Wind Resource Summary for Fort Collins Site
Final Report
Colorado Anemometer Loan Program

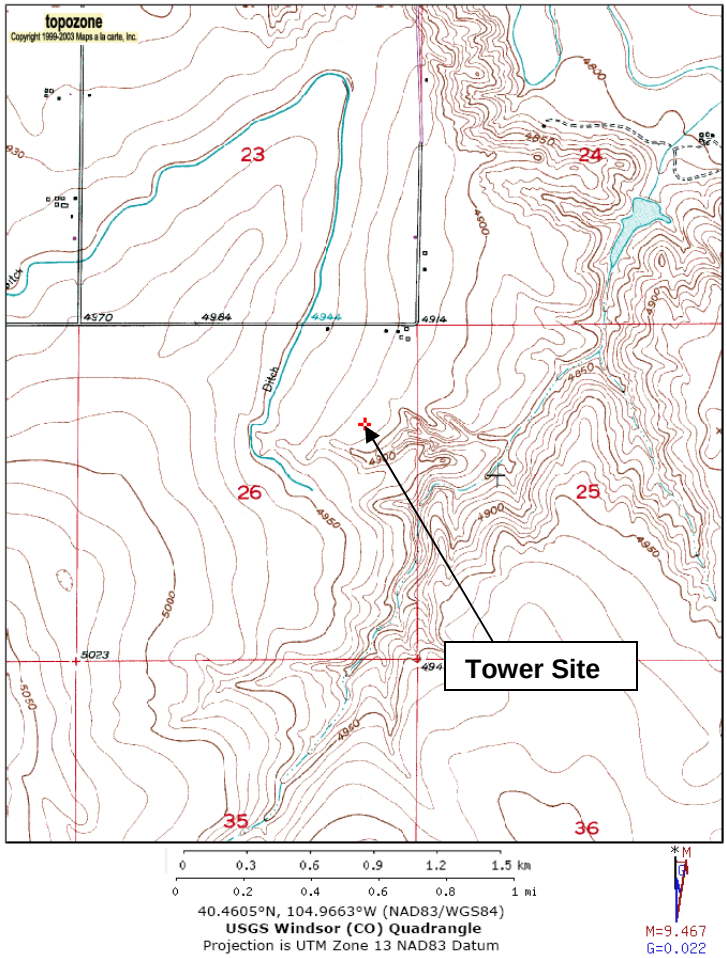
Monitoring Period: 10/02/2006 – 11/03/2007
Report Date: January 16, 2008

Site Description:

The site is located adjacent to the Highland Meadows Golf Course about 4 miles south west of the town of Windsor, Colorado. The tower was placed in a hay field about one and a half miles east of Interstate 25. The tower is located in a sheltered area downhill from a ridge on the east.

Note: Wind direction data appears to be suspect since the wind vane indicates that the wind was from the NNW direction during the entire data collection time period.

LOCATION DETAILS	
Latitude:	N 40° 27?
Longitude:	W 104° 57?
Township:	6 N
Range:	68 W
Section:	26
Elevation (ft.):	3,842
Tower Type:	NRG Tilt-Up
Tower Height (ft.):	66
Tower Height (m):	20
Vane Offset (deg):	337
Direction Basis:	Mag. North
Mag. Declination:	9.467° E



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Wind Resource Summary

All analysis performed using Windographer 1.13

Data Properties	
Data Set Starts:	10/2/2006 13:10
Data Set Ends:	11/3/2007 10:00
Data Set Duration:	13.1 months
Length of Time Step:	10 minutes
Elevation (ft.):	3,842
Calm threshold (mph):	0
Wind Power Coefficients	
Power Density at 50m:	94 W/m^2
Wind Power Class:	1 (poor)
Wind Power Coefficients	
Power Law Exponent:	0.14
Surface Roughness:	0.01 m
Roughness Class:	0.78
Roughness Description:	Rough Pasture

***Note**: Air temperature was not measured during the measuring period so air density taken to be 1.094 kg/m^3 throughout the period*

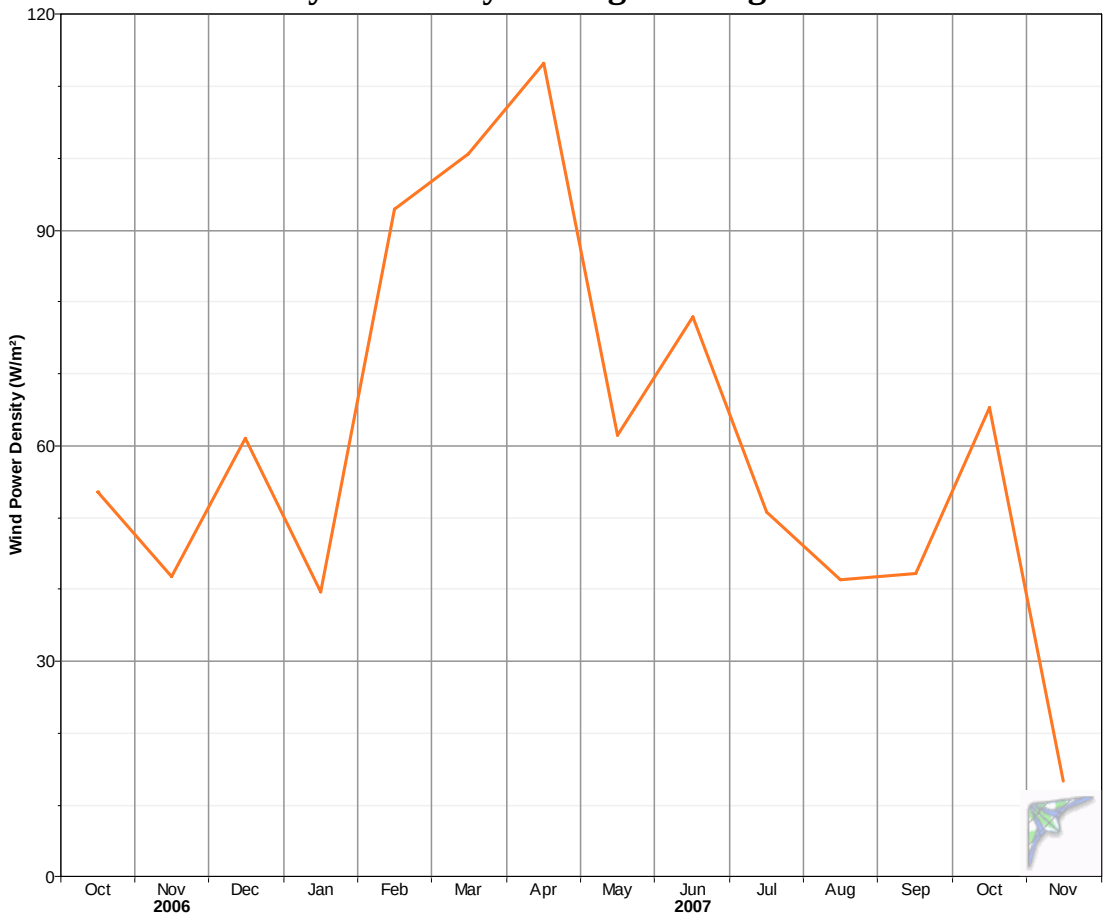
Height above ground (m)	20
Mean wind speed (mph)	7.26
Median wind speed (mph)	6.1
Min wind speed (mph)	0
Max wind speed (mph)	42.4
Mean power density (W/m²)	64
Mean energy content (kWh/m²/yr)	562
Energy pattern factor	3.428
Weibull k	1.315
Weibull c (mph)	7.89
1-hr autocorrelation coefficient	0.747
Diurnal pattern strength	0.292
Hour of peak wind speed	18
Mean turbulence intensity	0.284
Standard deviation (mph)	5.63
Coefficient of variation (%)	77.5
Frequency of calms (%)	0.45
Actual observations	57,149
Missing observations	0
Data completeness (%)	100

Annual Average Wind Resource Statistics – Speed and Direction

Hour of Day	Average Wind speed *mph*	Wind Power Density *W/m²*	Hour of Day	Average Wind speed *mph*	Wind Power Density *W/m²*
0.5	6.35	41.4	12.5	8.58	86.5
1.5	6.35	41.7	13.5	9.06	94.5
2.5	5.98	40.5	14.5	9.26	102.5
3.5	5.74	36.4	15.5	9.51	109.3
4.5	5.58	34.6	16.5	9.72	115.7
5.5	5.50	35.1	17.5	9.48	106.4
6.5	5.37	34.8	18.5	9.02	86.1
7.5	5.31	42.7	19.5	8.69	83.5
8.5	5.37	43.5	20.5	8.35	77.1
9.5	5.67	39.1	21.5	7.88	69.3
10.5	6.21	44.5	22.5	7.29	61.6
11.5	7.37	63.1	23.5	6.77	51.4

Direction Sector Midpoint *degrees*	Frequency *percent*	Direction Sector Midpoint *degrees*	Frequency *percent*
0	0.02	180	0
10	0	190	0
20	0	200	0.00
30	0	210	0
40	0	220	0
50	0	230	0.01
60	0	240	0
70	0	250	0.11
80	0	260	0
90	0	270	0.42
100	0	280	0
110	0.00	290	2.17
120	0	300	0
130	0	310	0
140	0	320	30.95
150	0	330	0
160	0	340	65.86
170	0	350	0

Wind Power Density – Monthly Average During Measurement Period



For reference, the table below provides a summary of the wind power classifications from the U.S. DOE's Colorado Wind Resource Map available at:

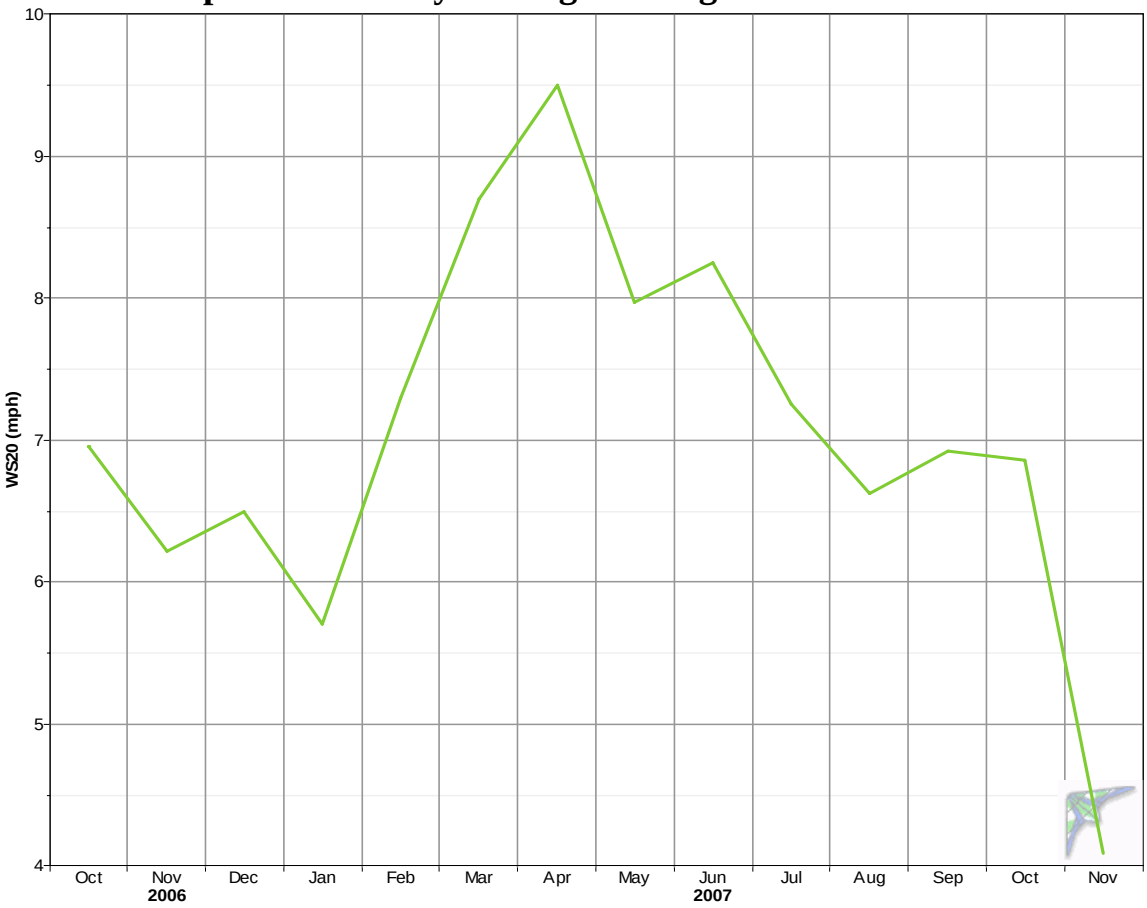
http://www.eere.energy.gov/windandhydro/windpoweringamerica/maps_template.asp?stateab=co

Wind Power Classification

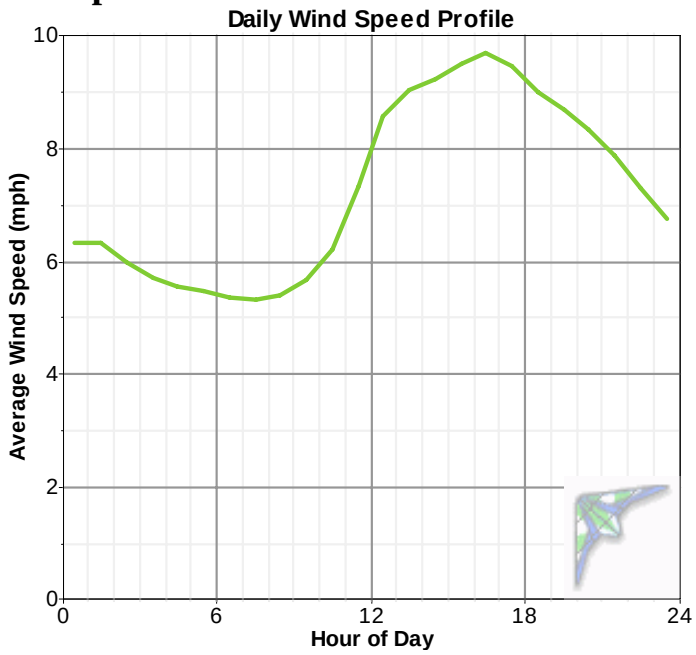
Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
1	Poor	0 - 200	0.0 - 5.9	0.0 - 13.2
2	Marginal	200 - 300	5.9 - 6.7	13.2 - 15.0
3	Fair	300 - 400	6.7 - 7.4	15.0 - 16.6
4	Good	400 - 500	7.4 - 7.9	16.6 - 17.7
5	Excellent	500 - 600	7.9 - 8.4	17.7 - 18.8
6	Outstanding	600 - 800	8.4 - 9.3	18.8 - 20.8
7	Superb	> 800	> 9.3	> 20.8

[a] Wind speeds are based on a Weibull k of 2.0 at 1500 m elevation.

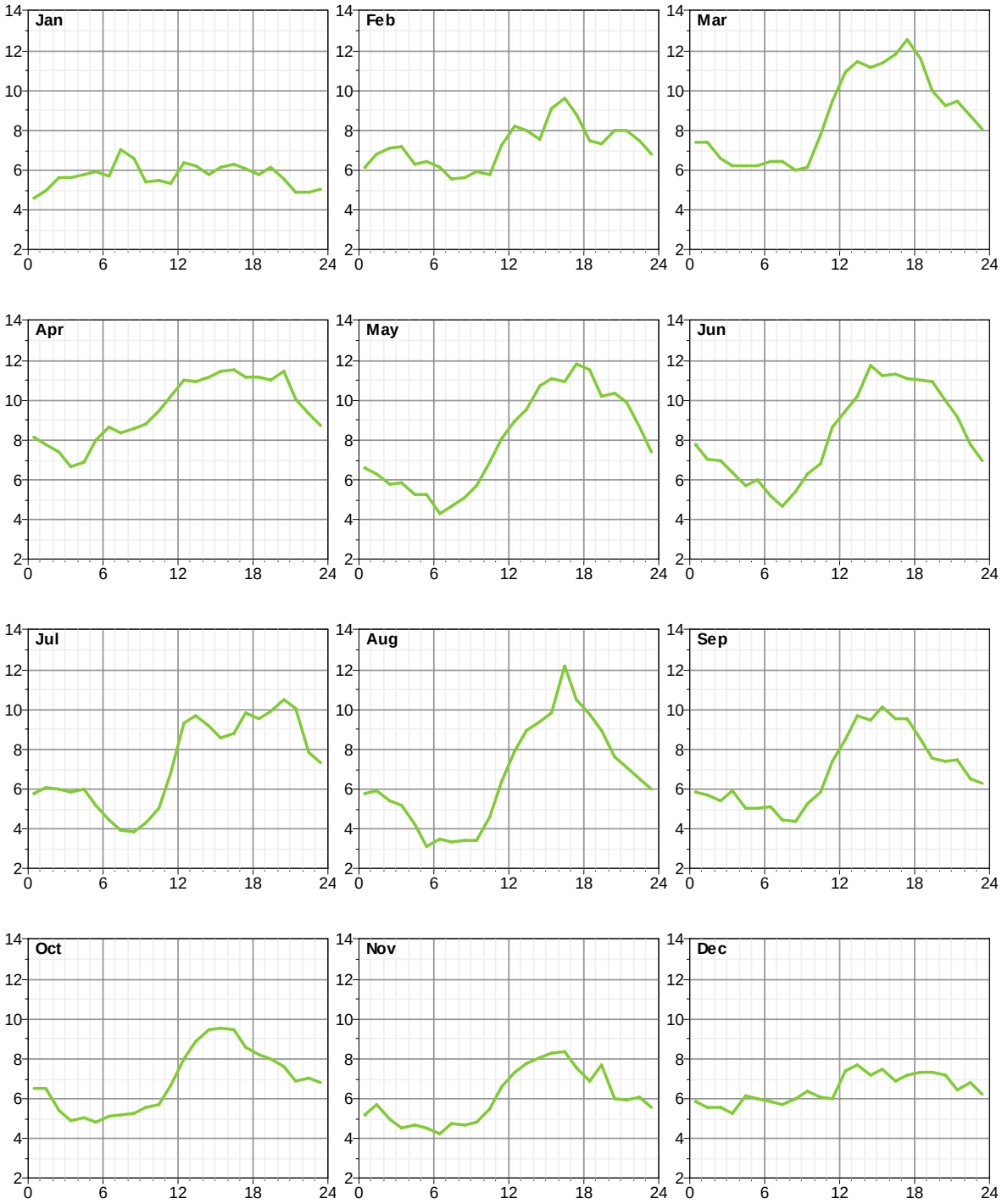
Wind Speed – Monthly Average During Measurement Period

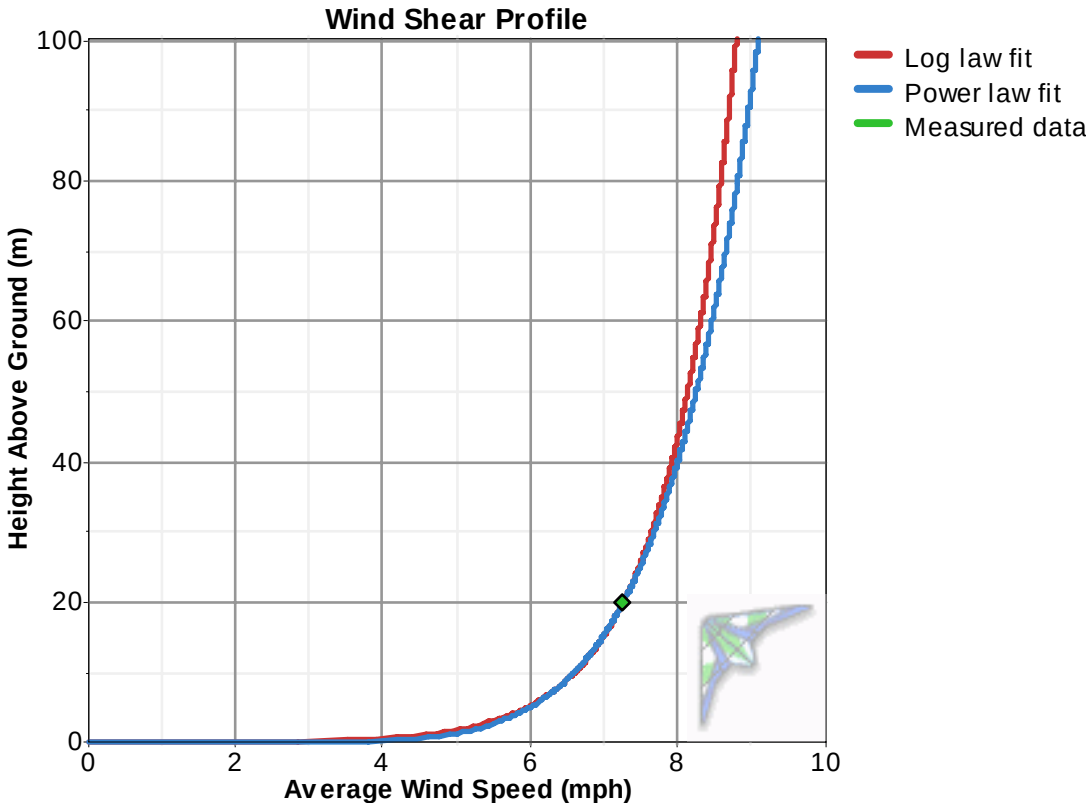


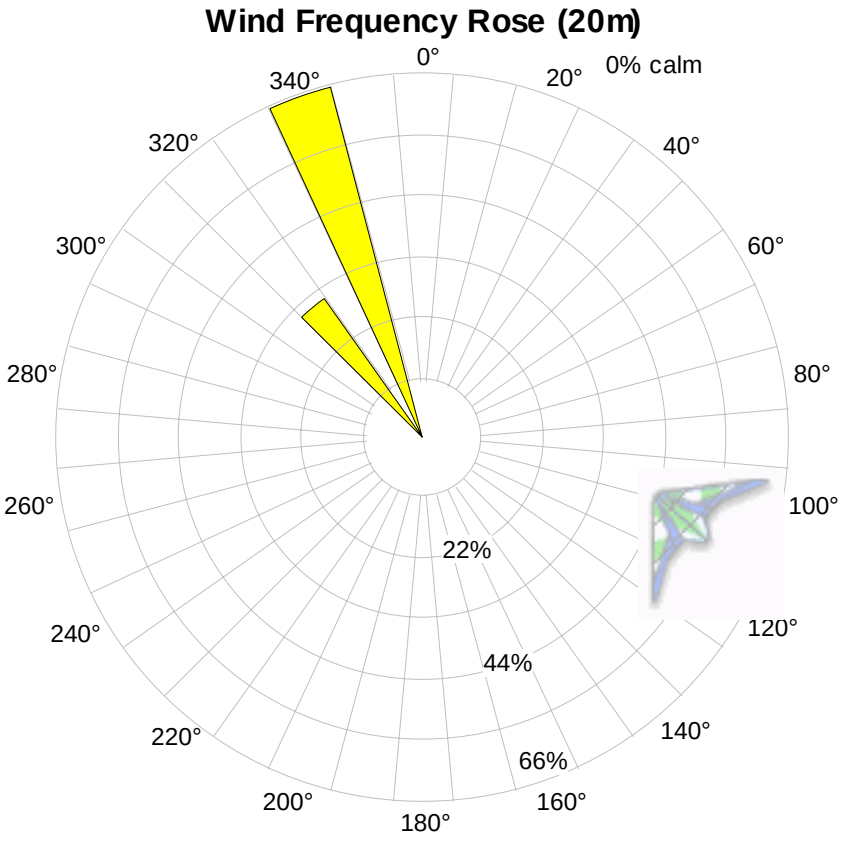
Daily Wind Speed Profile – Total For Measurement Period



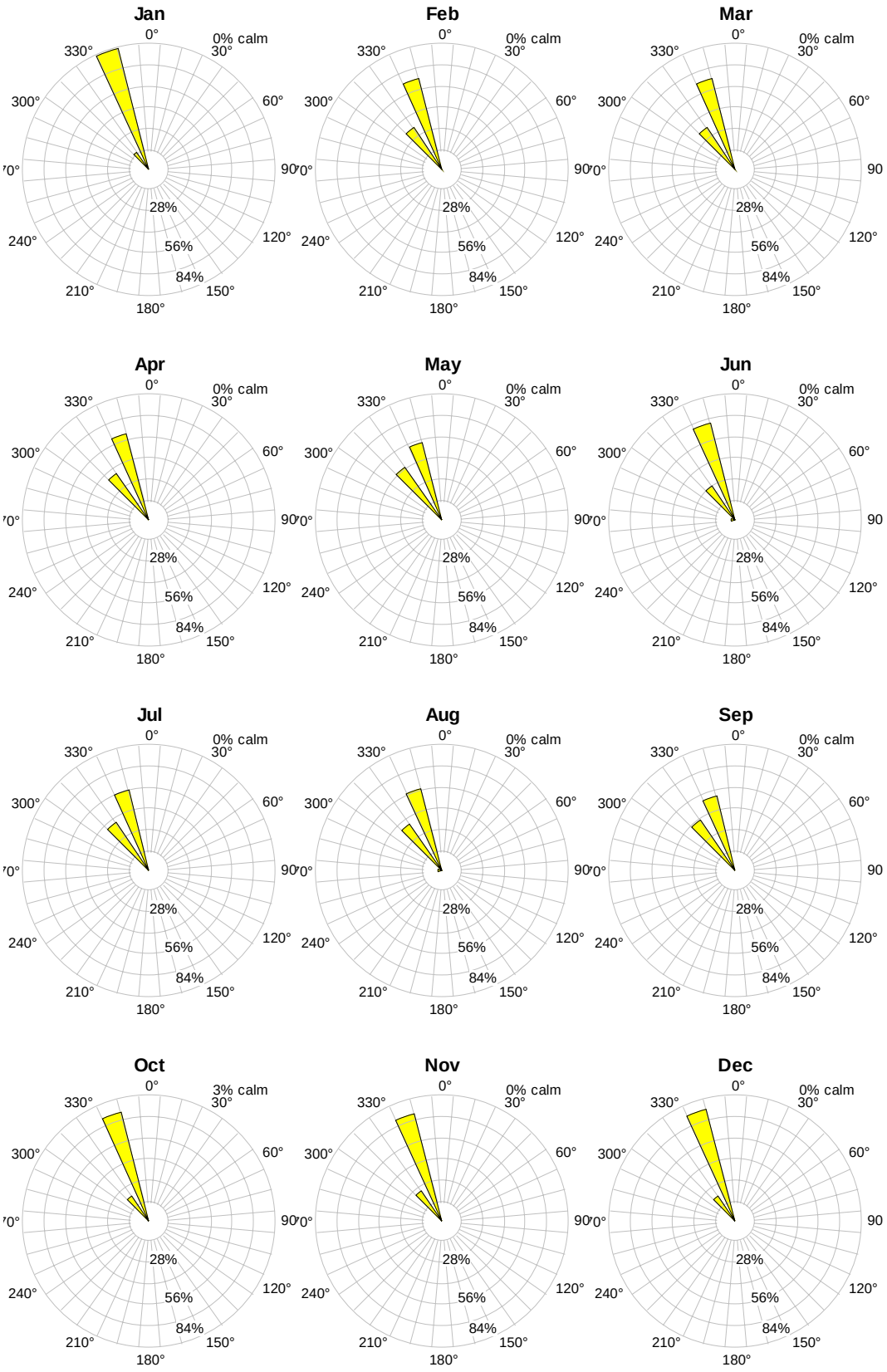
Hourly Wind Speed – By Month



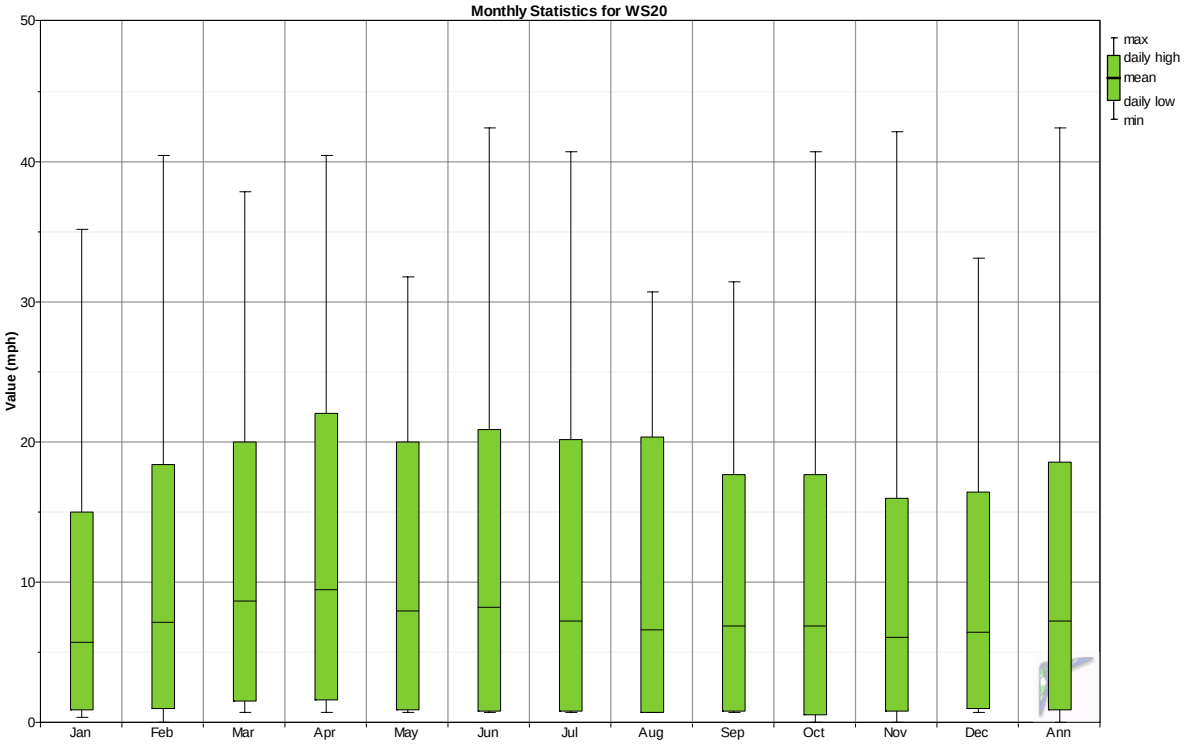

Wind Shear Profile
Log law fit
Power law fit
Measured data
Height Above Ground (m)
100
80
60
40
20
0
0
2
4
6
8
10
Average Wind Speed (mph)


Wind Frequency Rose (20m)
0°
20°
40°
60°
80°
100°
120°
140°
160°
180°
200°
220°
240°
260°
280°
300°
320°
340°
0% calm
22%
44%
66%

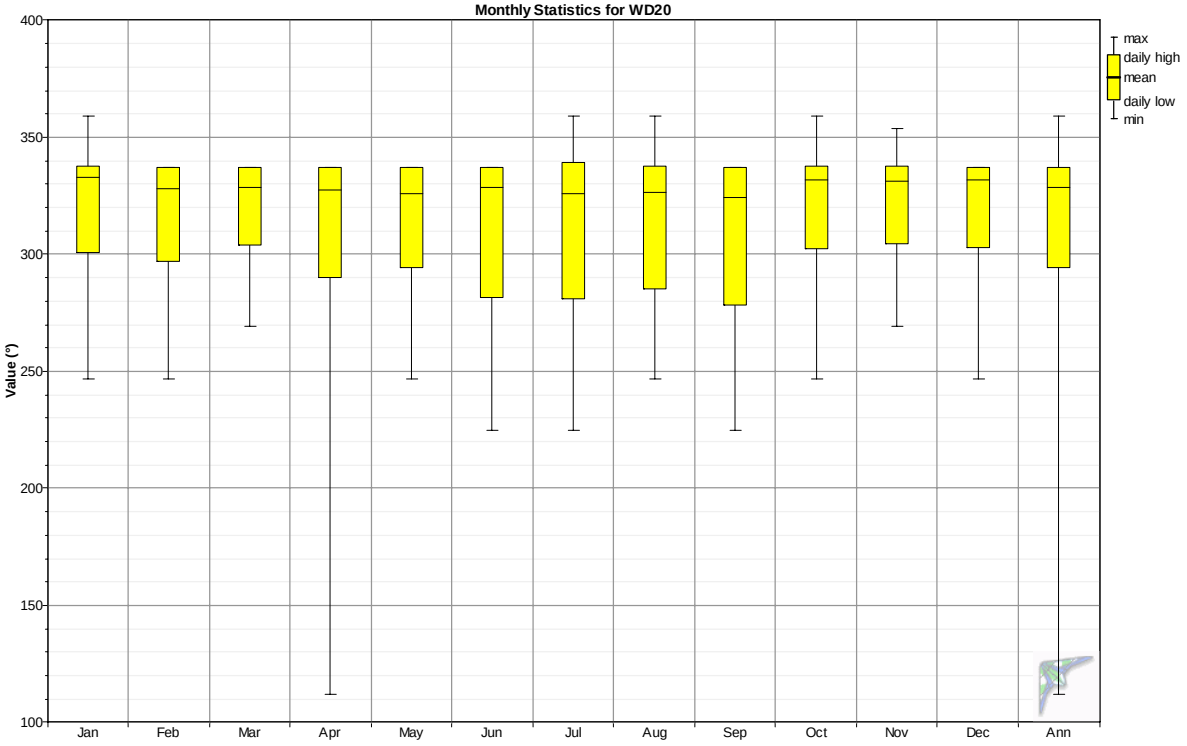
Wind Direction – By Month (All Years)



Box Plot for Wind Speed – By Month



Box Plot for Wind Direction – By Month



Estimated Wind Turbine Performance

The wind resource data from this site was compared against typical small wind turbines at 20m tower height to project the total energy production potential. The table below lists the turbines considered, the estimated turbine costs, and the expected turbine performance:

Turbine	Estimated Turbine Cost *(w/o tower)*	Rotor Diameter *meters*	Rotor Power *kW*	Hub Height *meters*	Hub Height Wind Speed *mph*	Time At Zero Output *percent*	Time At Rated Output *percent*	Average Net Power Output *kW*	Average Net Energy Output *kWh/yr*	Average Net Capacity Factor *%*
Bergey Excel-R/120V	$16,560	6.7	7.5	20	7.27	56.1	1.1	0.51	4,492	6.8
Bergey Excel-S/60	$20,610	6.7	10	20	7.27	38.2	0.4	0.57	5,017	5.7
Bergey XL.1	$2,650	2.5	1	20	7.27	20.9	1.4	0.08	712	8.1
Southwest Skystream 3.7	$8,999	3.7	1.8	20	7.27	54.5	0.0	0.16	1,354	8.6
Southwest Whisper 500	$6,062	4.5	3	20	7.27	56.1	1.2	0.27	2,361	9.0

Note that the costs do *not* include the costs for the tower or labor for installation.

These turbines are not recommended or endorsed. Landowners interested in installing a turbine are encouraged to contact a wind equipment dealer or a wind developer for design assistance and equipment recommendations.

The costs shown above were obtained from publicly available costs on the Internet. For reference, the costs for these turbines were obtained from the following vendor:

Earth Solar Group
6315 Canyon Dr.
Amarillo, TX 79110
1.800.329.3283
http://www.earthsolar.com/