

Wind Resource Summary

All analysis performed using Windographer 1.13

Data Properties	
Data Set Starts:	8/29/2006 13:00
Data Set Ends:	12/22/2007 15:10
Data Set Duration:	15.8 months
Length of Time Step:	10 minutes
Elevation (ft.):	4,902
Calm threshold (mph):	0
Wind Power Coefficients	
Power Density at 50m:	344 W/m ²
Wind Power Class:	3 (fair)
Wind Power Coefficients	
Power Law Exponent:	0.14
Surface Roughness:	0.01 m
Roughness Class:	0.78
Roughness Description:	Rough Pasture

Variable	
Height above ground (m)	20
Mean wind speed (mph)	13.94
Median wind speed (mph)	13
Min wind speed (mph)	0.64
Max wind speed (mph)	57
Mean power density (W/m ²)	234
Mean energy content (kWh/m ² /yr)	2,048
Energy pattern factor	1.825
Weibull k	2.132
Weibull c (mph)	15.72
1-hr autocorrelation coefficient	0.843
Diurnal pattern strength	0.054
Hour of peak wind speed	13
Mean turbulence intensity	0.133
Standard deviation (mph)	6.82
Coefficient of variation (%)	48.9
Frequency of calms (%)	0
Actual observations	69,133
Missing observations	0
Data completeness (%)	100

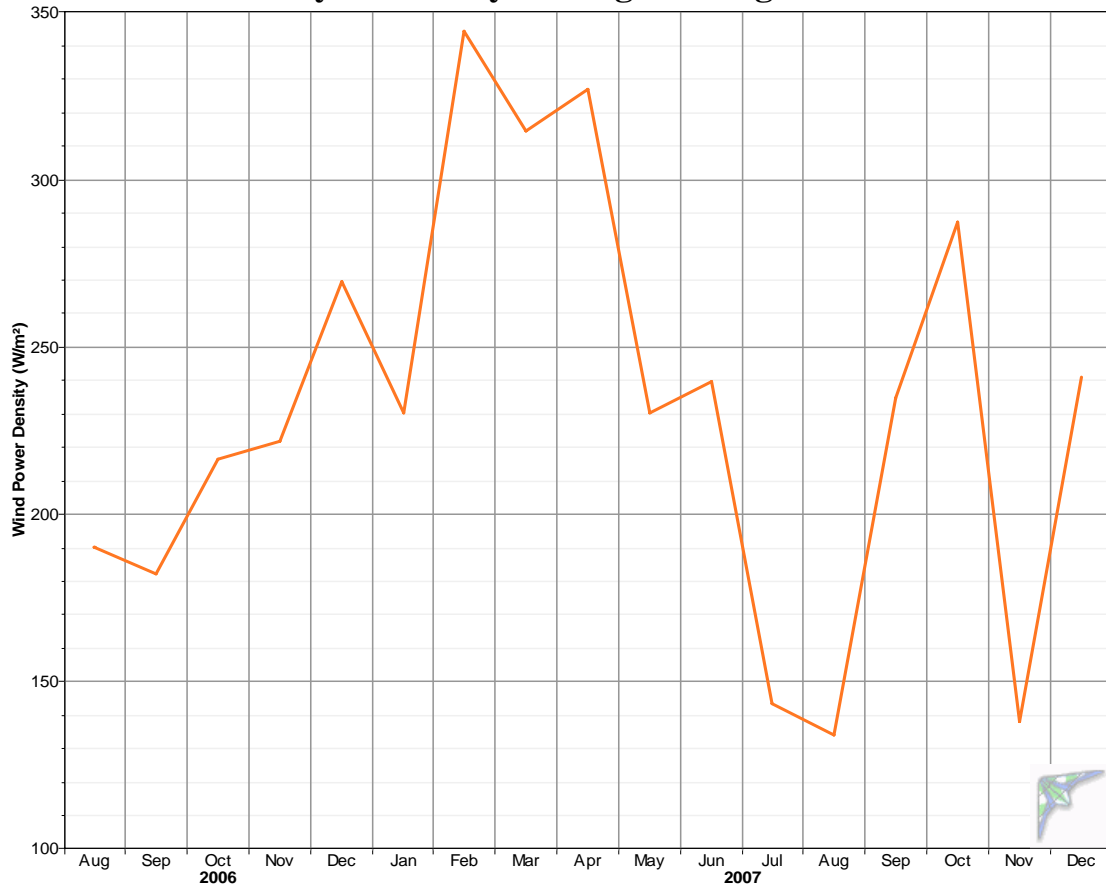
Note: Air temperature was not measured during the measuring period so air density taken to be 1.059 kg/m³ throughout the period

Annual Average Wind Resource Statistics – Speed and Direction

Hour of Day	Average Wind speed <i>mph</i>	Wind Power Density <i>W/m²</i>	Hour of Day	Average Wind speed <i>mph</i>	Wind Power Density <i>W/m²</i>
0.5	13.311	190.18	12.5	14.676	285.1
1.5	13.218	184.35	13.5	14.688	291.56
2.5	13.344	184.7	14.5	14.681	293.34
3.5	13.362	185.85	15.5	14.569	288.36
4.5	13.306	183.52	16.5	14.173	258.64
5.5	13.165	181.43	17.5	13.905	235.22
6.5	13.396	196.61	18.5	13.581	218.04
7.5	14.016	232.31	19.5	13.621	209.6
8.5	14.484	271.41	20.5	13.583	206.59
9.5	14.911	297.68	21.5	13.545	208.68
10.5	14.863	300.06	22.5	13.631	213.06
11.5	14.761	291.77	23.5	13.676	203.33

Direction Sector Midpoint <i>degrees</i>	Frequency <i>percent</i>	Direction Sector Midpoint <i>degrees</i>	Frequency <i>percent</i>
0	6.356	180	10.717
10	0.318	190	0.597
20	3.979	200	8.679
30	0.132	210	0.516
40	0.103	220	0.420
50	2.942	230	6.645
60	0.056	240	0.347
70	2.543	250	4.458
80	0.038	260	0.236
90	2.570	270	4.807
100	0.033	280	0.297
110	2.994	290	5.073
120	0.166	300	0.441
130	0.230	310	0.482
140	5.792	320	7.322
150	0.375	330	0.652
160	10.159	340	8.388
170	0.473	350	0.664

Wind Power Density – Monthly Average During Measurement Period



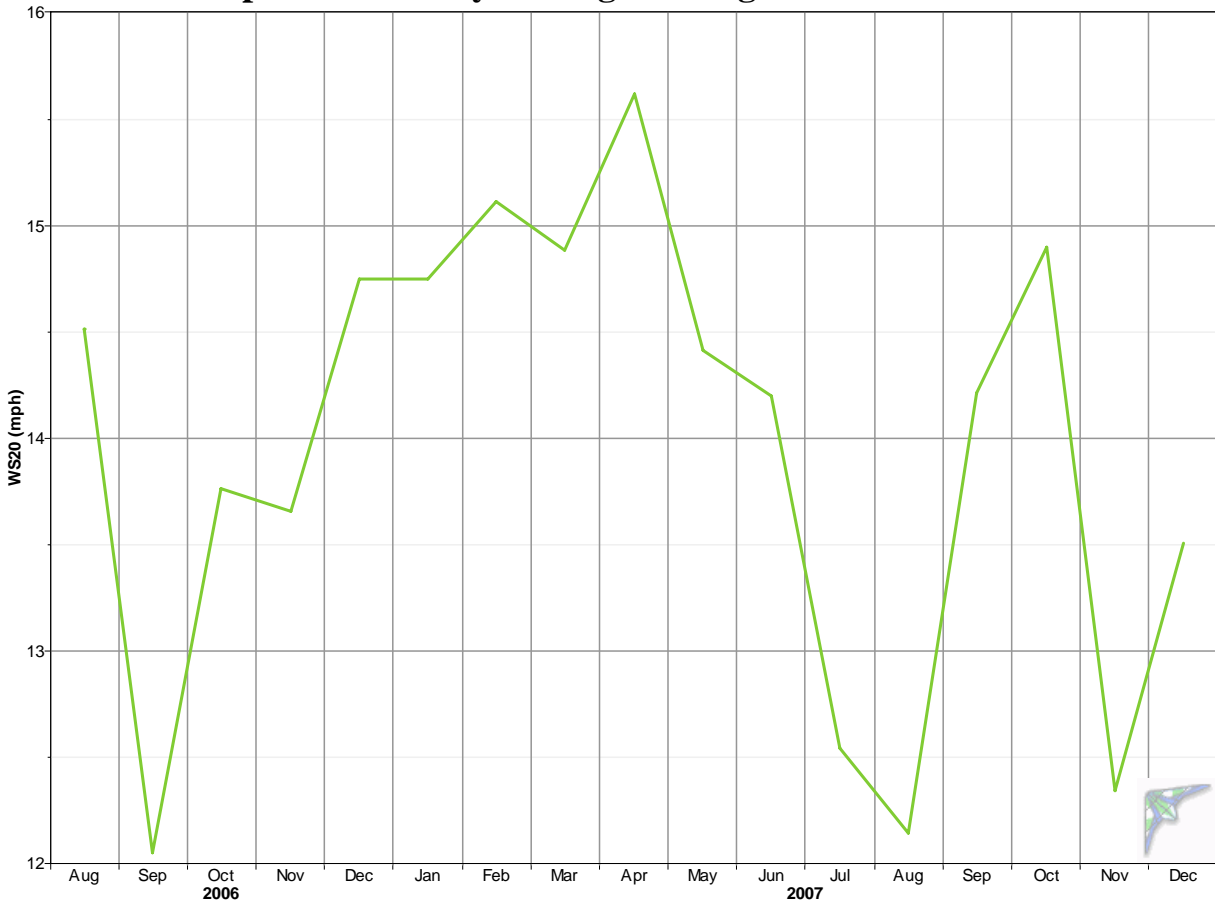
For reference, the table below provides a summary of the wind power classifications from the U.S. DOE's Colorado Wind Resource Map available at:

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

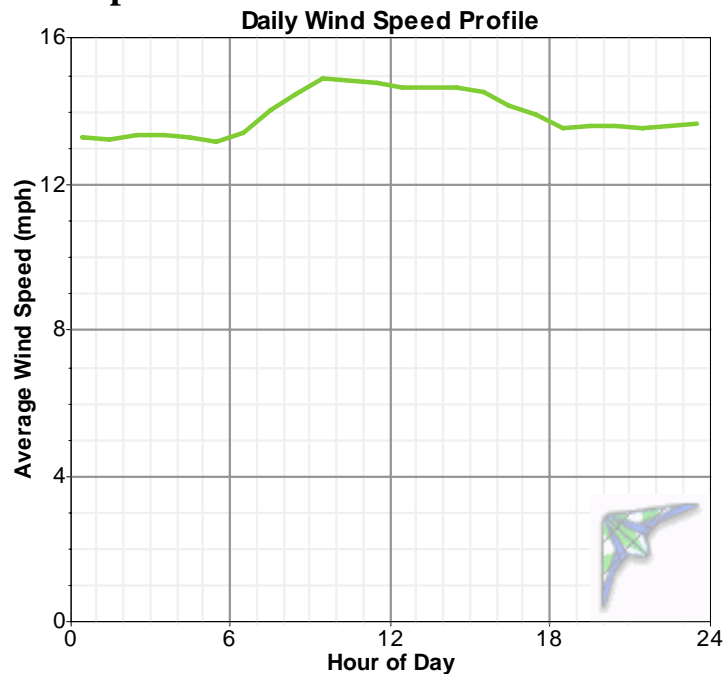
Wind Power Classification				
Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m ²	Wind Speed ^a at 50 m m/s	Wind Speed ^a at 50 m mph
1	Poor	0 - 200	0.0 - 5.9	0.0 - 13.2
2	Marginal	200 - 300	5.9 - 6.7	13.2 - 15.0
3	Fair	300 - 400	6.7 - 7.4	15.0 - 16.6
4	Good	400 - 500	7.4 - 7.9	16.6 - 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.

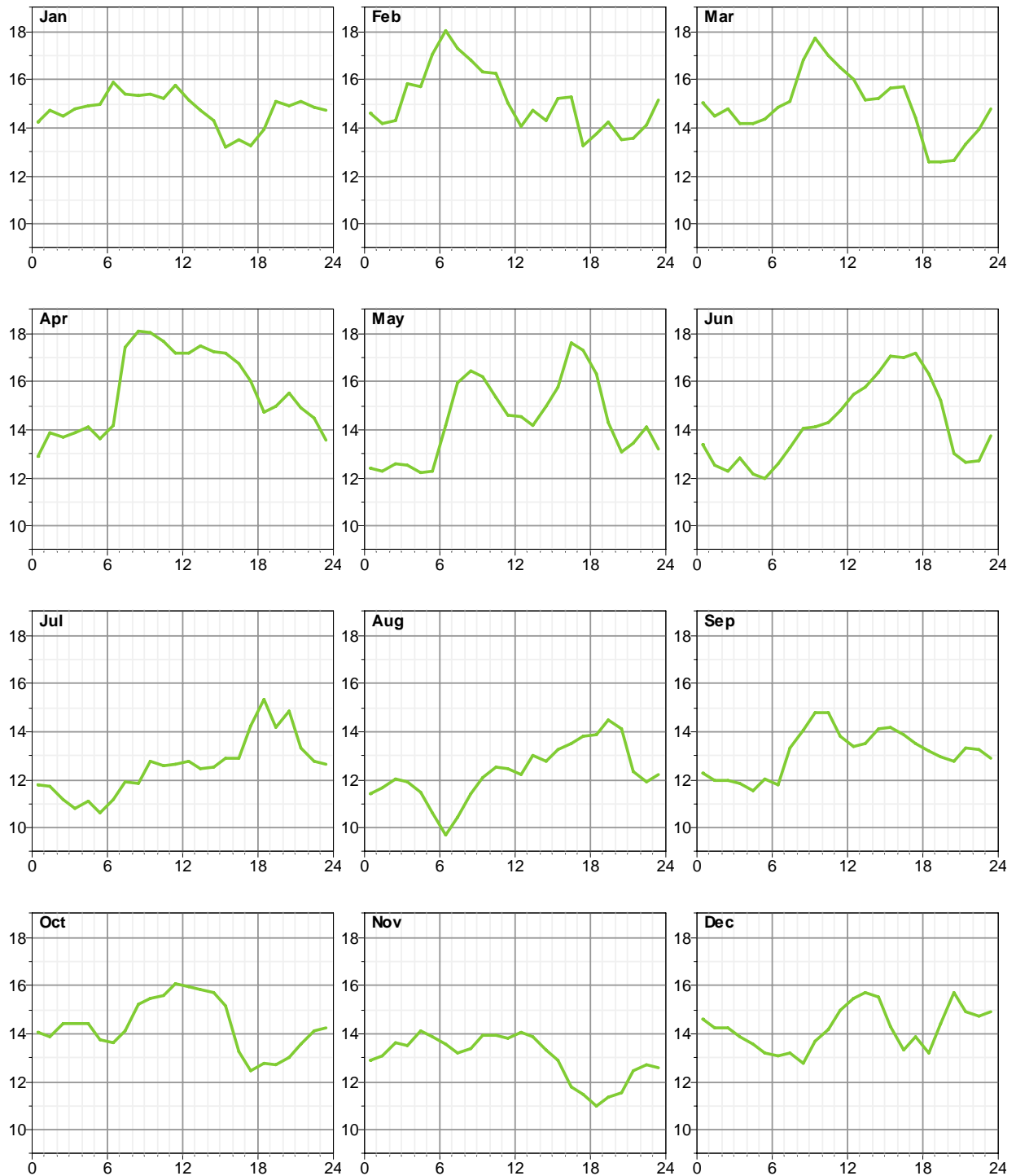
Wind Speed – Monthly Average During Measurement Period

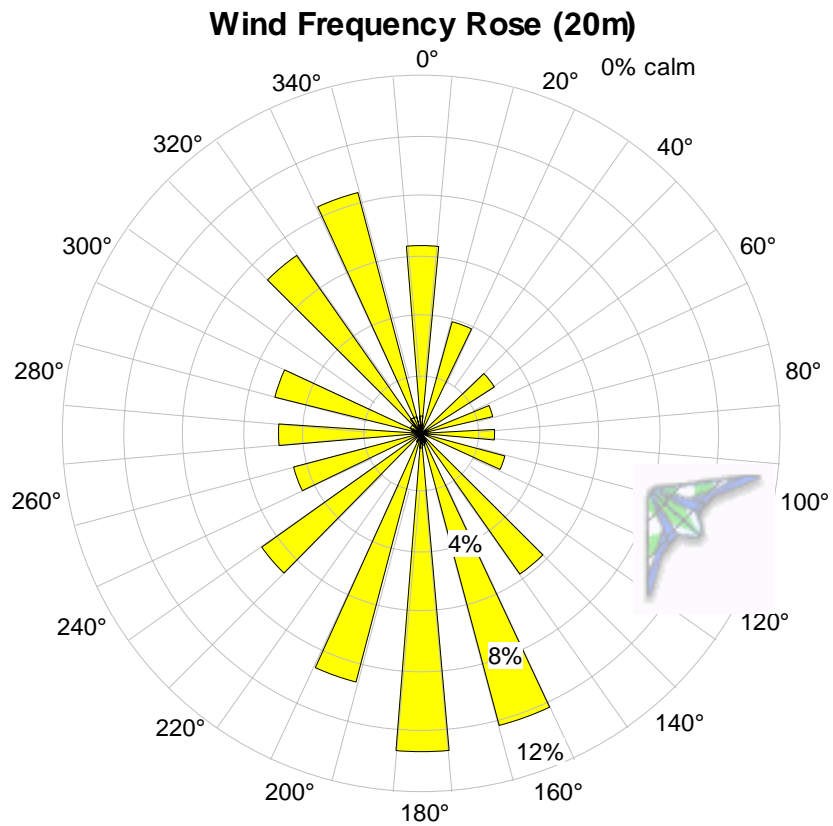
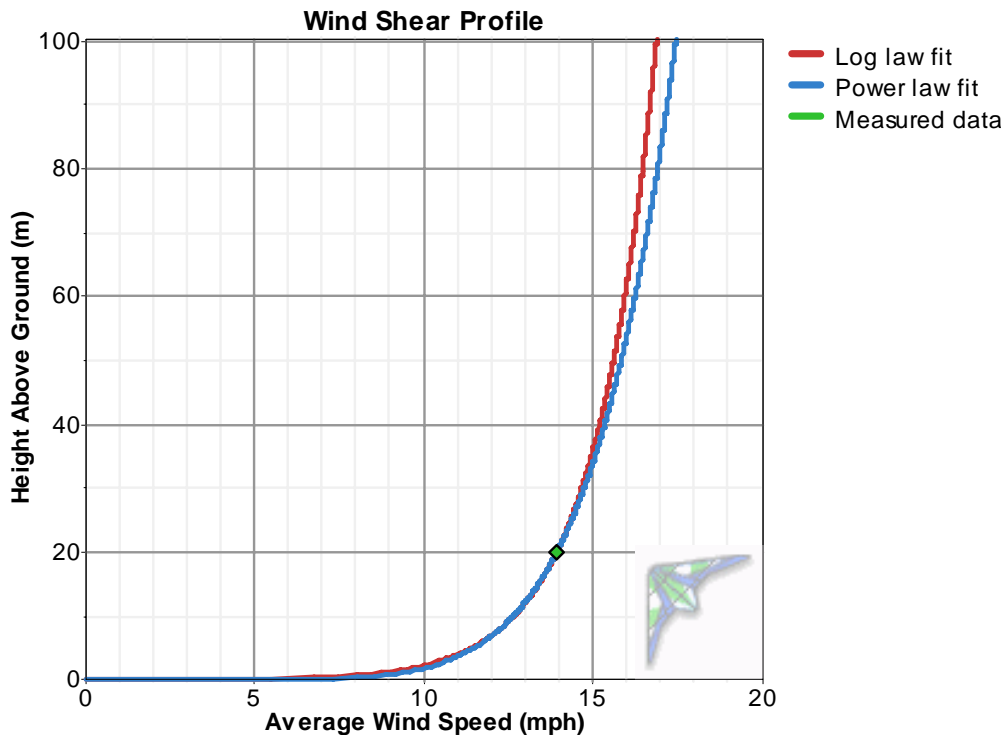


Daily Wind Speed Profile – Total For Measurement Period

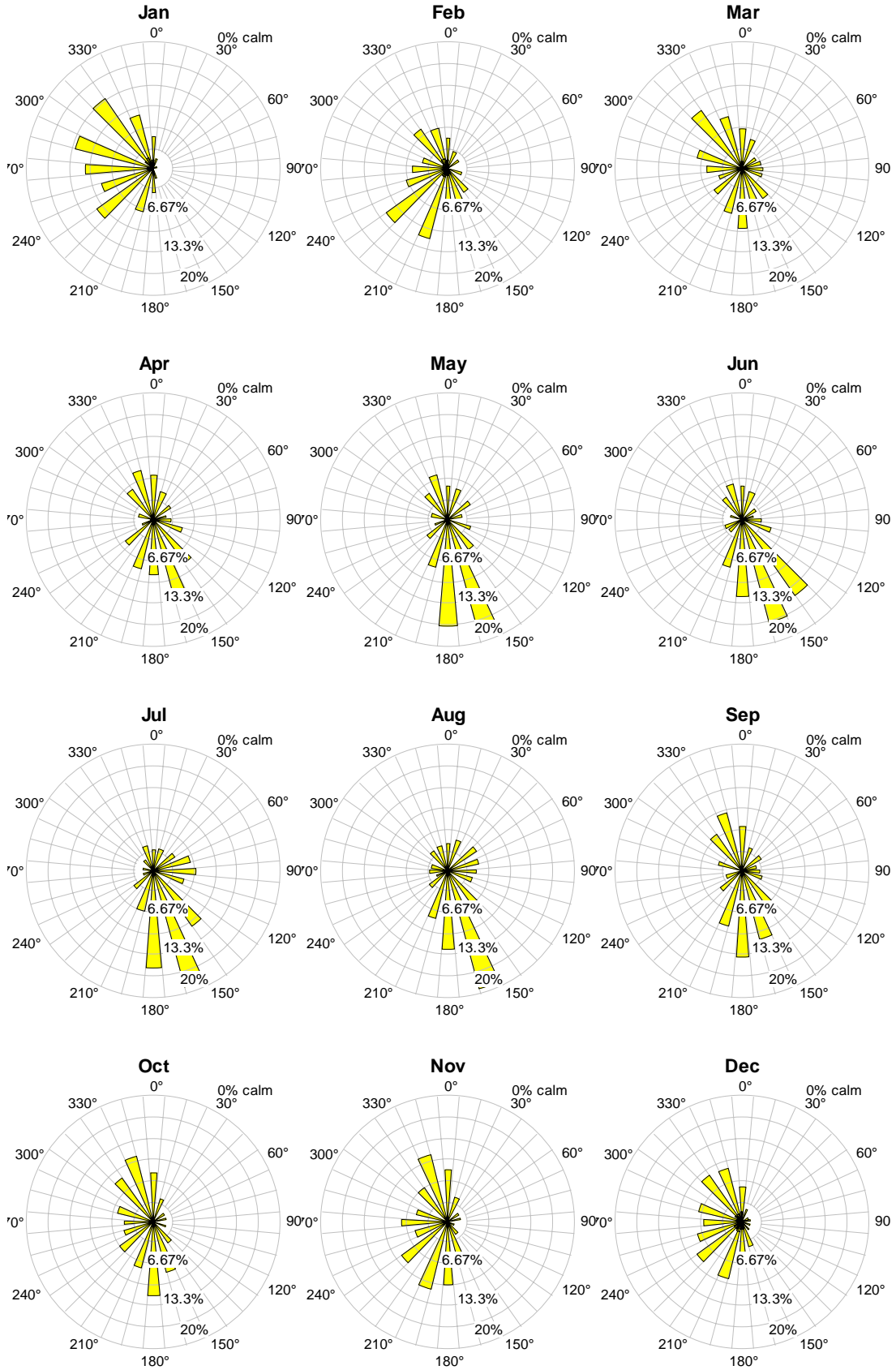


Hourly Wind Speed – By Month

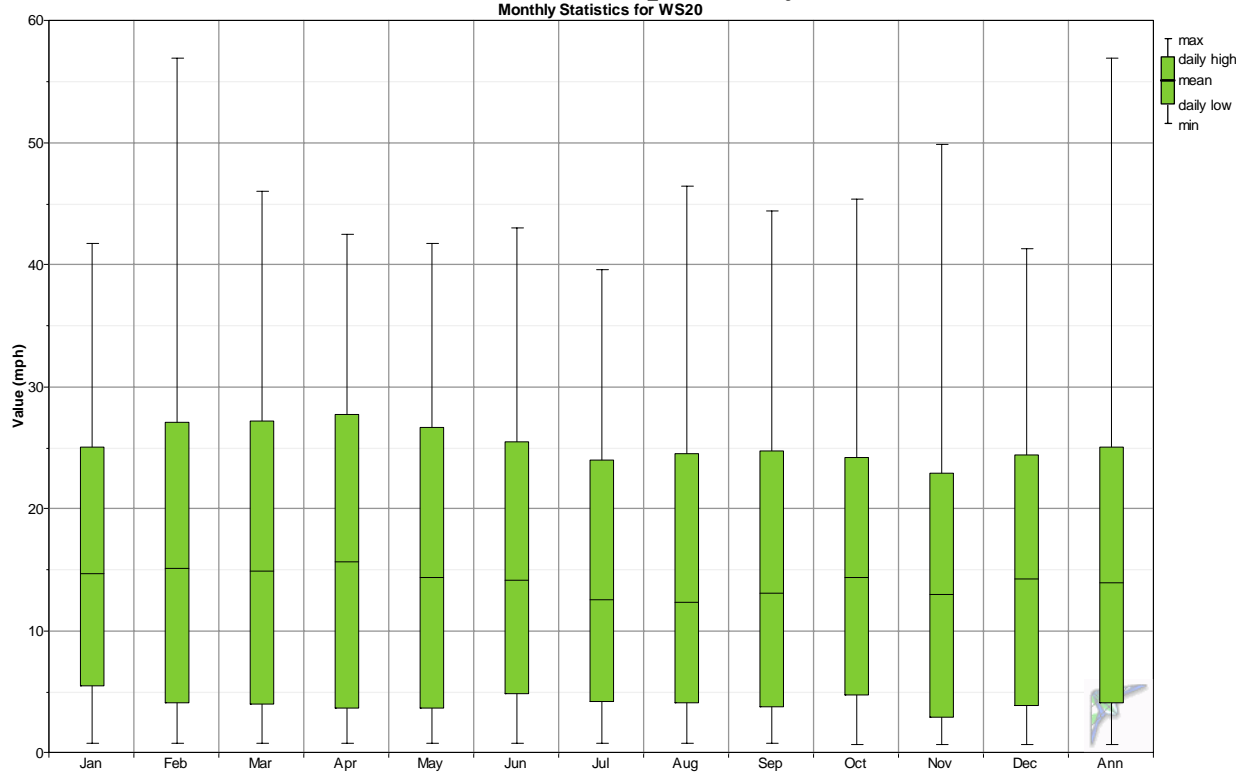




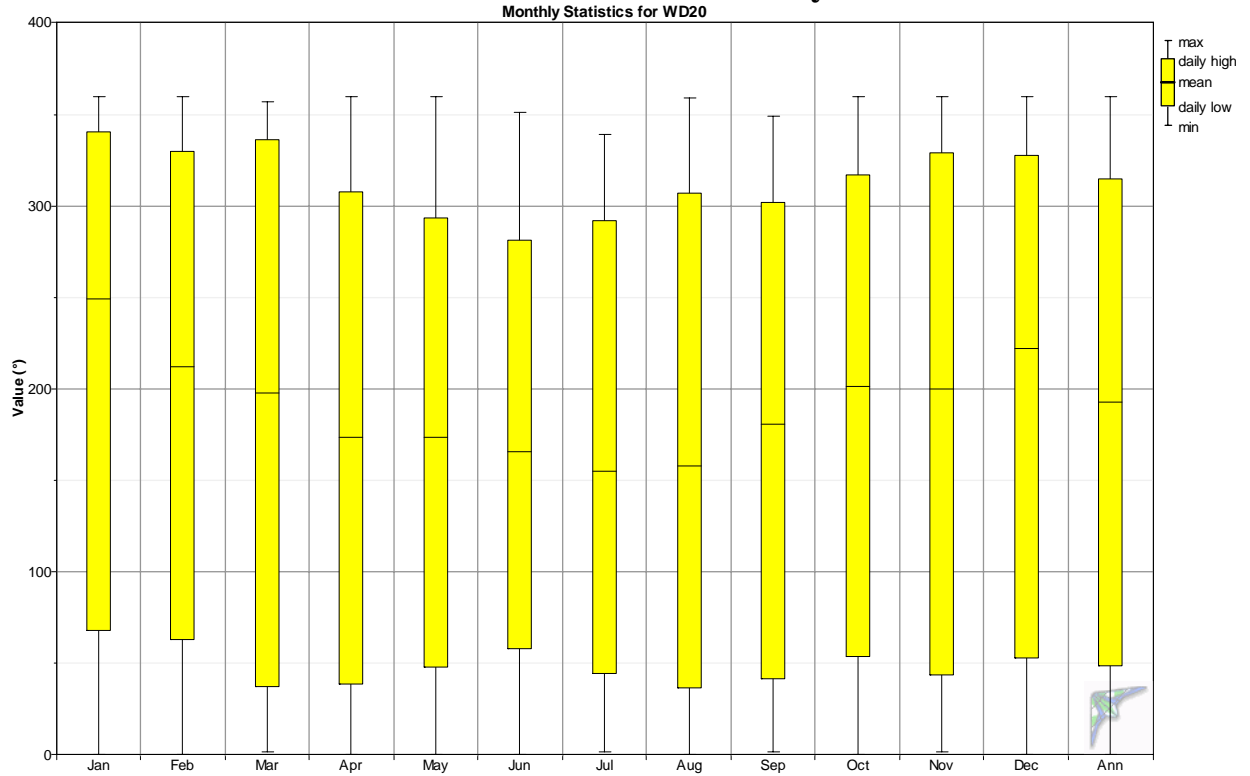
Wind Direction – By Month (All Years)



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	13.94	13.43	4.74	1.750	15,373	23.4
Bergey Excel-S/60	\$20,610	6.7	10	20	13.94	6.08	2.59	1.910	16,718	19.1
Bergey XL.1	\$2,650	2.5	1	20	13.94	2.08	6.73	0.264	2,313	26.4
Southwest Skystream 3.7	\$8,999	3.7	1.8	20	13.94	12.05	0.00	0.486	4,258	27
Southwest Whisper 500	\$6,062	4.5	3	20	13.94	13.37	5.73	0.856	7,501	28.5

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



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/>*

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.

For reference a local Skystream dealer was contacted for more specific local costs and estimates. For the Skystream 3.7 turbine with a 35 foot pole and bolt kit the cost would be about \$8,200 and an additional \$700 for a 45 foot pole and \$3,200 for a 65 foot pole. The installation cost for these configurations range from \$4,000 to \$5,500 depending on tower height. Further information for the dealer is given below.

*Chris Martin, P.E.
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115 Dreamcatcher Rd.
Buena Vista, CO 81211
1.719.395.9255
www.headwatersenergy.com*