You are provided with wind turbine and meteorological data for a mesa-top GE 1.5 MW SLE wind turbine in West Texas. The data are 10-minute averages, covering two months – January 2008 and July 2008. Two met towers (MET A and MET B) are located on the same mesa as the wind turbine, but we do not know which met tower best represents the wind conditions at the turbine. Both met towers take measurements at hub-height (i.e., 65 meters). There are some missing data – this can be handled by ignoring wind speeds less than 1.0 m/s.

Consider yourself as a consulting engineer, and the owner has hired you to answer the question, “how is my wind turbine doing?” Your task is to study the performance of the wind turbine, compare actual performance to specifications, and point out any observations that the owner should know about.

Your analysis should include the following steps:

1. Time plots of kW, MET A wind speed, and MET B wind speed. Use one graph for all three parameters, but with appropriate scales. Use separate graphs for January data and July data.
2. Scatter plot generator RPM and turbine RPM to determine the gear box ratio.
3. For the combined January and July data, scatter plot the experimental probability density functions (pdfs) for MET A wind speed, and separately for MET B wind speed, using 0.1 m/s increments. Use the Excel Solver to determine their Weibull curve fits. Does one of the met towers have a better curve? Note – if you get stuck on this step, use Dr. Grady’s spreadsheet.
4. For the combined January and July data, scatter plot kW versus MET A wind speed, and separately for MET B wind speed. Does one of the met towers appear to be better correlated with kW?  
5. Develop and use a screening process to identify and remove curtailed kW data from the performance analyses that follows in Steps 5 – 7.
6. For the combined January and July data, curve fit the un-curtailed kW versus wind speed data from the best MET tower. Piecewise-linear curve fits are acceptable. Overlay the curve fit on the GE SLE curve (GE_1.5MW_Wind_Turbine_Brochure.pdf) and compare.
7. Assume that your wind speed pdf applies to the entire year, and that there are no curtailments, and that there is no “down time” for maintenance. Use your Weibull wind speed pdf and kW vs. wind speed curve fit to estimate
   • annual MWH that the wind turbine will produce, and its capacity factor.
   • annual displaced CO2, assuming 0.9 kg CO2 per kWH for coal-fired generation.
   • number of “best wind” hours per year that produce one-half of the annual MWH.
   • wind speed value for which higher wind speeds produce one-half of the annual MWH.
8. Correct kW for temperature and pressure effects, and then repeat Step 5. Remember that the rated kW is that of the generator, not the wind.
9. Extra (if you have time)
   • Investigate the relationship between turbine blade pitch-back angle and kW reduction.
   • Wind generators, especially on mesa tops, are sited according to prevailing wind direction. Does our performance data show a relationship between wind direction and kW?
Sample

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