M6

Energy Economics

Energy economics

- In energy management, investment would be required for reducing the energy consumption of a process or utility.
- Investment would be required for modifications/retrofitting and for incorporating new technology.
- It would be sensible to adopt a systematic approach for merit rating of the different investment options in relation to the anticipated savings.
- It is important to identify the benefits of proposed measure with reference to not only energy savings but also other associated benefits such as increased productivity, improved product quality etc.

Investment Need, Appraisal and Criteria

- For an organization to commit a program of investment in energy efficiency, the energy auditor need to demonstrate
  - The size of the energy problem it currently faces
  - The technical and good housekeeping measure available to reduce waste
  - The predicted return on any investment
  - The real returns achieved on particular measures over time.

Is there any Investments needed in energy conservation???

- For new equipment, process improvements etc.
- To provide staff training
- To implement or upgrade the energy information system

An energy auditor, has to work out how benefits of increased energy efficiency can be best sold to top management as,

- Reducing operating /production costs
- Increasing employee comfort and well-being
- Improving cost-effectiveness and/or profits
- Protecting under-funded core activities
- Enhancing the quality of service or customer care delivered
- Protecting the environment

Cash Flow Model

- Cash Flow (CF) is the increase or decrease in the amount of money a business, institution, or individual has.
- In finance, the term is used to describe the amount of cash (currency) that is generated or consumed in a given time period.
- CF provide information on
  - profitability,
  - quality of earnings,
  - liquidity,
  - risks,
  - capital requirements,
  - future growth,
  - dividends, etc.
- CF is the most important tools for value investment analysis of investment opportunities.

Classifications – based on nature of transaction

1. **Operating activities:**

- cash activities related to net income.
- cash generated from the sale of goods (revenue) and cash paid for goods (expense) are operating activities because revenues and expenses are included in net income.

2. **Investing activities:**

- cash activities related to noncurrent assets.
- Noncurrent assets include (1) long-term investments; (2) property, plant, and equipment; and (3) the principal amount of loans made to other entities.
- For example, cash generated from the sale of land and cash paid for an investment in another company are included in this category.

3. **Financing activities:**

- cash activities related to noncurrent liabilities and owners' equity.
- Noncurrent liabilities and owners' equity items include (1) the principal amount of long-term debt, (2) stock sales and repurchases, and (3) dividend payments.

Time Value of Money

- A project usually requires an investment for the initial cost of installation, called the capital cost, and a series of annual costs (i.e. operating, energy, maintenance, etc.) throughout the life of the project.
- To assess project feasibility, all these present and future cash flows must be equated to a common basis.
- The problem with equating cash flows which occur at different times is that the value of money changes with time.
- The method by which these various cash flows are related is called **discounting,** or the **present value concept.**

- For example, if money can be deposited in the bank at 10% interest, then a Rs.100 deposit will be worth Rs.110 in one year's time. Thus the Rs.110 in one year is a future value equivalent to the Rs.100 present value.

- **Future Value (FV) = NPV $(1 + i)^n$ or NPV = FV / $(1+i)^n$**
- Where
  - FV = Future value of the cash flow
  - *NPV = Net Present Value of the cash flow*
  - i = Interest or discount rate
  - n = Number of years in the future

Evaluation of Proposals

1. The average rate of return method.
2. The payback period method (cash payback period method).
3. The net present value method.
4. The internal rate of return method.

Methods that Do Not Use Present Value		Methods that Use Present Value	
↓	↓	↓	↓
Average rate of return method	Payback period method	net present value method	internal rate of return method

Simple Pay-Back Period

- Simple Payback Period (SPP) is defined as the time (number of years) required to recovering the initial investment (First Cost), considering only the Net Annual Saving:

$$\text{Simple payback period} = \frac{\text{First cost}}{\text{Yearly benefits} - \text{Yearly costs}}$$

SPB=initial investment / periodic cash flow

SPB= years before full recovery + (Unrecovered cost at start of year/ cash flow during the year)

- 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, calculate the expected payback period for the project?.

- 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, calculate the expected payback period for the project?.

- PB = 22,20,000 / (4,86,000 – 42,000) = 5.0 years

- Project x has an initial investment of Rs 10 Lakhs. Its cash flow for five years are 300000, 360000, 300000,264000,240000,.determine pay back period?

- Suppose that a project requires an investment of Rs 20000. it then generates cash inflows of 8000,7000,4000,3000 during the next four years. Determine pay back period

Advantages

- It is simple, both in concept and application. Obviously a shorter payback generally indicates a more attractive investment. It does not use tedious calculations.
- It favors projects, which generate substantial cash inflows in earlier years, and discriminates against projects, which bring substantial cash inflows in later years but not in earlier years.

Limitations

- It fails to consider the time value of money. Cash inflows, in the payback calculation, are simply added without suitable discounting. This violates the most basic principle of financial analysis, which stipulates that cash flows occurring at different points of time can be added or subtracted only after suitable compounding/discounting.
- It ignores cash flows beyond the payback period. This leads to discrimination against projects that generate substantial cash inflows in later years.
- It is a measure of a project's capital recovery, not profitability.

Discounted pay back

- Assume the following cash flows for two projects

Year	Project 1	Project 2
0	-1000	-1000
1	500	100
2	400	300
3	300	400
4	100	600

Assume that the cash flows are occurring at the end of the year. Find out the discounted pay back period for the projects if the discount rate is 10% for both the projects

Year	Cash flow	Discounted cash flow	Cumulative dis CF
1	500	454.5	
2	400	330.6	
3	300		
4	100		

Future Value= Present Value(1+i)^n

Average Rate of Return / Accounting Rate of Return (ARR)

- The ARR is the percentage rate of return expected on an investment or asset as compared to the initial investment cost.
- ARR divides the average revenue from the asset by the initial investment to derive the ratio or return that can be expected over the lifetime of the project.
- ARR does not consider the time value of money or cash flows, which can be an integral part of maintaining a business.

$$ARR = \frac{Average\ annual\ profit}{Initial\ investment}$$

To calculate

$$ARR = \frac{\text{Total profit during project life} \;/\; \text{project number of years}}{\text{initial amount invested (\$)}} \times 100$$

OR

$$ARR = \frac{\text{Average annual net cash flows} - \text{Annual depreciation expense}}{\text{Initial investment}}$$

A project is being considered that has an initial investment of $250,000 and it's forecasted to generate revenue for the next five years. Below are the details:

- Initial investment: Rs 250,000
- Expected revenue per year: Rs 70,000
- Time frame: 5 years
- The ARR is calculated by: Rs 70,000 (annual revenue) / Rs 250,000 (initial cost)
- ARR = .28 or 28%

- Company is planning to undertake another project requiring initial investment of Rs400000 and is expected to generate Rs 100000 in year 1, Rs 200000 in year 2, Rs 180000 in year 3, Rs 120000 in year 4, and Rs 100000 in year 5 . Calculate the average rate of return of the project

- Company y is planning to undertake another project requiring initial investment of Rs400000 and is expected to generate Rs 100000 in year 1, Rs 200000 in year 2, Rs 180000 in year 3, Rs 120000 in year 4, and Rs 100000 in year . Calculate the average rate of return of the project
-

Year	Cah flow in 000s	Cumulative cash flow
0	-400000	-400000
1	100000	300000
2	200000	100000
3	180000	80000
4	120000	200000
5	100000	300000

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3	180000	80000
4	120000	200000
5	100000	300000

With depreciation

Accounting Rate of Return Example

Calculate the Accounting Rate of Return assuming a $30,000 Residual Value

Net Cash Flow		
Years	Amount Invested	Annual
0	$240,000	---
1	---	$100,000
2	---	$80,000
3	---	$50,000
4	---	$50,000
5	---	$50,000
6	---	$30,000

Accounting Rate of Return Example

Calculate the Accounting Rate of Return assuming a $30,000 Residual Value

Net Cash Flow			
Years	Amount Invested	Annual	Accumulated
0	$240,000	---	---
1	---	$100,000	$100,000
2	---	$80,000	$180,000
3	---	$50,000	**$230,000**
4	---	$50,000	**$280,000**
5	---	$50,000	$330,000
6	---	$30,000	$360,000

- Annual cash flows= 100000+80000+50000+50000+50000+30000=360000
- Avg cash flow= 360000/6=60000
- Annual Depreciation = (cost-virtual value)/ years
- = 240000-30000)/6=35000
- ARR= 60000-35000)/240000=10.42%

Internal Rate of Return

- The internal rate of return is the rate of return promised by an investment project over its useful life. It is also referred to as the yield on a project
- The internal rate of return (IRR) of a project is the discount rate, which makes its net present value (NPV) equal to zero .

$$0 = \frac{CF_0}{(1+\kappa)^0} + \frac{CF_1}{(1+\kappa)^1} + \ldots\ldots + \frac{CF_n}{(1+\kappa)^n} = \sum_{t=0}^{n} \frac{CF_t}{(1+\kappa)^t}$$

where CF_t = cash flow at the end of year "t"

κ = discount rate

n = life of the project.

CF^t value will be negative if it is expenditure and positive if it is savings.

- It works very well if a project's cash flows are identical every year. If the annual cash flows are not identical, a trial and error process must be used to find the internal rate of return

General decision rule . . .

If the Internal Rate of Return is . . .	Then the Project is . . .
Equal to or greater than the minimum required rate of return . . .	Acceptable.
Less than the minimum required rate of return . . .	Rejected.

When using the internal rate of return, the cost of capital acts as a hurdle rate that a project must clear for acceptance.

Advantages

- It takes into account the time value of money.
- It considers the cash flow stream in its entirety.
- It makes sense to businessmen who prefer to think in terms of rate of return and find an absolute quantity, like net present value, somewhat difficult to work with.

- **Limitations**

- The internal rate of return figure cannot distinguish between lending and borrowing and hence a high internal rate of return need not necessarily be a desirable feature.

- To illustrate the calculation of internal rate of return,

Year	0	1	2	3	4
Cash flow	100000	30000	30000	40000	45000

The internal rate of return is the value of “ k ” which satisfies the following equation:

$$100{,}000 = \frac{30{,}000}{(1+\kappa)^1} + \frac{30{,}000}{(1+\kappa)^2} + \frac{40{,}000}{(1+\kappa)^3} + \frac{45{,}000}{(1+\kappa)^4}$$

- The cost of a project is Rs 1000. it has a time horizon of 5 years and the expected cash flows are Y1: 200,Y2: 300, Y3 300, Y4:400, Y5: 500.
- Compute IRR of the Project. If the opportunity cost is 2%. Should we accept the project?

Profitability index- Decision making variable to choose a

Present Value of all future cash inflows divided by Initial cash outflows

$$\text{Profitability Index} = \frac{\text{Present Value of all future cash inflows}}{\text{Initial cash outflows}}$$

Project acceptance criteria using Profitability Index method.

Accept the project when $PI > 1$
Reject the project when $PI < 1$
May accept the project when $PI = 1$
Higher the profitability Index of the project, the better.

Note:
For a project with $NPV > 0$, PI is always greater than 1.
For a project with $NPV < 0$, PI is always less than 1

A sum of 25000 invested today in a project may give a series of cash inflows in future as described;

Y1: 5000, Y2 9000, Y3 10000, Y4 10000,Y5 3000

If the required return is 12%. What is the profitability index

PI 1.07

Net Present Value

- 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.
- The net present value (NPV) of a project is equal to the sum of the present values of all the cash flows associated with it.

$$NPV = \frac{CF_0}{(1+\kappa)^0} + \frac{CF_1}{(1+\kappa)^1} + \cdots + \frac{CF_n}{(1+\kappa)^n} = \sum_{t=0}^{n} \frac{CF_t}{(1+\kappa)^t}$$

Where NPV = Net Present Value

CF_t = Cash flow occurring at the end of year 't' (t=0,1,….n)

n = life of the project

κ = Discount rate

To determine net present value we . . .

- Calculate the present value of cash inflows,
- Calculate the present value of cash outflows,
- Subtract the present value of the outflows from the present value of the inflows.

If the Net Present Value is . . .	Then the Project is . . .
Positive . . .	Acceptable because it promises a return greater than the required rate of return.
Zero . . .	Acceptable because it promises a return equal to the required rate of return.
Negative . . .	Not acceptable because it promises a return less than the required rate of return.

NPV

- A sum of 400000 invested today in an IT industry project may give series of below cash in flows
- 70000 in Y1, 120000 in Y2, 140000 in Y3, 140000 in Y4, 40000in Y5. if opportunity of capital is 8% per annum. Then should we accept this project?
- Net Present Value= FV* 1/(1+r)^n

NPV

- A sum of 400000 invested today in an IT industry project may give series of below cash in flows
- 70000 in Y1, 120000 in Y2, 140000 in Y3, 140000 in Y4, 40000in Y5. if opportunity of capital is 15% per annum. Then should we accept this project?
- Net Present Value= FV* 1/(1+r)^n

- Though we have the same inflow of cash in the previous examples, the NPV changed with the change in the discount rate of interest. Thus NPV is dependent in discount rate of interest or the opportunity cost of capital

To illustrate the calculation of net present value, consider a project, which has the following cash flow stream:

Investment	Rs. (1,000,000)
Saving in Year	Cash flow
1	200,000
2	200,000
3	300,000
4	300,000
5	350,000

The cost of capital, κ, for the firm is 10 per cent. The net present value of the proposal is:

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Investment	Rs. (1,000,000)
Saving in Year	Cash flow
1	200,000
2	200,000
3	300,000
4	300,000
5	350,000

The cost of capital, κ, for the firm is 10 per cent. The net present value of the proposal is:

$$NPV = -\frac{1{,}000{,}000}{(1.10)^0} + \frac{200{,}000}{(1.10)^1} + \frac{200{,}000}{(1.10)^2} + \frac{300{,}000}{(1.10)^3} + \frac{300{,}000}{(1.10)^4} + \frac{350{,}000}{(1.10)^5} = (5{,}273)$$

Life Cycle Costing (LCC)

- Life cycle costing, or whole-life costing, is the process of estimating how much money you will spend on an asset over the course of its useful life.
- Whole-life costing covers an asset's costs from the time you purchase it to the time you get rid of it including the costs of acquisition, maintenance, repair, replacement, energy, and any other monetary costs (less any income amounts, such as salvage value) that are affected by the investment decision.
- The time value of money must be taken into account for all amounts, and the amounts must be considered over the relevant period.

To calculate an asset's life cycle cost, estimate the following expenses:

1. Purchase
2. Installation
3. Operating
4. Maintenance
5. Financing (example interest…)
6. Depreciation
7. Disposal