A Detailed Response to Mike Bergey: An Opinion Paper

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Introduction

It was great to get Mike Bergey involved in some discussion on SWIEP and the Small-Wind-Home site (SWIEP posting 222, 223 and 246) so I wrote to him (a private letter) to propose that we work together and with an ultimate aim to engage him in more private discussion, because if we work together we have to talk together. After several weeks I never got a response to my private letter. I will not unilaterally reveal my letter to the public but I do not object if M.B. wishes to release the letter. I had hoped to engage him to provide more compelling arguments after giving him a chance to clearly state his case to me. He failed to engage me in a conversation so I now have to reply without fully understanding his thinking.

At issue here is this question: Is the energy loss that occurs when the GridTek10 shuts down major or minor, i.e., >20% or < 2%, respectively, or somewhere in between? Mike still believes it is minor and he fails to accept the **measured numbers** I have presented to the small wind industry discussion groups. See SWIEP reports R#40 to R#49 which can be downloaded from
http://www.ualberta.ca/~mtyree/SWIEP/Publications.html

So let me try to respond to his arguments in a less than satisfactory way. What do I mean by a ‘satisfactory way’? I mean I would prefer to discuss with him the basis of his contrary beliefs so I am sure I am responding directly to his words and thoughts. My response is unsatisfactory because I have to interpret this thoughts and risk putting “words into his mouth” that do not reflect his true thoughts. Anyway, he has not engaged me privately so here goes my unsatisfactory public response.

Quotes, Interpretations of Quote and Responses

Quotes from Mike Bergey 5 Dec 2008 SWIEP posting # 222

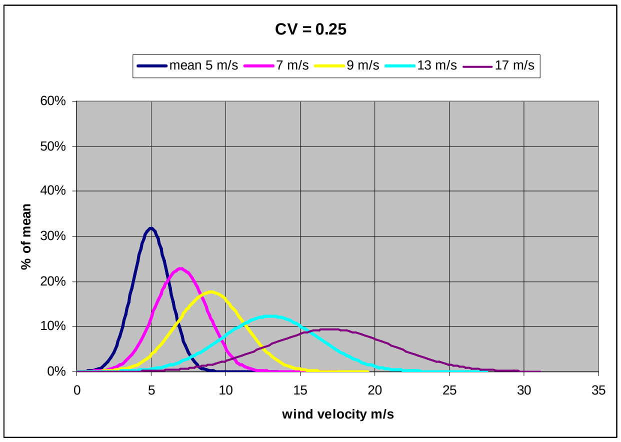
‘2. The behavior you "discovered" is the Xantrex inverter protecting itself from "DC bus over-voltage", which can literally blow-up the inverter. The over-voltages occur when the rotor speed gets too high. This occurs rarely at some sites, and regularly at some sites, when winds are above ~ 35 mph. The primary variable is the turbulence and gustiness of the site or specific storm and the effect they have on furling, and therefore peak rotor speeds.’

Interpretation of Quote:

When Mike refers to ‘gustiness’ he is referring to the fact that wind speeds are never constant. When you measure a power curve by IEC/AWEA standards you measure a mean wind speed, $\bar{u}$, based on a 10 min mean when NREL, for example, measured some power curves for BWC. But actual wind speeds vary kind of randomly up and down over a very wide range at any given mean wind speed. Experimentally this variation can be described by a Gaussian distribution (See R#30) for more details on Gaussian distributions.

Response to Quote:

Mike, what you really have to start thinking about seriously is the average wind speeds, $\bar{u}$, at which gusts are likely to occur up to 35 MPH (15.6 m/s). To examine this question we need to look at some Gaussian distributions around different mean values. So let me cut and past one of the figures from R#30.



In the above figure we see that when $\bar{u}$ = 9 m/s (the peak of the yellow line) there is little probability of having a gust up to 15.6 m/s. But if $\bar{u}$ = 13 m/s it is VERY likely that there will be gusts well beyond 15.6 m/s. I find that gusts need to be closer to 17 m/s to shut down the GridTek10, and I find that such gusts start occurring about once per hour when $\bar{u}$ = 10 or 11 m/s. Remember this figure, it is very important!

So when gusts start happening how does the Gaussian distribution affect an IEC/AWEA standard power curve? Well the raw data on the power curve starts showing a “snowfall” affect. Individual bin values start falling out below of the general trend of data. Now, when you want to use a power curve to predict annual yield you MUST include the mean of all these points including the snowfall points. The snowfall points occur when the Fault 1 or Fault 2 states happen (R#46 Figure 1), i.e., when the GridTek10 goes off-line for the 5-min periods. So you MUST include all these ‘bad points’ due to fault conditions in order to get a true estimate of energy production over a year. *But this estimate includes all these fault conditions too.* Remember that fact!

Quotes from Mike Bergey 5 Dec 2008 SWIEP posting # 222

‘3. The math behind our position that the energy loss is minor is simple and compelling. For most sites the amount of time the wind is above 35 mph is quite small, measured in days, not months per year. However, if you are not around to do a manual reset when the storm subsides, then yes, that will magnify the problem. But, there are good reasons why a manual reset requirement is prudent. Your time away from home is a factor.’

Interpretation of Quote:

The ‘simple and compelling’ math Mike refers to comes from his standard WindCad models for annual energy production. I reproduce my table below so the reader can see what Mike refers to (see next page). I have modified BWC’s WindCad model only to make it clearer. At the bottom half on the right I have added one more column in bold to show annual average energy production at each Weibull bin speed. For a discussion of Weibull fits and WindCad models in general see SWIEP (R#30,31,32,33,34 and 36). Here is what Mike means by simple and compelling. If you look a production at wind speeds above 16 m/s the total for all from 16 to 20 m/s is just 104.8 kWh out of a total prediction of 14,400 (nearly), which is less than 1% (actually 0.73%). I agree with Mike that this argument is simple *but it is not compelling!!!!*

Response to Quote:

Okay, so what is wrong with this simple and compelling math? I agree that when mean wind speeds are above 16 m/s you are making less than 1% of the energy at my site in Ellenburg, NY, which is NOT a very windy place. My site is good enough to make wind energy competitive with solar-PV energy but it is not quite up to commercial potential. That means that windier sites will have more energy loss. Read on!

So what is Mike missing? He is missing the fact that the Bergey/GridTek10 combination start cutting out on a regular basis when $\bar{u}$ exceeds 10 m/s, becomes more common when $\bar{u}$ exceeds 11 m/s and quite common when $\bar{u}$ exceeds 12 m/s. The other factor is that sometimes the GridTek10 clicks off requiring manual reset on a regular basis when MEAN wind speed exceeds about14 m/s. So that is more loss of energy production. The WindCad model ASSUMES the turbine is always functional. So on windy days there can be many hours of lost energy unless the owner wants to sit beside the inverter pressing reset as soon as a reset is needed.

Bottom line, you cannot predict the energy loss from the WindCad model because (1) it already includes the losses at ALL wind speeds, (2) it does not even try to estimate how many 5-min periods the GridTek10 is in a Fault 1 condition and (3) it does not even apply when the GridTek10 is in a Fault 2 condition.

So my approach is the way you have to do it. You have to collect a ‘power curve’ without the fault condition occurring and then use a model, like my DIRM model to estimate energy loss every time the GridTek10 is in a Fault 1 or Fault 2 state. And the only way you know when these faults occur is to monitor the inverter second-by-second (See R#49).

WindCad Turbine Performance Model

BWC EXCEL-S, Grid - Intertie

Prepared For:	**Customer**	Mel Tyree
	Customer	Bull Run,
Site Location:	**Site**	Ellenburg
Data Source:	**TrueWind Atlas**	
Date:	**1/21/2009**	

10 kW

Inputs:

Ave. Wind (m/s) =	5.464
Weibull K =	1.891
Site Altitude (m) =	280
Wind Shear Exp. =	0.143
Anem. Height (m) =	30
Tower Height (m) =	30
Turbulence Factor =	10.0%

Results:

Hub Average Wind Speed (m/s) =	5.46
Air Density Factor =	-3%
Average Output Power (kW) =	1.64
Daily Energy Output (kWh) =	**39.4**
Annual Energy Output (kWh) =	14,377
Monthly Energy Output =	1,198
Percent Operating Time =	70.8%

Weibull Performance Calculations

Wind Speed Bin (m/s)	Power (kW)	Wind Probability (f)	Net kW @ V	kWh/yr
1	0.00	5.92%	0.000	0.0
2	0.00	10.06%	0.000	0.0
3	0.00	12.57%	0.000	0.0
4	0.22	13.48%	0.030	259.0
5	0.70	13.02%	0.091	800.5
6	1.45	11.58%	0.168	1469.1
7	2.24	9.61%	0.215	1883.8
8	3.20	7.49%	0.240	2101.7
9	4.25	5.51%	0.234	2055.2
10	5.39	3.84%	0.207	1817.2
11	6.58	2.55%	0.167	1467.9
12	7.89	1.61%	0.127	1110.6
13	8.33	0.96%	0.080	704.6
14	8.77	0.55%	0.049	425.6
15	7.01	0.30%	0.021	186.7
16	5.26	0.16%	0.008	73.4
17	2.37	0.08%	0.002	16.6
18	2.63	0.04%	0.001	8.9
19	2.63	0.02%	0.000	4.1
20	2.63	0.01%	0.000	1.8
1997, Bergey Windpower	Totals:	99.36%	1.641	14386.7

Quotes from Mike Bergey 5 Dec 2008 SWIEP posting # 222

“Only a very few of our 10 kW customers use the "1/4 furling" technique that Logan Bryce reported. If you are not going to be home and you expect a storm, it might make sense for you.”

Interpretation of Quote

‘ “1/4 furling” refers here to the practice used by some people to ‘crank the tail’ of the turbine so it is pointing about 23 deg out of alignment with the turbine body. This tends to move the plane of the blades a little away from the perpendicular direction of the wind and reduces the power production of the Excel-s generator so it is less likely to shut down the GridTek10 inverter. ‘

Response to Quote

Read my SWIEP report R#46 and you will see that ¼ furling or even full-furling is not effective. Even a fully furled Excel-s can cause frequent Fault 1 and Fault 2 states.

Quote from Mike Bergey 6 Dec 2008 SWIEP posting #223.

‘Yes, the new Powersync II inverter will work with older Excel's. But, its expensive and we don't believe that upgrading is cost-effective.’

Response to Quote

I don’t think I need to interpret this one, but the thinking is too simple to apply to everyone. In some cases the upgrade to the Powersync II could be cost-effective. See SWIEP reports R#44 & 45.

Final request to Mike Bergey: Please contact me if you still disagree with my analysis. If I have missed something and you can convince me of the importance of what I have missed I will correct my mistakes. **Please also sell me a Powersync II inverter. I want one.** If you will work with me rather than against me, I might be able to provide you and your customers with evidence that might increase the sales of Powersync II inverters beyond what you would sell with new Excel-s turbines.

I hope the Powrsync II corrects the problems in the GridTek10. The history of the development of the GridTek10 you gave is a little different from what I have I learned indirectly from Xantrex. But who cares, if your new product is better let me spread the good word to everyone. If you will simply accept my findings I can move on to the next step, i.e., working out the cost-effectiveness criteria for people who might want to upgrade.

I welcome comments and suggestions for improvement to this and other SWIEP reports. I promise to correct mistakes promptly thru revised reports with acknowledgement to the person finding the mistake.

Mel Tyree