

ELEN 280 – Final Exam (Winter 2017)

T/F Questions

1. **YOLO**
2. **F** : Wind turbines become cost effective as size is increased
3. **T**: Storage is the only solution available for integration of larenewable energy.
4. **T**: A Wind turbine extracts kinetic energy for electricity not potential
5. **T**: With continued improvements a single-stage heat engine...able to exceed the efficiencies of the best fuel cells today...
6. **F**: The price of electricity from centralized power plants ...price of fuel and is independent of the capacity factor.
7. **T**: A carbon tax can help determine if one power generation...more economical than another thereby changing finan....
8. **T**: Combined cycle systems generally use a gas turbine to..generator directly and to then recover turbine exhaust...steam generation cycle.
9. **F**: CHP systems are limited to natural gas burning turbine....
10. **T**: Heat driven air-conditioning (e.g. absorption chilled..) are the latest technological breakthrough in AC and ...

Fill in the Blanks:

1. Systems where the heat is recovered when producing electricity are **WASTE HEAT RECOVERING UNIT** system.
2. NIH is an acronym for **NOT INVENTED HERE**
3. A carbon tax is one method for providing incentives for people to...carbon. A second method for reducing carbon production, that has launched in California, is **CAP AND TRADE.**
4. **DUCK CURVE** refers to the curve that is used ...impacts of high levels of solar PV on the grid.
5. **PLANNED OBSOLESCENCE** was coined by ...describe designing for a known time for failure.

QUESTION 1

Use the spreadsheet to calculate the U, UA, total UA and Thermal Index of a house, given a spreadsheet with R Values and Area of each surface. He notes UA(inf) = 0.0018 nV (BTU-hr-F).

Use infiltration to add to the total UA value.

table
6.7 Heat Loss Spreadsheet

House #1: Conventional

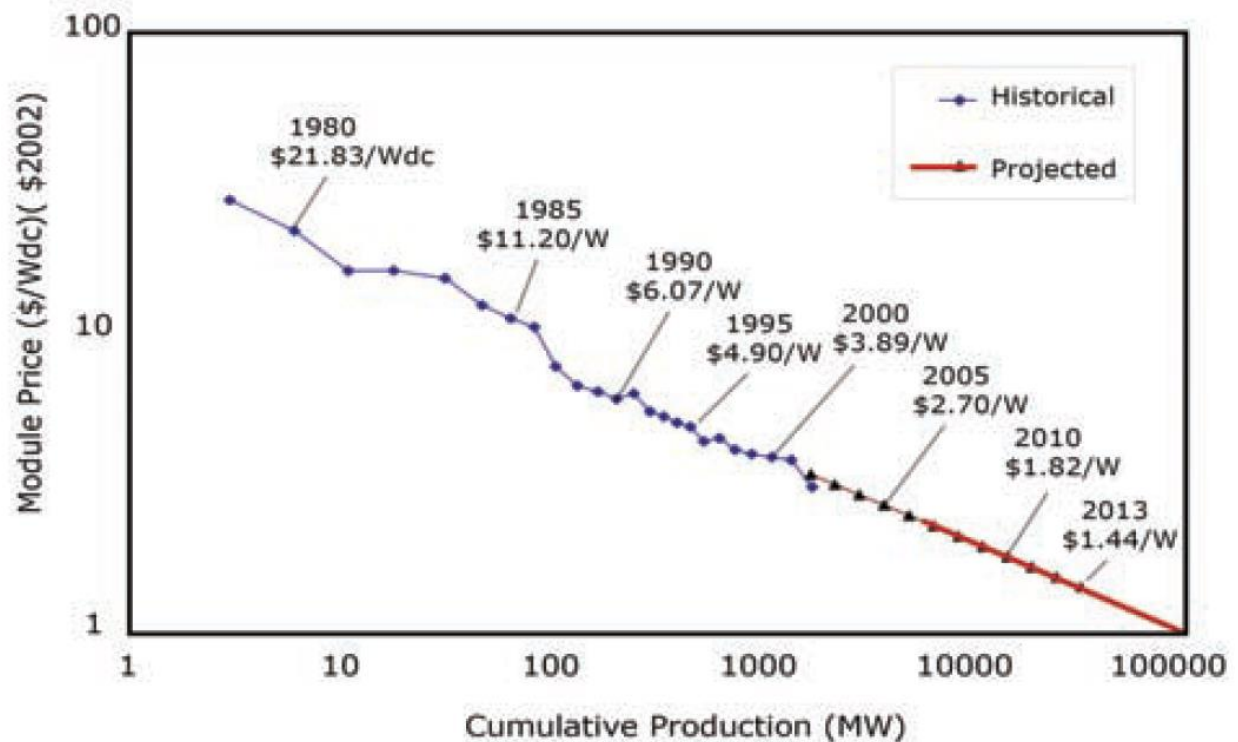
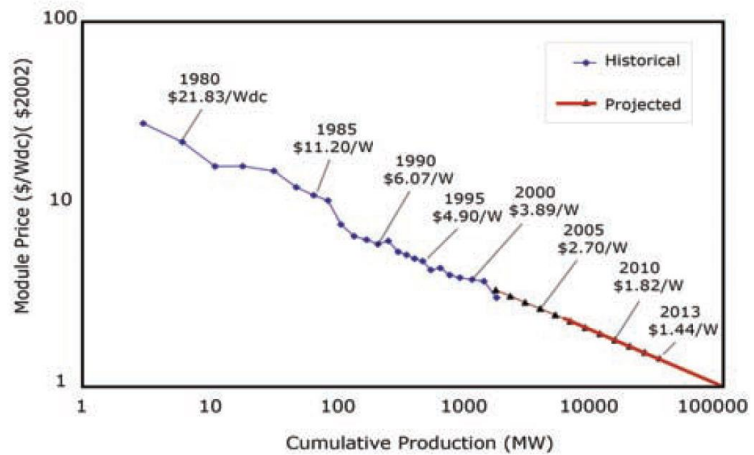
Component	Area (ft ²)	Insulation	<i>R</i>	<i>U</i> = 1/ <i>R</i> *	UA*	% of Total*
Ceiling	1500	R-30 #13	30.3	0.033	49.5	10%
Windows	250	dbl Al #21	1.4	0.714	178.6	37%
Doors	60	No storm #19	2.6	0.385	23.1	5%
Walls	970	R-21 #3	19.2	0.052	50.5	10%
Floors	1500	R-21 #7	29.3	0.034	51.2	11%
	ACH	Volume (ft ³)	Efficiency			
Infiltration	0.6	12,000	0		129.6	27%
Ventilation	0	12,000	70%		0	0%
TOTAL UA-value = 482 Btu/hr-°F						
Thermal Index = 7.7 Btu/ft ² -°F-day						

* Columns are calculated Values. All other information is data entry.

QUESTION 2

figure
11.21

Historical and projected manufacturer's price of PV modules suggests with cumulative production of 100,000 MW, costs might drop to \$1/watt(dc).



2b. Determine the learning coefficient for the curve in part a

$$0.82 = 2^{(-b)}$$

$$-b * \log 2 = \log 0.82$$

$$-b = -0.286$$

$$b = 0.286$$

QUESTION 3

1. Sizing a Solar PV System

The Rusk's own fairly large house near San Francisco and the following spreadsheet shows their month-to-month energy use for two years.

Billing Date	Days Billed	Kwh Billed	Kwh per Day	Payment (\$)	
5/13/12	30	1006	33.5	239.78	
4/12/12	29	1120	38.6	279.68	
3/14/12	32	1136	35.5	273.07	
2/12/12	30	1345	44.8	348.91	
1/12/12	30	1698	56.6	463.58	
12/13/11	32	1577	49.3	414.21	
11/13/11	29	1034	35.7	251.37	
10/13/11	29	952	32.8	227.33	
9/14/11	32	1196	37.4	300.63	
8/14/11	29	1368	47.2	369.63	
7/15/11	30	1519	50.6	424.03	
6/15/11	32	1632	51.0	489.7	
5/15/11	29	1098	37.9	286.44	
4/15/11	31	1139	36.7	289.14	
3/16/11	31	1192	38.5	305.38	
2/13/11	30	1265	42.2	334.9	
1/13/11	29	1775	61.2	546.03	
12/15/10	32	1573	49.2	453.47	
11/14/10	30	1150	38.3	299.02	
10/14/10	29	1107	38.2	289.71	
9/15/10	32	1269	39.7	338.7	
8/15/10	30	1463	48.8	426.99	
7/15/10	30	1545	51.5	459.85	
6/15/10	30	1684	56.1	550.54	
5/14/10	30	1391	46.4		
	Averages	1329.36	43.9		
				8662.09	total

1a. What is their monthly average energy use? Why do you think their use peaks twice a year?

$$\text{Ans) Monthly power average} = \frac{43.9 \text{ kWh/day} * 30 \text{ day}}{24 \text{ hours}} = 53.87 \text{ kW}$$

Use peaks twice a year because the house requires more cooling in the hot summer and more heating in the cold winter.

1b. Calculate the size of the solar PV system (kWh DC,STC) they will need in order to have a zero dollar electricity bill annually (use an average over the two years). Assume that you are using 14.9% efficient panels with an 80% de-rating factor. Also assume that your inverter is 95% efficient. Use an average solar insolation of 5.5kWh/m²/day for their location.

Ans) Since the average kWh per day=43.9 kWh

The annual kWh=43.9*365=16023.5 kWh/yr

$$P_{DC,STC} = \frac{16023.5 \text{ kWh/yr}}{0.8 * 5.5 \text{ hr/day} * 365 \text{ day/yr} * 0.95} = 10.5 \text{ kW}$$

1c. Assume this system will be mounted on the roof. How big will the area of solar collector be? Is this a reasonable size for a house (i.e. are roofs actually this big)?

$$\text{Ans) } A = \frac{P_{DC,STC}}{\eta} = \frac{10.5}{0.149} = 70.4 \text{ m}^2$$

No it is not reasonable size for a house in the United States. South-facing areas are usually less than 70.4 m²

1d. What is the AC,PTC per square meter for the system? Assume that the 80% de-rating factor gets you from DC,STC to DC,PTC.

Ans) (AC,PTC)=0.95 (DC,PTC)

(DC,PTC)=0.8 (DC,STC)

$$\rightarrow (AC,PTC) = 0.95 * 0.8 (DC,STC) = 0.95 * 0.8 * 10.5 \text{ kW} = 7.98 \text{ kW}$$

QUESTION 4

table
14.9 Biodiesel Yield Estimates for Various Sources

Source	Yield (gal/ac)
Corn	15–20
Soybeans	40–50
Safflower	80–90
Sunflower	100–110
Rapeseed	110–130
Palm oil	625–650
Microalgae	5000–15,000

SOURCE: NREL, 1998

Compare the maximum amount of energy that can be recovered from the sun in form of biodiesel versus electricity in one average year on one acre of land. Assume that values in the table are for biofuel that can be produced in one year.

Ans:

1 gallon of diesel produces = 139000 BTUs

1 gallon of diesel produces = 139000 BTU / 3412 BTU/kWh = 40.738 kWh

Source	Yield (kWh)
Corn	611.07 – 814.76
Soybean	1629.52 – 2036.92
Safflower	3259.04 – 3666.42
Sunflower	4073.8 – 4481.18
Rapeseed	4481.18 – 5295.94
Palm Oil	25461.25 – 26479.7
Microalgae	203690 – 611070

**Multiple AC/gal with 40.738 to obtain these values.

Solar Yield:

Solar Insolation: 5.5 kWh/ (m² -day)

Meter squared for 1 acre = 4046.86 m²

Days in year = 365 days

Solar Yield: 5.5 x 4046.86 x 365 = 8,124,071.45 kWh