

D-Lab

Practical PV

Due: October 16th, 2009

You are in charge of designing a solar panel installation for a rural health post. The requirements for the given location are as follows:

- There is a 220W freezer that needs to run 24/7
- The health post is open until 9pm, and, on average, they have to turn the lights on from 6pm until they close. Given their needs, it seems that the most adequate installation would be 2 fluorescent lights of 15W each.
- They have an amateur radio to communicate with the clinic in the city, that consumes 40W, and it is usually on for two hours every day.
- The health post is staffed every day of the year.

1. Calculate the average daily energy consumption at the health post.
2. The health post is located in a region that receives an average of eight hours of sun per day year round, and one can assume a solar irradiance of $1,000 \text{ W/m}^2$. How many panels will need to be installed to satisfy the energy demands of the health post given the following data?
 - The available solar panels have an efficiency of 12.5%, and a surface of 0.6 m^2
 - The charge controller has an efficiency of 80%
 - Since all items in the health post run of AC, an inverter is needed. The inverter has an efficiency of 80%
 - The batteries are 90% efficient in storing energy
 - For the purpose of this exercise, only consider the efficiencies outlined above, and disregard any other possible efficiencies in the system.
3. How many deep cycle 12 V batteries capable of providing 100 Ah each would be needed for the system to withstand a 3 day blackout?
4. Calculate the total amount of energy generated over the lifetime of a solar panel (30 years) for the system designed in question 2 (hint: note that the energy generated will be slightly higher than the energy requirements for the health post).
5. Assume that each battery costs \$100, and has a useful battery life of 3 years for this type of applications. Assume also that each solar panel costs \$250, and has a life expectancy of 30 years. Calculate the cost of kWh for the system considering the entire lifespan of the solar panels.
6. Compare the result above with the cost of kWh in Massachusetts (data provided by NSTAR for residential customers for the last quarter of 2009: 9.219 cents/kWh) and the country where you will be traveling (hint: look up rates for capital city provided by local power company. If hard to find, look up neighboring countries). Reflect on these numbers, and suggest what your recommendations would be to bring costs down, and make this implementation more cost-effective.

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