Online Preparatory Training Course For BEE Energy Managers /Energy Auditors Certification Exam 2020

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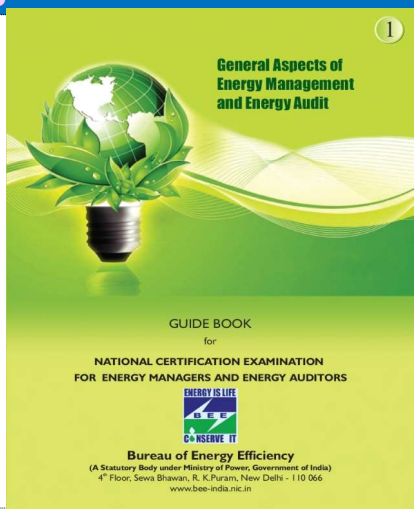
BOOK 1 – GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT

Brief Contents



Chapter-7 Financial Management

Contents

7.1 Introduction

- Energy Projects are very important to the economy and environment.
- Any **capital investment project to be justified** by carrying out a financial appraisal.
- Many energy managers have difficulty in understanding the variety of financial arrangements and use only simple payback analysis. But it will not reveal the added value of after-tax benefits.
- Hence the financial issues associated with the capital investment in energy saving projects are to be investigated

7.2 Investment Need, Appraisal and Criteria

❑ Energy management proposals should show the likely return on any capital that is invested.

❑ It is needed to demonstrate the following to the Top Management for acceptance.

- **Size of the energy problem it currently faces**
- **Technical and good housekeeping measure available to reduce waste**
- **Predicted return on any investment**
- **Real returns achieved on particular measures over time.**

7.3 Financial Analysis Techniques

1. Payback Period:

- Is a measure of how long it will be before the investment makes money, and how long the financing term needs to be

2. Net Present Value (NPV) and Cash Flow:

- Are measures that allow financial planning of the project and provide the company with all the information needed to incorporate energy efficiency projects in to the corporate financial system

3. Return on Investment (ROI) and

4. Internal Rate of Return (IRR)

- Are measures that allow comparison with other investment options

Payback Period

It represents, the time (number of years) required to recover the initial investment (capital cost), considering only the Annual Net Saving (Yearly benefits-Yearly costs).

$$\text{Payback period} = \frac{\text{Capital cost}}{\text{Annual net savings}}$$

Example of Simple Payback Period

A cogeneration system installation is expected to reduce a company's annual energy bill by Rs. 23 Lakhs. If the **capital cost** of the new cogeneration installation is Rs. 90 Lakhs, and the **annual** maintenance and **operating costs** are Rs. 5 Lakhs, what will be the expected payback period for the project?

Simple payback period = $\frac{90}{23-5}$

= **5 years**

Simple Payback 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 **favours** 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 of payback period

- The payback period does not consider savings that are accrued after the payback period has finished

Example 7.2: Drawback of payback period

Which project is better? A or B

Investment	Rs. (100,000)	Rs.(100,000)
Savings in Year	**Cash Flow of A**	**Cash flow of B**
1	50,000	20,000
2	30,000	20,000
3	20,000	20,000
4	10,000	40,000
5	10,000	50,000
6	-	60,000

- The **payback criteria** prefer **Project A** which has a payback period **of 3 years**, in comparison to **Project B** which has a payback period of **4 years**, even though Project B has very substantial cash inflows in years 5 and 6.
- It does not consider the time value of money i.e. money which is invested would accrue interest as time passes.
- Cash inflows 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.**

Return On Investment (ROI)

ROI expresses the annual return from project as % of capital cost.

This is a broad indicator of the annual return expected from initial capital investment, expressed as a percentage

$$ROI = \frac{\text{Annual Net Cash Flow}}{\text{Capital Cost}} \times 100$$

Example : ROI

An outlay of Rs.100,000 for equipment is expected to provide an after-tax cash flow of Rs. 25,000 over a period of six years, without significant annual fluctuations. What is the return on investment?

ROI = Average annual operating cash flow / Net investment

= 25,000 x 100 / 100,000

= 25%

Return On Investment (ROI)

Advantages

- Simple method and easy to calculate
- Returns expressed as percentage makes it easier to evaluate against the borrowing interest

Limitations of ROI

- It does not take into account the time value of money. The measure will give the same answer whether the economic life is 1 year, 10 years, or 100 years.
- It also does not account for the variable nature of annual net cash inflows. The 25 percent return indicated in the Example would be economically valid only if the investment yields Rs. 25,000 per year *in perpetuity* -not a very realistic condition!

Time Value of Money

- If money is 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**.
- In the same manner, Rs.100 received one year from now is only worth Rs.90.91 in today's money (i.e. Rs.90.91 plus 10% interest equals Rs.100).
- Thus Rs.90.91 represents the present value of an Rs.100 cash flow occurring one year in the future. If the interest rate were something different than 10%, then the equivalent present value would also change. The relationship between present and future value is determined as follows:

$$\text{Future Value (FV)} = \text{NPV}\,(1+i)^n \quad \text{or} \quad \text{NPV} = \text{FV} / (1+i)^n$$

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

Net Present Value Method

The net present value method considers the time value of money. Discounting is the opposite process to compounding. **Compounding determines the future value** of present cash flows, whereas **discounting determines the *present value*** of future cash flows.

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. Symbolically

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

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

Discount rate (κ) employed for evaluating the present value of the expected future cash flows should reflect the risk of the project

Net Present Value - Decision

- Represents benefit over and above the compensation for time and risk
- Decision associated with NPV criterion is:
  - **Accept the project if NPV is positive**
  - **Reject the project if NPV is negative**

Example 7.4: NPV

Using the ***net present value*** **analysis technique**, evaluate the financial merits of the two proposed projects shown in the table. The annual discount rate is 8% for each project.

	Project 1	Project 2
Capital cost (Rs.)	30000	30000
Year	Net annual saving (Rs.)	Net annual saving (Rs.)
1	+6000	+6600
2	+6000	+6600
3	+6000	+6300
4	+6000	+6300
5	+6000	+6000
6	+6000	+6000
7	+6000	+5700
8	+6000	+5700
9	+6000	+5400
10	+6000	+5400
Total net savings at end of 10^{th} year	+60000	+60000

For Project 1

$$NPV = -\frac{30000}{(1+0.08)^0} + \frac{6000}{(1+0.08)^1} + \frac{6000}{(1+0.08)^2} + \frac{6000}{(1+0.08)^3} + \frac{6000}{(1+0.08)^4}$$
$$+ \frac{6000}{(1+0.08)^5} + \frac{6000}{(1+0.08)^6} + \frac{6000}{(1+0.08)^7} + \frac{6000}{(1+0.08)^8} + \frac{6000}{(1+0.08)^9} + \frac{6000}{(1+0.08)^{10}}$$

= - 30000 x 1 + 6000 x 0.926 + 6000 x 0.857 + 6000 x 0.794 + 6000 x 0.735 + 6000 x 0.681 + 6000 x 0.630 + 6000 x 0.583 + 6000 x 0.540 + 6000 x 0.500 + 6000 x 0.463

= + 10254

For Project 2

$$NPV = -\frac{30000}{(1+0.08)^0} + \frac{6600}{(1+0.08)^1} + \frac{6600}{(1+0.08)^2} + \frac{6300}{(1+0.08)^3} + \frac{6300}{(1+0.08)^4}$$
$$+ \frac{6000}{(1+0.08)^5} + \frac{6000}{(1+0.08)^6} + \frac{5700}{(1+0.08)^7} + \frac{5700}{(1+0.08)^8} + \frac{5400}{(1+0.08)^9} + \frac{5400}{(1+0.08)^{10}}$$

= - 30000 x 1 + 6600 x 0.926 + 6600 x 0.857 + 6300 x 0.794 + 6300 x 0.735 + 6000 x 0.681 + 6000 x 0.630 + 5700 x 0.583 + 5700 x 0.540 + 5400 x 0.500 + 5400 x 0.463

= + 10867

Advantages

The net present value criterion has considerable merits.

- It takes into account the time value of money.
- It considers the cash flow stream in its project life.

For a 10-year life-span, the **net present value for project 1 is Rs. 10,254**, while for **project 2 it is Rs. 10867**
Therefore project 2 is preferential proposal.

The whole credibility of the net present value depends on a realistic prediction of discount rate which could often be unpredictable. It is prudent to set the discount rate **slightly above the interest rate** at which the capital for the project is borrowed.

Internal Rate of Return Method

By setting the net present value of an investment **to zero** (the minimum value that would make the investment worthwhile), the discount rate can be computed.

The internal rate of return (IRR) of a project is the discount rate, which makes its net present value (NPV) equal to zero. It is the discount rate in the equation:

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

Where, 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.

If this discount rate is greater than current interest rate, the **investment is sound.**

Net present value, can be used to compare alternatives.

The **criterion for selection** among alternatives is to choose the investment with the highest rate of return.

Determining IRR is an iterative process requiring guesses and approximations until a satisfactory answer is derived.

Example 7.5: IRR (Example of iterative procedure to estimate the IRR)

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:

Investment	Rs. 20,000
Saving in Year	Cash flow
1	6000
2	5500
3	5000
4	4500
5	4000
6	4000

The cost of capital (discount rate), κ, for the firm is **8 per cent**.

The net present value of the proposal is:

$$NPV = -\frac{20000}{(1+0.08)^0} + \frac{6000}{(1+0.08)^1} + \frac{5500}{(1+0.08)^2} + \frac{5000}{(1+0.08)^3} + \frac{4500}{(1+0.08)^4} + \frac{4000}{(1+0.08)^5} + \frac{4000}{(1+0.08)^6}$$

$$= -20000 \times 1 + 6000 \times 0.926 + 5500 \times 0.857 + 5000 \times 0.794 + 4500 \times 0.735 + 4000 \times 0.681 + 4000 \times 0.630$$

$$= 2791$$

The discount rate has to be increased to bring NPV to zero.

Increasing the discount rate to 12%,

$$NPV = -\frac{20000}{(1+0.12)^0} + \frac{6000}{(1+0.12)^1} + \frac{5500}{(1+0.12)^2} + \frac{5000}{(1+0.12)^3} + \frac{4500}{(1+0.12)^4} + \frac{4000}{(1+0.12)^5} + \frac{4000}{(1+0.12)^6}$$

$$= -20000 \times 1 + 6000 \times 0.893 + 5500 \times 0.797 + 5000 \times 0.712 + 4500 \times 0.636 + 4000 \times 0.567 + 4000 \times 0.507$$

$$= 495$$

Further increasing the discount rate to 16%

$$NPV = -\frac{20000}{(1+0.16)^0} + \frac{6000}{(1+0.16)^1} + \frac{5500}{(1+0.16)^2} + \frac{5000}{(1+0.16)^3} + \frac{4500}{(1+0.16)^4} + \frac{4000}{(1+0.16)^5} + \frac{4000}{(1+0.16)^6}$$

$= -20000 \times 1 + 6000 \times 0.862 + 5500 \times 0.743 + 5000 \times 0.641 + 4500 \times 0.552 + 4000 \times 0.476 + 4000 \times 0.410$

$= -1508.5$

For a discount rate of 13%

$$NPV = -\frac{20000}{(1+0.13)^0} + \frac{6000}{(1+0.13)^1} + \frac{5500}{(1+0.13)^2} + \frac{5000}{(1+0.13)^3} + \frac{4500}{(1+0.13)^4} + \frac{4000}{(1+0.13)^5} + \frac{4000}{(1+0.13)^6}$$

$= -20000 \times 1 + 6000 \times 0.885 + 5500 \times 0.783 + 5000 \times 0.693 + 4500 \times 0.613 + 4000 \times 0.543 + 4000 \times 0.480$

$= -65$

It can be clearly seen that the discount rate which results in the net present value being zero lies somewhere between 12% and 13%. It is closer to 13%.

By interpolation Method

NPV at 13% = -65
NPV at 12% = +495

$$IRR = \text{Lower rate} + \frac{\text{NPV at lower rate} \times (\text{Higher rate} - \text{lower rate})}{(\text{NPV at lower rate} - \text{NPV at higher rate})}$$

$$IRR = 12 + \frac{495 \times (13-12)}{495 - (-65)}$$

$= 12.88\ \%$

By Graphical Method

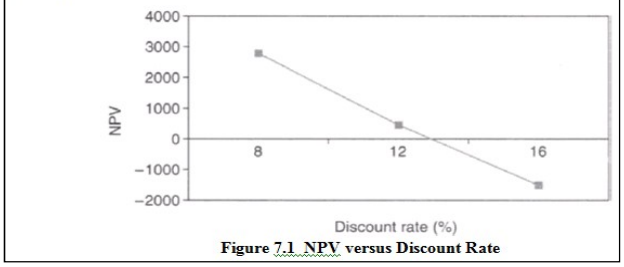


Figure 7.1 NPV versus Discount Rate

the IRR for the project from graph is 12.88%.

Advantages

The internal rate of return criterion has several 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.

Comparison between Net Present Value and Internal Rate of Return

In the net present value calculation, **NPV of the project** is determined **by assuming that the discount rate** (cost of capital) is known.

In the internal rate of return calculation, **we set the net present value equal to zero** and determine the discount rate (internal rate of return), which satisfies this condition.

The *net present value* method is essentially a comparison tool which enables number of different 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.

7.4 Cash Flow

Capital Investment Considerations

To judge the attractiveness of any investment, we must consider the following four elements involved in the decision:

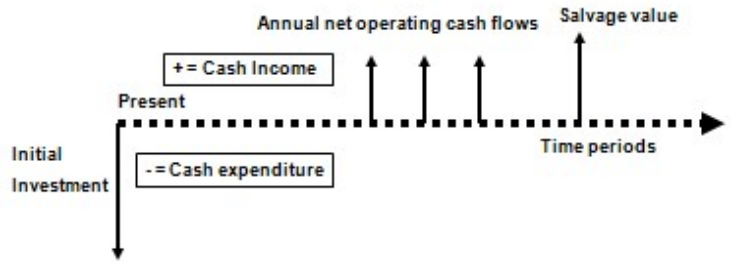
1. Initial capital cost or net investment
2. Net operating cash inflows (the potential benefits)
3. Economic life (time span of benefits)
4. Salvage value (any final recovery of capital)

A convenient way to display the revenues and costs associated with an investment is a *cash flow diagram*.

By using diagram, the timing of the cash flows is clear and the chances of properly applying time value of money concepts are increased

Rules for cash flow diagram
Arrows always point away from the time axis
Arrows pointing up are income
Arrows pointing down are expenses
Arrows can be summed in the same year
Arrows can be summed in the same year

Cash Flow Diagrams



Sensitivity Analysis

- Almost all the cash flow methods involve uncertainty
- Sensitivity analysis is assessment of risk
- Recommended for projects whose feasibility is marginal
- Assesses how sensitive the project to changes in input parameters
- What if one or more factors are different from what is predicted?
- Use of spreadsheets (with built-in what if?) is recommended

The various micro and macro factors that are considered for the sensitivity analysis are listed below.

Micro factors

- ✓ Operating expenses *(various expenses items)*
- ✓ Capital structure
- ✓ Costs of debt, equity
- ✓ Changing of the forms of finance *e.g. leasing*
- ✓ Changing the project life

Macro factors

Macro economic variables are the variable that affects the operation of the industry. They cannot be changed by the firm's management.

- ✓ Changes in interest rates
- ✓ Changes in the tax rates
- ✓ Changes in depreciation rates
- ✓ if the government changes the salary scales
- ✓ Imposition of regulations on environmental issues
- ✓ Energy Price change
- ✓ Technology changes

7.6 Financing Options

The **process of obtaining funds** for capital investment **is called financing.** The various conventional financing options are:

- ✓Debt financing
- ✓Equity financing
- ✓Retained earnings
- ✓Capital lease
- ✓True lease
- ✓Performance contracting

7.7 Energy Performance Contracting and Role of ESCOs

Energy Performance contracting is a unique arrangement that allows the industry to make necessary improvements in energy efficiency
The contractor is purchasing and installing the equipment, and also doing maintenance throughout the contract.

Only after the installed equipment actually reduces expenses **does the contractor get paid**.
Energy service companies (ESCOs) typically serve as contractors within this line of business

What are ESCOs?
ESCOs are usually companies that provide a complete energy project service, from assessment to design to construction or installation, along with engineering and project management services, and financing.

Types of Performance Contracting

Fixed fee

- **Shared savings**
- **Guaranteed savings**

In **fixed fee**, ESCO conducts an audit, designs the project and either assists the customer or simply advises the customer for a **fixed lump-sum fee**.

In **shared savings**, ESCO designs, **finances** and implements the project, verifies energy savings and shares an agreed percentage of the actual energy savings over a fixed period with the customer. The more energy saved, the higher the revenues to both
In **guaranteed savings**, ESCO designs and implements the project **but does not finance** it,.
The ESCO guarantees that the energy savings bill be sufficient to cover debt service payments.
Energy Saved = Baseline – Current +/- Adjustment

Role of ESCOs

It has become a customer-driven industry and the customer typically has a selection of ESCO services from which to choose (Fig). Services offered by an ESCO usually include:

- ✓***An investment grade energy audit*** to identify energy and operational savings opportunities, asses risks, mitigating strategies, and calculate cost-effectiveness of proposed measures over time;
- ✓Financing from its own resources or through arrangements with banks
- ✓The purchase, installation and maintenance of the installed energy efficient equipment
- ✓Training of O&M personnel in energy-efficient practices;
- ✓Monitoring of the operations and energy savings
- ✓Measurement and savings verification; and
- ✓A guarantee of the energy savings to be achieved.

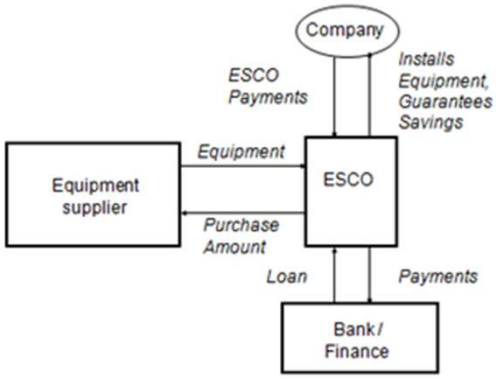


Figure 7.3 Role of ESCO

7.9 A Case Study - Energy Efficiency in Buildings through ESCO

Project

ABC is one of buildings taken up for implementation of Energy Efficiency Measures (EEMs) under performance contracting.

The investment grade energy audit was conducted. The energy audit included collection of past energy consumption data and field-testing of various energy consuming equipment and systems.

Summary of EEMs A brief overview of EEMs is presented in table below:

Table 7.1 Overview of Energy Efficiency Measures

S.No.	Area	Brief Description
1.	Lighting	Retrofit based on Design and Technology for task lighting
2.	Air Conditioning	Replacement of Window and Split ACs with Centrifugal Chiller based Central AC System
3.	Winter Heating	With the infrastructure available for central cooling distribution system, it is possible to use the same for Central Heating System in winter at marginal cost
4.	Pumping System	Replacement of existing pumps with the more efficient pumps and piping modification for more efficient pumping
5.	Canteen Heating	Replacing Electrical heating with LPG heating

The total energy reduction potential is estimated to be 39% in energy consumption and 33% in energy bill.

Performance Measurement and Verification (PMV)

The PMV would ensure that the guaranteed savings have been achieved. The whole facility PMV has been selected for establishing baseline and post implementation verification. After the implementation of project, the actual savings is calculated based on the facility utility bills after making adjustments.

Baseline Power Consumption

The present power consumption based on the analysis of three years energy bill and adjusting the errors in the metering

Savings Guarantees

The contractor guarantees that in each year of the term following substantial completion, the facility owner will realize the savings of at least 7,93,250 kWh (95% of the proposed 39% savings of approximately 8,35,000 kWh)

Term of Contract

The term of the Performance Contract and Maintenance services **is 5 years** from the day of Project.

Energy Saving Payments

The energy savings would be shared between contractor and facility owner in the **ratio of 95% for contractor** and **5% for owner for the first three years** and in the ratio of **90% for contractor and 10% for owner** in the **fourth and fifth year**. **From the sixth year**, the asset would be transferred to the host at the end of the contract period at nominal cost.

Solved Example:

An oil fired reheating furnace heats steel billets from 40°C to 1220°C at a furnace efficiency of 28%. The furnace operates for 4700 hours per annum. The GCV of furnace oil is 10,000 kcal /kg and density is 0.94kg/litre. The cost of furnace oil is Rs.45 /liter. The specific heat of billets is 0.12 kcal/kg°C.

- Calculate the amount of energy necessary to heat 12 tons of steel billets per hour
- Calculate liters of furnace oil fired per tons of steel billets.
- If the efficiency of the furnace is improved from 28% to 30% by adopting ceramic fibre insulation, calculate the hourly furnace oil cost saving
- What is the simple payback period if the investment is Rs. 20 lakhs ?

How large could be the investment to improve the efficiency at an internal rate of 16% and per year over 6 years

Ans:

a) Amount of energy necessary to heat 12 tons of steel billets

= m x cp x $\triangle$ t

= 12000 Kgs x 0.12 x (1220- 40) kCals/hr

= 16,99,200 Kcals/hr

b) Litres of furnace oil fired per ton of steel billet

= [(1699200/12)]

= 141600 Kcal/ tonne of billet

Input energy per ton of billet = 141160/0.28

= 505714 kcal/ tonne of billet

Furnace oil required in kg = $\frac{505714}{10,000}$

= 50.57 Kg/ tonne of billet

Furnace oil required in litres= $\frac{50.57}{0.94}$

= 53.79 litres/ tonne of billet

c) Hourly furnace oil cost savings/ton

= 53.79 x [1 – (0.28/0.30)] * Rs 45

= Rs 161.37/tonne

Hourly furnace oil cost savings for 12 tons

= Rs 161.37 *12

=Rs 1936/hr

d) Simple payback period @ 4700 hrs of operation

=20,00,000/1936*4700

= 0.352 yrs or 4.2 months

e) Net cash inflow per annum = 1936*4700

= Rs 91.0 lakhs

$$\text{Investment} = 91.0 \left[\frac{1}{1.16} + \frac{1}{(1.16)^2} + \frac{1}{(1.16)^3} + \frac{1}{(1.16)^4} + \frac{1}{(1.16)^5} + \frac{1}{(1.16)^6} \right]$$

$$= 91.0 [0.862 + 0.743 + 0.641 + 0.552 + 0.476 + 0.410]$$

= Rs. 3.35 Crores

Objective Type Questions

1.	**What does the concept of time value of money imply** a) present value of money b) future value of money c) discounting of cash flows d) all of the above
2.	**Return on Investment (ROI) as a fraction means** a) initial investment / annual return b) annual cost / cost of capital c) annual net cash flow / capital cost d) none of the above.
3.	**The net present value (NPV) is** a) equal to the sum of the present values of all cash flows b) equal to the sum of returns c) equal to the sum of all cash flows d) none of the above
4.	**The Internal Rate of Return (IRR), of an investment is calculated by** a) selecting a discount rate so that NPV = 0 b) equating total discounted costs with total discounted benefits c) making sure the benefit / cost ratio equals unity d) all of the above
5.	Assume project A has an IRR of 85% and NPV of Rs 15,000 and project B has an IRR of 25% and NPV of 200,000. Which project would you implement first if financing is available and project technical life is the same? a) B b) A c) cannot be decided d) question does not make sense

Practice Assignments

Solve the problems step by step and submit by email

S-1	100 numbers of fused 60 Watt incandescent light bulbs (ILB) are replaced by same numbers of 12 Watt CFL instead of new ILB. Calculate the following for 4000 hours of operation per year. (i) The annual reduction in electricity costs if Rs. 4 per kWh is the energy charge and Rs. 250 per kVA per month is the demand charge. (ii) The simple payback period if the ILB costs Rs. 10 and the CFL costs Rs. 100 (assume life of ILB and CFL as 1000 hours and 4000 hours respectively).

L-1	A company invests Rs.10 lakhs and completes an energy efficiency project at the beginning of year 1. The firm is investing its own money and expects an internal rate of return, IRR, of at least 26% on constant positive annual net cash flow of Rs.2 lakhs, over a period of 10 years, starting with year 1. 1. Will the project meet the firm's expectations? 2. What is the IRR of this measure?

Thank You

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