

Homework 7**Quiz Date: Thursday, November 30, 2017 during class**

The quiz is based on the following material: Lecture 15, Lecture 16, Lecture 17, and the problems in Homework 7.

Problem 1: 6.3 (part c) from the textbook.

Solution:

- c. Find the first-year net cost of electricity (\$/kWh) if the system costs \$4 per peak watt (\$4/Wdc,STC), it is paid for with a 5%, 30-yr loan, interest on the loan is tax deductible, and the owner is in a 29% marginal tax bracket.

SOLN:

$$CRF(5\%, 30yr) = \frac{0.05(1.05)^{30}}{(1.05)^{30} - 1} = 0.06505 / yr$$

$$\text{System Cost} = \$4/W \times 2770 W = \$11,080$$

$$\text{Annual payments} = \$11,080 \times 0.06505/yr = \$720.8$$

$$\text{1st year interest} = 0.05 \times \$11,080 = \$554$$

$$\text{Reduced taxes} = \$554 \times 0.29 = \$160.7$$

$$\text{1st year cash flow} = \$720.8 - \$160.7 = \$560$$

$$\text{1st year PV cost} = \$560/4000 kWh = \$0.14 = 14 \text{ ¢/kWh}$$

Problem 2: The PV system for a Daggett (CA) house is designed to generate roughly 5,000 kWh annually. The key cost components are:

<i>component</i>	<i>costs(\$)</i>
<i>PVs</i>	$4.20/W (DC)$
<i>inverter</i>	$1.20/W (DC)$
<i>tracker</i>	$400 + 100/m^2$
<i>installation</i>	4,100

We assume the PVs have a 15 % efficiency and the inverter efficiency is 80 %.

- Calculate** the the costs of a fixed array with a -15° tilt angle
- Calculate** the costs of an array with a single – axis tracker
- State** whether you would like 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 reason.

Solution:

- In the Appendix G of the textbook, the average daily insolation of a fixed array with a 15° tilt angle in Daggett is provided as: $6.5 kWh/m^2 - d$

$$P_{DC, stc} = \frac{5,000}{(0.80)(6.5)(365)} = 2.634 kW_p$$

$$\text{costs of PVs} = 4.20 \times 2,634 = 11,063 \$$$

$$\text{costs of inverters} = 1.20 \times 2,634 = 3,161 \$$$

$$\text{total costs} = \text{costs of PVs} + \text{costs of inverters} + \text{installation costs}$$

$$= 11,063 + 3,161 + 4,100 = 18324 \$$$

- b. In the Appendix G of the textbook, the average daily insolation of an array with a single – axis tracker in Daggett is provided as: $9.1 \text{ kWh/m}^2 - d$

$$P_{DC, stc} = \frac{5,000}{(0.80)(9.1)(365)} = 1.882 \text{ kW}_p$$

$$\text{costs of PVs} = 4.20 \times 1,882 = 7904 \text{ \$}$$

$$\text{costs of inverters} = 1.20 \times 1,882 = 2258 \text{ \$}$$

Given the 15 % efficiency of the PVs, the array area required is

$$\text{area} = \frac{P_{DC, stc}}{(1 \text{ kW/m}^2)(\eta)} = \frac{1.882}{(1)(0.15)} = 12.55 \text{ m}^2$$

$$\text{costs of trackers} = 400 + (12.55 \times 100) = 1655 \text{ \$}$$

$$\text{total costs} = \text{costs of PVs} + \text{costs of inverters} + \text{tracker costs}$$

$$+ \text{ installation costs} = 7,904 + 2,258 + 1,655 + 4,100 = 15917 \text{ \$}.$$

- c. It is more rational to invest in an array with a single-axis tracker, as the resulting total costs of an array with a single – axis tracker is lower than the resulting total costs of a fixed array with a -15° tilt angle.

Problem 3: Circle the correct answer for each statement below –either **True** or **False** or **a.**, **b.**, **c.**, **d.**, or **e.**

- i. The global cumulative *PV* capacity at the end of 2016 is:

a. 30.6 *GW*

b. 150 *GW*

c. 306.5 *GW*

d. 450 *GW*

e. 650 *GW*

- ii. Approximately 33 % of the world's total *PV* capacity makes Europe the world's leading region in terms of cumulative installed capacity at the end of 2016.

True _____

False _____

- iii. Germany has the highest cumulative *PV* capacity at the end of 2016.

True _____

False _____

iv. The *US* state with the largest *PV* capacity additions in 2016 is:

a. Texas

b. California

c. Nevada

d. New York

e. North Carolina

v. The world's largest *PV* plant is located in Potsdam, Germany.

True _____

False _____

vi. The payment foregone by the net metered solar owners are pushing the distribution utilities to shift the collection of the electricity infrastructure to the non-solar-owner customers.

True _____

False _____

vii. Residential and commercial *PV* system installations reduce the amount of electricity such customers purchase from the local utility.

True _____

False _____

viii. China is the country that has the largest share in *PV* manufacturing in 2014.

True _____

False _____

ix. Parabolic trough *CSP* technology employs heliostats collectors with dual-axis trackers to concentrate *DNI* onto a central receiver.

True _____

False _____

x. *US* is the leading nation in total installed *CSP* capacity at the end of 2016.

True _____

False _____

xi. The *US* state that has the highest cumulative *CSP* capacity at the end of 2016 is:

a. Illinois

b. Texas

c. Michigan

d. California

e. Maine

xii. *CSP* with *TES* decreases the range of *CSP LCOE* for parabolic trough *CSP*.

True _____

False _____