WIND DATA REPORT

Worcester, MA

October 15, 2009 to October 15, 2010

Prepared for

Massachusetts Clean Energy Center
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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 Wind Energy Center (WEC) at the University of Massachusetts, Amherst.

This report covers wind data measured by a Second Wind Triton SODAR unit installed at Green Hill Park complex in the city of Worcester, MA. Installed on October 15th, 2009, the SODAR unit was in continuous operation until October 22nd, 2010. This report is the final report for Worcester.

The data covered by this final report is one calendar year from October 15th, 2009 until October 15th 2010. 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 has a quality value of 90% or higher) varies between 92% at 40 m to 30% at 200 m for the annual period covered in this report.

The mean recorded wind speed for this year at 50 m was 5.53 m/s (12.4 mph*) and at 100 m was 6.75 m/s (15.1 mph*). The prevailing wind direction was from the west at both 50 m and 100 m height.

The average wind shear coefficient was 0.25. The average turbulence intensity was both 0.15 at 50 m and at 100 m.

Additional information about interpreting the data presented in this report can be found in the Fact Sheet, "Interpreting Your Wind Resource Data," produced by WEC and the Massachusetts Technology Collaborative (MTC). This document is found through the WEC 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 site is a parking lot by a baseball field within the Green Hill Park complex in Worcester. The coordinates of the site is 42.27927 N, 71.78072 W (WGS84) and shown as the white triangle in Figure 1. The site sits close to the western face of a ridge that runs from the northeast to the southwest. A lower and shorter ridge runs in the same direction a quarter of a mile to the west.

Figure 1 – Site Location

SECTION 2 - Instrumentation and Equipment

The Second Wind Triton SODAR is used at this location with the following package versions:

Triton	Base Package	Platform Package	SelfTest Package	Sodar Package
183	1.7	2.2	1.1	1.7

SECTION 3 - Data Summary

An excerpt of the wind speeds and wind directions measured during the reporting period is included in Table 1. Table 1 includes the mean wind speeds, the maximum instantaneous wind speed and the prevailing wind direction measured at 50 m and 100 m together with the percentage of data used in the calculations of those values. The full table including measurement from all measured heights is given in the Appendix. These values are provided for each month of the reporting period and for the year between October 15th 2009 to October 15th 2010.

Table 1. Wind Speed and Direction Data Summary

Month Height Units	Mean Wind Speed 50 m [m/s]	Max Wind Speed 50 m [m/s]	Prevailing Wind Direction 50 m	Percentage of Data	Mean Wind Speed 100 m [m/s]	Max Wind Speed 100 m [m/s]	Prevailing Wind Direction 100 m	Percentage of Data
Oct-09	5.56	14.92	NNW	98%	7.14	17.34	NNW	92%
Nov-09	5.53	15.58	NNW	97%	7.01	16.92	NW	89%
Dec-09	6.04	16.57	W	68%	7.62	18.88	WNW	49%
Jan-10	6.05	18.13	W	61%	7.39	17.51	WNW	55%
Feb-10	6.37	16.14	WNW	86%	7.60	16.84	WNW	79%
Mar-10	6.57	17.27	NNW	97%	7.66	17.81	NNW	84%
Apr-10	5.45	17.95	W	98%	6.58	14.99	WNW	90%
May-10	5.20	15.83	ENE	100%	6.32	16.24	ENE	95%
Jun-10	4.73	12.31	ENE	99%	5.90	13.96	ENE	98%
Jul-10	4.82	10.62	ENE	97%	6.00	13.20	ENE	94%
Aug-10	4.97	11.54	ENE	99%	6.32	14.20	ENE	95%
Sep-10	5.45	12.04	ENE	99%	6.93	14.97	ENE	96%
Oct-10	6.16	14.85	NW	92%	7.72	18.59	NNW	87%
Oct 2009 to Oct 2010	**5.53**	**18.13**	**W**	**90%**	**6.75**	**18.88**	**W**	**83%**

The values above are calculated when the 10-minute data has a Quality Factor of 90% and above. The percentage of data used to obtain values in the table above is reported to show how well they represent their respective time periods.

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. Measurement of Turbulence Intensity from SODAR data is slightly different than from anemometer data. In principle, 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. Anemometers provide measurements of the standard deviation and mean wind speed in the same horizontal plane, therefore the turbulence intensity calculated from anemometer measurements is characteristic of the horizontal flow. The Triton measures in 3 directions 11.4 degrees from vertical and equispaced horizontally to derive the horizontal and vertical wind speed components. This means that the direct measurements are made very close to the vertical and the turbulence intensity given by the Triton is characteristic of the turbulence in those directions at which the sound beam is pointed to. During periods of high atmospheric mixing the difference between turbulence from these two methods are close to each other but they may differ up to 30% when there is less mixing, for example during night time.

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 at 50 m and 100 m reported by the Triton.

Shear coefficients provide a measure of the change in wind speed with height. When data is only available at a limited number of heights, shear coefficients, α, may be calculated to help estimate wind speeds at other heights. 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.

Measurements made by the Triton provide a better look at how wind speed changes with height because they are at the heights that is of interest for wind turbines. An estimate of the shear coefficient in this case then is more useful as a comparison to other locations rather than as a means of obtaining wind speeds at a different height.

The mean wind shear coefficient that is provided here is calculated based on the annual mean wind speeds for all the heights, and is the slope of the linear fit in the following equation, where z are the heights at the various height stations, z_r is the reference height, in this case 40 m, $U(z)$ are the mean wind speeds at height z and $U(z_r)$ is the mean wind speed at the reference height:

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

Table 2. Shear and Turbulence Intensity Data Summary

Month	Turbulence Intensity	Turbulence Intensity	Shear Coefficient
Height	50 m	100 m	-
Oct-09	0.15	0.13	0.40
Nov-09	0.13	0.12	0.39
Dec-09	0.14	0.14	0.33
Jan-10	0.14	0.16	0.35
Feb-10	0.15	0.18	0.22
Mar-10	0.15	0.16	0.21
Apr-10	0.14	0.16	0.24
May-10	0.15	0.17	0.26
Jun-10	0.14	0.15	0.31
Jul-10	0.15	0.14	0.28
Aug-10	0.15	0.15	0.29
Sep-10	0.14	0.13	0.34
Oct-10	0.14	0.13	0.31
October 2009 to October 2010	**0.15**	**0.15**	**0.25**

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 Paxton between June 24th. 2003 and June 24th, 2010 is used as reference in the case of Worcester. Correlation between the two sites are obtained from concurrent data between January 1st, 2010 and October 15th, 2010. The long term mean at Worcester at 80 m is estimated to be 6.1 m/s with an uncertainty of 1.3% 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 same height. 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 0.28.

SECTION 5- Graphs

This report contains several types of wind data graphs. Unless otherwise noted, each graph represents data from one calendar year (October 15th 2009 to October 15th 2010). The following graphs are included:

- Time Series – 10-minute average wind speeds at 100 m are plotted against time.

- Wind Speed Distribution – A histogram plot giving the percentage of time that the wind is at a given wind speed at each measured height. The graph shows that wind speeds are higher as the height increase.

- Monthly Average – A plot of the monthly average wind speed for 100 m and 50 m over a 12-month period. This graph shows the trends in the wind speed over the whole period of data collection. The lowest average wind speed is recorded during the summer while the winter months show higher averages.

- Diurnal – A plot of the average wind speed for each hour of the day. It is interesting to note that while the wind speeds at the lower heights remain near

constant throughout the day, wind speeds at the higher heights are significantly higher during the night and drops during the day.

- Turbulence Intensity – A plot of turbulence intensity as a function of wind speed at 100 m. Turbulence Intensity 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. The graph indicates that at the lower heights the winds are predominantly coming in from the northwest while at the higher heights they are coming in from the southwest and south-southwest. The average wind speeds are highest for the sector between south-southwest and northwest together with the north-northeast and northeast sector. The lowest average wind speed comes in from the east-southeast direction.

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

Wind Speed Time Series
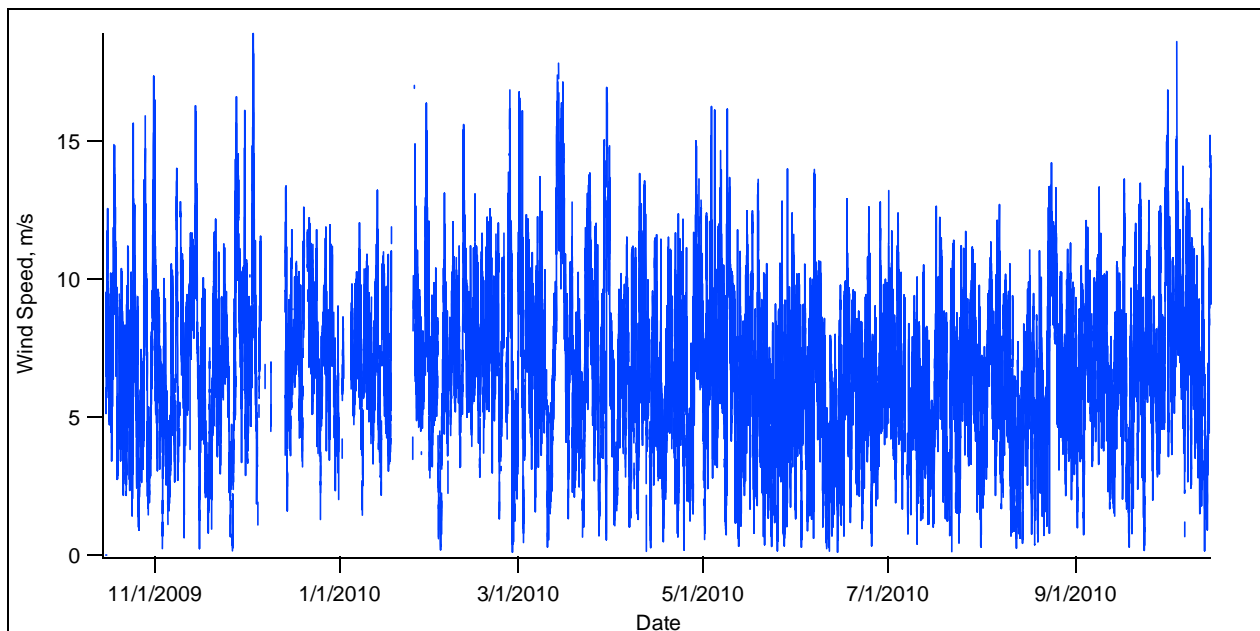
Figure 2 - Wind Speed Time Series at 100 m

Wind Speed Distributions
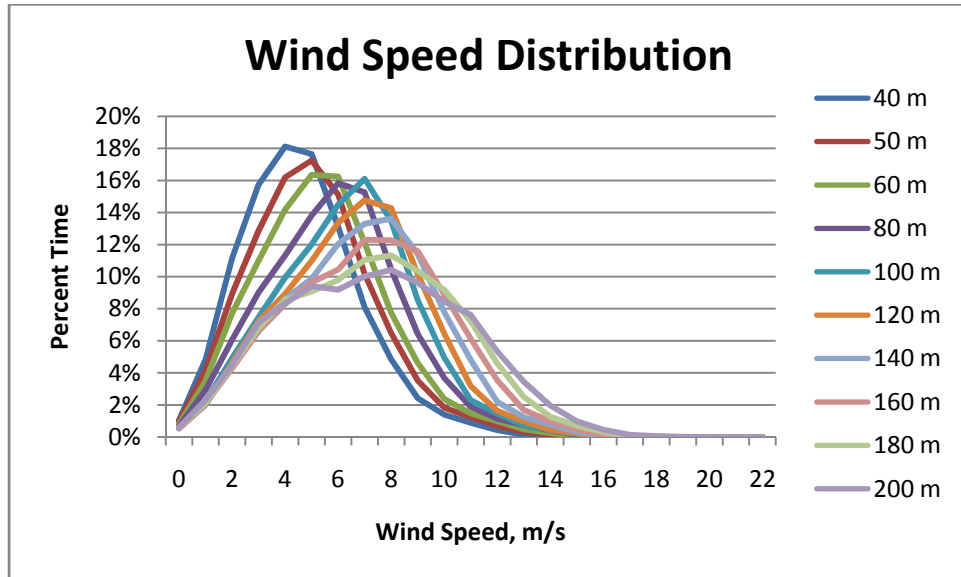
Figure 3 – Wind Speed Distribution, October 2009 to October 2010

Monthly Average Wind Speeds
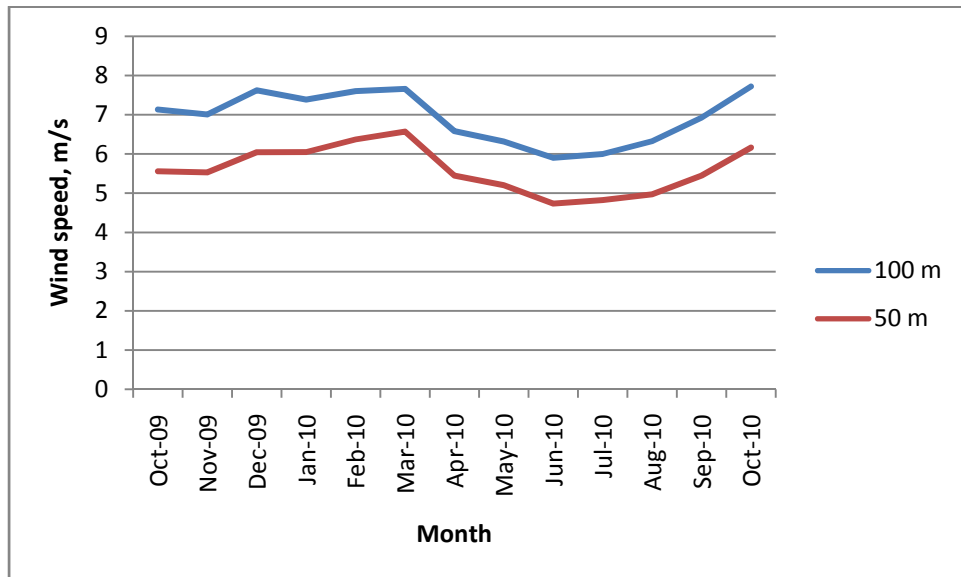
Figure 4 – Monthly Average Wind Speed at 50 m and 100 m, October 2009 to October 2010

Diurnal Average Wind Speeds
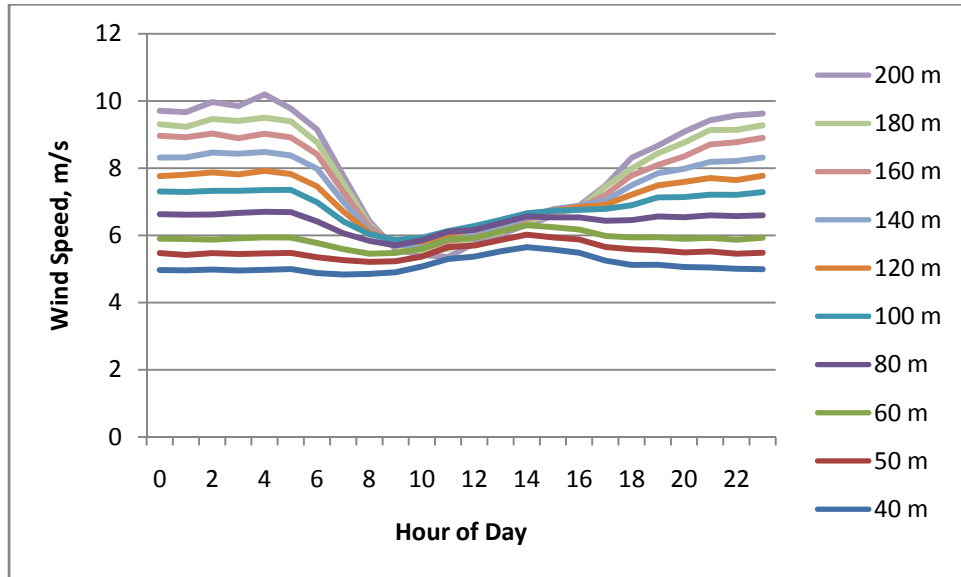
Figure 5 – Diurnal Average Wind Speed, October 2009 to October 2010

Turbulence Intensities
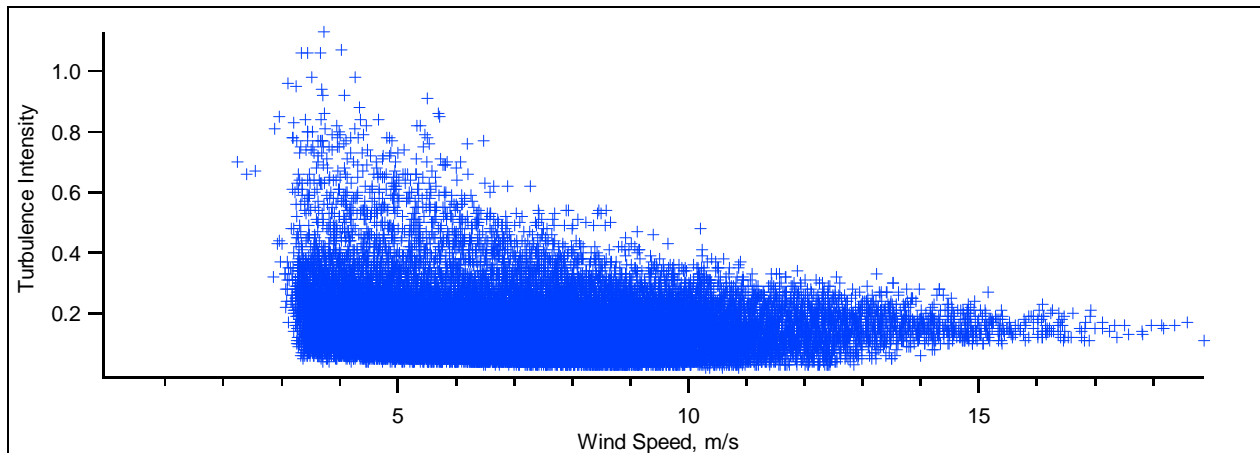
Figure 6 – Turbulence Intensity at 100 m, October 2009 to October 2010

Wind Roses
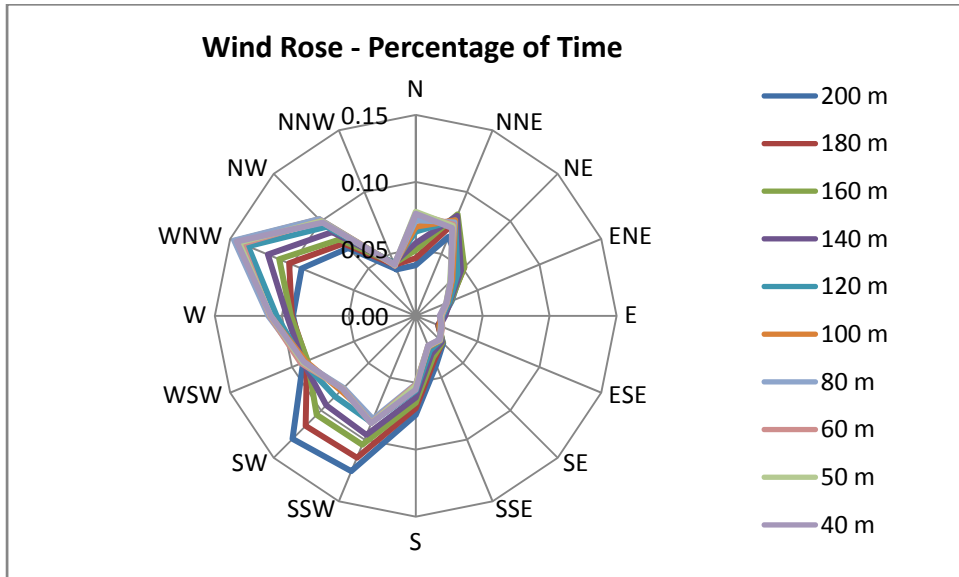
Figure 7 – Wind Rose – Percentage of Time, October 2009 to October 2010
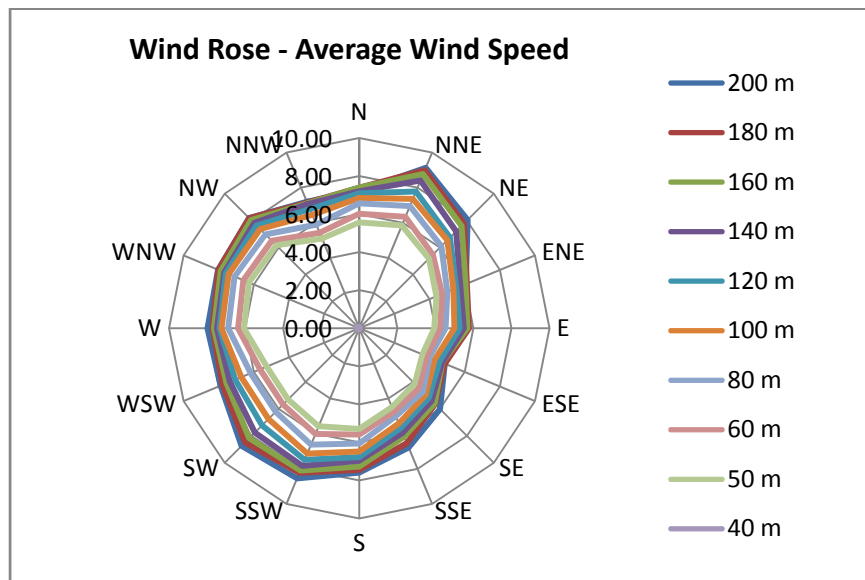
Figure 8 – Wind Rose – Average Wind Speed, October 2009 to October 2010

SECTION 6 - Significant Meteorological Events

There were multiple instances of sustained 10-minute wind speed averages above 15 m/s but no reported wind speeds out of the ordinary for the time period included in this report.

SECTION 7 - Data Collection and Maintenance

The PV panels on the Triton unit were stolen around October 5th 2010 but the unit had enough power to remain operational until data for a full calendar year was obtained.

SECTION 8 - Data Recovery and Validation

Although the Triton SODAR may be operational at all times, the data it collects may not be valid at all times depending upon external and internal conditions such as echoes and precipitation. Each data point from the Triton carries a Quality Index that quantifies the reliability of that particular data point based upon the proprietary procedure that Second Wind has put together. All analysis in this report is based on filtering the data for a quality level of 90% and higher. The table below shows the percentage of data over the annual period that is at this quality level and used for the analysis.

Height, m	40	50	60	80	100	120	140	160	180	200
Percentage of data accepted	91%	91%	90%	89%	85%	76%	62%	51%	40%	30%

APPENDIX A - Plot Data

Wind Speed Distribution Data

Wind Speed [m/s]	40 m	50 m	60 m	80 m	100 m	120 m	140 m	160 m	180 m	200 m
0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1	0.05	0.04	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.02
2	0.11	0.09	0.08	0.06	0.05	0.05	0.04	0.04	0.04	0.04
3	0.16	0.13	0.11	0.09	0.07	0.07	0.07	0.07	0.07	0.07
4	0.18	0.16	0.14	0.11	0.10	0.09	0.09	0.08	0.09	0.08
5	0.18	0.17	0.16	0.14	0.12	0.11	0.10	0.10	0.09	0.09
6	0.13	0.15	0.16	0.16	0.15	0.13	0.12	0.10	0.10	0.09
7	0.08	0.10	0.12	0.15	0.16	0.15	0.13	0.12	0.11	0.10
8	0.05	0.06	0.08	0.10	0.13	0.14	0.14	0.12	0.11	0.10
9	0.02	0.04	0.05	0.06	0.09	0.10	0.11	0.12	0.10	0.10
10	0.01	0.02	0.02	0.04	0.05	0.06	0.08	0.09	0.09	0.08
11	0.01	0.01	0.01	0.02	0.02	0.03	0.05	0.06	0.07	0.08
12	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.04	0.05	0.05
13	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.03	0.03
14	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01

Monthly Average Wind Speed Data

Month	Mean Wind Speed	Max Wind Speed	Prev Dir	% of data	Mean Wind Speed	Max Wind Speed	Prev Dir	% of data	Mean Wind Speed	Max Wind Speed	Prev Dir	% of data
Height	40 m				50 m				60 m			
Units	[m/s]	[m/s]			[m/s]	[m/s]			[m/s]	[m/s]		
Oct-09	5.06	13.78	NNW	97%	5.56	14.92	NNW	98%	6.03	16.16	NNW	98%
Nov-09	5.11	15.08	NW	97%	5.53	15.58	NW	97%	5.94	15.52	NNW	97%
Dec-09	5.57	15.10	W	69%	6.04	16.57	W	68%	6.47	16.91	W	60%
Jan-10	5.67	14.95	W	58%	6.05	18.13	W	61%	6.41	18.19	W	57%
Feb-10	5.97	15.27	WNW	87%	6.37	16.14	WNW	86%	6.79	17.74	WNW	81%
Mar-10	6.07	15.87	NNW	97%	6.57	17.27	NNW	97%	6.93	17.26	NNW	96%
Apr-10	5.10	16.13	W	98%	5.45	17.95	W	98%	5.77	17.98	W	96%
May-10	4.82	16.27	ENE	99%	5.20	15.83	ENE	100%	5.51	17.25	ENE	99%
Jun-10	4.36	11.15	ENE	99%	4.73	12.31	ENE	99%	5.04	12.31	ENE	99%
Jul-10	4.47	10.11	ENE	96%	4.82	10.62	ENE	97%	5.13	11.20	ENE	96%
Aug-10	4.56	11.18	ENE	99%	4.97	11.54	ENE	99%	5.31	15.86	ENE	99%
Sep-10	4.98	11.34	ENE	99%	5.45	12.04	ENE	99%	5.83	12.78	ENE	99%
Oct-10	5.62	13.51	NW	92%	6.16	14.85	NW	92%	6.60	16.00	NW	92%
Oct-09 to Oct-10	5.13	16.27	W	90%	5.53	18.13	W	90%	5.88	18.19	W	88%

Month	Mean Wind Speed	Max Wind Speed	Prev Dir	% of data	Mean Wind Speed	Max Wind Speed	Prev Dir	% of data	Mean Wind Speed	Max Wind Speed	Prev Dir	% of data
Height	80 m				100 m				120 m			
Units	[m/s]	[m/s]			[m/s]	[m/s]			[m/s]	[m/s]		
Oct-09	6.60	16.83	NNW	97%	7.14	17.34	NNW	92%	7.51	17.37	NNW	81%
Nov-09	6.51	17.65	NW	94%	7.01	16.92	NW	89%	7.41	16.20	NNW	79%
Dec-09	7.19	19.45	WNW	57%	7.62	18.88	WNW	49%	7.85	20.49	WNW	41%
Jan-10	6.90	17.21	WNW	61%	7.39	17.51	WNW	55%	7.69	16.27	WNW	42%
Feb-10	7.24	17.19	WNW	86%	7.60	16.84	WNW	79%	7.76	17.31	WNW	56%
Mar-10	7.39	20.00	NNW	92%	7.66	17.81	NNW	84%	7.86	17.77	NNW	69%
Apr-10	6.19	15.20	W	95%	6.58	14.99	W	90%	6.82	14.73	W	79%
May-10	5.96	15.06	ENE	99%	6.32	16.24	ENE	95%	6.51	15.69	ENE	88%
Jun-10	5.50	13.68	ENE	99%	5.90	13.96	ENE	98%	6.16	14.49	ENE	96%
Jul-10	5.58	12.05	ENE	96%	6.00	13.20	ENE	94%	6.29	13.86	ENE	92%
Aug-10	5.83	13.33	ENE	98%	6.32	14.20	ENE	95%	6.66	14.69	ENE	92%
Sep-10	6.39	14.28	ENE	98%	6.93	14.97	ENE	96%	7.34	16.02	ENE	93%
Oct-10	7.23	17.28	NNW	91%	7.72	18.59	NNW	87%	8.06	16.78	NNW	80%
Oct-09 to Oct-10	6.37	20.00	WNW	88%	6.75	18.88	W	83%	6.96	20.49	W	73%

Month	Mean Wind Speed	Max Wind Speed	Prev Dir	% of data	Mean Wind Speed	Max Wind Speed	Prev Dir	% of data	Mean Wind Speed	Max Wind Speed	Prev Dir	% of data
Height	140 m				160 m				180 m			
Units	[m/s]	[m/s]			[m/s]	[m/s]			[m/s]	[m/s]		
Oct-09	8.03	17.06	NNW	64%	8.63	16.87	NNW	49%	9.28	16.60	NNW	34%
Nov-09	7.91	16.79	NNW	64%	8.50	16.06	NNW	49%	9.14	16.24	N	35%
Dec-09	8.29	20.20	WNW	31%	8.74	20.27	WNW	23%	9.22	18.98	NNW	15%
Jan-10	8.29	15.57	WNW	24%	9.10	18.08	WNW	15%	9.62	16.57	WNW	9%
Feb-10	8.00	16.37	NNW	28%	8.10	15.15	NNE	12%	8.05	16.74	ENE	6%
Mar-10	8.16	18.37	N	46%	8.39	17.66	NNE	29%	8.34	18.85	NNE	15%
Apr-10	7.07	16.59	E	61%	7.31	15.29	E	44%	7.35	15.51	ENE	30%
May-10	6.75	15.78	ENE	76%	7.03	17.37	ENE	65%	7.27	18.24	ENE	57%
Jun-10	6.45	16.48	ENE	91%	6.72	17.02	ENE	81%	6.96	18.63	ENE	69%
Jul-10	6.56	14.74	ENE	88%	6.77	15.95	ENE	82%	6.87	16.29	ENE	74%
Aug-10	6.95	14.73	ENE	86%	7.14	15.80	ENE	78%	7.20	15.92	ENE	69%
Sep-10	7.74	16.63	ENE	85%	8.04	16.64	ENE	72%	8.40	17.56	NE	57%
Oct-10	8.39	17.71	NNW	70%	8.80	16.56	NNW	58%	9.16	15.63	NNW	41%
Oct-09 to Oct-10	7.19	20.20	W	59%	7.41	20.27	E	47%	7.55	18.98	ENE	37%

Month	Mean Wind Speed	Max Wind Speed	Prev Dir	% of data
Height	200 m			
Units	[m/s]	[m/s]		
Oct-09	10.25	16.97	E	22%
Nov-09	10.02	17.61	N	23%
Dec-09	9.80	18.44	NNW	10%
Jan-10	10.08	17.42	NW	6%
Feb-10	7.90	14.42	ENE	3%
Mar-10	7.51	17.54	ENE	8%
Apr-10	7.39	16.19	NE	20%
May-10	7.48	19.09	ENE	47%
Jun-10	7.22	19.23	ENE	55%
Jul-10	6.98	15.99	ENE	62%
Aug-10	7.13	15.55	ENE	56%
Sep-10	8.77	18.45	NE	42%
Oct-10	9.50	16.08	N	26%
Oct-09 to Oct-10	7.69	19.23	ENE	28%

Diurnal Average Wind Speed Data

Hour	40 m	50 m	60 m	80 m	100 m	120 m	140 m	160 m	180 m	200 m
0	4.97	5.48	5.91	6.63	7.31	7.77	8.32	8.97	9.30	9.71
1	4.96	5.42	5.89	6.61	7.30	7.81	8.32	8.92	9.23	9.67
2	4.98	5.47	5.87	6.62	7.33	7.87	8.46	9.03	9.46	9.97
3	4.96	5.45	5.91	6.67	7.33	7.82	8.43	8.89	9.40	9.85
4	4.98	5.46	5.94	6.70	7.35	7.92	8.48	9.03	9.50	10.20
5	5.00	5.48	5.94	6.69	7.36	7.83	8.38	8.92	9.40	9.77
6	4.88	5.35	5.78	6.42	6.98	7.46	7.98	8.42	8.77	9.15
7	4.84	5.27	5.59	6.07	6.42	6.71	7.00	7.29	7.56	7.77
8	4.85	5.21	5.46	5.84	6.03	6.08	6.15	6.25	6.30	6.42
9	4.90	5.23	5.48	5.70	5.86	5.83	5.74	5.74	5.69	5.59
10	5.07	5.37	5.60	5.85	5.93	5.81	5.67	5.63	5.55	5.42
11	5.30	5.65	5.88	6.11	6.13	6.03	5.89	5.80	5.60	5.36
12	5.37	5.70	5.92	6.16	6.28	6.20	6.13	6.00	5.93	5.77
13	5.53	5.86	6.12	6.36	6.46	6.37	6.28	6.20	6.10	6.04
14	5.65	6.02	6.30	6.56	6.66	6.60	6.54	6.50	6.42	6.31
15	5.58	5.94	6.25	6.53	6.73	6.74	6.78	6.71	6.62	6.58
16	5.48	5.88	6.18	6.53	6.76	6.85	6.89	6.80	6.80	6.89
17	5.25	5.65	5.99	6.43	6.79	6.91	7.04	7.21	7.45	7.49
18	5.12	5.59	5.94	6.46	6.90	7.21	7.49	7.79	7.99	8.31
19	5.13	5.56	5.94	6.56	7.13	7.49	7.85	8.10	8.44	8.67
20	5.06	5.49	5.90	6.54	7.14	7.59	7.98	8.35	8.76	9.08
21	5.05	5.52	5.93	6.60	7.22	7.71	8.19	8.71	9.14	9.43
22	5.01	5.46	5.87	6.57	7.21	7.65	8.22	8.77	9.14	9.57
23	4.99	5.48	5.93	6.60	7.29	7.77	8.32	8.90	9.28	9.62

Wind Rose Data

Percentage of time

	40 m	50 m	60 m	80 m	100 m	120 m	140 m	160 m	180 m	200 m
0	0.08	0.08	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.04
22.5	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.06
45	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05
67.5	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
90	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
112.5	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
135	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
157.5	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04
180	0.06	0.05	0.05	0.05	0.05	0.06	0.06	0.07	0.07	0.07
202.5	0.09	0.09	0.09	0.08	0.08	0.09	0.10	0.10	0.11	0.13
225	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.10	0.12	0.13
247.5	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
270	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.09	0.09	0.09
292.5	0.14	0.14	0.14	0.15	0.15	0.14	0.12	0.11	0.10	0.09
315	0.10	0.10	0.10	0.10	0.10	0.09	0.09	0.08	0.08	0.07
337.5	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04

Average Wind Speed

	40 m	50 m	60 m	80 m	100 m	120 m	140 m	160 m	180 m	200 m
0	5.10	5.57	6.02	6.56	6.85	7.10	7.21	7.40	7.39	7.22
22.5	5.19	5.85	6.34	6.95	7.36	7.78	8.41	8.77	9.00	9.13
45	4.78	5.18	5.48	6.10	6.55	6.75	7.20	7.61	7.79	8.06
67.5	4.07	4.40	4.72	5.01	5.36	5.53	5.75	6.05	6.13	6.06
90	3.64	3.94	4.24	4.54	5.00	5.28	5.50	5.69	5.77	5.58
112.5	3.29	3.59	3.85	3.99	4.30	4.57	4.72	4.73	4.87	4.87
135	3.87	4.13	4.45	4.73	4.95	5.18	5.39	5.60	5.64	6.00
157.5	4.20	4.49	4.76	5.01	5.42	5.68	5.95	6.17	6.54	6.78
180	4.91	5.30	5.59	6.06	6.48	6.77	6.97	7.27	7.44	7.58
202.5	5.13	5.58	6.02	6.62	7.13	7.48	7.83	8.10	8.22	8.54
225	4.80	5.29	5.67	6.21	6.75	7.22	7.76	8.17	8.48	8.74
247.5	4.83	5.26	5.64	6.18	6.71	7.06	7.35	7.55	7.78	7.88
270	5.66	6.06	6.37	6.89	7.24	7.34	7.48	7.64	7.71	7.97
292.5	5.88	6.28	6.59	7.09	7.43	7.58	7.68	7.88	8.02	8.03
315	5.81	6.17	6.50	6.97	7.37	7.64	7.82	8.05	8.19	8.20
337.5	4.77	5.11	5.43	5.89	6.45	6.78	7.07	7.10	7.15	7.20