PV and wind labs

Part 1: Photovoltaic energy

Uphill from the elab there is a large PV array. Our goal is to determine the efficiency for this array.

1. walk up and measure the effective area of one panel in m2
2. count the number of panels
3. calculate the total area of the panels
4. look up the total solar radiation at the elab here: https://tempestwx.com/station/85882/
5. multiply by the total area to determine ideal power harvest capacity
6. go to 10.14.4.5 and search for PPA array for the power actually harvested
7. determine the efficiency of the array

Part 2: Wind power

1. look outside the energy lab at the sometimes wind turbine on the tower.
2. determine the type of turbine, and notice the placement of the blades and generator
3. walk up to the smaller turbines (careful-don't reach up to the blades!)
4. determine the type of turbine, and notice the placement of blades and generator
5. if you have time, look at the turbine at the far northeast part of the elab, compare blades

Part 3: ROI and TCO

If a device that saves you money costs money to purchase, the amount of time for the money gathered to equal the money spent is known as return on investment, or ROI for short, often measured in years.

If the device lasts longer than the ROI, the total cost of ownership or TCO can be calculated. If this is negative, the device made you money over the lifetime of the device. If negative, it cost you money.

Here's an example:

A 300W solar PV panel costs $300 and harvests solar energy for 5 hours each day.

300W is 0.3 kW, which for 5 hours is 1.5 kWh every day harvested.

If electricity costs $0.40 per kWh, this earns you $0.60 per day

To pay off this $300 investment, it would take $300/$0.60/day or 500 days to pay it off. This is the ROI.

If the panel works for 20 years, subtracting the 500 days (which is about 1.4 years) you have 20-1.4 or 18.6 years of free money.

18.6 years * 365* $0.60 = $4,073 TCO.

See below for questions.

Questions:

Part 1:

1. how would you compare the energy harvesting efficiency of the PV array with the solar thermal panel downstairs?
2. what are the benefits and drawbacks of using PV versus a solar thermal panel or wind turbine?

Part 2:

1. why are turbine blades thicker at the root (closer to the generator)?
2. why are they twisted at a greater angle near the root?
3. if the blades of the smaller turbine rotate too fast, what happens to the generator and why?
4. what are the benefits and drawbacks of using wind power versus PV and solar thermal?

Part 3:

1. Ella Finoe installs 3 kW of PV on her roof at a cost of $6,000. If she has 5 hours of sun at her location, what is her ROI and if it lasts for 20 years, the TCO? Electricity costs $0.40 per kWh.
2. Is this a good investment?
3. She then decides to install a 1 kW wind turbine that works about 50% of the time, 24 hours a day at capacity, and costs $10,000, but only lasts 4 years. What is the ROI and TCO?
4. Is this a good investment?
5. Wanting to heat her massive hot tub with solar energy, Ella replaces her electric hot water heater with a solar thermal panel which collects 4.5 kW of heat for 5 hours each day and costs $900. What is the ROI and TCO if the panel lasts for 25 years?
6. Is this a good investment?
7. Which of these are you going to put on your dream home and why?

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