Physics and Mathematics of Sustainable Energy

Finance Exercises

College of the Atlantic

Due Wednesday, October 18, 2017

Guidelines

- You can work on this with a partner and hand in only one writeup. If you opt for this route, I strongly recommend that you each write one of the spreadsheet models. Don't have the same person in the duo write both of the models.

- This should be typed up (not handwritten) and should be reasonably well explained. In particular, but sure to clearly enumerate the various assumptions that you make in your models.

- Email me (or share with me on google docs) the spreadsheets you wrote to answer these questions. Your spreadsheets should use the techniques that I demonstrated in class last week. Namely, all the parameters (system factor, capacity factor, discount rate, etc.) in your model should be in their own cells—nothing should be hidden in a formula. This way you can easily adjust these parameters and see what happens. Also, anything that is a dollar amount should be indicated as such with a "$", and you should round everything to the nearest dollar or perhaps the nearest ten dollars.

The Situations

There are two situations you will analyze and compare: purchasing solar cells and insulating your attic. The basics of each are described below.

Solar PV

- 20 solar panels, 250 Watts (nameplate) each.
- Capacity factor is 0.15.
- Installation cost: $3/Watt.
- The electricity you generate is worth 17 cents per kWh.
- You may (or may not) get a 30% tax credit on the installation costs.
- Assume that the solar panels last for 25 years.

Attic Insulation

- Insulating your attic will cost $15,000.
- Doing so will reduce your heating bill between 20 and 25%.
- You will get a rebate of $1000 off the cost of the insulation.
- You heat your house using oil. Before insulation you used around 3000 gallons of fuel per year.
- Oil prices in Maine for the last 12 years can be found at `http://maine.gov/energy/fuel_prices/archives.shtml`.
- Assume you will own your house for 25 years.

Things to do and Figure Out

Once you have the spreadsheet set up, use it to answer the following questions.

1. For each of the two investments, build a spreadsheet model that you can use to to analyze it.

2. For each investment, calculate the payback time, ROI, NPV, and IRR for the solar cells. Determine the NPV for discount rates of 5 and 10 %.

3. For the solar panels, calculate the above quantities with and without factoring in the 30% tax credit.

Your Report

Suppose that COA is trying to decide between these two choices; there is only funding to do one of these projects. Write a report that will help inform this decision. Assume that your reader understands ROI, NPV, and IRR.

Your report should be structured as follows:

1. Analysis of solar PV. Write a few paragraphs summarizing your analysis of this project. This summary should include not only your values for IRR, payback, NPV, and IRR, but the assumptions that went into these calculations. Include some assessment of risk. How confident are you of your analysis? What are some ranges or bounds for the quantities you calculated? Your analysis should include analysis both with and without the 30% rebate.

2. Analysis of attic insulation. Repeat the above analysis but for the insulation. Be sure to include a discussion of how you handled the uncertainty around the price of heating oil.

3. Recommendation. Which investment do you recommend, and why?

Your report should be typed/word-processed (i.e., not handwritten) and will probably be between two and three pages.

Other, Optional things to Consider

If you have time and the inclination, there are some other considerations you could add to your analysis.

- What happens if the cost of electricity increases by 1% a year?
- What happens if the capacity factor of the solar installation is slightly different?
- What happens if the solar panels only last 20 years? Or if they last 30 years?
- What happens if there is a 2000 state rebate for solar PV? For the attic insulation?
- How does your analysis change if the cost of electricity was 11.3 cents per kWh, as it is in New Mexico?
- How does your analysis change if the cost of electricity was 20.7 cents, as it is in Connecticut?
- A more difficult thing to do would be to compare the two investments in terms of CO_2 saved instead of money.