ELEC 481 Homework 4

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Question 1. Potential costs:

- Monetary cost for construction: there would be a large cost associated with the construction of the plant
- Monetary cost for maintenance: each years repairs must be made to ensure safety, plus the annual cost of fuel
- Cost of disposing nuclear waste: large societal (and monetary) cost to dispose of nuclear waste that doesn't decay for a very long time

Potential benefits:

- Cheaper power: power from nuclear plant can be much cheaper than the alternatives, such as solar or wind
- Better long term effects for the environment: if replacing coal/gas, much lower CO2 emissions which improves environmental effects
- Boosting local economy: construction of the plant creates jobs for local community

Stakeholder viewpoints:

- Locals: people who are close to the plant might object due to environmental/economic concerns
- Citizens who get power: people who get power from the plant (not necessarily locals) may appreciate the lower costs or have concerns about the implementation
- Indigenous people: the traditional indigenous land rights should be taken into account if applicable, and they should be consulted since they may have something valuable to say

Question 2. Let B be the PW of benefits and C be the PW of costs. We are trying to solve the optimization problem $\frac{B}{C}$ subject to $B^2 - 18C + 54 = 0$. Substituting these together we get that:

$$\frac{1}{18}\frac{\mathrm{d}}{\mathrm{d}B}\left(\frac{B}{B^2+54}\right) = 0 \implies \frac{B^2+54-2B^2}{(B^2+54)^2} = 0 \implies B = 3\sqrt{6}.$$

Plugging this back into the limitation we find that $C = \frac{108}{18} = \$6$ million and $\frac{B}{C} = 1.225$.

Question 3a. Net benefits:

$$B_A = 2400(P/A, 0.09, 15) = A\frac{(1+i)^n - 1}{i(1+i)^n} = \$19345.65.$$

$$B_B = 5500(P/A, 0.09, 15) = A\frac{(1+i)^n - 1}{i(1+i)^n} = \$44333.79.$$

$$B_C = 9600(P/A, 0.09, 15) = A\frac{(1+i)^n - 1}{i(1+i)^n} = \$77382.61.$$

Net costs:

$$C_A = 10000 + 1000(P/A, 0.09, 15) - \frac{6000}{1.09^{15}} = \$16413.46.$$

$$C_B = 17300 + 2750(P/A, 0.09, 15) - \frac{4400}{1.09^{15}} = \$38258.93.$$

$$C_C = 22000 + 6400(P/A, 0.09, 15) - \frac{14000}{1.09^{15}} = \$69744.87.$$

B/C ratio:

$$B/C_A = 1.179.$$

$$B/C_B = 1.159.$$

$$B/C_C = 1.110.$$

Since all of the ratios are over 1, we must do an incremental analysis to find the best option. We start with A since it has the highest B/C ratio. The B/C ratio for switching to A is 1.14, so it is worth switching. Similarly the ratio for switching from B to C is 1.05, so it makes sense to switch. Therefore according to this analysis the best option is option C.

Question 3b. Present worth:

$$PW_A = B_A - C_A = \$2932.$$

$$PW_B = B_B - C_B = \$6075.$$

$$PW_C = B_C - C_C = \$7638.$$

Sine option C has the highest net present worth, it is the option that will result in the highest total benefit.

Question 3c. We can construct a spreadsheet with the given values as seen in figure 1 for option A for example. Using the excel IRR we then get that:

$$IRR_A = 13.0\%.$$

$$IRR_B = 14.2\%.$$

$$IRR_C = 13.7\%.$$

Start with choice A because it has the lowest cost. We must use incremental analysis to determine the best choice. The incremental IRR to switch to option B is 16.2% (calculated using excel). Since this is above the interest rate of 9% we should switch. Similarly switching from B to C gives us an incremental IRR of 12.3%, so C is the best available option according to this analysis.

Question 3d. Here we can simply take the total cost and divide by annual cost:

$$T_A = \frac{10000}{2400 - 1000} = 8 \text{ years.}$$

$$T_B = \frac{17300}{5500 - 2750} = 7 \text{ years.}$$

$$T_C = \frac{22000}{9600 - 6400} = 7 \text{ years.}$$

year	payment	revenues	sum
0	(10,000)	-	(10,000)
1	(1,000)	2,400	1,400
2	(1,000)	2,400	1,400
3	(1,000)	2,400	1,400
4	(1,000)	2,400	1,400
5	(1,000)	2,400	1,400
6	(1,000)	2,400	1,400
7	(1,000)	2,400	1,400
8	(1,000)	2,400	1,400
9	(1,000)	2,400	1,400
10	(1,000)	2,400	1,400
11	(1,000)	2,400	1,400
12	(1,000)	2,400	1,400
13	(1,000)	2,400	1,400
14	(1,000)	2,400	1,400
15	(1,000)	8,400	7,400

Figure 1: Income stream for project AA

By this analysis we see that B and C both have the lowest payback period, so they are the best. However without rounding option C has the lowest payback period (6.3 years) so it is the best.

Question 4. Break even interest rate is equivalent to the IRR, so using excel we can calculate that. The revenue stream is shown in figure 2, and using the IRR excel function we find that it is equal to 13.7%.

year	payment	revenues	sum
0	(4,000,000)	-	(4,000,000)
1	(450,000)	1,000,000	550,000
2	(450,000)	1,000,000	550,000
3	(450,000)	1,000,000	550,000
4	(450,000)	1,000,000	550,000
5	(450,000)	1,000,000	550,000
6	(450,000)	1,000,000	550,000
7	(450,000)	1,000,000	550,000
8	(450,000)	1,000,000	550,000
9	(450,000)	1,000,000	550,000
10	(450,000)	1,000,000	550,000
11	(450,000)	1,000,000	550,000
12	(450,000)	1,000,000	550,000
13	(450,000)	1,000,000	550,000
14	(450,000)	1,000,000	550,000
15	(450,000)	1,000,000	550,000
16	(450,000)	1,000,000	550,000
17	(450,000)	1,000,000	550,000
18	(450,000)	1,000,000	550,000
19	(450,000)	1,000,000	550,000
20	(450,000)	1,000,000	550,000
21	(450,000)	1,000,000	550,000
22	(450,000)	1,000,000	550,000
23	(450,000)	1,000,000	550,000
24	(450,000)	1,000,000	550,000
25	(450,000)	1,000,000	550,000
26	(450,000)	1,000,000	550,000
27	(450,000)	1,000,000	550,000
28	(450,000)	1,000,000	550,000
29	(450,000)	1,000,000	550,000
30	(450,000)	1,000,000	550,000