ENGR290: Renewable Energy

Quiz 2: Time Value of Money, Energy Density and Efficiency

Oct, 10, 2013

Problem 1

A PNM customer saw a commercial that claims she can spin her meter backwards and make all kinds of money by generating power from her roof. She immediately plans to retire off of this income, so she asks you, the SIPI renewable energy experts, to tell her if it is a good idea and if so, how big of a system she should install. Since you are all proficient in time-value-of-money calculations, you tell her that it should take you no more than 15 minutes to do the analysis and give her an answer.

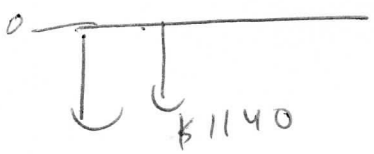
Since Mr. West is such a nice guy, he gave you the very simplified power load distribution shown in Figure 1. On this household, calculate:

1. The total energy consumed by the house each day (kWh) 24 kwh
2. The peak power consumed by the house (kW) 1 kw

Problem 2

Her house is already connected to PNM and they charge $\$0.13/kWh$.

1. Draw a Cash Flow Diagram over 20 years for energy costs of using PNM's electricity.



$\frac{24\text{kwh}}{\text{day}} \frac{\$0.13}{1\text{kwh}} \frac{365\text{day}}{\text{yr}} = \$1140$

2. Calculate the Present value of that cash flow. $11200

$PV = \frac{1140}{0.1019} = \$11,200$

Problem 3

PNM uses "net metering" for renewable energy systems which means at the end of a 6 month cycle, they calculate the net power flow into or out of your system and charge or pay you accordingly. The going "Renewable Energy Credit" rate for a medium sized system is $\$0.05/kWh$. (so they charge you $\$0.13/kWh$ if you use more than you produce, and they pay you $\$0.05/kWh$ if you produce more than you use.)

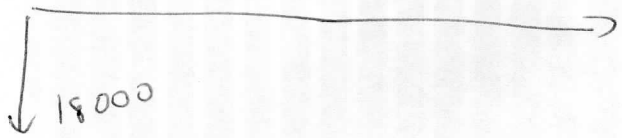
Say a residential sized, grid-tied PV system can be purchased and installed for $\$3/W$ and will produce the normalized power distribution shown in the grossly oversimplified PV power curve in Figure 2. (normalized means the peak of the plot is 1, but you must multiply it by your actual peak to do the energy calculation.)

each day has 4 hrs so $\frac{24 kWh}{4h} = 6kW$

$6kW \cdot 3\$/W = 18000$

First we decide to design a system that will just produce what she uses.

1. Given the daily energy usage from Problem 1, how big should her PV system be (peak kW) to just produce what she uses? 6kW
2. How much will that PV system cost? $18000
3. Draw a Cash Flow Diagram over 20 years for our PV system.



4. Calculate the Present value of that cash flow. 18000
5. How much money will she make (or lose) compared to Problem 2? loose $7800

Problem 4: Extra Credit

Well, it doesn't look like she is getting rich off of that, so she decides to go for broke and put in a 30kW system (she has a very large roof!)

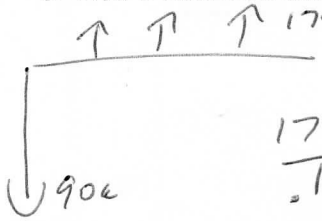
30kw $3 = 90k

1. How much will the 30kW PV system cost? $90k
2. How much net energy will she sell to PNM each year (kWh)? 35000 kwh Generates 30x4 = 120 kw
3. Draw a Cash Flow Diagram over 20 years for this large PV system.

$\frac{120kwh}{day} \cdot \frac{365day}{yr} = 43800 \frac{kwh}{yr}$

Uses 8760

Net 35 kwh



$\frac{1750}{.1019} = \$17k$

$-90 + 17 =$

4. Calculate the Present value of that cash flow. -73k
5. How much money will she make (or lose) compared to Problem 2? -62k
6. How big would her PV system have to be for her to break even? Never happens.

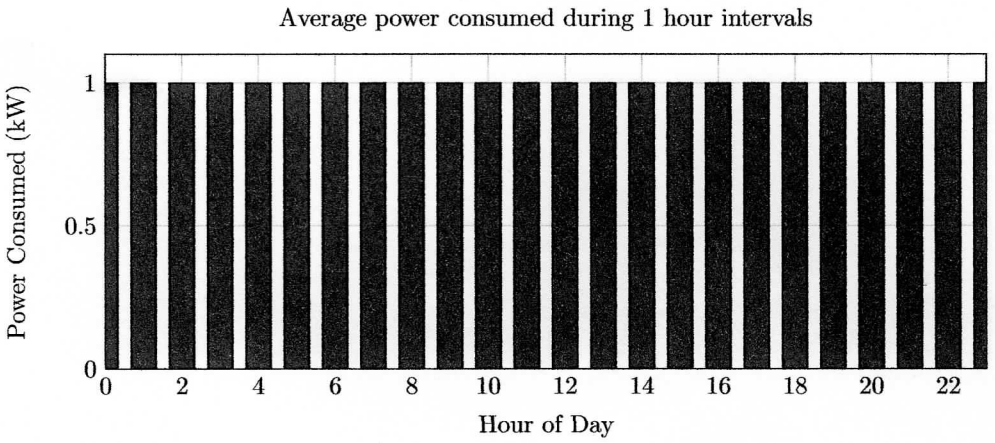


Figure 1: Her (very simplified) household daily power consumption

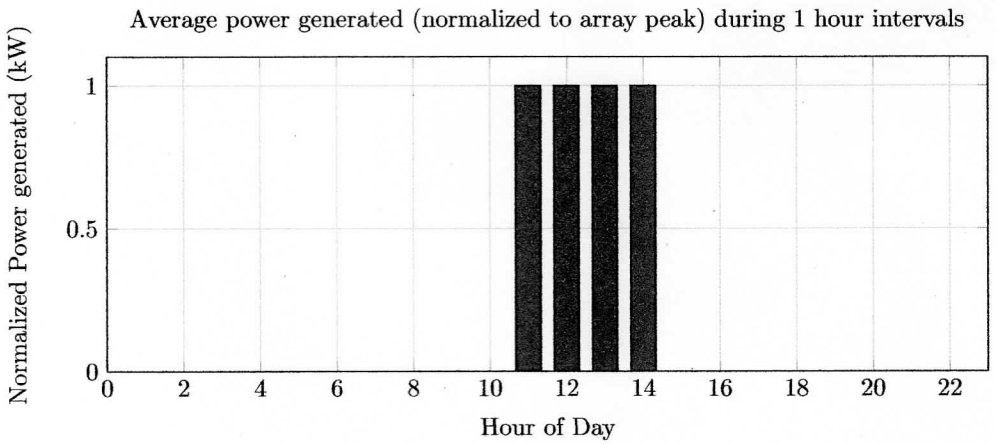


Figure 2: PV power generation curve