Problem Set 3:
Scale and Timing

Part A: Scale--Power Plant for Industrial Park

Situated in the foothills of the Andes is the city of Loma Linda, famous for the captivating beauty of its landscape and meadows. To give an impetus to the economic welfare of this region while given due consideration to environmental effects, the government of Pluton has encouraged industrial projects in this area for the manufacture of electronic products because of their non-polluting nature. In an Electronics Industrial Park, about 200 electronic projects have been commissioned and another 80 projects are under implementation. Some plots are still vacant.

The industrial park is equipped with a 10 megawatt (MW) power plant to cater to the requirements of the industrial units as well as the nearby residential colony. On average, the power requirement is 50 kilowatts (KW) per industrial unit and 1,000 KW for the colony. As a result, there is a shortfall of about 1,000 KW of power, resulting in electricity rationing. Moreover, with the commissioning of an additional 80 projects within the year, this deficit would increase to about 5,000 KW. (1 MW = 1000 KW).

Under the new economic policy which allows the private sector to generate, transmit, and distribute electricity, Fernandez Power Company Pvt. Ltd. (FPCPL) has decided to set up a new power plant in the Loma Linda industrial park. The company belongs to a large diversified industrial group and has a great deal of experience in installing captive power plants.

Ms. Gloria Fernandez, managing director of FPCPL, wants to find the optimal capacity of the power plant expressed in KW. The total cost of this power facility is made up of the capital cost of the power plant, the installation cost, and the cost of fuel and maintenance. The relevant parameters are:

1. Capital costs (C_i) of the Power Plant are captured by the following equation:

$$C_i = C_0 * [(X_i/X_0)^L + N * \{(X_i/X_0)^M - 1\}]$$

where

C_i = Capital costs for power plant of size i
C_0 = Capital cost for the plant of base capacity = 100,000,000 Pesos
X_i = Plant capacity

X_0 = Base plant capacity = 3,000 KW
L = 0.65
M = 2.60
N = 0.10

2. Installation costs ($IC_i = IC_0 * (Xi/X_0)$^H

where

IC_0 = Installation cost for plant of base capacity = 6,000,000 pesos
H is a parameter: H = 0.025

3. The costs of fuel and maintenance are as follows:

Fuel cost (FC) per year,
$FC_i = FC_0 * (X_i/X_0)$^K
FC_0 = 250,000*p, where p, the cost of fuel/liter, is 6 Pesos
K is a parameter; K = 0.90

Annual maintenance costs are 5% of the capital cost of the plant.

4. Depreciation expense, residual value, and project life: Assume that the plant will have a useful life of 15 years regardless of the number of the operating hours per year. Straight line depreciation of the historical costs appropriately measures the declining value of this asset (annual depreciation = investment cost/years of life). Carry out your analysis for 10 years of plant operation. Assume investment occurs in year 0, the plant operates in years 1 through 10 and liquidation occurs in year 11.

5. Hours of generation per day: The plant will operate ten hours per day on average, since the customer electronics industry generally operates on single-shift basis.

6. Days of generation per year: The plant will operate for 300 days per year on average.

7. Tariff per unit of power: the company will charge 2.95 pesos per kilowatt-hour. These rates are comparable to the existing tariff of government-supplied power.

8. The discount rate is 10% per annum.

9. All values are in real terms.

Assignment:
As a consultant, you have been asked to help Ms. Fernandez:

1. Assess whether the base case is financially attractive.

2. Calculate the NPV and IRR for the project at various scales from 3,000 KW to 10,000 KW, in steps of 500 KW.

Based on these calculations, what scale do you choose? Briefly explain your reasoning.

3. Calculate the NPV and IRR of each increment to scale (i.e. the Marginal net present value and the marginal internal rate of return.

Based on these calculations, what scale do you choose? Briefly explain your reasoning.

4. Is your choice in (2) the same as your choice in (3)?

Briefly explain your answer with reference to the underlying relationships between the NPV, the MNPV, the IRR, and the MIRR.

Discuss whether the IRR is a reliable criterion for selecting the optimal scale? What is an appropriate decision rule(s) for selecting the optimal scale of a project?

5. Show in one computer generated graph (ONE only) the relationships between these different measure by showing the discount rate and the NPV, the MNPV, the IRR, and the MIRR as a function of the scale of the plant.

Hints to expedite your work:
1) After obtaining the pro forma cashflows, NPV and IRR for the base capacity,
then use the "Data, Tables" command in Excel to generate cashflows, NPVs, and IRRs for the other scales.

2) To obtain the NPV and IRR of the incremental investments (MNPV and MIRR), subtract the undiscounted net cashflows of scale S from the undiscounted net cashflows of the next scale (S+1) from the previous table.

3) Your spreadsheet is capable of generating graphs with two Y-axes: put NPV and MNPV on one Y axis and IRR and MIRR on the other.

Part B: Timing: Establishing a Lithotripsy Clinic

Dr. E. Rojas, director general of the Bolivar Post Graduate Institute (BPGI), Pluton, is examining the feasibility of starting a lithotripsy service, utilizing a process by which kidney stones are pulverized through shock waves without resorting to surgery. The process has become popular in other large cities over the past few years. The demand for treatment of kidney stones has been rising, and since surgical capacity is limited, there is already a long waiting list of patients at BPGI.

In view of the benefits of this method, Dr. Rojas has obtained the approval of the governing body to establish a lithotripsy clinic with an adequate number of lithotripters and supporting staff. There are three different cost scenarios (see below), and the question before Dr. Rojas is when to set up the clinic in each case.

In Year 0, the capital cost would be 65 million pesos. Annual operating and training costs would be 4 million pesos in Year 1.

The benefits of the lithotripsy clinic come from quicker treatment and the resultant increase in revenue to BPGI. These benefits grow over time because of an expansion in market size that will occur independently of when the clinic is established. The benefits, amounting to 10 million pesos is Year 1, are expected to grow at the rate of 20% per annum.

Use a discount rate of 8%.

The three scenarios are as follow:

Scenario 1: Neither the cost of the clinic nor the operating cost change over time.

Scenario 2: Over time, lithotripters and accessories begin to be assembled in the country, leading to a reduction in capital cost at the rate of 10% per annum. Operating and training costs, on the other hand, are expected to grow at 3% per annum.

Scenario 3: This is the same as Scenario 2, except that with rising demand, indigenous manufacture of lithotripters accelerates, and the resulting economies of scale lead to a greater decline in the capital cost at a rate of 20% per annum.

Assignment

For each of the three scenarios, calculate the following:

a) The optimal year in which to invest.

b) The change in NPV, if any, if the project is implemented in the optimal year rather than in Year 0.