PS#7, Due in class, Monday, Feb 24

1. You don't have to do this calculation, and you won't be tested in anything so complicated… but you might take a look at it and the solutions. Then look at the Excel Model in the next question. Calculate the busbar cost of electricity from a nuclear plant. Please do this for a 1 GW nuclear electricity generation facility. Assume a 7% discount rate. I provide information below. Do this using the formula we introduced in in the video. a) b) and c) do not use the excel *model* but you should use an Excel Spreadsheet. We will calculate the cost of Nuclear electricity production for a **1 GW** Nuclear power facility. Nuclear Power Plants now have a duty cycle of 90% and a lifetime of 40 years. Then there is the cost of fuel, which last I checked is about 0.635 cents/kWh_e. This means that the cost is 0.635 cents for every kWh of *electricity produced*. They have already divided by the efficiency of the nuclear facility. At present, only ¼ the operating costs are for fuel because nuclear requires a considerable amount of highly paid operators, fire fighters, safety oversight, and people carrying machine guns to protect from possible attack. Read more about the cost of nuclear on the Wikipedia article:
https://en.wikipedia.org/wiki/Economics_of_nuclear_power_plants

a) Assume that the plant is miraculously dropped down the moment you pay the capitol cost and begins generating electricity for a 40-year lifetime. Solve this on an Excel Spreadsheet.
b) Repeat the above problem for a 20-year lifetime.
c) The reality is that nuclear power facilities can take up to 12 years to construct… or have traditionally taken that long in the US. Assume that the citing and capital costs are spread uniformly over the 12-year construction period, with electricity generation beginning in year 13. Please solve this problem by calculating the debt that you have accumulated by the time the facility begins its 40 year operational stint. Hint: It may be best to put all costs into "present value" for t = 12 years, and start the problem at the beginning of the useful lifetime of the facility.

2. You can also do the calculations by using a financial *model* in Excel. You just calculate your balance every year… You go deep into debt and have to pay off the loan. As soon as the facility is finished, you start taking in money and use the surplus to pay off some of your loan. Please download the accompanying Excel File. It is for a Natural Gas Peaker Plant and all the costs are a few years old, before fracking brought down the price of NG. Please note the graph describes the financial balance (y axis) if we were to have taken out a loan from the bank at the indicated interest rate. With the present values, we would pay off the loan in 17 years, but the lifetime might be 40 years so you see that I make a huge amount of money by the end of the 40 years… but the price I am charging for electricity is very high and may not be competitive.
a) Please lower the price of electricity until I take an entire 40 years to pay off the loan. What is this price of electricity? What happens to the required price of electricity for a 40-year lifetime if:

i) I finance the project with a 6% interest rate rather than a 10% interest rate?
ii) The duty cycle is increased to 95%?
iii) The duty cycle drops to 0.05% for a true peaker plant that only runs for 4 hours a year.
iv) The cost of NG doubles?
v) If the facility was a NGCC: (Check capital cost in document at top, efficiency 60%, duty cycle 90%)

b) Solve question #1 by modifying this spreadsheet to correspond to a nuclear facility. Make sure you figure out how the model works before you start changing it. How do I calculate costs? Revenue. See

if you can get the same cost for electricity as you did for question #2 – that would be the price of electricity so that you end up at the end of the lifetime with zero balance.

c) Now that you have a financial model (see Excel Document), please explore what the following changes do to the cost of electricity, stating what the new price of electricity is:

i) a 12 year building time as in #1 part c)

ii) doubling the cost of nuclear fuel (without increasing the rest of the O&M costs)

iii) changing the useable lifetime to 20 years.

iv) a $2 per watt decommission fee at the end of the 40 years. Don't believe me? See: http://en.wikipedia.org/wiki/Nuclear_decommissioning

v) if instead of decommissioning as in part iv) above, you pay off the debt after 40 years, and (*instead*) invest $700 million for two new steam generators, and extend the lifetime of the plant 20 *more* years thereby, and you keep the cost of electricity the same as in iii) above, how much money have you made at the end of the extra 20 years? Don't believe me? See: http://www.ksby.com/news/700-million-steam-generator-replacement-project-nears-an-end-at-diablo-canyon/

3. I used to enjoy driving my jeep that got 20 MPG… some 10,000 miles per year. However, I sold it and bought a used Prius (50 MPG), for a net cost of $10,000! I'm thinking this will last me 6 years nicely.

a) Calculate my annual use of gallons for both vehicles and my annual savings in gallons and dollars.
b) How much less CO_2 will I emit each year (in tons)?
c) What is my cost of conserved energy in $/gallon?
d) What is my cost of abated carbon in $/Ton($CO_2$)?
e) Would a carbon tax be necessary to make this a financially advantageous decision? If so, how much of a carbon tax?
f) Maybe I should keep the car longer than 6 years? What is the payback time of this efficiency investment?
g) Would there be other "additional value" or "disadvantages" not seen in this calculation? Would you do it?