PROBLEM SET 3: ENERGY ECONOMICS

Energy and the built environment CRP 570.004/470.004

Total Points: 20 pts
Due Date: 2/18, 12 pm, in class.
Grading: Most of the problems are worth 2 points: 1 point for completion, 1 point for clearly showing all steps of your work. Every number should have a unit next to it (unless it is unitless, like efficiency).

1. Lighting Audit for a single room (14 pts – 2pts each)

- Choose 1 room in your home that has a light fixture that uses the most lighting (it is turned on the most)
- Fill out the information below for this bulb. Just make an estimate of the average hours/night for the bulb (e.g., if the bulb is left on 5 hrs/night for 5 nights/week, the average would be 5/7 * 5hrs/night = 3.6 hrs/night). Get the price of electricity ($/kWh) from your electric bill:

Price of electricity ($/kWh) :

Type of bulb	CFL			
Power (W)	13			
# of bulbs	1			
Hours/night	5			

- Calculate the annual energy (kWh/yr) for the bulb(s) :
  13Wx2x6hrs/nightx365 nights = 28 kWh/yr
- PNM gets about 60% of its electricity from coal, 20% from natural gas, and 20% from nuclear. In 2012 the emissions factor for its electricity was about 0.66 kgCO2/kWh. Calculate how many tons of CO2/year result from your use of this bulb(s) :
  28 kWh/yr x 0.66 kgCO2/kWh x 1ton/1000kg = 0.02 tCO2/yr

- Calculate the variable cost of the bulb (annual electricity cost to operate the bulb(s))
  28 kWh/yr x 0.12 $/kWh = 3.36 $/yr

- Look up information about the bulb (or a similar bulb) on home depots website). Specifically, find the capital cost of the bulb and its estimated lifetime (hours). Using your estimate for nightly use, calculate the lifetime of the bulb in years:
  $10{,}000hrs\ x \frac{day}{5\ hrs} x \frac{yr}{365day} = 5.5yrs$

- Using the formula below, which converts the present value of a cost into annual (or monthly) payments, using a discount rate, calculate the annualized cost of the light bulb. Use a discount rate of 7%. U is the annualized cost of the bulb, P is the present value of the bulb (capital cost), r is the discount rate (7% = 0.07) and n is the lifetime of the bulb (years). Show your work!

$$U = P\left[\frac{r}{1-(1+r)^{-n}}\right] = \$3.00\left[\frac{0.07}{1-(1+0.07)^{-5.5}}\right] = \$0.68$$

- What is the total annualized cost of the bulb:
  Capital Cost ($/yr) + Variable Cost ($/yr) = 0.68$/yr + 3.36 $/yr = 4.04 $/yr

2. Light bulb replacement (6 pts)

- Now, using the spreadsheet provided, calculate the energy savings, $ savings (or costs) , and CO2 savings that would result from switching to a more efficient bulb (either a CFL or LED), with the same light output. *NOTE: the data in the spreadsheet is for a 60W incandescent, 13W CFL, and 11W LED, which put out about 800 lumens. If your lightbulb puts out different lumens, then find the equivalent CFL and LED on Home Depot, look at their specs, and update the cost, power, and lifetime in the spreadsheet.*
- You can use the spreadsheet, so you don't have to show your calculations. (2pts)
  - Energy savings (kWh/yr) 40.15 kWh/yr – 47.45 kWh/yr = -7.3 kWh/yr (savings)
  - $ savings (cost) : $/yr 0.93$/yr – 0.51$/yr = 0.42 $/yr (cost)
  - Emissions savings (kg CO2/yr) 26 kg CO2/yr - 31 kg CO2/yr=-4.8 kg CO2/yr (savings)

- Recalculate the $ savings (cost) by changing the discount rate to 20%. (2pts)
  - $ savings (cost) : $/yr $1.74-$0.71 =$1.03 (cost)

- If there are cost savings for swapping out your bulb, please explain why you haven't done it? Does this mean you have a high or low discount rate? (2 pts)
  In the case of switching from a CFL to an LED, there may or may not be cost savings. It depends upon the wattage of the bulb and the cost of the LED. But switching from an incandescent to an LED/CFL there will always be cost savings due to the longer lifetime and 75% increase in efficiency, causing large savings on the variable cost. As you notices, when the discount rate goes up, the annualized capital cost increases (this is equivalent to saying that it would cost more to borrow money from the bank – you have to pay back at a higher interest rate) so it becomes more expensive for things with higher capital costs. Therefore, if there are cost savings (at reasonable interest rates) for switching to a technology with greater capital costs, but you don't do it, we can say that you are acting as though there is a very high discount rate – you value money in your pocket today much more than buying something more expensive but saving money in the future.