Lecture – 6A

Energy Resources, Economics and Environment

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Energy Economics

Example problem

A 100 h.p. motor is being used to run a pump in a process industry. The motor can be retrofitted with a variable speed drive that costs Rs. 8 lakhs. The motor runs for 7000 hours annually (3000 hours at part load). Take 90% as the full load efficiency. During part load operation, an average saving of 30 % of the full load consumption is possible with the variable speed drive (VSD). The life of the VSD can be taken as 10 years. The electricity price is Rs. 5 Rs/kWh. The minimum (real) rate of return on investment for the company is 30%. Calculate the simple payback period, Net Present Value, Benefit/Cost ratio, IRR, Cost of Saved Energy for the VSD. Comment on the viability of the VSD.

Annualised Life Cycle Cost

- Annualised Life Cycle Costs (ALCC) - annual cost of owning and operating equipment
- $ALCC = C_0\ CRF(d,n) + AC_f + AC_{O\&M}$
- $CRF(d,n) = [d(1+d)^n]/[(1+d)^n-1]$
- discount rate d, Life n years, C_0 Capital Cost, AC_f, $AC_{O\&M}$, annual cost - fuel and O&M CRF – Capital recovery factor

Energy Efficient Refrigerator

- The cost of a standard refrigerator is Rs 10,000 and the expected electricity consumption per year is 450 kWh. The cost of an energy efficient refrigerator of the same capacity (and with the same features) is Rs 10,500. For the same load, the annual electricity consumption is expected to be 400 kWh. What is the cost of saved energy? The life of the refrigerator can be taken as 10 years.

Cost of Saved Energy

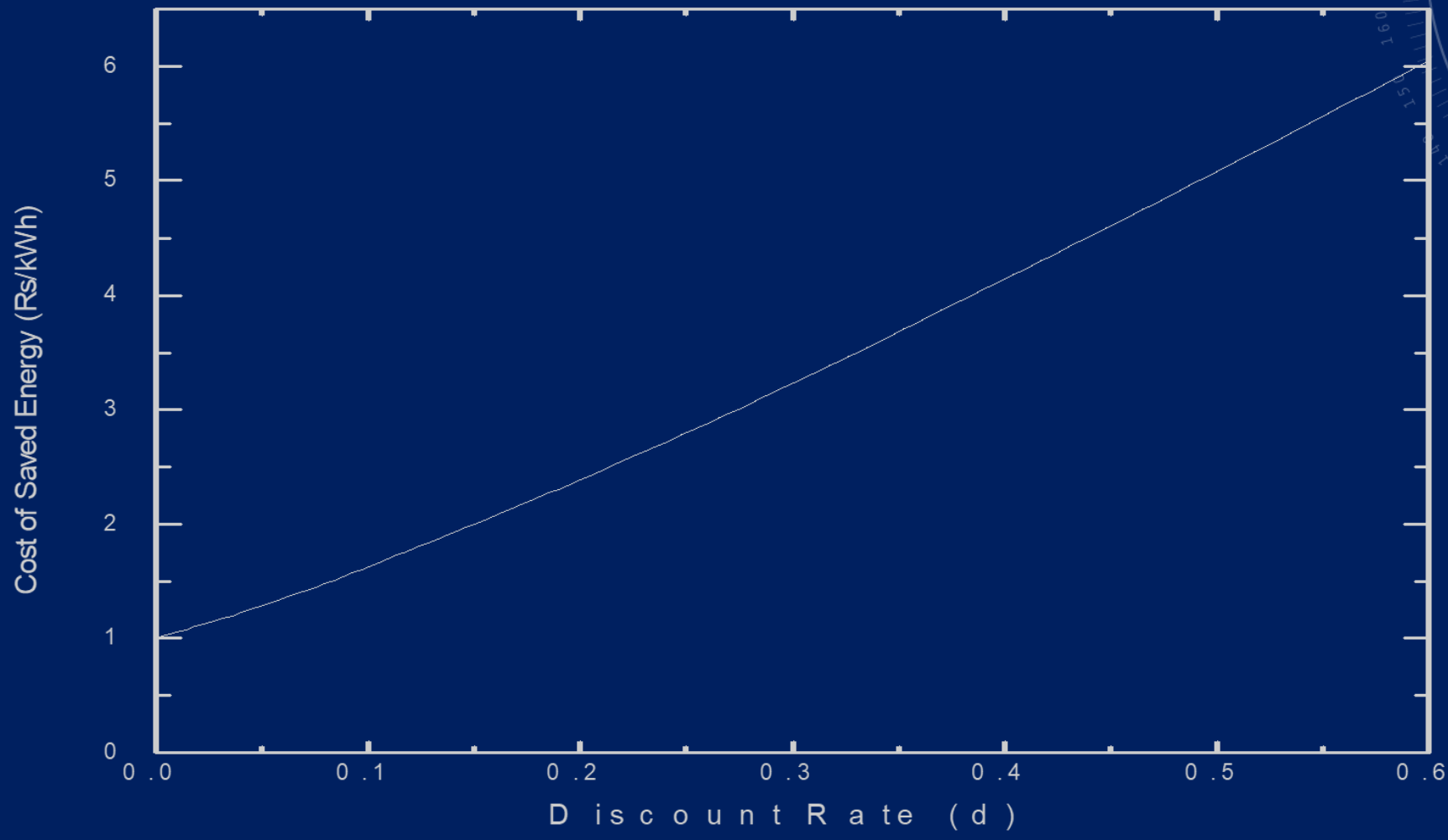
CSE = Annualised Investment / Annual Energy Saving

$= C_0 \, CRF(d,n) / ES$

Unit: Rs/(energy unit)

viz. Rs/kWh, Rs/kJ, Rs/kg of coal, Rs/litre of oil.

Refrigerator Example



Depreciation

Accounting concept

Annual depreciation (A_D)is

$A_D = (C_0 - S)/n$

S is the salvage value at the end of the life of the equipment

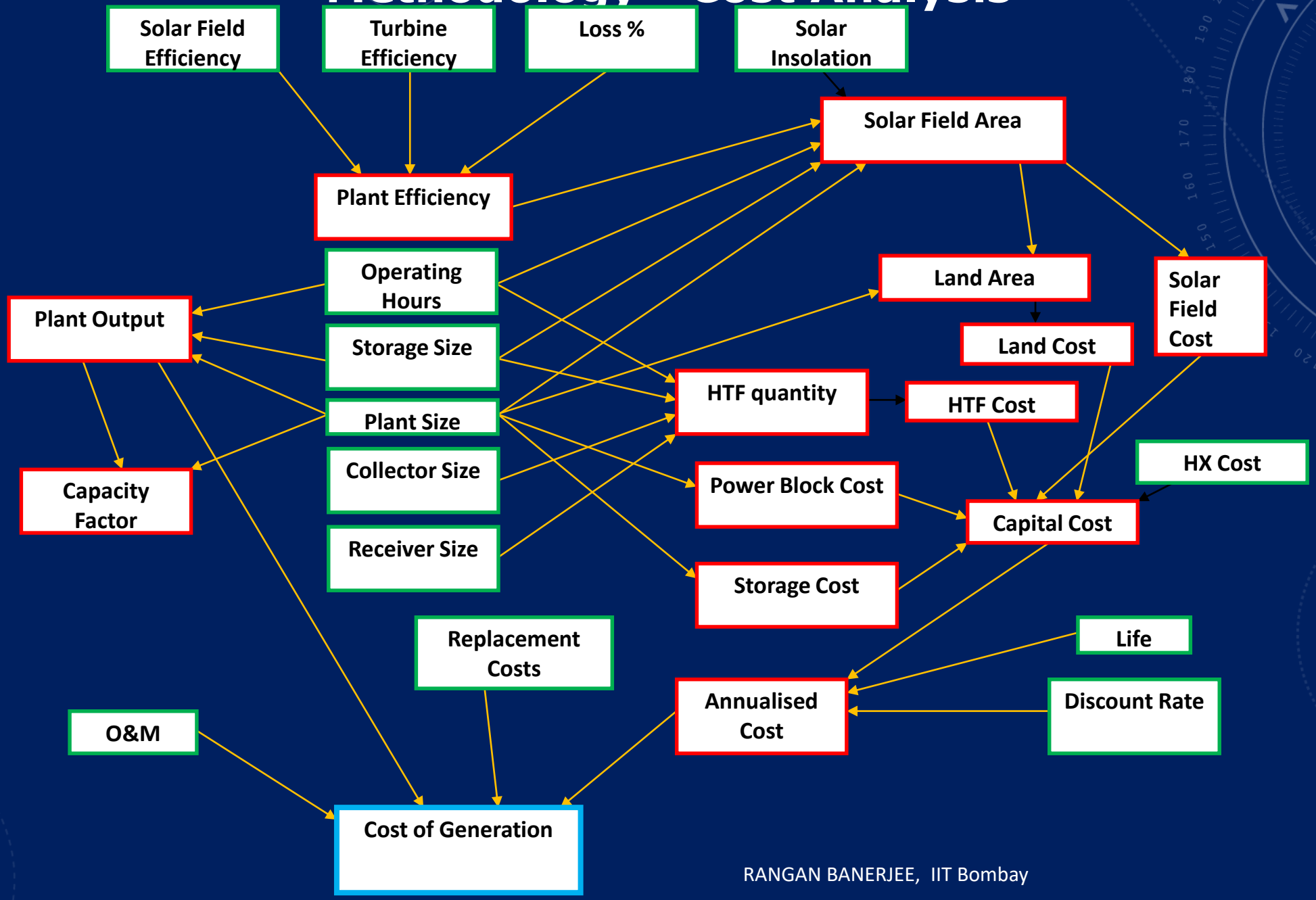
$A_D = C_0/n$ (if S=0)

Tax = t A_D where t is the tax rate

Tutorial problem 2 Solar Water Heater

- Capital cost Rs 400,000 (4L-1.5L)/20 = 12500
- Annual savings Rs 150,000 Life 20 years
- Discount rate 30%
- 100% accelerated depreciation
- Tax rate 30% 12500 * 0.3 = 3750

Methodology - Cost Analysis



Solar Water Heater (Flat plate)

	Area	Cost	Viability
Residential Single	$2m^2$, 125lpd	20000	SPP 7.9 years CSE Rs 6.78/kWh
Six-Res HH	4 m^2 250 lpd	40000	SPP 2.4 years CSE Rs 1.99/kWh
Hospital 20 beds	16 m^2 1000 lpd	1.6 lakh	SPP 3.2 years CSE Rs 2.68/kWh
Hotel 30 rooms	34 m^2 2125lpd	3.4 lakh	SPP 3.9 years CSE Rs 3.31/kWh

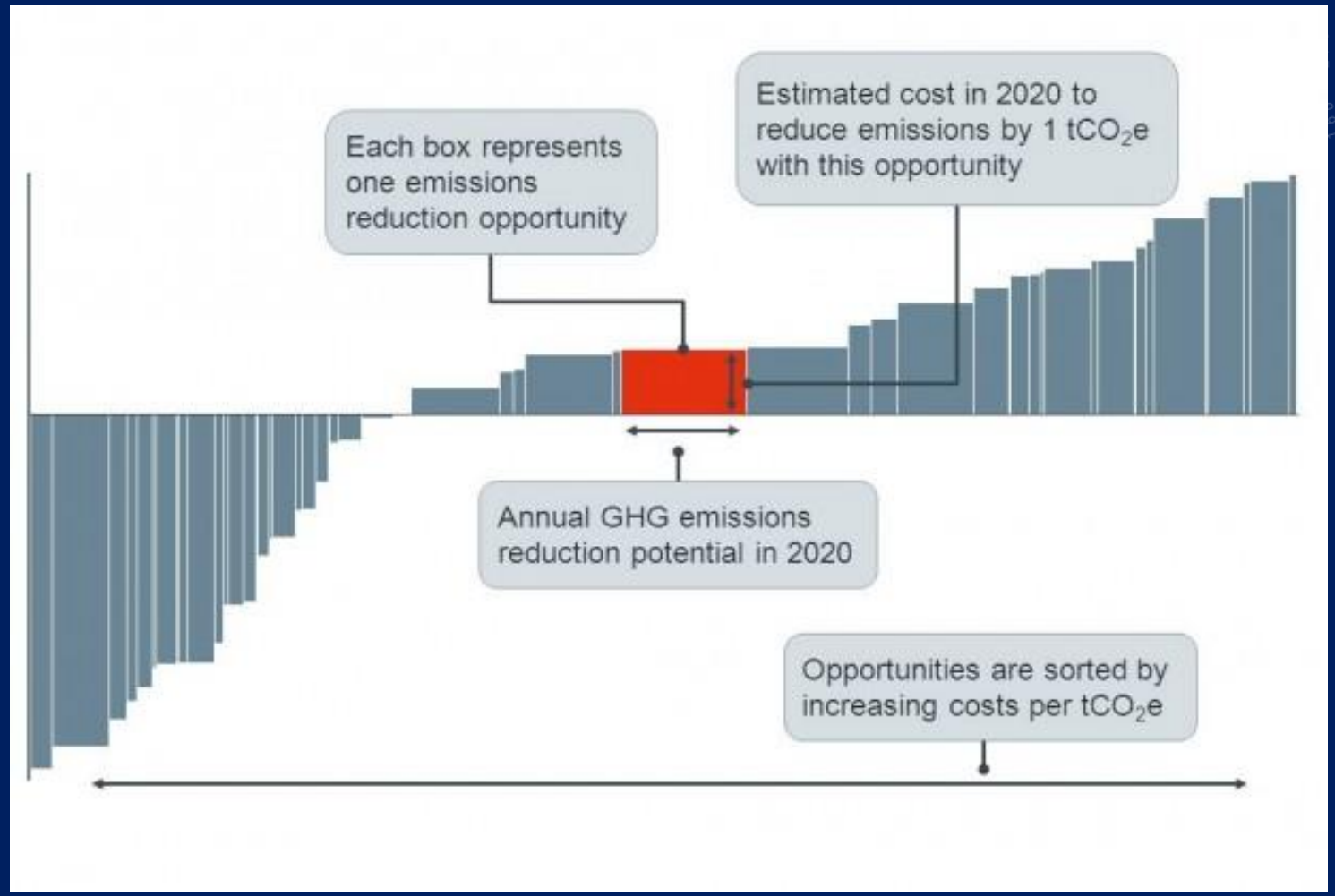
Economic indices

- SPP = 2.3 years
- NPV = 117, 895 Rs
- B/C ratio = 1.4
- IRR = 42.8%

Economic indices with tax saving

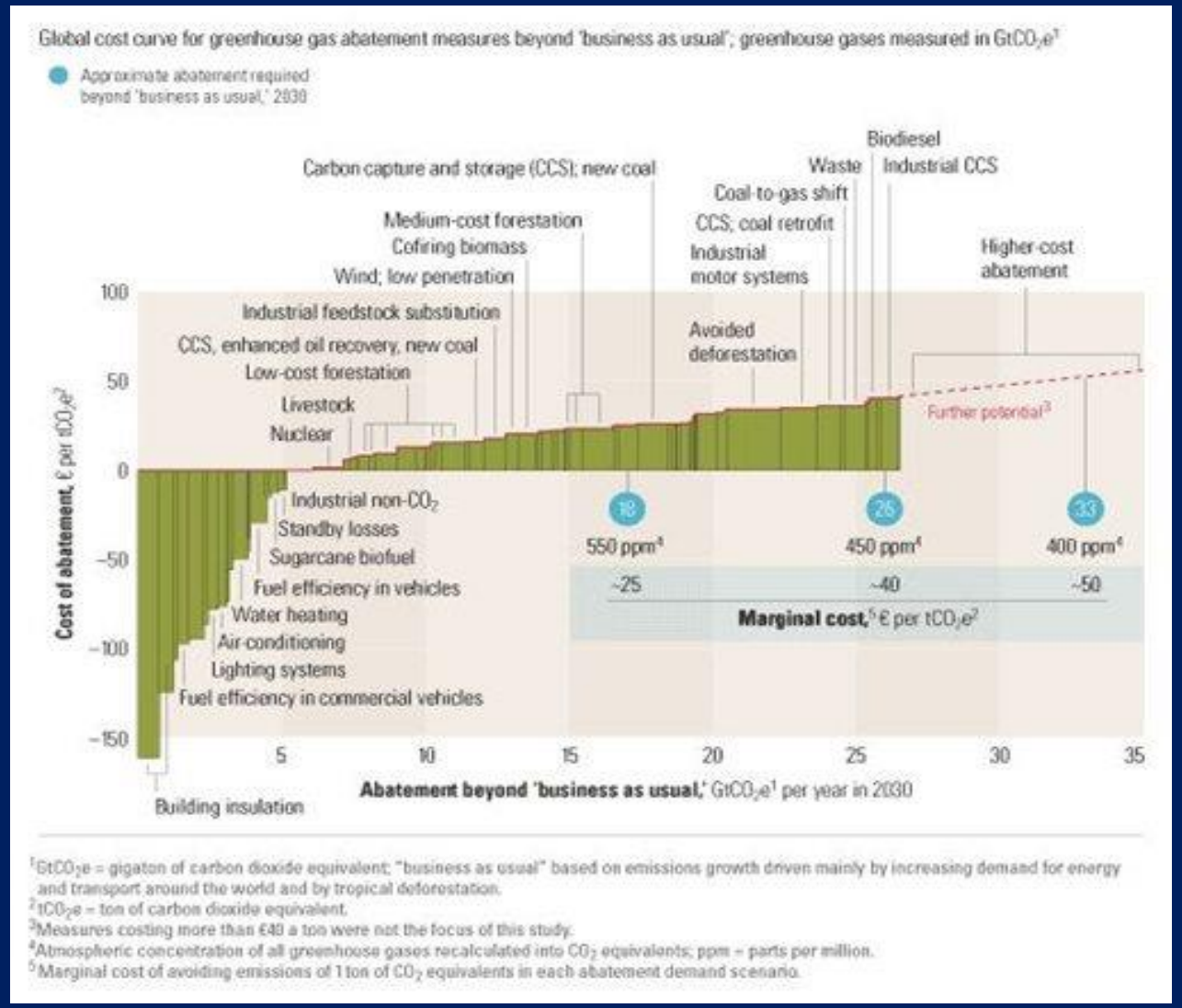
- SPP = 2.3 years
- NPV = 182,511 Rs
- B/C ratio = 1.7
- IRR =53.2%

Marginal Abatement Cost Curve



http://www.climateworksaustralia.org/project/national-plan/how-read-marginal-abatement-cost-curve

Global Cost Curve



Summing Up

- Economic criteria used as basis for decisions
- Discount rate- scarcity of capital
- Life Cycle costing, Marginal cost of carbon saved
- Taxes, Government Policies
- Sensitivity, Impact of variables

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Lecture – 6B

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Energy Economics

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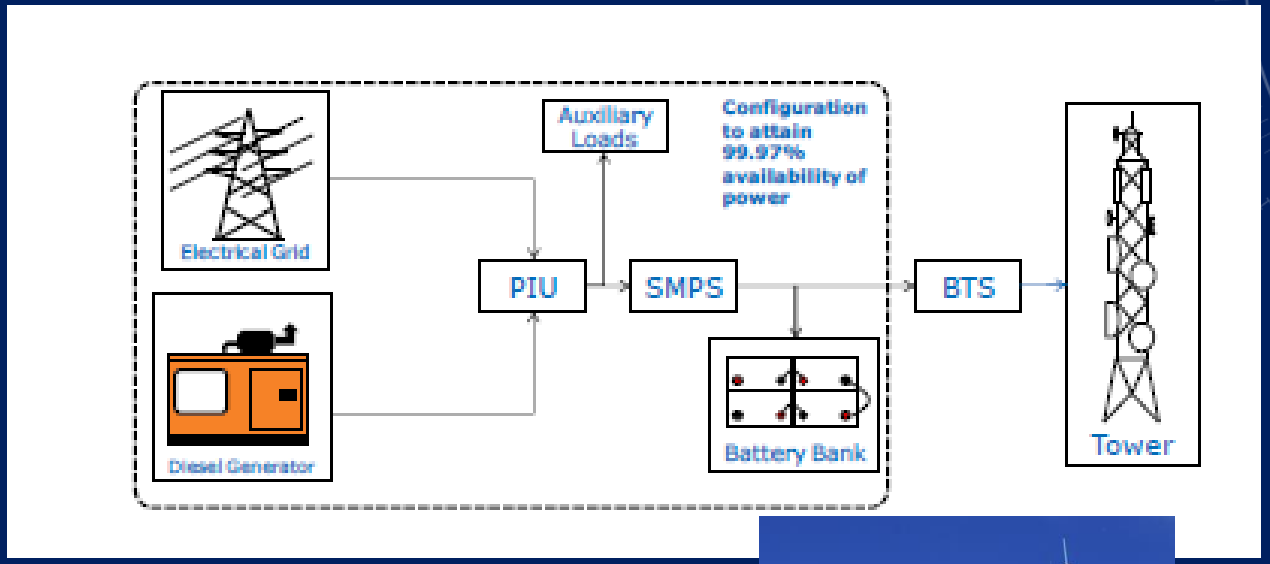
Cost Of Carbon saved

- Incremental ALCC
  $=ALCC_{Project} - ALCC_{Base\ Case}$
- Annual Carbon Dioxide Savings
  $= Annual\ CO_2\ _{Base\ Case} - Annual\ CO_2\ _{Project}$
- Cost of Saved Carbon = Incremental ALCC/Annual Carbon Dioxide Savings

Telecom Tower



425,000 Towers –
16.5 Billion kWh,
5 Billion litres of diesel

Example Problem

- Demand :Peak 5 kW, Average 2 kW continuous operation

  Options

  A: Diesel engine-generator

  B: PV- Battery system

A:Diesel Engine - Generator

- Rating 5 kW
- Cost Rs 1.7 lakhs, life 10 years,
- efficiency 35%,
- diesel price Rs 70 /kg, diesel NCV 42 MJ/kg (86% C by weight),
- Non – fuel O&M cost Rs 0.3/kWh

B.PV-Battery system

- Peak rating 12 kW
- Module cost Rs 6.5 lakhs life 25 years,
- Battery 50 kWh Rs 4.5 lakhs life 5 years,
- Balance of system costs Rs 3.0 lakhs, 10 years
- O&M cost Rs 0.25/kWh