

# 11. PERFORMING FINANCIAL ANALYSIS

## 11.1 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.

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.

## 11.2 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:

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 16.37% of the total. Thus the average unit cost of production decreases as output increases.

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.

$$UC_{\text{util}} \times W_{\text{av}} \times n = FC + (UC_{\text{prod}} \times W_{\text{av}} \times n)$$

Where,

$UC_{\text{util}}$  is the unit cost per kWh of energy bought from utility (Rs./kWh)

$UC_{\text{prod}}$  is the unit cost per kWh of produced energy (Rs./kWh)

FC is the fixed costs (Rs.)

$W_{\text{av}}$  is the average power output (or consumption) (kW)

n is the number of hours of operation (hours).

### Example 2

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

$$4.5 \times 50 \times n = (9,00,000 + 150000) + (3.5 \times 50 \times n)$$

$$n = 21000 \text{ hours}$$

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

$$4.5 \times 70 \times n = (9,00,000 + 150000) + (3.50 \times 70 \times n)$$

$$n = 15000 \text{ hours}$$

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

## 11.3 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.

(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.

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

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).

(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.

$$\text{TRV} = LV \times (1 + \text{IR}/100)^P$$

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

### Example 3

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.

(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:

$$\text{Repayment at end of year 3} = \text{Rs. } 39,93,000$$

$$\text{Repayment at end of year 4} = \text{Rs. } 43,92,300$$

$$\text{Repayment at end of year 5} = \text{Rs. } 48,31,530$$

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

$$\text{Total repayment value} = 30,00,000 \times (1 + 10 / 100)^5 = \text{Rs. } 48,31,530$$

$$\text{Monthly repayment} = \frac{4831530}{5 \times 12} = \text{Rs. } 80,525$$

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.

## 11.4 Simple Payback Period

This is the simplest technique that can be used to appraise a proposal. The simple payback period can be defined as 'the length of time required for the running total of net savings before depreciation to equal the capital cost of the project'. In theory, once the payback period has ended, all the project capital costs will have been recouped and any additional cost savings achieved can be seen as clear 'profit'. Obviously, the shorter the payback period, the more attractive the project becomes. The length of the maximum permissible payback period generally varies with the business culture concerned. In some companies, payback periods in excess of 3 years are considered acceptable.

The payback period can be calculated using the equation

$$\text{Simple payback period (years)} = \frac{\text{Capital cost of the project (in Rs.)}}{\text{Net Annual savings (in Rs.)}}$$

$$\text{PB} = \frac{\text{CC}}{\text{AS}}$$

Where PB is the payback period (years), CC is the capital cost of the project (Rs.), and AS is the annual net cost saving achieved (Rs.).

The annual net cost saving (AS) is the least savings achieved after all the operational costs have been met. Simple payback period is illustrated in Example 4.

### Example 4

A new small cogeneration plant installation is expected to reduce a company's annual energy bill by Rs.4,86,000. If the capital cost of the new boiler installation is Rs.22,20,000 and the annual maintenance and operating costs are Rs. 42,000, the expected payback period for the project can be worked out as.

### Solution

$$PB = 22,20,000 / (4,86,000 - 42,000) = 5.0 \text{ years}$$

## 11.5 Discounted Cash Flow Methods

The payback method is a simple technique, which can easily be used to provide a quick evaluation of a proposal. However, it has a number of major weaknesses:

- The payback method does not consider savings that are accrued after the payback period has finished.
- The payback method does not consider the fact that money, which is invested, should accrue interest as time passes. In simple terms there is a 'time value' component to cash flows. Thus Rs.1000 today is more valuable than Rs.1000 in 10 years' time.

In order to overcome these weaknesses a number of discounted cash flow techniques have been developed, which are based on the fact that money invested in a bank will accrue annual interest. The two most commonly used techniques are the 'net present value' and the 'internal rate of return' methods.

### Net Present Value Method

The net present value method considers the fact that a cash saving (often referred to as a 'cash flow') of Rs.1000 in year 10 of a project will be worth less than a cash flow of Rs.1000 in year 2. The net present value method achieves this by quantifying the impact of time on any particular future cash flow. This is done by equating each future cash flow to its current value today, in other words determining the *present value* of any future cash flow. The *present value* (PV) is determined by using an assumed interest rate, usually referred to as a *discount rate*. Discounting is the opposite process to compounding. Compounding determines the future value of present cash flows, where" discounting determines the *present value* of future cash flows.

In order to understand the concept of *present vale*, consider the case described in Example 3.

If instead of installing a new cogeneration system, the company invested Rs.22,20,000 in a bank at an annual interest rate of 8%, then:

The value of the sum at the end of year 1 =  $22,20,000 + (0.08 \times 22,20,000) = \text{Rs.}23,97,600$

The value of the sum at the end of year 2 =  $23,97,600 + (0.08 \times 23,97,600) = \text{Rs.}25,89,408$

The value of the investment would grow as compound interest is added, until after n years the value of the sum would be:

$$FV = D \times (1 + IR/100)^n$$

Where FV is the future value of investment in Rs., and D is the value of initial deposit (or investment) in Rs., IR is Interest Rate and n is number of years.

### Example :

The future value of the investment made at present, after 5 years will be:

$$FV = 22,20,000 \times (1 + 8/100)^5 = \text{Rs.}32,61,908.4$$

So in 5 years the initial investment of 22,20,000 will accrue Rs.10,41,908.4 in interest and will be worth Rs.32,61,908.4. Alternatively, it could equally be said that Rs.32,61,908.4 in 5 years time is worth Rs.22,20,000 now (assuming an annual interest rate of 8%). In other words the *present value* of Rs.32,61,908.40 in 5 years time is Rs.22,00,000 now.

The *present value* of an amount of money at any specified time in the future can be determined by the following equation.

$$PV = S \times (1 + IR/100)^{-n}$$

Where PV is the present value of S in n years time (Rs.), and S is the value of cash flow in n years time (Rs.).

The net *present value* method calculates the *present value* of all the yearly cash flows (i.e. capital costs and net savings) incurred or accrued throughout the life of a project, and summates them. Costs are represented as a negative value and savings as a positive value. The sum of all the present values is known as the *net present value* (NPV). The higher the *net present value*, the more attractive the proposed project.

The *present value* of a future cash flow can be determined using the equation above. However, it is common practice to use a *discount factor* (DF) when calculating present value. The discount factor is based on an assumed discount rate (i.e. interest rate) and can be determined by using equation.

$$DF = (1 + IR/100)^{-n}$$

The product of a particular cash flow and the discount factor is the present value.

$$PV = S \times DF$$

The values of various discount factors computed for a range of discount rates (i.e. interest rates) are shown in Table 11.1. The Example 5 illustrates the process involved in a net present value analysis.

<b>TABLE 11.1 COMPUTED DISCOUNT FACTORS</b>								
<b>Discount rate % (or interest rate %)</b>								
<b>Year</b>	<b>2</b>	<b>4</b>	<b>6</b>	<b>8</b>	<b>10</b>	<b>12</b>	<b>14</b>	<b>16</b>
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	0.980	0.962	0.943	0.926	0.909	0.893	0.877	0.862
2	0.961	0.825	0.890	0.857	0.826	0.797	0.769	0.743
3	0.942	0.889	0.840	0.794	0.751	0.712	0.675	0.641
4	0.924	0.855	0.792	0.735	0.683	0.636	0.592	0.552
5	0.906	0.822	0.747	0.681	0.621	0.567	0.519	0.476
6	0.888	0.790	0.705	0.630	0.564	0.507	0.456	0.410
7	0.871	0.760	0.665	0.583	0.513	0.452	0.400	0.354
8	0.853	0.731	0.627	0.540	0.467	0.404	0.351	0.305
9	0.837	0.703	0.592	0.500	0.424	0.361	0.308	0.263
10	0.820	0.676	0.558	0.463	0.386	0.322	0.270	0.227
11	0.804	0.650	0.527	0.429	0.350	0.287	0.237	0.195
12	0.788	0.625	0.497	0.397	0.319	0.257	0.208	0.168
13	0.773	0.601	0.469	0.368	0.290	0.229	0.182	0.145
14	0.758	0.577	0.442	0.340	0.263	0.205	0.160	0.125
15	0.743	0.555	0.417	0.315	0.239	0.183	0.140	0.108
16	0.728	0.534	0.394	0.292	0.218	0.163	0.123	0.093
17	0.714	0.513	0.371	0.270	0.198	0.146	0.108	0.080
18	0.700	0.494	0.350	0.250	0.180	0.130	0.095	0.069
19	0.686	0.475	0.331	0.232	0.164	0.116	0.083	0.060
20	0.673	0.456	0.312	0.215	0.149	0.104	0.073	0.051

### Example 5

Using the net present value analysis technique, let us evaluate the financial merits of the proposed projects shown in the Table below. Assume an annual discount rate of 8% for each project.

	<b>Project – 1</b>	<b>Project – 2</b>
Capital cost (Rs.)	30 000.00	30 000.00
Year	Net annual saving (Rs.)	Net annual saving (Rs.)
1	+6 000.00	+6 600.00
2	+6 000.00	+6 600.00
3	+6 000.00	+6 300.00

4	+6 000.00	+6 300.00
5	+6 000.00	+6 000.00
6	+6 000.00	+6 000.00
7	+6 000.00	+5 700.00
8	+6 000.00	+5 700.00
9	+6 000.00	+5 400.00
10	+6 000.00	+5 400.00
Total net saving at end of year 10	+60 000.00	+ 60 000.00

### Solution

The annual cash flows should be multiplied by the annual discount factors for a rate of 8% to determine the annual present values, as shown in the Table below:

Year	Discount Factor for 8% (a)	Project 1		Project 2	
		Net savings (Rs.) (b)	Present value (Rs.) (a x b)	Net savings (Rs.)	Present value (Rs.) (a x c) (c)
0	1.000	-30 000.00	-30 000.00	-30 000.00	-30 000.00
1	0.926	+6 000.00	+5 556.00	+6 600.00	+6 111.60
2	0.857	+6 000.00	+5 142.00	+6 600.00	+5 656.20
3	0.794	+6 000.00	+4 764.00	+6 300.00	+5 002.20
4	0.735	+6 000.00	+4 410.00	+6 300.00	+4 630.50
5	0.681	+6 000.00	+4 086.00	+6 000.00	+4 086.00
6	0.630	+6 000.00	+3 780.00	+6 000.00	+3 780.00
7	0.583	+6 000.00	+3 498.00	+5 700.00	+3323.10
8	0.540	+6 000.00	+3 240.00	+5 700.00	+3 078.00
9	0.500	+6 000.00	+3 000.00	+5 400.00	+2 700.00
10	0.463	+6 000.00	+2 778.00	+5 400.00	+2 500.20
		<b>NPV = +10 254.00</b>		<b>NPV = +10 867.80</b>	

It can be seen that over a 10 year life-span the *net present value* for Project 1 is Rs.10,254.00, while for Project 2 it is Rs.10,867.80. Therefore Project 2 is the preferential proposal.

The whole credibility of the net present value method depends on a realistic prediction of future interest rates, which can often be unpredictable. It is prudent therefore to set the discount rate slightly above the interest rate at which the capital for the project is borrowed. This will ensure that the overall analysis is slightly pessimistic, thus acting against the inherent uncertainties in predicting future savings.

### Internal rate of return method

It can be seen from Example 5 that both projects returned a positive net present value over 10 years, at a discount rate of 8%. However, if the discount rate were reduced there would come a point when the net present value would become zero. It is clear that the discount rate which must be applied, in order to achieve a net present value of zero, will be higher for Project 2 than for Project 1. This means that the average rate of return for Project 2 is higher than for Project 1, with the result that Project 2 is the better proposition.

The discount rate which achieves a net present value of zero is known as the internal rate of return (IRR). The higher the internal rate of return, the more attractive the project.

Example 6 illustrates how an *internal rate of return* analysis is performed.

### Example 6

A proposed project requires an initial capital investment of Rs.20 000. The cash flows generated by the project are shown in the table below:

Year	Cash flow (Rs.)
0	-20,000.00
1	+6000.00
2	+5500.00
3	+5000.00
4	+4500.00
5	+4000.00
6	+4000.00

Given the above cash flow data, let us find out the internal rate of return for the project.

## Solution

	Cash flow (Rs.) (Rs.)	8% discount rate		12% discount rate		16% discount rate	
		Discount factor	Present value (Rs.)	Discount factor	Present value	Discount factor (Rs.)	Present value
0	-20000	1.000	-20000	1.000	-20000	1.000	-20000
1	6000	0.926	5556	0.893	5358	0.862	5172
2	5500	0.857	4713.5	0.797	4383.5	0.743	4086.5
3	5000	0.794	3970	0.712	3560	0.641	3205
4	4500	0.735	3307.5	0.636	3862	0.552	2484
5	4000	0.681	2724	0.567	2268	0.476	1904
6	4000	0.630	2520	0.507	2028	0.410	1640
		NPV = 2791		NPV = 459.5		NPV = -1508.5	

It can clearly be seen that the discount rate which results in the net present value being zero lies somewhere between 12% and 16%.

For 12% discount rate, NPV is positive; for 16% discount rate, NPV is negative. Thus for some discount rate between 12 and 16 percent, present value benefits are equated to present value costs. To find the value exactly, one can interpolate between the two rates as follows:

$$\text{Internal rate of return} = 0.12 + (0.16 - 0.12) \times \frac{459.5}{(459.5 - (-1508.5))} \times 100$$

$$\text{Internal rate of return} = 0.12 + (0.16 - 0.12) \times \frac{459.5}{(459.5 + 1508.5)} \times 100 = 12.93\%$$

Thus the internal rate of return for the project is 12.93 %. At first sight both the net present value and internal rate of return methods look very similar, and in some respects are. Yet there is an important difference between the two. The net present value method is essentially a comparison tool, which enables a number of projects to be compared, while the internal rate of return method is designed to assess whether or not a single project will achieve a target rate of return.

## Profitability index

Another technique, which can be used to evaluate the financial viability of projects, is the profitability index. The profitability index can be defined as:

$$\text{Profitability index} = \frac{\text{Sum of the discounted net savings}}{\text{Capital costs}}$$

The higher the profitability index, the more attractive the project.

The application of profitability index is illustrated in Example 7.

### Example 7

Determine the profitability index for the projects outlined in Example 5

$$\begin{aligned} \text{For Project 1: Profitability index} &= \frac{10254}{30,000} = 0.342 \\ \text{For Project 2: Profitability index} &= \frac{10867}{30,000} = 0.362 \end{aligned}$$

Project 2 is therefore a better proposal than Project 1.

## 11.6 Factors Affecting Analysis

Although the Examples 5 and 6 illustrate the basic principles associated with the financial analysis of projects, they do not allow for the following important considerations:

- The capital value of plant and equipment generally depreciates over time
- General inflation reduces the value of savings as time progresses. For example, Rs.1000 saved in 1 year's time will be worth more than Rs.1000 saved in 10 years time.

The capital depreciation of an item of equipment can be considered in terms of its salvage value at the end of the analysis period. The Example 8 illustrates the point.

### Example 8

It is proposed to install a heat recovery equipment in a factory. The capital cost of installing the equipment is Rs.20,000 and after 5 years its salvage value is Rs.1500. If the savings accrued by the heat recovery device are as shown below, we have to find out the net present value after 5 years. Discount rate is assumed to be 8%.

#### Data

Year	1	2	3	4	5
	7000	6000	6000	5000	5000

## Solution

Year	Discount Factor for 8% (a)	Capital Investment (Rs.) (b)	Net Savings (Rs.) (c)	Present Value (Rs.) (a) x (b + c)
0	1,000	-20,000.00		-20,000.00
1	0.926		+7000.00	+6482.00
2	0.857		+6000.00	+5142.00
3	0.794		+6000.00	+4764.00
4	0.735		+6000.00	+3675.00
5	0.681	+1,500.00	+5000.00	+4426.50
				<b>NPV = +4489.50</b>

It is evident that over a 5-year life span the net present value of the project is Rs.4489.50. Had the salvage value of the equipment not been considered, the net present value of the project would have been only Rs.3468.00.

## Real value

Inflation can be defined as the rate of increase in the average price of goods and services. In some countries, inflation is expressed in terms of the retail price index (RPI), which is determined centrally and reflects average inflation over a range of commodities. Because of inflation, the real value of cash flow decreases with time. The real value of sum of money (S) realised in n years time can be determined using the equation.

$$RV = S \times (1 + R/100)^{-n}$$

Where RV is the real value of S realized in n years time. S is the value of cash flow in n years time and R is the inflation rate (%).

As with the discount factor it is common practice to use an inflation factor when assessing the impact of inflation on a project. The inflation factor can be determined using the equation.

$$IF = (1 + R/100)^{-n}$$

The product of a particular cash flow and inflation factor is the real value of the cash flow.

$$RV = S \times IF$$

The application of inflation factors is considered in Example 9.

## Example 9

Recalculate the net present value of the energy recovery scheme in Example 8, assuming the discount rate remains at 8% and that the rate of inflation is 5%.

**Solution**

Because of inflation; Real interest rate = Discount rate – Rate of inflation

Therefore Real interest rate =  $8 - 5 = 3\%$

Year	Capital Investment (Rs.)	Net real Savings (Rs.)	Inflation Factor For 5%	Net real Savings (Rs.)	Real Discount Factor For 3%	Present Value (Rs.)
0	-20,000.00		1.000	-20,000.00	1.000	-20,000.00
1		+7000.00	0.952	+6664.00	0.971	+6470.74
2		+6000.00	0.907	+5442.00	0.943	+5131.81
3		+6000.00	0.864	+5184.00	0.915	+4743.36
4		+5000.00	0.823	+4145.00	0.888	+3654.12
5	+1500.00	+5000.00	0.784	+5096.00	0.863	+4397.85
						<b>NPV = +4397.88</b>

The Example 9 shows that when inflation is assumed to be 5%, the net present value of the project reduces from Rs.4489.50 to Rs.4397.88. This is to be expected, because general inflation will always erode the value of future 'profits' accrued by a project.

## QUESTIONS

1.	Why fresh investments are needed for energy conservation in industry ?
2.	Cost of an heat exchanger is Rs.1.00 lakhs. Calculate simple pay back period considering annual saving potential of Rs.60,000/- and annual operating cost of Rs.15,000/-.
3.	What is the main draw back of simple pay back method?
4.	Calculate simple pay back period for a boiler that cost Rs.75.00 lakhs to purchase and Rs.5 lakhs per year on an average to operate and maintain and is expected to save Rs.30 lakhs.
5.	What are the advantages of simple pay back method?
6.	What do you understand by the term " present value of money"?
7.	Define ROI.
8.	What is the objective of carrying out sensitivity analysis?
9.	You are investing Rs.100 in a bank. The bank gives 10% interest per year for two years. What is the present value and what is the future value?

## REFERENCES

1. Energy Management, Supply and Conservation, Dr. Clive Beggs, .Butterworth Heinemann