ECE 333 Green Electric Energy - Quiz 7

Thursday, November 30, 2017

Duration: 20 minutes

Name: _____ **last 4 digits of your UIN:**_____

Closed book, closed notes, cell phones are not allowed.
Show all you work and always indicate the units, as appropriate.

Problem 1 [70 points]:

Suppose you are hired as a consultant on a project for a *PV* system for a Daggett (*CA*) house that is designed to generate 6,000 *kWh* annually. Assume that PVs have a 15 *%* efficiency and the temperature-related derate factor χ'=0.7. The key cost components for the project are:

component	*costs*(*$*)
PVs	4.10/*W* (*DC*)
inverter	1.10/*W* (*DC*)
tracker	390 + 105/m^2
installation	4,300

Your client asks you to compare the total costs for the installation of an array with a single – axis tracker with the installation of a fixed array with a -15 ° tilt angle.

a. [30 points] Calculate the total costs of an array with a single – axis tracker. (The average daily insolation of an array with a single – axis tracker in Daggett is: 9.1 $kWh/m^2 - d$).

Solution:

$$P_{DC,stc} = \frac{daily\ energy}{(\chi')\left(\frac{daily\ insolation}{1\ kW\ /m^2}\right)(365)} = \frac{6{,}000}{(0.7)\left(\frac{9.1}{1}\right)(365)} = 2.581\ kW_p$$

$$costs\ of\ PVs = 4.10\ x\ 2{,}581 = 10{,}582\ \$$$

$$costs\ of\ inverters = 1.10\ x\ \ 2{,}581 = 2{,}839\ \$$$

Given the 15 *%* efficiency of the *PV*s, the array area required is

$$area = \frac{P_{DC,stc}}{(1\ kW/m^2)(\eta)} = \frac{2.581}{(1\ )(0.15)} = 17.21\ m^2$$

$$costs\ of\ trackers = 390 + \ (17.21\ x\ 105) = 2197\ \$$$

$$total\ costs = costs\ of\ PVs + costs\ of\ inverters + tracker\ costs + \ installation\ costs = \ 10{,}582 + 2{,}839 + 2{,}197 + 4{,}300 = 19{,}918\ \$.$$

b. [30 points] Calculate the total costs of a fixed array with a -15° tilt angle. (The average daily insolation of a fixed array with a 15° tilt angle in Daggett is: 6.5 $kWh/m^2 - d$).

Solution:

$$P_{DC,stc} = \frac{daily\ energy}{(\chi')\left(\frac{daily\ insolation}{1\ kW\ /m^2}\right)(365)} = \frac{6{,}000}{(0.7)\left(\frac{6.5}{1}\right)(365)} = 3.61\ kW_p$$

$$costs\ of\ PVs = 4.10\ x\ 3{,}610 = 14{,}801\ \$$$

$$costs\ of\ inverters = 1.10\ x\ \ 3{,}610 = 3{,}971\ \$$$

$$total\ costs = costs\ of\ PVs + costs\ of\ inverters + installation\ costs$$

$$total\ costs = 14{,}801 + 3{,}971 + 4{,}300 = 23{,}072\ \$$$

c. [10 points] State whether you would propose your client to invest in a fixed array with a -15° tilt angle or in an array with a single – axis tracker, **provide** the rationale for your selection.

Solution:

We propose our client to invest in an array with a single – axis tracker, because we found that the total costs of an array with a single – axis tracker is lower than the total costs of a fixed array with a -15° tilt angle.

Problem 2 [30 points]:

Circle the correct answer for each statement below –either **True** or **False.**

a. [10 points] *CSP* plants with *TES* tend to be cheaper and have lower *c.f.*s, and lack the capability to shift generation outside the sunrise–sunset periods.

True_____ **False** _____

b. [10 points] For a loan over several years, almost all of the first year payments constitute the interest due, with a very small repayment of the loan principal, while the opposite allocation occurs towards the end of the loan life.

True_____ **False** _____

c. [10 points] Behind–the–meter *PV* systems are generally large farms with power outputs sold by their owners into the wholesale electricity markets.

True_____ **False** _____