since the start of the measurement period. This graph shows the trends in the wind speed over the year.
- Diurnal – A plot of the average wind speed for each hour of the day. On average the wind speed was relatively uniformly distributed throughout 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.

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SECTION 5- Significant Meteorological Events

No significant meteorological events were recorded at this station.

SECTION 6 - Data Collection and Maintenance

Data collection will start on October 7, 2011.

SECTION 7 - 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.

Gross Data Recovered [%]	N/A
Net Data Recovered [%]	N/A

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. 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. 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*.