Wind Velocity Report

May 11, 2011 → Oct 8, 2011

Prepared by

Vertical Power Systems LLC

Nov 16, 2011

Wind Performance Report: Assumed parameters

Parameter	Value
Location coordinates	123° 34' 56" N / 45° 34' 56" W
Location description	Top of knoll to left of big tree
Height above ground	5.8m / 19ft.
Absolute altitude	923m / 3,234 ft.
Proposed swept area	23 m^2
Assumed efficiency	20%
Value of a kw-hr.	$.19
Cut-in speed	4 m/s
Seasonal adjustment	+15%
Cut-out speed	16 m/s
Survival speed	50 m/s
Max generator power	6 kw
Sample period	May 8, 2011 → Oct 21, 2011

Wind Performance Report: Summary assessment

Average Daily Energy Potential

In consideration of a wind turbine project, the most important single number is the **average daily energy potential**. This would be the amount of energy in the motion of the air molecules as they pass through an imaginary 1 m² of area. For this period, at this location, we measured:

12,345 joules/m²/day wind potential

What does this mean exactly? This is the amount of kinetic energy (energy of motion) which was contained in the air, on average, for one day. Since we are assuming an efficiency of **20%,** let's adjust this for what we may capture:

2,675 joules/m²/day considering efficiency

Some of this wind was going too slow to be useful. Since we are assuming a cut-in speed of **4 m/s**, let's exclude the wind below that speed:

1,935 joules/m²/day excluding low winds

Some of this wind was going too fast to be fully exploited. The winds may have been dangerously strong, or beyond the capability of the generator. Excluding those two possibilities we have this amount of energy left:

1,725 joules/m²/day excluding high winds also

A joule is a measure of energy (not power). It can be converted into kw-hrs (not kw). Converting the last number to kw-hrs gives you:

.93 kw-hrs/m²/day

Since you are considering a turbine with 23 m^2 of area, you would get

14.5 kw-hrs/day average

406 kw-hrs/month average

Wind Performance Report: Geographical comparison

Your Region

According to statistics published for your region, the average potential would be:

16,000 joules/m/day at 30m.

We estimate that at the sample height of 5.8m, this is equivalent to:

13,521 joules/m/day at 5.8m.

Your site experienced:

9,367 joules/m/day at 5.8m.

Your proposed site is:

27% less wind than the regional average.

Wind Performance Report: Power

Power discussion

Power is the rate at which “work” can be done. It is measured at an instant, not over a period of time. Common units of power are horse-power, or watts, or kilowatts, or megawatts.

The power in wind is a function of the cube of the speed. Wind at 12m/s is not 50% more powerful than wind at 8m/s; it is 337% more powerful. It is also sensitive to the altitude, the temperature, and to a lesser degree, the humidity.

Using the assumptions given on the first page of this report, here is the amount of power this turbine would generate on average during a typical day:

At least	At most	Daily hours
0	0	6:25
1 watts	499 watts	9:05
500 watts	999 watts	3:50
1000 watts	1999 watts	3:22
2000 watts	2999 watts	1:45
3000 watts	3999 watts	1:32
4000 watts	4999 watts	0:58
5000 watts	5999 watts	0:34
6000 watts	9345 watts	1:12*

*The last row indicates power that would be lost, as the generator and the circuitry is only capable of handing power up to 6000 watts.

There exists some speed at which the turbine is not designed to survive—the wind will destroy it. Had you had your turbine installed during this period, it would have survived just fine, as the peak speed was:

18 m/s peak speed

With the specified turbine, but with a generator and circuitry 25% smaller, you would have sacrificed:

3.5% of the power lost with 25% smaller generator

Wind Performance Report: Capacity

“Capacity” is the term used in the industry which measures how close a turbine is operating to its full potential. If the wind blew lightly, but 24 hours a day, such that the turbine generated half of the maximum power for which it was designed, we would say the capacity of the turbine during this period was 50%.

But also if the wind blew strongly so the turbine was generating at maximum potential, but for only 12 hours a day, we would say the capacity was 50%.

Combining these two factors, and using the assumed turbine from the first page, we compute that the capacity of this turbine would have been:

18.4% Capacity

It is almost impossible to reach 100% capacity. Anything over 30% is exceptional. A very well placed turbine would reach between 20% and 30%.

If a turbine is inexpensive, a capacity between 10% and 20% can still be economically viable.

Below 10% would mean the turbine is poorly placed.

Wind Performance Report: Idle time

Especially if you intend to use batterys to store your electricity the duration of idle time may be very important.

Below is a listing of continuous periods where no electricity would have been generated:

Duration	# of Times
5 consecutive days	1
3 consecutive days	3
2 consecutive days	8
1 day	10

And below a count of badly performing days:

Energy generation	# of Days
0 → 5 kw-hrs	27
5 → 10 kw-hrs	14
10 → 15 kw-hrs	8
15 → 20 kw-hrs	3

Wind Performance Report: Best days

Here is a listing of the top 10 best days, and how much electricity you would have generated:

Date	Kw-hrs
05/06/11	135
05/07/11	130
04/23/11	122
07/18/11	102
10/10/11	94
07/12/11	94
06/14/11	88
10/11/11	81
09/29/11	78
08/02/11	75

Wind Performance Report: Value of Electricity

There is more to “the value” of electricity than a pure monetary number. There is first the hardship of what it would be like without electricity. There is also the environmental impact if the same electricity were generated with non-renewable resources. On a national level, there is also the balance of trade, and dependance on oil factor.

But here we are interested only in the monetary value, and that which was defined on the front page of this report. Here is what it would be worth, by month:

Month	Value
May 2011	$3.20
Jun 2011	$22.70
Jul 2011	$36.60
Aug 2011	$55.30
Sep 2011	$40.00
Oct 2011	$38.90

And here is what it would mean in tons of carbon, were the electricity generated actually displacing fossil fuels that would be burned;

Month	Tons of carbon
May 2011	.02
Jun 2011	.13
Jul 2011	.16
Aug 2011	.20
Sep 2011	.25
Oct 2011	.19

Wind Performance Report: Tower height

As you go up, the wind increases in strength. Generally it is predictable. Using the generally accepted science, this is how we would expect various tower heights to affect perfomance:

Tower height	Avg monthly
4m	123 kw-hrs
6m	184 kw-hrs
8m	243 kw-hrs
10m	255 kw-hrs
12m	302 kw-hrs
14m	322 kw-hrs
16m	344 kw-hrs
18m	360 kw-hrs
20m	372 kw-hrs
30m	422 kw-hrs
40m	455 kw-hrs
50m	510 kw-hrs

Wind Performance Report: Energy subsidies

The federal government, and some states, offer a subsidy as a function of the electricity generated.

The period for which this report is being generated represents 125 days, or 4.76 months. This is what the subsidies would be worth on average, for a year assuming various values of the subsidies:

Subsidy/kw-hr in cents	Value
2.0	$234
2.5	$265
3.0	$322
3.5	$376
4.0	$402
4.5	$421
5.0	$455

Wind Performance Report: Daily perfomance

Below is a detail, by day, of the wind during the sample period

May 2011 daily performance

Day	Kw-hrs	Value
05/12/11	4.65	$.54
05/13/11	4.90	$.94
05/12/11	3.65	$.84
05/14/11	2.65	$1.54
05/15/11	4.75	$2.54
05/16/11	4.95	$1.54
05/17/11	8.65	$.51

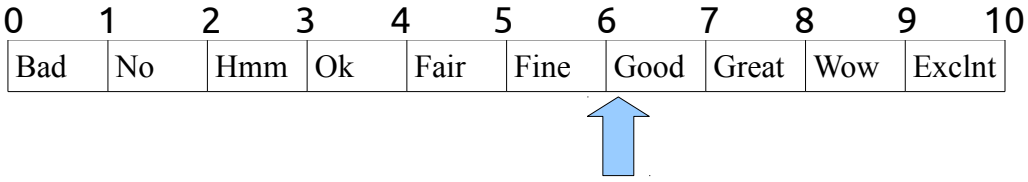
May totals: 85.3 kw-hrs $16,45

June 2011 daily performance

(etc.)

Wind Performance Report: Conclusions

If this were representative of what you think is “normal” for this site, then we would place it here on this arbitrary scale:



Anything above a 6, and you have a viable site. Anything below a 2, should make you think twice. The area between 2 and 6 is fuzzy. A lot depends on WHY you may want to do this. If it is to save money, it is probably not wise. If it is to “save the world,” well, everything helps. If it is to escape dependance on the grid, then if this is important to you, you now know what you should expect.

Good luck in your decision!!