

Sonic Detection and Ranging (SODAR) Data Collection and Evaluation Report

International Coal Group Eastern, LLC Birch River Surface Mine Operation

Cowen, Webster County, West Virginia

(Data Evaluation Period: May 19, 2010 to September 29, 2010)

Compiled by:

Marshall University Center for Environmental, Geotechnical and Applied Sciences
(CEGAS)

and

Marshall University Center for Business and Economic Research (CBER)

Under Direction of:

West Virginia Division of Energy

Funded by:

Appalachian Regional Commission

West Virginia Division of Energy

January, 2011

Table of Contents

1.0	Introduction	2
1.1	Project Location and Site Conditions	2
1.2	Data Collection Description	2
1.3	SODAR Configuration	3
2.0	SODAR Data Filtering and Performance	3
3.0	Results	3
4.0	Estimated Capacity Factor as an Indicator of Performance	4
5.0	Findings Calculated to Specific Wind Turbine Energy Output	5
6.0	Conclusions and Recommendations	5

Attachments

Attachment A

Site Location Map

Site Photos

SecondWind Site Information Form and Checklist

Attachment B

Windographer Monthly Reports

Windographer Summary Report

Wind Turbine Energy Output Summaries

1.0 Introduction

Marshall University's Center for Environmental, Geotechnical and Applied Sciences (CEGAS) partnered with the West Virginia Division of Energy to perform initial screening and wind resource data collection to assess wind development opportunities at selected surface mine properties in West Virginia using Sonic Detection and Ranging technologies. This report has been compiled with assistance from Marshall University's Center for Business and Economic Research (CBER), with funding for this study provided under joint partnership from the Appalachian Regional Commission and the West Virginia Division of Energy.

1.1 Project Location and Site Conditions

The site is located at the International Coal Group Eastern, LLC (ICG) Birch River surface mine operations, located near Cowen, Webster County, West Virginia. Wind resource data collection occurred on the site at Latitude 38.44110, Longitude -80.61167, at an elevation of 2,686 feet (819 meters) above mean sea level. This area is along a ridgeline, part of large reclaimed surface mine area, with active surface mine operations located generally west to southwest. Permitted mining operations, reclaimed and active mining areas, currently total nearly 5,000 acres. A site location map is provided in Attachment A.

The immediately surrounding area consists of reclaimed surface mine property. Minimal ground vegetation is present, and various species of trees have been planted throughout the immediate area. Trees range in age from 1 to 3 years, and are generally less than 8 feet tall. An access road and electric power line are located generally north of the SODAR location, with minimal traffic and/or related noise from surface mine operations. Reclaimed valley areas are located east, south and west of the site.

Property ownership of reclaimed, current and future tracts of the ICG mining complex includes a number of entities. The tract where the SODAR was located is owned by Knight and Ink heirs, and includes approximately 1,200 acres. Other property owners and approximate acreage include: Pardee Resources, 10,000 acres; Beckwith Lumber Company, 5,500 acres; H.R. Deitz et al., 600 acres, and MB, LLC, 600 acres. ICG Eastern also currently owns small acreage in the area.

1.2 Data Collection Description

Wind resource data was collected using a Triton Sonic Wind Profiler, manufactured by SecondWind, utilizing Sonic Detection and Ranging (SODAR) technology. Data collection occurred continuously during the period of May 19, 2010 to September 29, 2010, for a total of 133 days. Photos showing the Triton unit and surrounding area are included in Attachment A.

The Triton unit was set up per SecondWind recommendations, including leveling of the unit to within operating condition (within 3 degrees of level), and proper directional orientation of the unit using Global Positioning System and magnetic compass equipment. The Triton unit is oriented properly when the south sound beam is positioned to within a few degrees of South. A Site Information Form and Checklist was completed during initial setup, which records site conditions, including nearby surface features, site noise, and unit operation parameter checks. A copy of the Site Information Form and Checklist is included in Attachment A.

1.3 SODAR Configuration

The Triton Sonic Wind Profiler utilizes a hexagonal 36-speaker array to transmit high frequency acoustic pulses, or “chirps”, and measures how they scatter and return to the unit. Sources of scattering are irregularities in wind velocities, air temperature and density, causing acoustic refractive index changes. By measuring the Doppler shifted frequency of the returned signal or echo, the SODAR determines wind speed and direction at various altitudes. Additional information on Triton Sonic Wind Profiler’s operational details is available at:

www.secondwind.com.

The SODAR unit saves records on 10-minute intervals. Each record includes data from 10 heights, ranging from 40 meters to 200 meters above ground surface. Data collected includes wind direction, horizontal and vertical wind speeds, turbulence, and general weather parameters, including temperature and barometric pressure.

2.0 SODAR Data Filtering and Performance

Using guidelines provided by Second Wind, SODAR data was filtered to remove low-quality data before analysis was performed. For this study, a 90% wind speed quality factor, as recommended by Second Wind, was used. During the 133-day time frame for this study, the SODAR unit operated continuously.

3.0 Results

All data collected during the 4-month study was exported into *Windographer* software for data analysis. *Windographer* is a wind data analysis program that reads data files directly from SODAR wind profilers and performs a number of calculations, including wind shear, turbulence intensity, extreme wind speeds, and wind turbine energy production. The newest *Windographer* software version, Version 2.0, released in May of 2010, was used for data analysis. Wind speed mean averages at various elevations above the ground surface ranged from 4.5 meters per second (m/s) at 40 meters, increasing consistently to just over 6 m/s at 200 meters. Wind direction was predominantly from the south to west, with mean wind directions generally South-Southwest.

The following table, summarized from *Windographer* data analysis, provides a summary of wind speed, wind direction, vertical wind speed, and power density estimates at specified elevations from 40 to 200 meters above existing ground surface:

Elevation Above Ground Surface (819 m)	Wind Speed (m/s, mean)	Wind Direction (degrees, mean)	Vertical Wind Speed (m/s, mean)	Power Density (W/m ² , mean)
40 Meters	4.51	236.9	0.009	87
50 Meters	4.64	240.1	-0.008	95
60 Meters	4.77	243.1	-0.023	105
80 Meters	5.06	247.3	-0.051	127
100 Meters	5.36	250.0	-0.076	151
120 Meters	5.66	254.1	-0.100	181
140 Meters	5.90	256.3	-0.113	209
160 Meters	6.03	258.1	-0.118	219
180 Meters	6.11	261.0	-0.110	231
200 Meters	6.16	264.1	-0.096	240

Monthly wind speed and wind direction graphs are provided in Appendix B. Also in Appendix B is a Data Summary Report, which includes wind frequency, mean wind speed, and total wind energy rose diagrams, plus project period wind speed and diurnal wind speed profiles. A complete SODAR data collection package is available upon request to the West Virginia Division of Energy.

4.0 Estimated Capacity Factor as an Indicator of Performance

Measured wind speeds for the four-month assessment periods were compared to generation data at operating wind facilities in West Virginia, New York and Pennsylvania. Generation data for 2004 through 2008 was utilized. Wind facilities in these states achieved aggregate monthly capacity factors as follows: June (17 percent), July (15 percent), August (13 percent), September (17 percent). The four-month average was 16 percent for the five-year period. Individual facility capacity factors for June through September for any single year ranged from a maximum of 24 percent to a low of five percent.

Based on data provided by AWS TrueWind the implied four-month capacity factor of a 2 megawatt turbine at the location of the SODAR is between 8 and 12 percent, based on an average wind speed of 5.1 to 5.4 meters per second (m/s). The 12 percent performance corresponds with the 5.4 m/s speed recorded at 100 meters while the 8 percent corresponds with the 5.1 m/s speed recorded at 80 meters.

Because performance data for 2010 is not yet available, a comparison of the ICG site data with actual facilities for the same time period is not possible. Additional assessment would allow more accurate evaluation of this site.

5.0 Findings Calculated to Specific Wind Turbine Energy Output

Three wind turbines were selected for comparison of energy output based on the findings from this data collection period. The three units selected are representative of small, medium, and large-scale wind turbines that may be utilized for small to large-scale wind power generation. Each turbine was selected with an appropriate hub height and energy output calculated using *Windographer* software. The following table summarizes turbine properties and associated energy output and related information:

Wind Turbine Model Number	Rated Power (kW)	Hub Height (meters)	Hub Height Wind Speed (m/s)	Mean Net Power Output (kW)	Net Capacity Factor (%)
Endurance G-3120	35	42.7	4.40	5.6	16.0
Vestas V52	850	74	4.85	77.5	9.1
GE 2.5xl	2,500	75	4.86	255.5	10.2

Complete wind turbine comparison summaries are provided in Attachment B.

6.0 Conclusions and Recommendations

Wind resource data was collected from the ICG site from May 19th through September 29th, 2010. Late Spring and Summer months normally experience lower than yearly average wind speeds; winter months normally experience the highest wind speeds for a given 1-year period. At the ICG site, recorded wind resource data and associated net capacity factors were somewhat below levels normally associated with commercial wind energy development standards. It is expected that overall yearly wind speeds would be somewhat higher than the wind speeds

recorded during the late Spring and Summer timeframe of this study period. A full 1-year study would better define yearly wind resource potential.

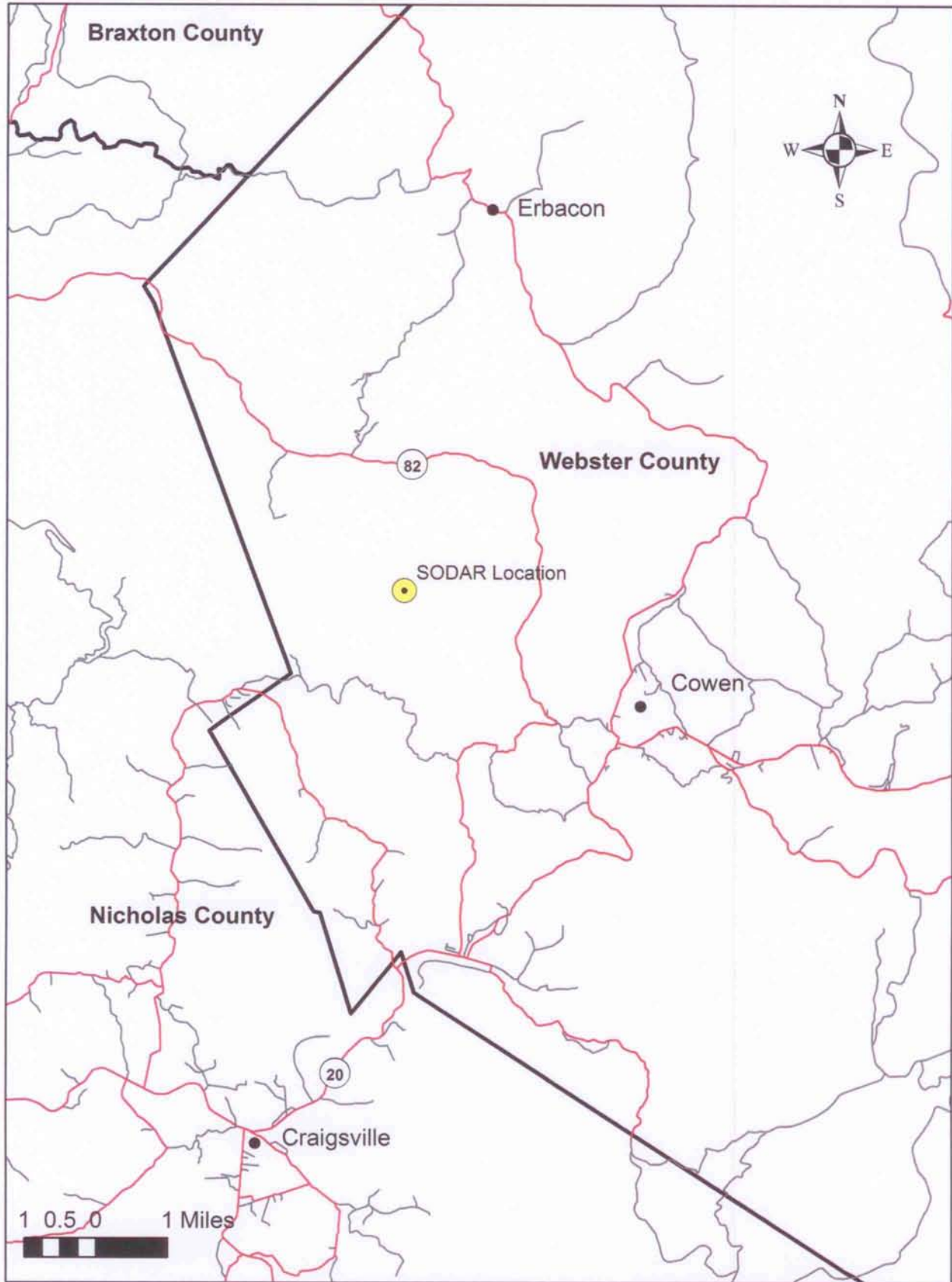
ATTACHMENT A

Site Location Map

Site Photos

SecondWind Site Information Form and Checklist

ICG SODAR Site Map





Top View: SODAR unit looking Southwest

Bottom View: Area immediately North of SODAR unit location





Top View: SODAR unit looking Southeast

Bottom View: Area immediately Northeast of SODAR unit location



4. Installation Checklist

Item	✓	Unit	Value
Mechanical Inspection		List Damage/Defects	NA
Exterior Warning Sign Cover Removed (Heater Only)		none	NA
Triton Properly Oriented		Record Azimuth of B-Beam (deg mag)	aligned using hand-held compass
Triton Secured		Method (i.e. earth anchors, trailer, snow platform, etc.)	leveled trailer w/ 6-foot security fence
Batteries Charged (>12.7V)		Record voltage level, V - DC	16.2
Solar Panels Installed, Connected		# of Panels	2
Solar Panels Charging		V - DC	14.42
Antifreeze Fluid Level (Heater Only)		none	NA
Propane Tanks installed		Tank capacity and level	NA
Propane Leak Test (Heater Only)		none	NA
Operator Panel: GPS		Red/Green/Rapid/Off	green
Operator Panel: SENSORS		Red/Green/Rapid/Off	green
Operator Panel: SUPPLIES		Red/Green/Rapid/Off	green
Operator Panel: SD CARD		Red/Green/Rapid/Off	green
Operator Panel: HEATER		Off/NA	NA
Operator Panel: NOTA (self-test)		Red/Green/Rapid/Off/NA	NA
Operator Panel: ARRAY		Red/Green/Rapid/Off	green
Operator Panel: SODAR		Red/Green/Rapid/Off	green
Operator Panel: SNR		Red/Green/Rapid/Off	green
Operator Panel: INTERNET		Red/Green/Rapid/Off	green
Operator Panel: TSP		Red/Green/Rapid/Off	green
Operator Panel: SKYSERVE		Red/Green/Rapid/Off	green
Take Photos or Videos		Pictures of 360deg site and Anchored Triton	8 photos taken 5/20/2010
Ambient Noise Level		dB	minimal
Ambient Noise Description		(i.e. Birds, Crickets, Highway)	dozers, trucks (plus 1 mile), birds
Triton Information (1) Section Complete		none	
Site Information (2) Section Complete		none	
Fixed Obstacle Vista Table (3) Complete		none	

Installer's Signature: *George Carico*

Date: 19-May

Installer's Name (print): George Carico

Installer's ID #: _____

Rev5 March 2010

ATTACHMENT B

Windographer Monthly Reports

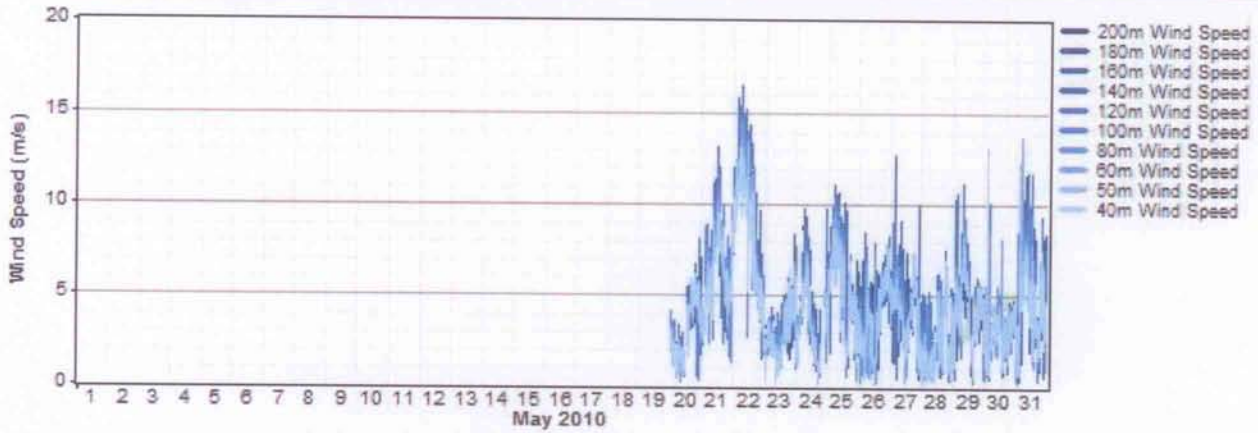
Windographer Summary Report

Wind Turbine Energy Output Summaries

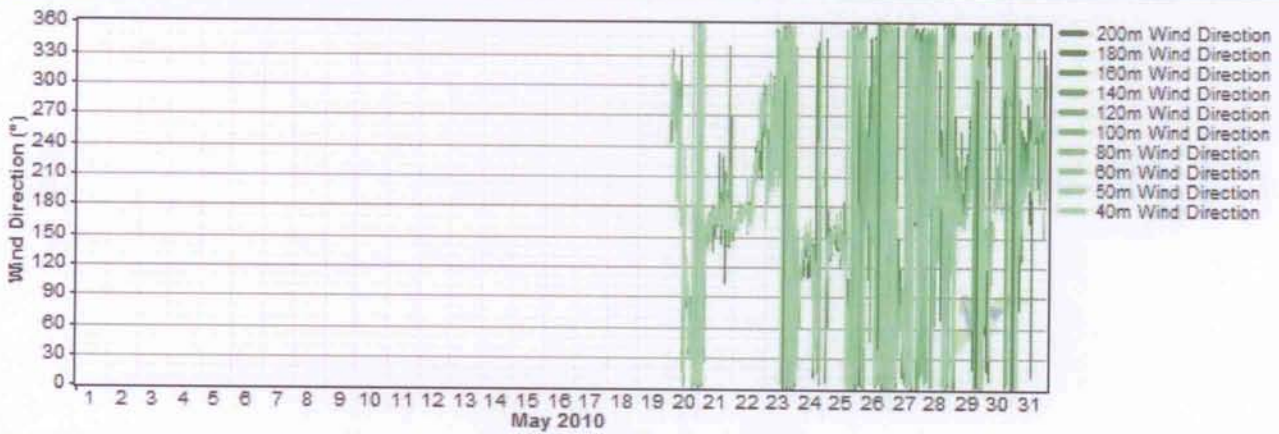
Report Settings

Report Created: 12/15/2010 15:06 using Windographer 2.2
Report Period: May 2010

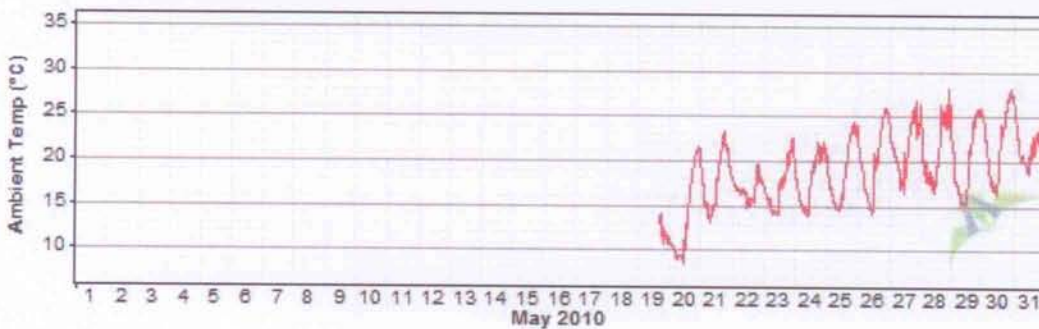
Wind Speed Data



Wind Direction Data



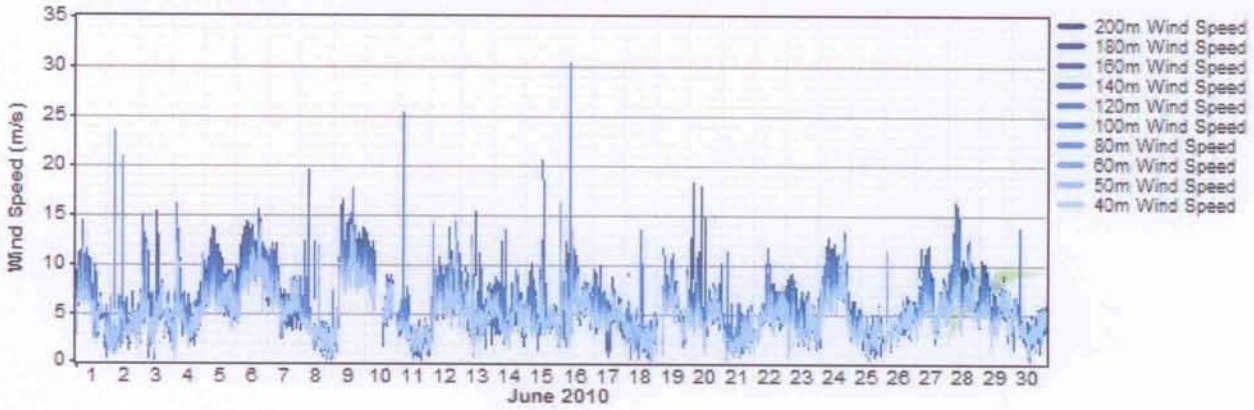
Temperature Data



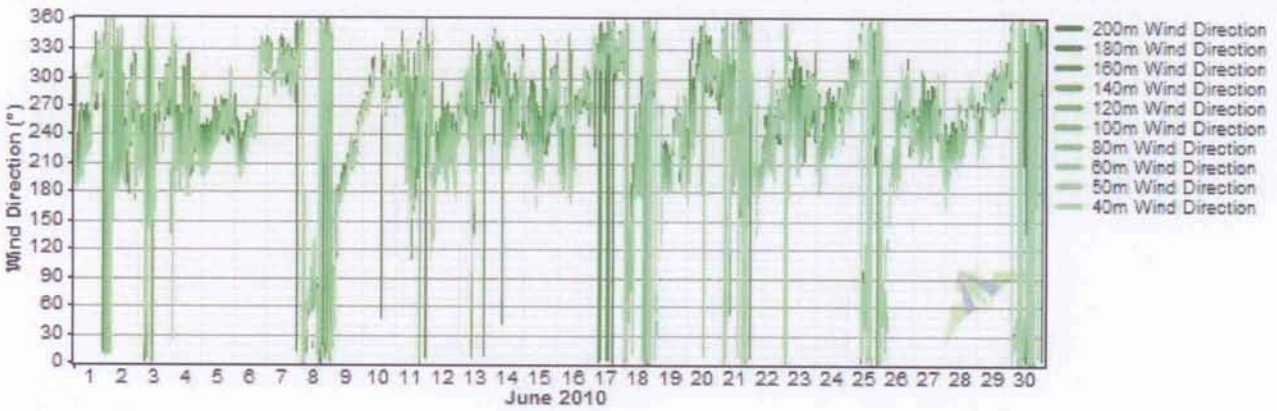
Report Settings

Report Created: 11/16/2010 09:16 using Windographer 2.0.4
Report Period: June 2010

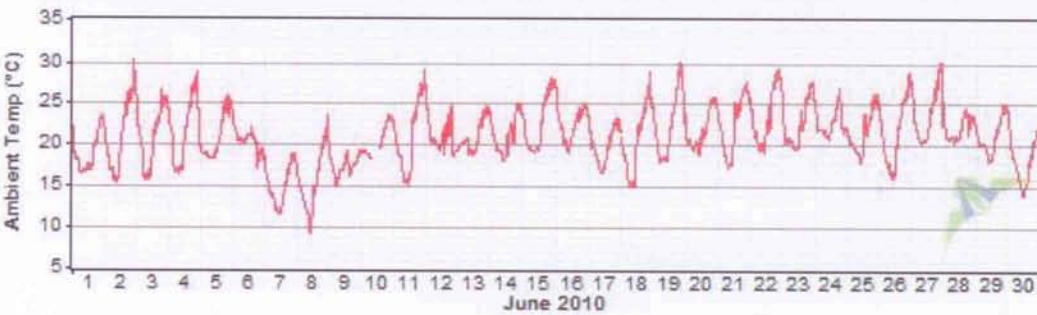
Wind Speed Data



Wind Direction Data



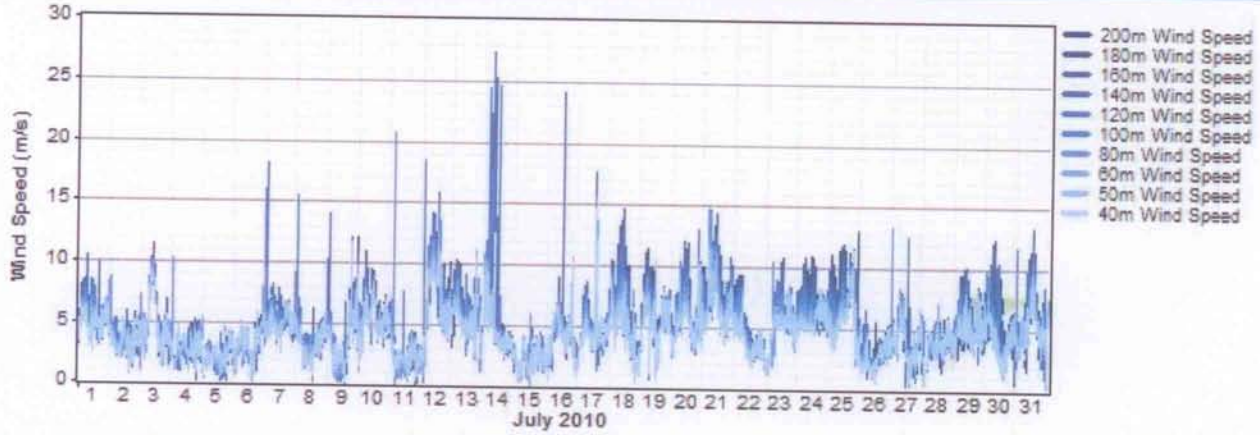
Temperature Data



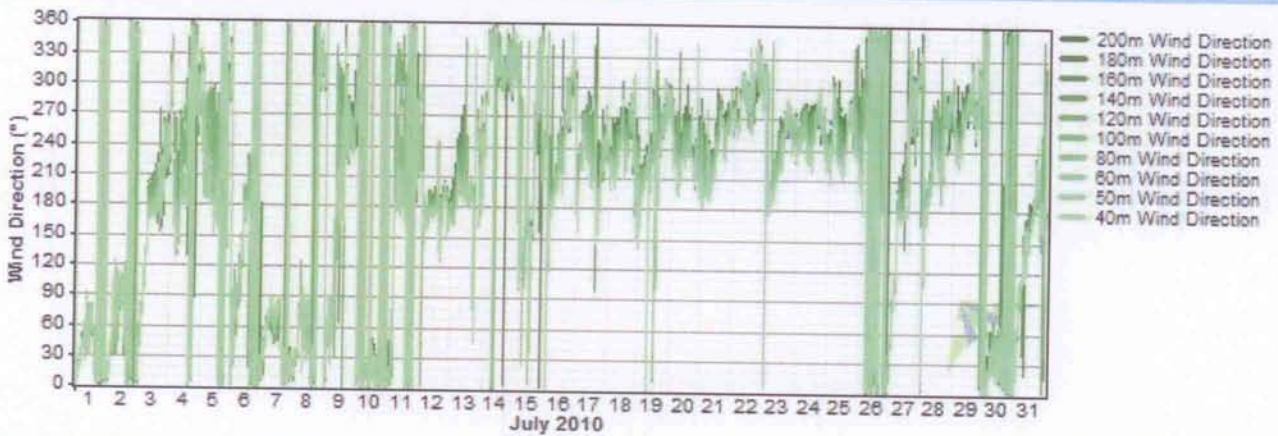
Report Settings

Report Created: 12/15/2010 15:07 using Windographer 2.2
Report Period: July 2010

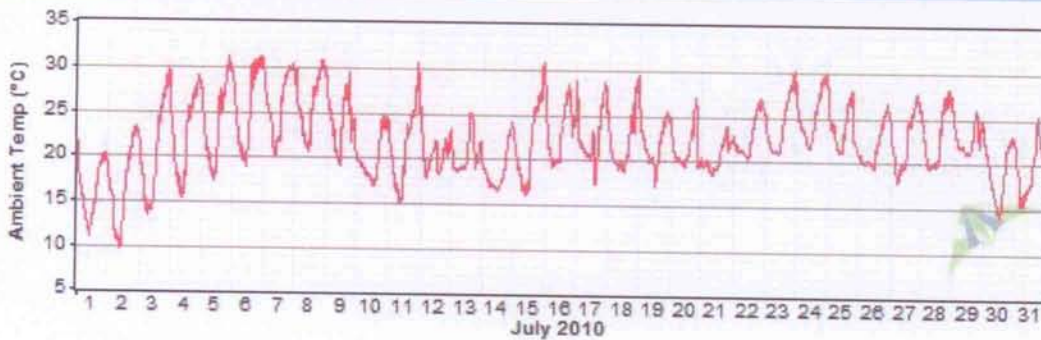
Wind Speed Data



Wind Direction Data



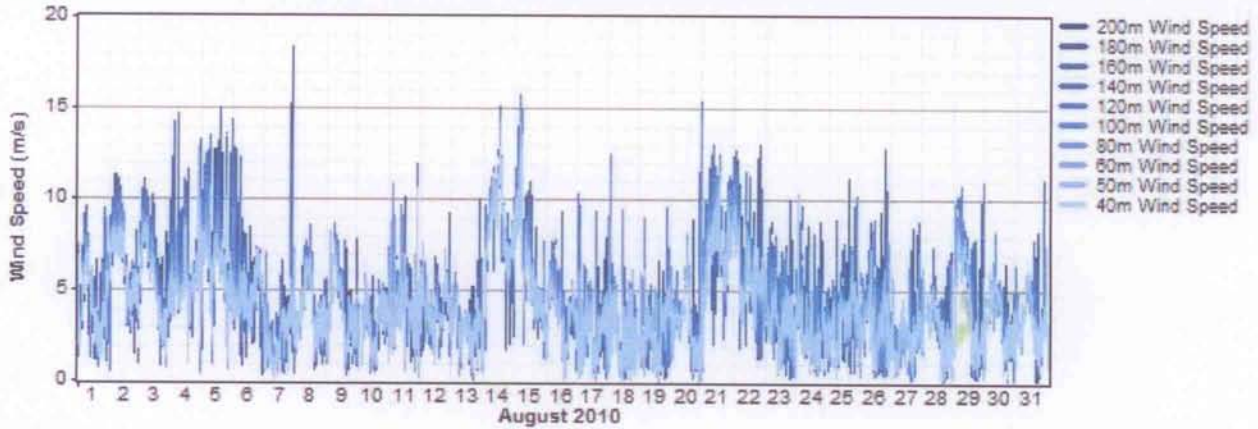
Temperature Data



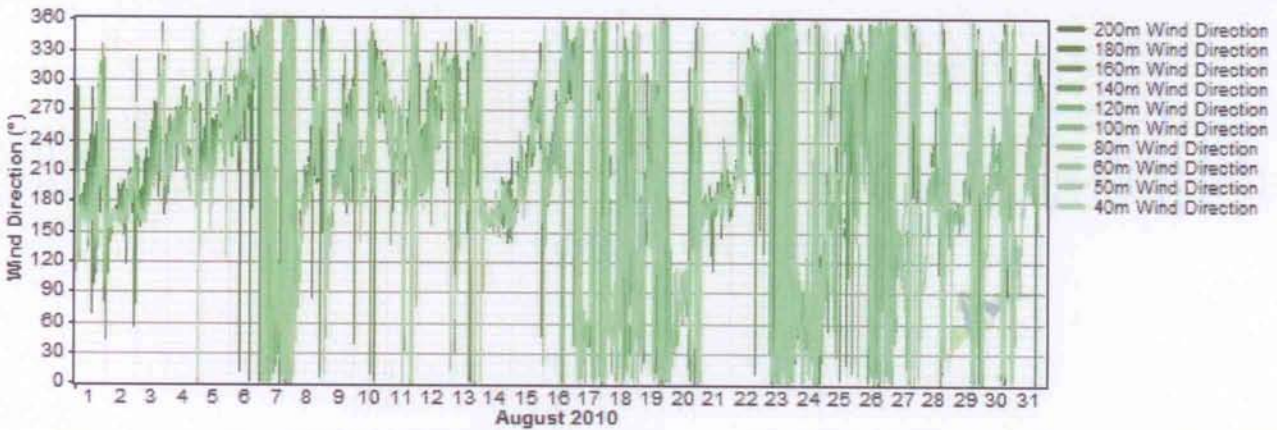
Report Settings

Report Created: 12/15/2010 15:07 using Windographer 2.2
Report Period: August 2010

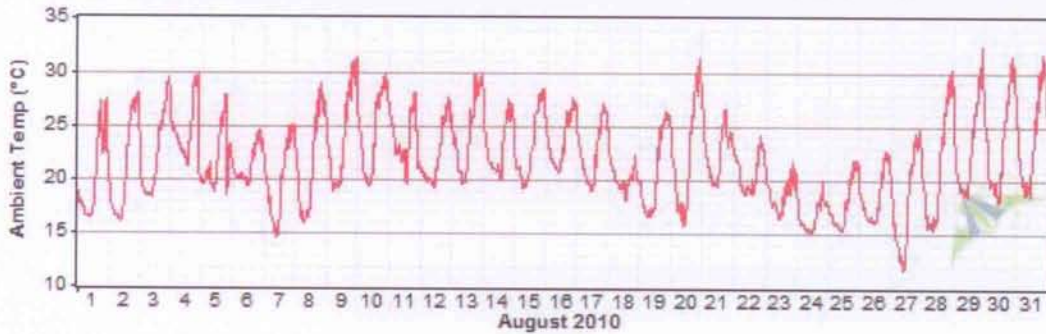
Wind Speed Data



Wind Direction Data



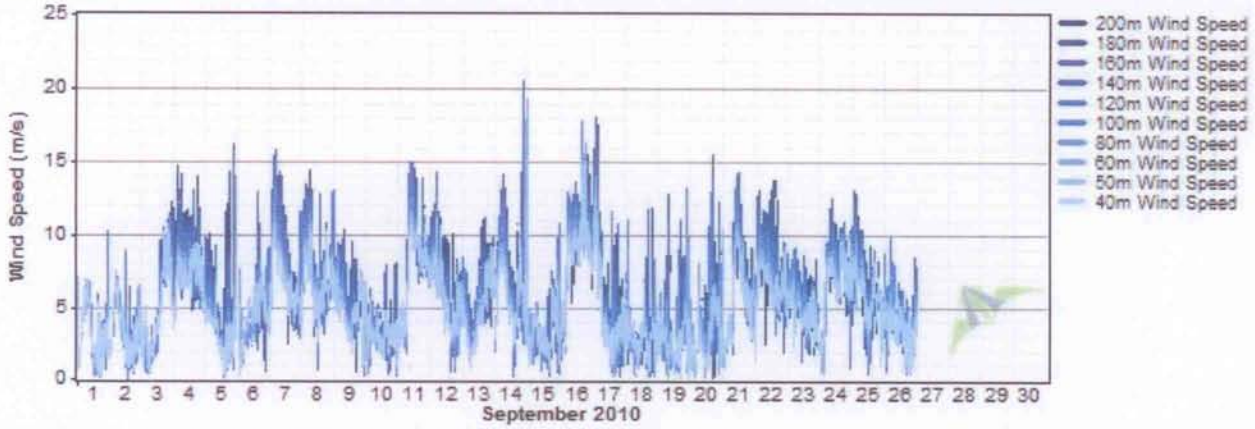
Temperature Data



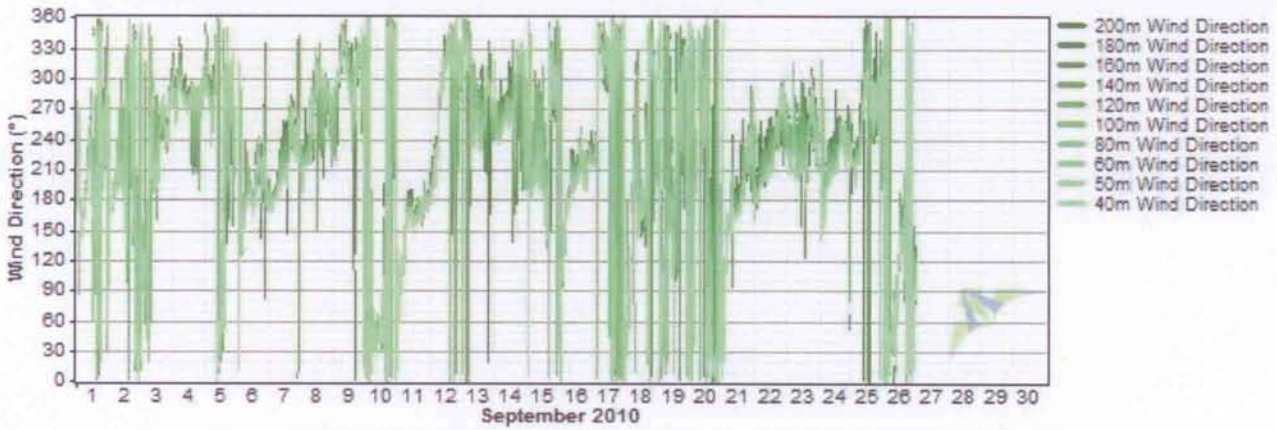
Report Settings

Report Created: 12/15/2010 15:07 using Windographer 2.2
Report Period: September 2010

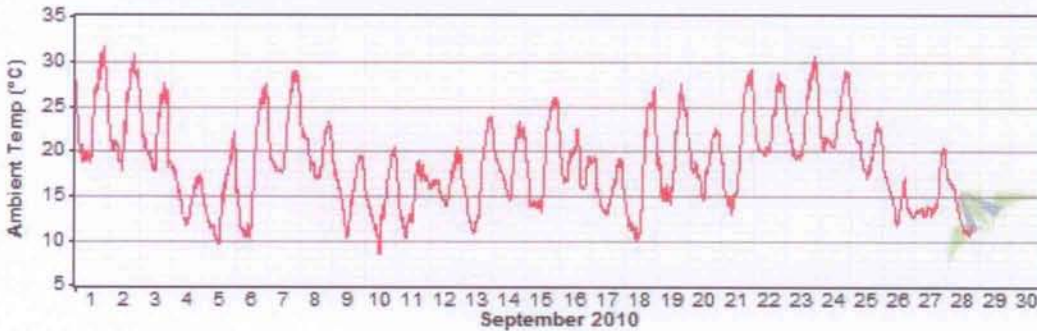
Wind Speed Data



Wind Direction Data



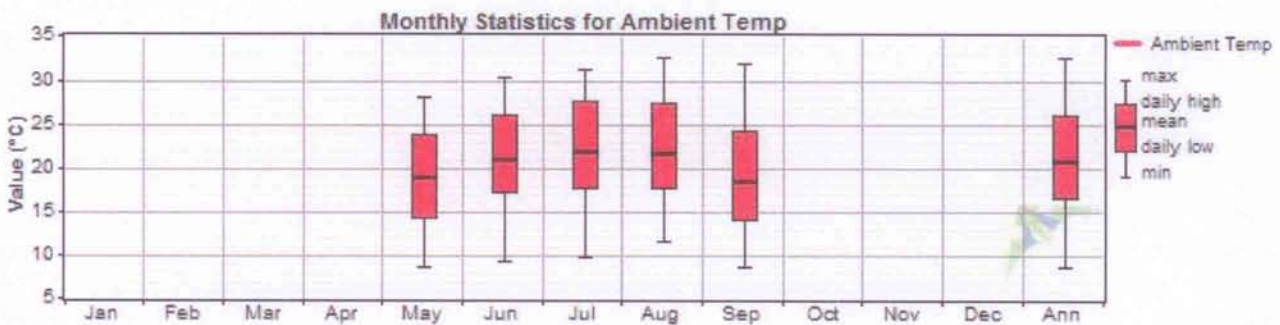
Temperature Data



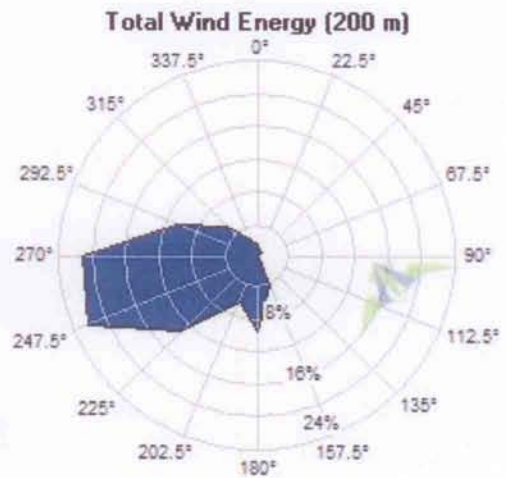
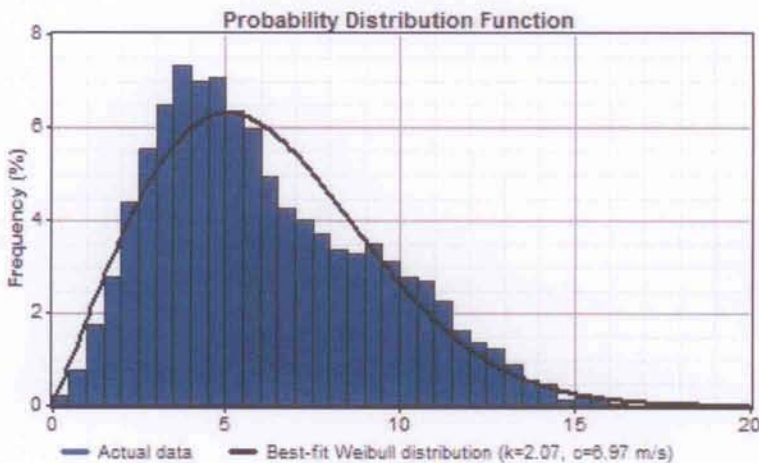
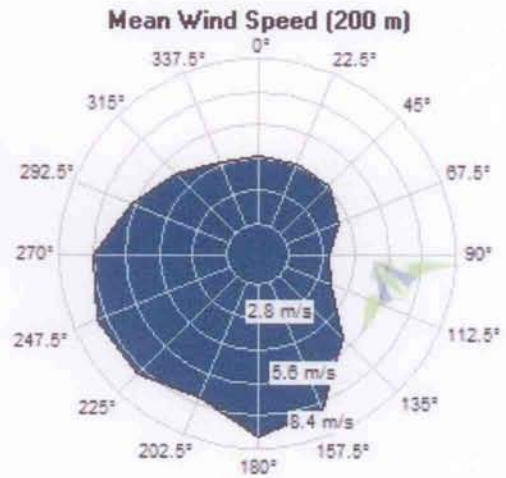
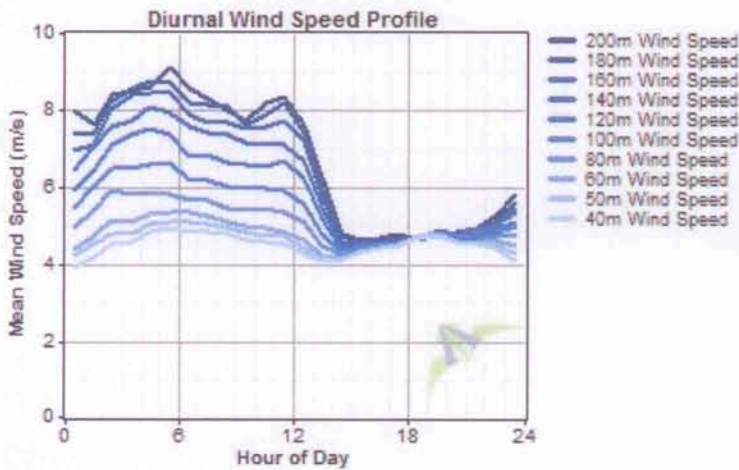
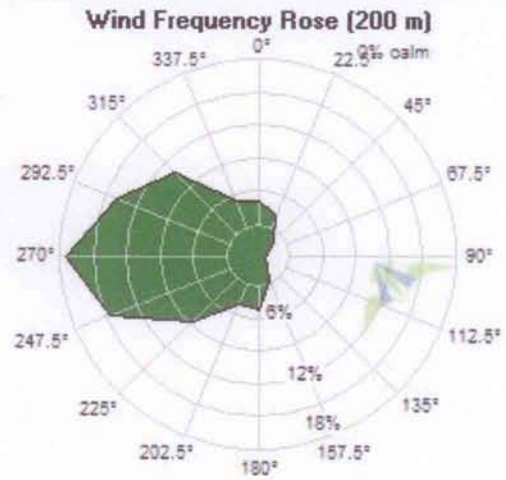
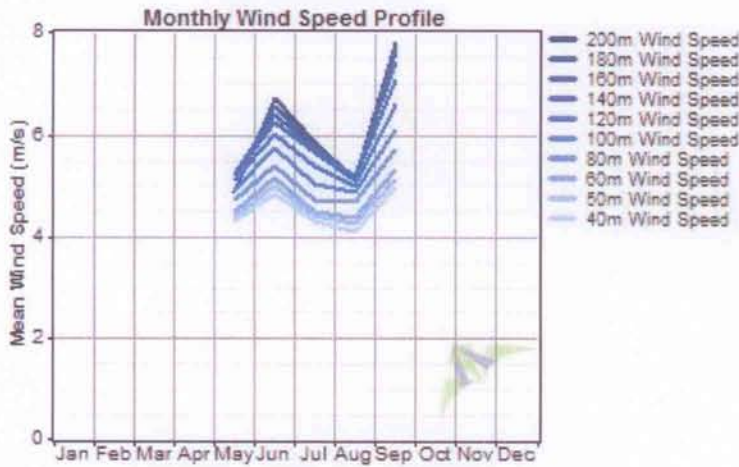
Data Set Properties

Report Created: 1/3/2011 15:26 using Windographer 2.2
 Filter Settings: <Unflagged data>

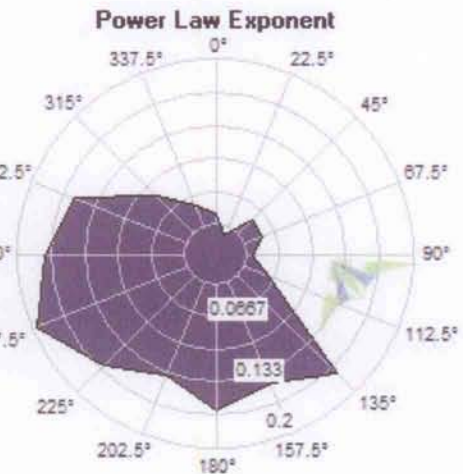
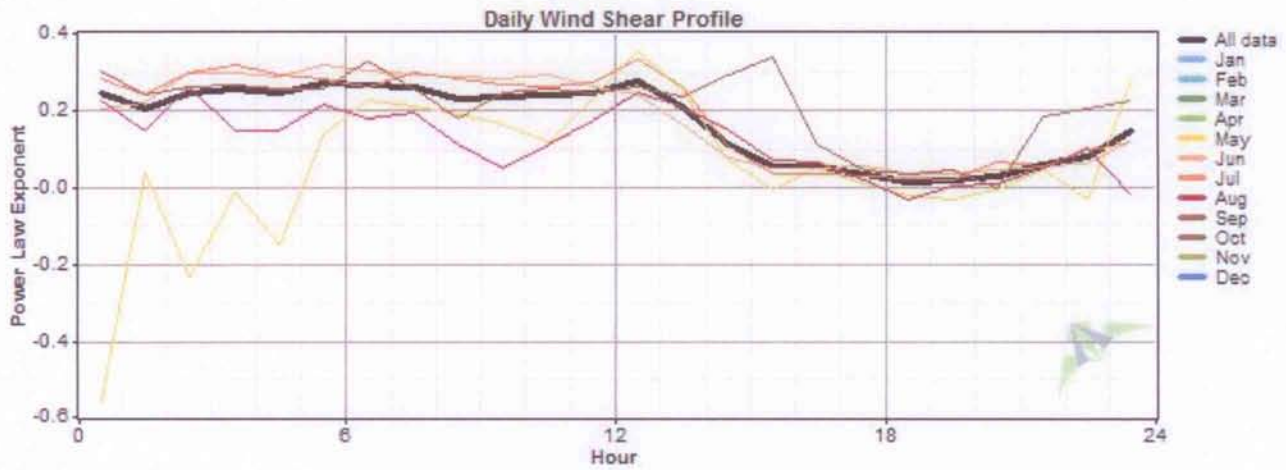
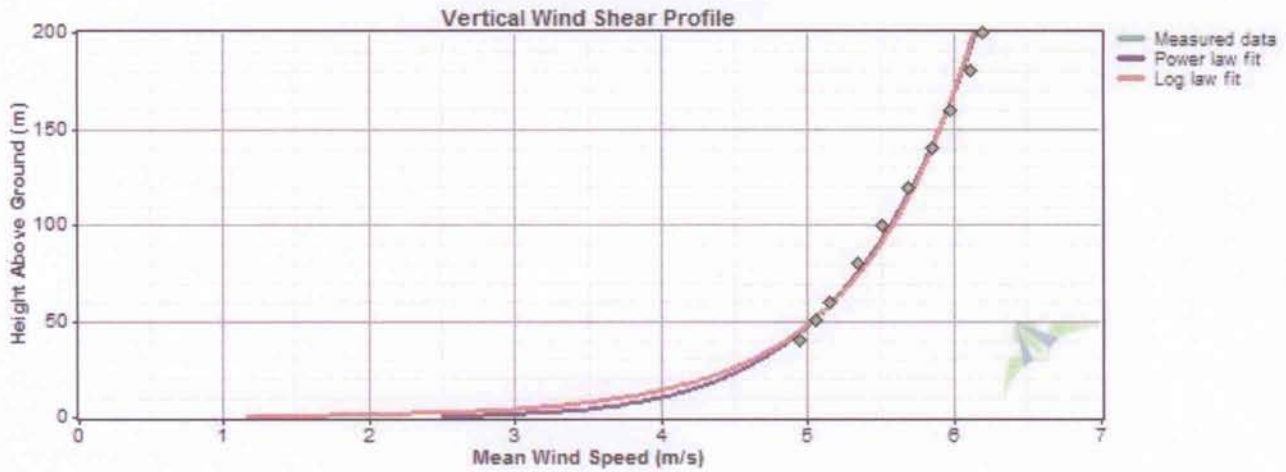
Variable	Value
Latitude	N 38.441100
Longitude	W 80.611670
Elevation	819 m
Start date	5/19/2010 16:40
End date	9/28/2010 17:20
Duration	4.3 months
Length of time step	10 minutes
Calm threshold	0 m/s
Mean temperature	20.7 °C
Mean pressure	922.1 mbar
Mean air density	1.094 kg/m ³
Power density at 50m	96 W/m ²
Wind power class	1 (Poor)
Power law exponent	0.145
Surface roughness	0.093 m
Roughness class	1.94
Roughness description	Few trees



Wind Speed and Direction



Wind Shear



Data Column Properties

Label	Units	Height	Possible Records	Valid Records	Recovery Rate (%)	Mean	Min	Max	Std. Dev
40m Wind Direction	°	40 m	19,012	17,994	94.65	236.9	0.0	360.0	91.2
40m Wind Speed	m/s	40 m	19,012	17,994	94.65	4.51	0.06	15.01	2.11
40m Wind Vert	m/s		19,012	17,994	94.65	0.009	-9.440	4.660	0.782
Quality (Station Height 40m)	%		19,012	17,994	94.65	97.4	90.0	100.0	2.1
50m Wind Direction	°	50 m	19,012	17,706	93.13	240.1	0.0	360.0	91.5
50m Wind Speed	m/s	50 m	19,012	17,706	93.13	4.64	0.06	15.51	2.19
50m Wind Vert	m/s		19,012	17,706	93.13	-0.008	-9.500	4.670	0.801
Quality (Station Height 50m)	%		19,012	17,706	93.13	97.3	90.0	100.0	2.1
60m Wind Direction	°	60 m	19,012	17,297	90.98	243.1	0.0	360.0	91.7
60m Wind Speed	m/s	60 m	19,012	17,297	90.98	4.77	0.01	19.25	2.29
60m Wind Vert	m/s		19,012	17,297	90.98	-0.023	-9.910	4.780	0.819
Quality (Station Height 60m)	%		19,012	17,297	90.98	97.1	90.0	100.0	2.2
80m Wind Direction	°	80 m	19,012	16,193	85.17	247.3	0.0	359.9	91.4
80m Wind Speed	m/s	80 m	19,012	16,193	85.17	5.06	0.03	20.90	2.48
80m Wind Vert	m/s		19,012	16,193	85.17	-0.051	-9.460	4.750	0.852
Quality (Station Height 80m)	%		19,012	16,193	85.17	96.8	90.0	100.0	2.4
100m Wind Direction	°	100 m	19,012	15,083	79.33	250.0	0.1	360.0	90.8
100m Wind Speed	m/s	100 m	19,012	15,083	79.33	5.36	0.06	23.76	2.62
100m Wind Vert	m/s		19,012	15,083	79.33	-0.076	-9.060	5.820	0.920
Quality (Station Height 100m)	%		19,012	15,083	79.33	96.6	90.0	100.0	2.5
120m Wind Direction	°	120 m	19,012	13,572	71.39	254.1	0.0	360.0	90.9
120m Wind Speed	m/s	120 m	19,012	13,572	71.39	5.66	0.10	30.43	2.80
120m Wind Vert	m/s		19,012	13,572	71.39	-0.100	-9.630	6.790	0.981
Quality (Station Height 120m)	%		19,012	13,572	71.39	96.3	90.0	100.0	2.6
140m Wind Direction	°	140 m	19,012	12,050	63.38	256.3	0.1	359.9	89.4
140m Wind Speed	m/s	140 m	19,012	12,050	63.38	5.90	0.04	27.36	2.96
140m Wind Vert	m/s		19,012	12,050	63.38	-0.113	-9.280	6.800	1.009
Quality (Station Height 140m)	%		19,012	12,050	63.38	96.0	90.0	100.0	2.7
160m Wind Direction	°	160 m	19,012	10,784	56.72	258.1	0.0	360.0	87.8
160m Wind Speed	m/s	160 m	19,012	10,784	56.72	6.03	0.05	24.10	3.01
160m Wind Vert	m/s		19,012	10,784	56.72	-0.118	-9.750	6.990	1.066
Quality (Station Height 160m)	%		19,012	10,784	56.72	95.7	90.0	100.0	2.7
180m Wind Direction	°	180 m	19,012	9,533	50.14	261.0	0.1	359.7	86.9
180m Wind Speed	m/s	180 m	19,012	9,533	50.14	6.11	0.01	20.53	3.10
180m Wind Vert	m/s		19,012	9,533	50.14	-0.110	-9.010	7.380	1.108
Quality (Station Height 180m)	%		19,012	9,533	50.14	95.4	90.0	100.0	2.7

Label	Units	Height	Possible Records	Valid Records	Recovery Rate (%)	Mean	Min	Max	Std. Dev
200m Wind Direction	°	200 m	19,012	8,179	43.02	264.1	0.0	359.9	86.7
200m Wind Speed	m/s	200 m	19,012	8,179	43.02	6.16	0.18	18.41	3.16
200m Wind Vert	m/s		19,012	8,179	43.02	-0.096	-9.640	7.670	1.167
Quality (Station Height 200m)	%		19,012	8,179	43.02	94.9	90.0	100.0	2.7
40m Wind Turbulence	m/s	40 m	19,012	12,584	66.19	0.136	0.030	1.230	0.095
50m Wind Turbulence	m/s	50 m	19,012	12,569	66.11	0.146	0.020	1.100	0.106
60m Wind Turbulence	m/s	60 m	19,012	12,380	65.12	0.154	0.030	1.020	0.113
80m Wind Turbulence	m/s	80 m	19,012	11,886	62.52	0.172	0.030	1.110	0.132
100m Wind Turbulence	m/s	100 m	19,012	11,415	60.04	0.190	0.030	1.140	0.146
120m Wind Turbulence	m/s	120 m	19,012	10,559	55.54	0.209	0.030	1.200	0.159
140m Wind Turbulence	m/s	140 m	19,012	9,538	50.17	0.227	0.030	1.440	0.168
160m Wind Turbulence	m/s	160 m	19,012	8,546	44.95	0.242	0.030	1.370	0.174
180m Wind Turbulence	m/s	180 m	19,012	7,540	39.66	0.256	0.030	1.200	0.178
200m Wind Turbulence	m/s	200 m	19,012	6,477	34.07	0.270	0.030	1.470	0.179
Turbu. Quality (Station Height 40m)	%		19,012	12,584	66.19	97.8	90.0	100.0	2.0
Turbu. Quality (Station Height 50m)	%		19,012	12,569	66.11	97.6	90.0	100.0	2.1
Turbu. Quality (Station Height 60m)	%		19,012	12,380	65.12	97.5	90.0	100.0	2.1
Turbu. Quality (Station Height 80m)	%		19,012	11,886	62.52	97.2	90.0	100.0	2.3
Turbu. Quality (Station Height 100m)	%		19,012	11,415	60.04	96.8	90.0	100.0	2.4
Turbu. Quality (Station Height 120m)	%		19,012	10,559	55.54	96.4	90.0	100.0	2.6
Turbu. Quality (Station Height 140m)	%		19,012	9,538	50.17	96.1	90.0	100.0	2.7
Turbu. Quality (Station Height 160m)	%		19,012	8,546	44.95	95.8	90.0	100.0	2.7
Turbu. Quality (Station Height 180m)	%		19,012	7,540	39.66	95.4	90.0	100.0	2.8
Turbu. Quality (Station Height 200m)	%		19,012	6,477	34.07	95.0	90.0	100.0	2.7
Ambient Temp	°C		19,012	18,966	99.76	20.71	8.50	32.50	4.29
Barometric Pressure	mbar		19,012	18,966	99.76	922	895	1,056	9
Azimuth	Â°		19,012	18,966	99.76	0	0	0	0
TiltY	Â°		19,012	18,966	99.76	-0.10	-51.70	53.60	5.60
TiltX	Â°		19,012	18,966	99.76	0.24	-68.10	44.60	4.81
Humidity	%		19,012	18,966	99.76	66.13	21.00	97.00	14.81
Noise Level-A	dB		19,012	18,966	99.76	12.61	5.00	17.20	2.21
Noise Level-B	dB		19,012	18,966	99.76	12.64	5.00	17.40	2.23
Noise Level-C	dB		19,012	18,966	99.76	12.62	5.00	17.20	2.21
Modem Power	W		19,012	18,966	99.76	0.764	0.100	1.700	0.344
CPU Power	W		19,012	18,966	99.76	1.129	1.000	1.300	0.068
Core Power	W		19,012	18,966	99.76	3.415	3.100	3.700	0.069
PWM Power	W		19,012	18,966	99.76	1.044	0.700	1.800	0.137
Speaker Power	W		19,012	18,966	99.76	5.50	0.00	19.40	3.09
Solar Power	W		19,012	18,966	99.76	0	0	0	0

Label	Units	Height	Possible Records	Valid Records	Recovery Rate (%)	Mean	Min	Max	Std. Dev
Heater Temp	Å°C		19,012	18,966	99.76	0	0	0	0
Mirror Temp	Å°C		19,012	18,966	99.76	24.68	8.00	52.30	8.43
Internal Temp	Å°C		19,012	18,966	99.76	25.41	10.10	43.90	6.92
CPU Temp	Å°C		19,012	18,966	99.76	0	0	0	0
VibrationX	g		19,012	18,966	99.76	0	0	0	0
VibrationY	g		19,012	18,966	99.76	0	0	0	0
Battery	V		19,012	18,966	99.76	13.15	12.40	14.80	0.69
Beep Volume	dB		19,012	18,966	99.76	98.2	1.0	100.0	13.3
Air Density	kg/m ³		19,012	19,012	100.00	1.094	1.030	1.214	0.026
200m Wind Speed WPD	W/m ²		19,012	8,179	43.02	240	0	3,409	343
180m Wind Speed WPD	W/m ²		19,012	9,533	50.14	231	0	4,765	322
160m Wind Speed WPD	W/m ²		19,012	10,784	56.72	219	0	7,619	318
140m Wind Speed WPD	W/m ²		19,012	12,050	63.38	209	0	11,405	384
120m Wind Speed WPD	W/m ²		19,012	13,572	71.39	181	0	15,484	323
100m Wind Speed WPD	W/m ²		19,012	15,083	79.33	151	0	7,464	224
80m Wind Speed WPD	W/m ²		19,012	16,193	85.17	127	0	5,100	193
60m Wind Speed WPD	W/m ²		19,012	17,297	90.98	105	0	3,897	160
50m Wind Speed WPD	W/m ²		19,012	17,706	93.13	95	0	2,039	140
40m Wind Speed WPD	W/m ²		19,012	17,994	94.65	87	0	1,895	128

Wind turbine **Endurance G-3120**

Properties

Manufacturer: Endurance Wind Power
Website: www.endurancewindpower.co
Rotor diameter: 19.2 m
Rated power: 35 kW
Power regulation: Stall control

Losses

Downtime losses (%)
Array losses (%)
Icing/soiling losses (%)
Other losses (%)
Overall loss factor (%) 17.70

Calculate Output

Hub height

- 30.5 m
 42.7 m
 Other m



Compare...

New...

Edit...

Details...

▼

Delete...

Monthly details

Turbine comparison

Month	Valid Data Points	Hub Height Wind Speed (m/s)	Time At Zero Output (%)	Time At Rated Output (%)	Mean Net		Net Capacity Factor (%)
					Power Output (kW)	Energy Output (kWh/yr)	
Jan	0	n/a	n/a	n/a	n/a	n/a	n/a
Feb	0	n/a	n/a	n/a	n/a	n/a	n/a
Mar	0	n/a	n/a	n/a	n/a	n/a	n/a
Apr	0	n/a	n/a	n/a	n/a	n/a	n/a
May	1,676	4.13	36.58	0.00	5.1	3,796	14.6
Jun	4,099	4.77	19.76	0.00	6.4	4,632	18.4
Jul	4,381	4.22	27.25	0.00	4.7	3,477	13.4
Aug	4,337	3.98	36.38	0.00	4.5	3,315	12.7
Sep	3,647	4.83	27.42	0.00	7.4	5,336	21.2
Oct	0	n/a	n/a	n/a	n/a	n/a	n/a
Nov	0	n/a	n/a	n/a	n/a	n/a	n/a
Dec	0	n/a	n/a	n/a	n/a	n/a	n/a
Overall	18,140	4.40	28.64	0.00	5.6	49,136	16.0

Wind turbine Vestas V52 - 850 kW

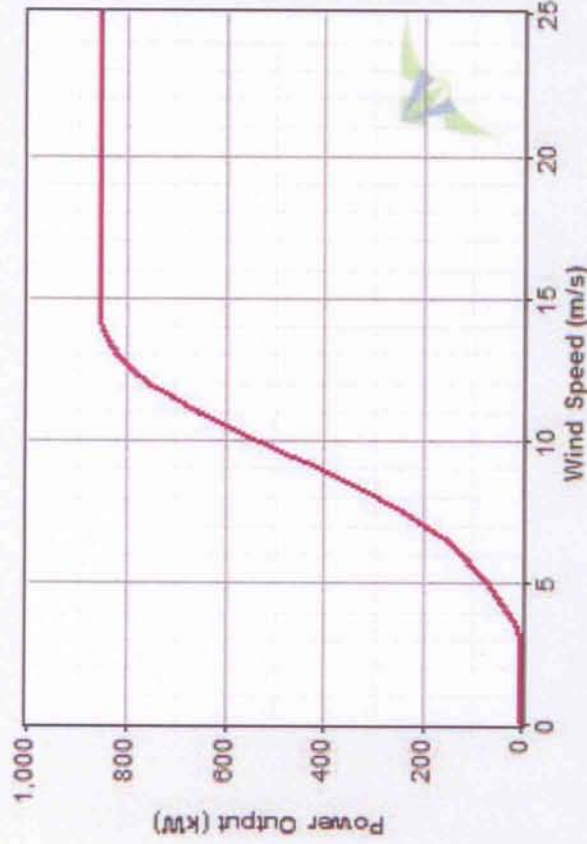
Properties

Manufacturer: Vestas Wind Systems A/S
 Website: www.vestas.com
 Rotor diameter: 52 m
 Rated power: 850 kW
 Power regulation: Pitch control

Losses

Downtime losses (%)
 Array losses (%)
 Icing/soiling losses (%)
 Other losses (%)
 Overall loss factor (%)

Calculate Output



- Hub height
- 40 m
 - 44 m
 - 49 m
 - 55 m
 - 60 m
 - 65 m
 - 74 m
 - 86 m
 - Other



Monthly details

Turbine comparison

Month	Valid Data Points	Hub Height (m)	Wind Speed (m/s)	Time At Zero Output (%)	Time At Rated Output (%)	Mean Net Power Output (kW)	Mean Net Energy Output (kWh/yr)	Net Capacity Factor (%)
Jan	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Feb	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Mar	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Apr	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
May	1,676	4.45	4.45	34.73	0.00	70.7	52,621	8.3
Jun	4,099	5.25	5.25	17.42	0.00	88.5	63,742	10.4
Jul	4,381	4.61	4.61	26.48	0.02	61.1	45,460	7.2
Aug	4,337	4.41	4.41	32.88	0.00	61.0	45,360	7.2
Sep	3,647	5.38	5.38	22.70	0.14	107.5	77,382	12.6
Oct	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Nov	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Dec	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Overall	18,140	4.85	4.85	25.96	0.03	77.5	678,726	9.1

Wind turbine GE 2.5xl

Properties

Manufacturer: GE Wind
 Website: www.gepower.com
 Rotor diameter: 100 m
 Rated power: 2,500 kW
 Power regulation: Pitch control

Losses

Downtime losses (%)
 Array losses (%)
 Icing/soiling losses (%)
 Other losses (%)
 Overall loss factor (%) 17.70

Calculate Output



Hub height

- 75 m
- 85 m
- 100 m
- Other m

Compare...

Delete...

New...

Edit...

Details...

Monthly details

Turbine comparison

Month	Valid Data Points	Hub Height (m)	Wind Speed (m/s)	Time At Zero Output (%)	Time At Rated Output (%)	Mean Net Power Output (kW)	Mean Net Energy Output (kWh/yr)	Net Capacity Factor (%)							
									0	1,676	4,099	4,381	4,337	3,647	0
Jan	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a							
Feb	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a							
Mar	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a							
Apr	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a							
May	1,676	4.46	4.46	34.61	0.24	230.5	171,502	9.2							
Jun	4,099	5.27	5.27	17.32	0.12	292.7	210,750	11.7							
Jul	4,381	4.62	4.62	26.46	0.09	198.4	147,575	7.9							
Aug	4,337	4.42	4.42	32.74	0.05	199.8	148,673	8.0							
Sep	3,647	5.39	5.39	22.62	0.47	360.0	259,198	14.4							
Oct	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a							
Nov	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a							
Dec	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a							
Overall	18,140	4.86	4.86	25.88	0.18	255.5	2,238,144	10.2							