

INTRODUCTION

When planning an energy efficiency or energy management project, the costs involved should always be considered. Therefore, as with any other type of investment, energy management proposals should show the likely return on any capital that is invested.

Consider the case of an energy auditor who advises the senior management of an organisation that capital should be invested in new boiler plant. Inevitably, the management of the organisation would ask:

- ✓ How much will the proposal cost?
- ✓ How much money will be saved by the proposal?

These are, of course, not unreasonable questions, since within any organisation there are many worthy causes, each of which requires funding and it is the job of senior management to invest in capital where it is going to obtain the greatest return. In order to make a decision about any course of action, management needs to be able to appraise all the costs involved in a project and determine the potential returns.



PERFORMANCE FINANCIAL ANALYSIS

This however, is not quite as simple as it might first appear. The capital value of plant or equipment usually decreases with time and it often requires more maintenance as it gets older. If money is borrowed from a bank to finance a project, then interest will have to be paid on the loan.

Inflation too will influence the value of any future energy savings that might be achieved. It is therefore important that the cost appraisal process allows for all these factors, with the aim of determining which investments should be undertaken, and of optimising the benefits achieved. To this end a number of accounting and financial appraisal techniques have been developed which help energy managers and auditors make correct and objective decisions.

The financial issues associated with capital investment in energy saving projects are investigated in this chapter. In particular, the discounted cash flow techniques of net present value and internal rate of return are discussed in detail.



FIXED AND VARIABLE COSTS

When appraising the potential costs involved in a project it is important to understand the difference between fixed and variable costs. Variable costs are those which vary directly with the output of a particular plant or production process, such as fuel costs. Fixed costs are those costs, which are not dependent on plant or process output, such as site-rent and insurance

The total cost of any project is therefore the sum of the fixed and variable costs. Example 1 illustrates how both fixed and variable costs combine to make the total operating cost.

Example 1 The capital cost of the DG set is Rs.9,00,000, the annual output is 219 MWh, and the maintenance cost is Rs.30,000 per annum. The cost of producing each unit of electricity is 3.50 Rs./kWh. The total cost of a diesel generator operating over a 5-year period, taking into consideration both fixed and variable cost is:



EXAMPLE.1

Item	Type of cost	Calculation	Cost
Capital cost of generator	Fixed	-	9,00,000
Annual maintenance	Fixed	30,000 x 5 (years)	1,50,000
Fuel cost	Variable	219,000 x 3.50 x 5	3,83,2500
		Total cost	4,88,2500

From Example 1, it can be seen that the fixed costs represent 21.5% of the total cost. In fact, the annual electricity output of 219 MWh assumes that the plant is operating with an average output of 50 kW. If this output were increased to an average of 70 kW, then the fuel cost would become Rs. 53,65,500, with the result that the fixed costs would drop to

$$UC_{\text{gen}} \times W_{\text{gen}} \times n = FC + (UC_{\text{fuel}} \times W_{\text{gen}} \times n)$$

Where,
 UC_{gen} is the unit cost per kWh of energy bought from utility (Rs./kWh)
 UC_{fuel} is the unit cost per kWh of produced energy (Rs./kWh)
 FC is the fixed costs (Rs.)
 W_{gen} is the average power output (or consumption) (kW)
 n is the number of hours of operation (hours).

The concept of fixed and variable costs can be used to determine the break-even point for a proposed project. The break-even point can be determined by using the following equation.

EXAMPLE 2

If the electricity bought from a utility company costs an average of Rs.4.5/kWh, the breakeven point for the generator described in Example 1, when the average output is 50 kW is given by:

$$4.5 \times 50 \times n = (9,00,000 + 150,000) + (3.5 \times 50 \times n)$$
$$n = 21000 \text{ hours}$$

If the average output is 70 kW, the break-even point is given by:

$$4.5 \times 70 \times n = (9,00,000 + 150,000) + (3.5 \times 70 \times n)$$
$$n = 15000 \text{ hours}$$

Thus, increasing the average output of the generator significantly reduces the breakeven time for the project. This is because the capital investment (i.e. the generator) is being better utilised.

INTEREST CHARGES

In order to finance projects, organizations often borrow money from banks or other lending organizations. Projects financed in this way cost more than similar projects financed from organisation's own funds, because interest charges must be paid on the loan. It is therefore important to understand how interest charges are calculated. Interest charges can be calculated by lending organization in two different ways: simple interest and compound interest.

$$\text{Total Repayment Value (TRV)} = LV + (IR/100 \times LV \times P)$$

Where TRV is the total repayment value (Rs.), LV is the value of initial loan (Rs.), IR is the interest rate (%), and P is the repayment period (years).

(i) **Simple Interest:** If simple interest is applied, then charges are calculated as a fixed percentage of the capital that is borrowed. A fixed interest percentage is applied to each year of the loan and repayments are calculated using the equation.

COMPOUND INTEREST

(ii) **Compound interest:** Compound interest is usually calculated annually (although this is not necessarily the case). The interest charged is calculated as a percentage of the outstanding loan at the end of each time period. It is termed 'compound' because the outstanding loan is the sum of the unpaid capital and the interest charges up to that point. The value of the total repayment can be calculated using the equation.

$$TRV = LV \times (1 + IR/100)^n$$

The techniques involved in calculating simple and compound interest are illustrated in Example 3 given below:

EXAMPLE 3

(i) Assuming simple interest:

$$\begin{aligned}\text{Total repayment} &= 30,00,000 + (10/100 \times 30,00,000 \times 5) = \text{Rs.} 45,00,000 \\ \text{Monthly repayment} &= 45,00,000 / (5 \times 12) = \text{Rs.} 75,000\end{aligned}$$

(ii) Assuming compound interest

$$\begin{aligned}\text{Repayment at end of year 1} &= 30,00,000 + (10/100 \times 30,00,000) = \text{Rs.} 33,00,000 \\ \text{Repayment at end of year 2} &= 33,00,000 + (10/100 \times 33,00,000) = \text{Rs.} 36,30,000\end{aligned}$$

Similarly, the repayments at the end of years 3, 4 and 5 can be calculated:

$$\begin{aligned}\text{Repayment at end of year 3} &= \text{Rs.} 39,93,000 \\ \text{Repayment at end of year 4} &= \text{Rs.} 43,92,300 \\ \text{Repayment at end of year 5} &= \text{Rs.} 48,31,530\end{aligned}$$

Alternatively, the following equation can be used to determine the compound interest repayment value.

$$\begin{aligned}\text{Total repayment value} &= 30,00,000 \times (1 + 10 / 100)^5 = \text{Rs.} 48,31,530 \\ \text{Monthly repayment} &= \frac{4831530}{5 \times 12} = \text{Rs.} 80,525\end{aligned}$$

It can be seen that by using compound interest, the lender recoups an additional Rs.33,1530. It is not surprisingly lenders usually charge compound interest on loans.

A company borrows Rs.3,00,00,00 to finance a new boiler installation. If the interest rate is 10% per annum and the repayment period is 5 years, let us calculate the value of the total repayment and the monthly repayment value, assuming (i) simple interest and (ii) compound interest.

BEYOND
SMART CITIES

THANK YOU

**THE WORLD'S 1ST GREEN TECHNOLOGY
MARKETPLACE**