An Example of Power Loss during a Windy Event:
10-kW-Bergey + GridTek10 Inverter
summarized by

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Disclaimer: I am not an expert on wind turbines. So I welcome comments from experts so that I can improve this and future summaries I might write. Email comments to mtyree@ales.ualberta.ca

The full reports are quite long so many people might not be bothered to read them in detail. The full reports can be downloaded from the SWIEP website. Go to:

http://www.ualberta.ca/~mtyree/swiep and go to publications.

## Introduction:

My inverter sometimes gets overloaded by the output of the 10 kW Bergey turbine and goes into standby mode for 5 minute periods or even shuts down completely (needing manual reset). On windy days (>30 MPH sustained winds) the GridTek 10 spends most of its time in standby mode, i.e., off line. This is a problem because the wind probability curves predict that 10% of my annual energy production should occur on the 8 most-windy days per year. I consulted the GridTek Manual and found it stated: "If the available generator power is above the maximum allowable power level of the BWT-10240 [the GridTek 10 model #], the control circuit will maintain maximum power." What happens is that power output increases as RPM increases from 100 to 300 when the nominal maximum of 10 kW is reached (Fig 1). After that power output continues in increase but more slowly until at 420 RPM (12.4 kW output) the inverter reports a fault code #52 and goes into standby mode for 5 minutes and then attempts to go into production again. So if it is windy this happen repeatedly every 5 minutes. Worse yet, if it tries to produce power again when RPM is > 460 RPM it goes off line permanently with a Bus Overload error code (#21) and it stays off line until I notice the problem and do a manual reset. If I am on travel, a week might pass before I notice the inverter needs to be reset. So there may

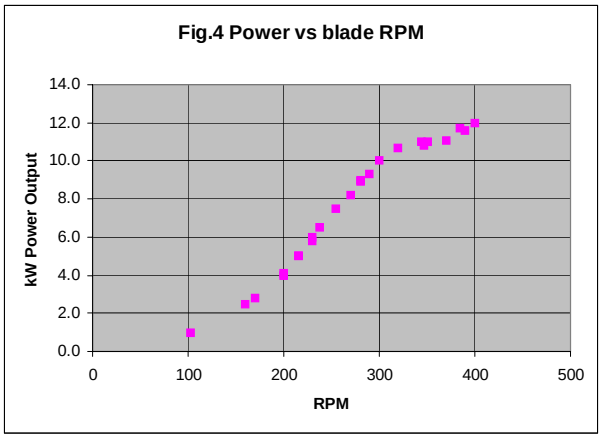


*Fig. 1 Power output reported by the GridTek 10 versus reported blade RPM measured on a windy day when the inverter was frequently going into standby mode, i.e., whenever RPM exceeded 420. All these values were read from the LED monitor on the inverter. Power increases ~ with the square of the RPM.*

be hours or days of lost production. I estimate I am loosing 10 to 20% of my potential power because of this problem. In contrast, my solar inverters, also made by a Xantrex subsidiary, do correctly max out. In fact you can program them to put out ANY desired

maximum kW output (set by a current limit value) and the inverters will 'ignore' any excess energy and operate at the preset maximum. The question is: On windy events how much energy (kWh) do I lose?

Materials and Methods:

*At the time of this test I did not have a cup anemometer nor much specialized test equipment. I am in the process of getting about $8,000 of equipment to do more testing so this report must be taken as preliminary.*

I used a webcam to take photos of the LED display on the GridTek10. The LED display gives blade RPM, kW power output, and AC current. Photos were taken about once per minute via a computer interface. I also monitored the power output on the GridTek10 using a TED power monitor which gives kW to the nearest 10 W (0.01 kW) and total energy in kWh to the nearest 0.1 kWh. For details see:
http://www.powermeterstore.com/p3528/the_energy_detective.php

Calibration:

I needed a way to estimate the amount of time the GridTek10 inverter is off-line and not producing power during windy events. My idea was to use the instantaneous kW readings recorded once per minute prior to and following a power loss event to estimate how much energy (kWh) I might have lost. The calibration I did was to take photos to record power (kW) on the GridTek10 LED once per minute and correlate this with total energy produced as measured by the TED. The wind speed can change a lot during the hour so it was not clear to me if 60 1-min readings would be enough. But it was not too bad. See the graph below:

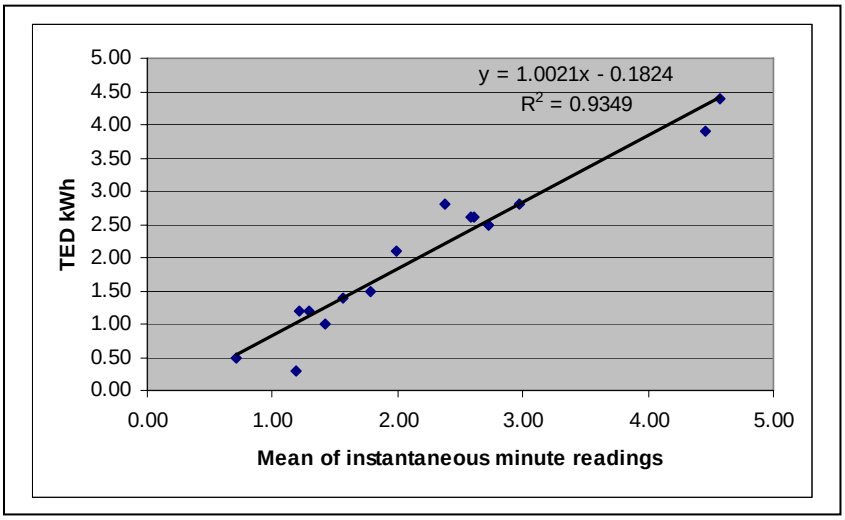


***Fig.2:*** *Calibration of the web came method of measuring energy production. Each point in the graph above represents the kWh produced in 1-h (on the y-axis) versus the estimated kWh by taking the sum of 60 readings of power (kW) in that hour. The interval for each point was never exactly 1 hr, but the data were scaled to represent the time period during which the TED was read.*

Results during a windy event:

On Jan 9 to Jan 10, 2008, the wind was high and I collected 1394 photographs = about 24 h of data given that the timing between photos was slightly over 60 s because the time-laps photography software did not keep good time. During this period:

**35.3 kWh** of energy was produced (410 minutes)
**52.8 kWh** of energy was lost because the GridTek10 was in standby mode (459 minutes)
**57.3 kWh** of energy was lost because the GridTek10 needed manual reset (525 minutes)
Manual reset is needed when the inverter tries to turn on when the blade RPM is too high (about 430 RPM). I spent most of the night awake trying to reset the inverter promptly.

Conclusion:
Total energy produced (35.3 kWh) was much less than the energy lost (110.2 kWh). The energy produced was 24.3% of the energy I might have had if the inverter worked better. This short-coming of the inverter was reported by NREL in 2002/2003 and it seems not to have been corrected by the time I bought my system (2006).
How often do I have windy days like this? My guess is 8 to 12 times per season. I will do more testing to let you know. But my problem relates to the need for manual reset. I don't always spend a lot of time at home and my wife does not want to bother checking the inverter. So I probably loose 30% of my potential production per winter.
I will document this more to let you know. This is a very cheap method of documenting power loss by the GridTek10. It costs only $60 for a webcam with time-lapse software. But it is labor intensive going through thousands of photos and writing down in an Excel sheet the once-per-minute kW values.

Final note:
Customers want to buy a turbine expecting it to work according to specifications but can't afford to buy thousands of dollars worth of equipment to check. I absolve Mike Bergey of any blame nor do I expect him to fix my problem. It could cost him lots of time and money to do that! And if he went after every complaint in a diligent fashion he would never make money selling turbines. But I am a scientist constantly curious about physics, engineering, and electronics. So I plan to figure out some more facts and will share them with the public. Maybe future turbines/inverters can be made better and maybe future customers can make informed choices. **I encourage others to try this experiment. Does your inverter do the same?**
***Expert comments will be added to this summary if I get any.***