Visit to VUSE-MWS Showcase site at Love Circle & Energy Audit

Introduction

During the visit to the renewable energy site, we were introduced to the solar panel array and wind turbine there. Once familiar with the basics, we delved into what an energy audit would consist of at this location.

The first concept to understand was the broader context of their uses: how much energy they could produce and how much energy an average US household consumes. The 3 kW wind turbine installed was chosen because it is quiet, and also because it turns at low wind speeds ($V_{wind} > 2.2$ m/s). The location for this wind facility (more so than for the solar facility) was chosen because it is one of the highest points in Nashville. The altitude is important to consider because the amount and speed of wind increases with altitude, and power generated correlates to the wind speed cubed (V_{wind}^3). The wind turbine is expected to produce about 5 kWh per day, on average. The amount varies with time of year (it is more windy between November and April), as well as with time of day. During the day, the wind speed changes as a result of changing temperature differences, the trend is shown below:

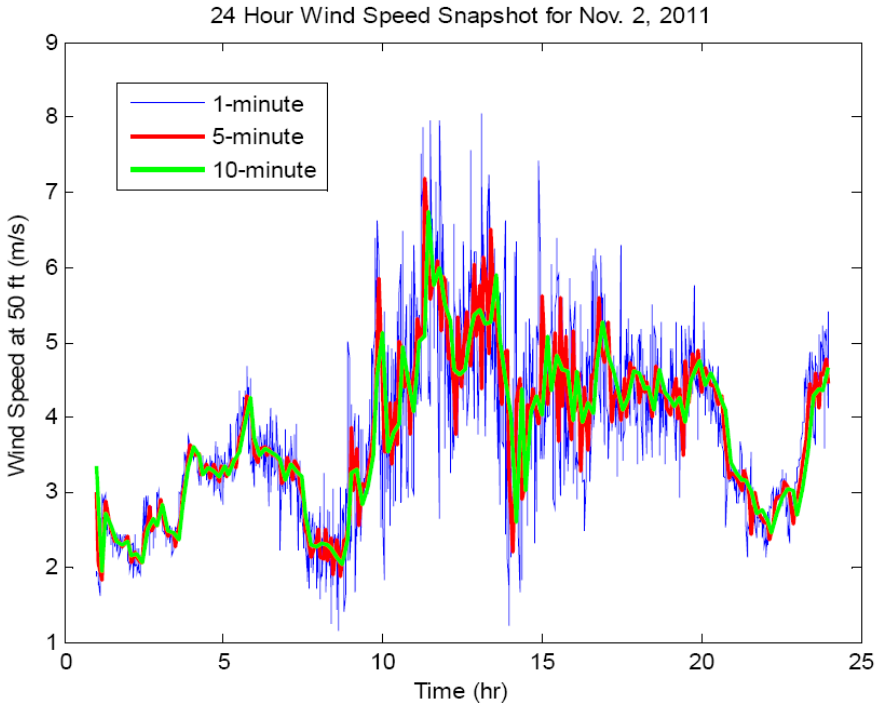


Figure 1: Wind speed changing during a typical day

The installed wind turbine (Kestrel e400i) has about 13ft diameter blades. Wind turbines with blades of twice the size will produce more than four times the energy, as energy scales with blade swept area, and conversion efficiency improves with size. It turns out that project costs would also be favorable with installation of a bigger turbine, as two

thirds of the costs are related to geotechnical site analysis, foundation, and the pole, including its transport and installation.

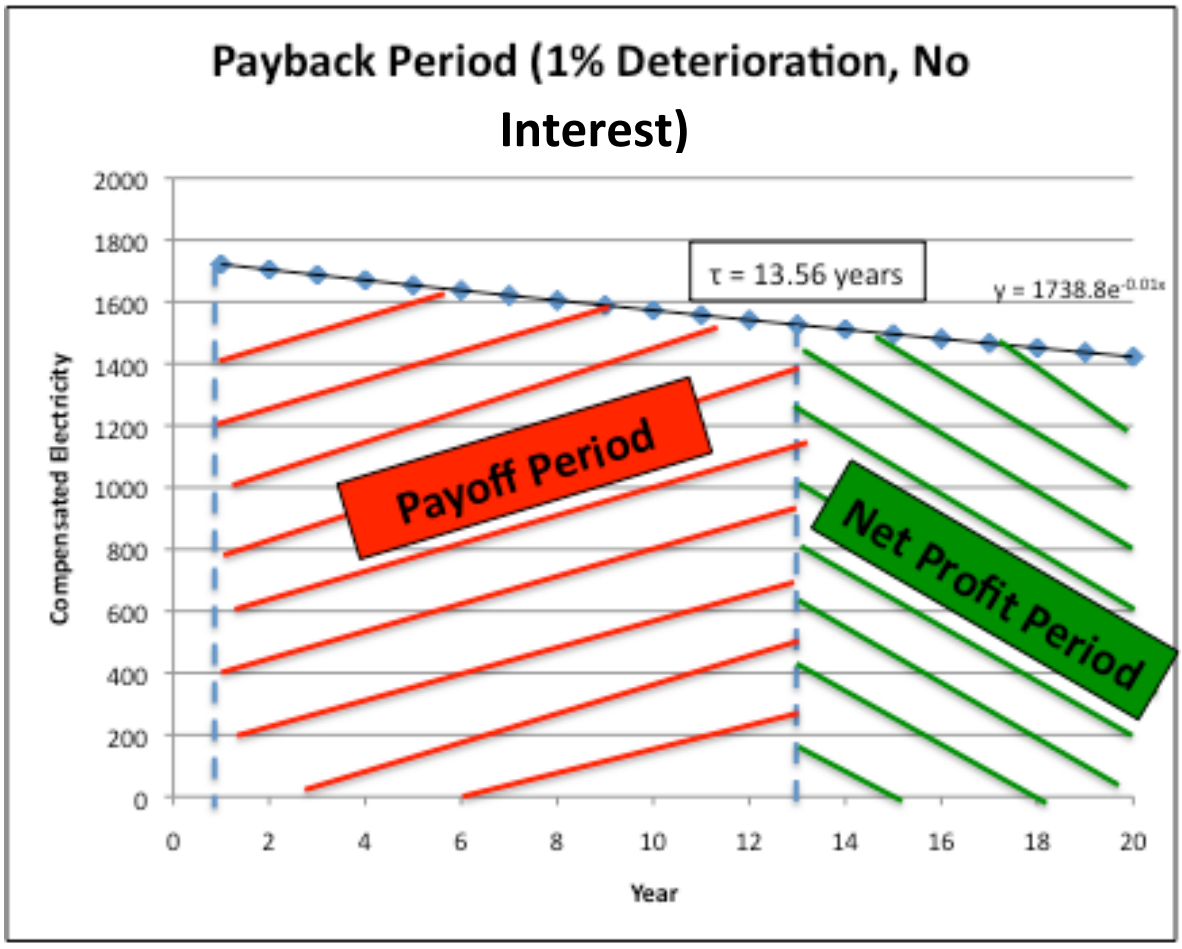
The solar facility consisted of two arrays of solar panels, and had a 4.8 kW capacity. On an average day, the solar facility can produce 24 kWh of electrical power with 5 good hours of sunshine at 100% inverter efficiency (100% inverter efficiency is not realistic and will be discussed later). The solar panels are facing in the southern direction to optimally catch the sun during the day. Finally, we learned about that the average daily consumption of electrical power of a US household is 30 kWh (according to the US Energy Information Administration). Therefore, the expectation of the alternative energy facility as a whole is a daily generation of 30 kWh.

The solar and wind energy generated at the site are re-inserted into the NES grid to enable NES/TVA to sell them to consumers interested in buying green energy at a premium. NES/TVA compensate MWS at +12c for solar green energy produced and +3c for wind green energy produced. In some sense, NES/TVA favor installation of solar panels in this geographic area, as they judge that it would be more financially feasible for home owners.

Solar Energy/Facility Audit

Solar Panel Total Capacity	**4.8 kW**
Solar Energy Produced since 8/02/12	**2,217 kWh**
Expected production of solar energy based on regional maps since 8/02/12 (assuming 100% inverter efficiency)	**2,645 kWh**
Calculated inverter efficiency (expected/actual)	**83.83%**
Cost of electricity in Middle TN (w/ fuel surcharge)	**10.8 ¢/kWh**
Total direct value of solar energy produced up-to date	**$239.44**
Projected production in a year (scaled w/o reference to seasons)	**7,550 kWh**
Total value of electricity generated in first year	**$815.4**
Total cost of setting up solar facility	**$30,457.00**
Federal Green Program credit	**$9,137.10**
TVA Green Participant credit	**$1,000.00**
Actual cost of facility to home owner	**$20,320.00**
Total value of compensated electricity in first year (@+12c green credit)	**$1,721.40**
Total value of compensated electricity at 1% panel deterioration per year for a 20 year life span	**$31,345.50**

Payback period with no assumed interest	**13.56 years**
Total profit on the facility over a 20 year life span (assuming no interest on payback)	**$9,469.69**



As the data and graph above show, the solar facility will produce a return on investment after 13.56 years of operation in a realistic scenario. The rest of the 20-year lifespan will then generate a profit of $9,469.7 for the homeowner.

Note 1: this analysis has been performed assuming 0% interest, which is unrealistic. However, at the current interest rates, a home owner can expect to pay back for the panels in 15 years.

Note 2: This analysis has been performed assuming that TVA will continue to buy solar green energy at a premium of +12c over the life span of the panels; an issue for TVA and Government to review.

Either way, it looks like an interestingly 'green' investment!