

Financial Analysis of Clean Energy Technologies, Barriers, Micro-Financing, Subsidy

Management of Micro Level Micro Level
Clean Energy Projects
(Elective Course II)

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Contents

- Overview of Basic Concepts
 1. Time Value of Money
 2. Financial Evaluation Techniques
 3. Depreciation
 4. Escalation
- Cost Concepts for Electricity Generating System
- Levelized Cost of Electricity (LCOE)
- Example of Financial Analysis
- Barriers
- Micro-Financing
- Subsidy

Overview of Basic Concepts

□ Time Value of Money

1. Five basic variables are used in time money relationship to develop various formulas.

‘i’ : Interest or discount rate

N : Number of interest or discounting periods

P : Present sum of money (Principal)

F : Future sum of money at the end of N periods

A : Annuity payment/receipt over N periods at
‘i’ interest rate

Time Value of Money

- Future Value of Money:

$$F = P(1 + i)^N$$

- Present Value of Money:

$$P = F / (1 + i)^N$$

- Future Value of Annuity:

$$F = A [\{ (1 + i)^N - 1 \} / i]$$

- Sinking Fund: A fund established to accumulate a desired future sum of money at the given period of time through the collection of uniform series of payment (annuity).

$$A = F [\underbrace{i / (1 + i)^N - 1}_{\text{Sinking fund factor}}]$$

Sinking fund factor

Time Value of Money

- Present Value of Annuity:

$$P = A \left[\frac{(1+i)^N - 1}{i(1+i)^N} \right]$$

- Capital Recovery: It is the annuity of investment required to accumulate to a given present investment P for a known period and interest rate.

$$A = P \left[\frac{i(1+i)^N}{(1+i)^N - 1} \right]$$

Capital Recovery Factor

Inflation and Escalation



- ❑ Escalation and inflation affect the cost of project.
- ❑ Inflation refers to a rise in general price level of goods and services over a period of time.
- ❑ Escalation also refers to a rise in prices over and above the general rate of inflation and may result from factors such as resource depletion, new regulations, increased demand with limited supply.
- ❑ The effect of inflation and escalation need to be taken into account in financial analysis.

Inflation and Escalation

- If only inflation or escalation is considered, the effect is adjusted as:

$$\text{Future Price} = \text{Present Price} (1 + \text{inflation rate})^N$$

$$\text{Future Price} = \text{Present Price} (1 + \text{escalation rate})^N$$

- If both inflation and escalation are considered, the effect is adjusted as:

$$\text{Future Price} = \text{Present Price} (1 + \text{escalation rate})(1 + \text{inflation rate})^N$$

Depreciation



- The value of fixed asset like plant & machinery, building etc. decreases over time due to physical wear and tear. Depreciation refers to this decrease in worth.
- In terms of cost accounting, the concept of depreciation is to recover the initial capital invested in plant from the revenues it generates during the operating life.
- Commonly used methods are : Straight line, Declining Balance and Sum-of-years digit method

Depreciation

- Straight Line Method (SLM): Each year same amount of depreciation is charged.

$$D = \frac{1}{N} (I - S)$$

- Declining Balance Method (DBM): Depreciation rate is equal to SML rate. Depreciation is charged as long as the BV is greater than Salvage value. No more depreciation is charged when BV equals the Salvage Value.

$$D_t = \frac{1}{N} BV_{(t-1)}$$

Where, D_t = Annual depreciation charge in year t

N = Life of asset

$BV_{(t-1)}$ = Book value in year (t-1) from year of purchase

S = Salvage value

P = Purchase price

t = No. of years of depreciation or use from time of purchase

Depreciation

- Double Declining Balance Method: Depreciation rate is double the SLM rate.

$$D_t = \frac{2}{N} BV_{(t-1)}$$

- Sum-of-Years Digit Method (SYDM): Accelerated depreciation method.

$$SYD = \frac{N(N + 1)}{2}$$

$$D_t = \frac{2(N - t + 1)(I - S)}{SYD}$$

Depreciation

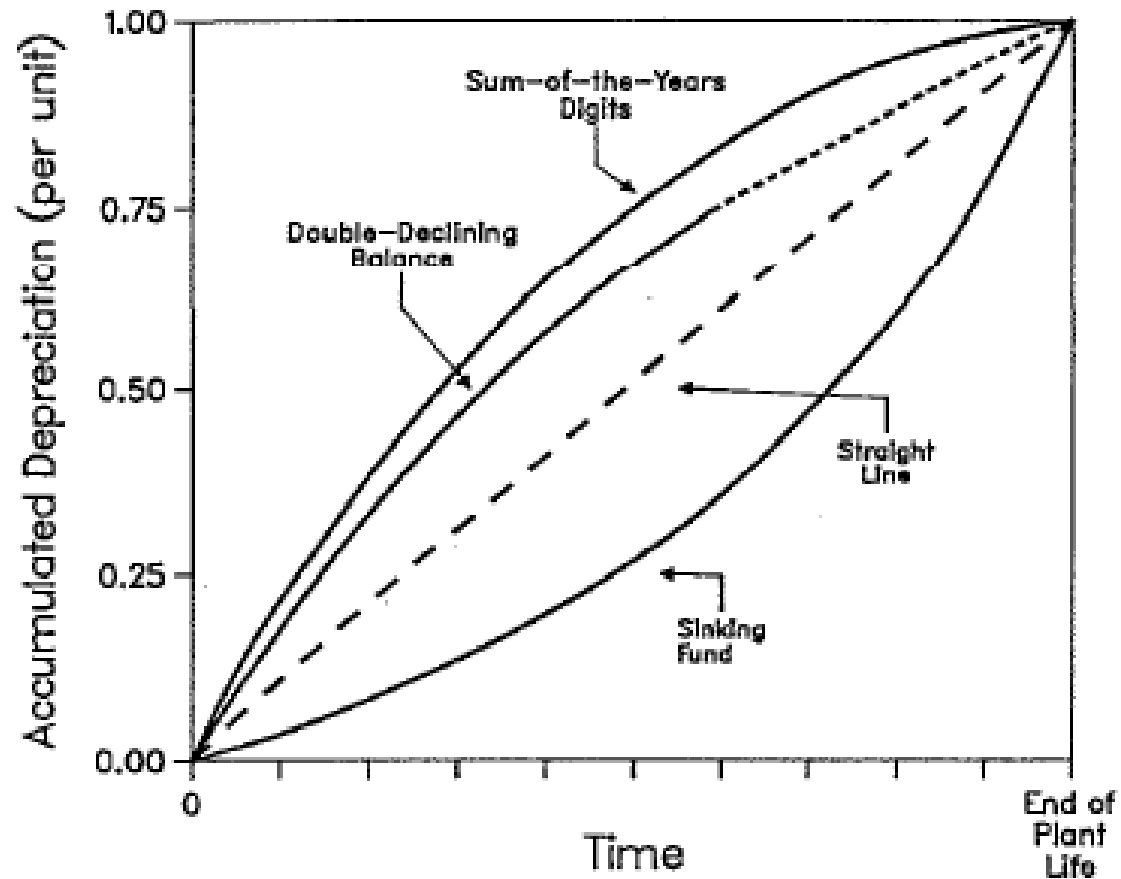


Figure: Comparison of depreciation methods (Source: IAEA 1984)

Financial Evaluation Techniques



- Three techniques are used to evaluate a project.
 - 1) Net Present Value (NPV)
 - 2) Internal Rate of Return (IRR)
 - 3) Pay Back Period
 - 4) Benefit Cost Ratio
- We need to know cost, revenue, project life, discount rate to evaluate a project.

Financial Evaluation Techniques

- Net Present Value (NPV) : We compare the PV of all costs to the PV of revenues (benefits) arising at different time periods of a project. If PV of benefits outweighs the PV of cost, the project is worthwhile for selection.

$$NPV = \sum_{t=1}^N \frac{R_t - C_t}{(1 + i)^t}$$

Where, R_t = Revenue arising in year t
 C_t = Cost occurring in year t
 N = Project life in years
 i = Discount rate

Acceptance Rule:
Accept if $NPV > 0$
Reject if $NPV < 0$
Indifferent if $NPV = 0$

Financial Evaluation Techniques

- Excel Function: Excel sheet can be used to calculate NPV.
 - a) Estimate all cost and revenue occurring at different time periods.
 - b) Calculate the PV of all costs and revenue using Excel built-in formula.
 - c) Syntax: NPV(rate, value 1, [value 2],...)
 - d) Calculate Net Present Value by subtracting PV of cost from PV of revenues.

B	C	D	E	F	G
Year	Cost	Revenue	Discount Rate	10%	
0	₹10,000.00				
1	₹1,000.00	₹1,500.00			
2	₹500.00	₹2,000.00			
3	₹500.00	₹2,500.00			
4	₹1,000.00	₹2,500.00			
5	₹400.00	₹3,000.00			
PV	₹12,629.35	\$8,465.11			
NPV	(\$4,164.24)				

ADMIN:
=C3+NPV(F2,C4:C8)

ADMIN:
=NPV(F2,D4:D8)

Financial Evaluation Techniques

- Internal Rate of Return (IRR): The rate of return at which the PV of cost is equal to the PV of benefits is called Internal Rate of Return. If IRR is greater than company's required rate of return (RRR), then project is worthwhile to select.

$$\sum_{t=1}^N \frac{R_t}{(1+i)^t} = \sum_{t=1}^N \frac{C_t}{(1+i)^t}$$

- Required rate of return is company's weighted average cost of capital (WACC).

$$i_0 = i_d \frac{D}{(D+E)} + i_e \frac{E}{(D+E)}$$

Financial Evaluation Techniques

Where, i_o = Required rate of return(RRR)

i_d = cost of debt

i_e = cost of equity

D = Debt

E = Equity

- Cost of debt is equal to the bank lending interest rate.
- Cost of equity is equal to the expected dividend yield plus capital gain rate.

Financial Evaluation Techniques

- Excel Function: Excel sheet can be used to calculate IRR.
 - a) Estimate all cost and revenue occurring at different time periods.
 - b) Calculate the net cash flow of revenue and cost.
 - c) Calculate the IRR using Excel Built-in IRR formula.
 - d) Syntax: $\text{IRR}(\text{values}, [\text{guess}])$

B	C	D	E	F	G
Year	Cost	Revenue	Net Cash Flow	Discount Rate	10%
0	₹10,000		-₹10,000		
1	₹1,000	₹3,500	₹2,500		
2	₹500	₹3,000	₹2,500		
3	₹500	₹4,000	₹3,500		
4	₹1,000	₹4,500	₹3,500		
5	₹400	₹3,000	₹2,600		
PV	₹12,629	₹13,603	₹973		
NPV	\$973.39				
IRR	15%				

ADMIN:
=NPV(F2,D4:D8)

ADMIN:
=C3+NPV(F2,C4:C8)

ADMIN:
=IRR(E2:E8,12)

Financial Evaluation Techniques

- Payback Period Method: Payback period is the number of years required to recover the initial cash outlay invested in a project.

$$\text{Payback Period} = \frac{\text{Initial Investment } (C_0)}{\text{Annual Revenue } (R)}$$

- Discounted Payback Period: Discounted payback time 'T' of an investment with revenue and cost streams R_t and C_t respectively is defined by equation:

$$\text{Payback Period: } \sum_{t=1}^T \frac{R_t}{(1+i)^t} - \sum_{t=1}^T \frac{C_t}{(1+i)^t} = 0$$

Financial Evaluation Techniques

- **Benefit Cost Ratio:** It is the ratio of the PV of benefits (revenue) to the PV of cost. Project is worthwhile to select if the ratio is greater than 1.

$$BC \text{ Ratio} = \frac{\sum_{t=1}^N \frac{R_t}{(1+i)^t}}{\sum_{t=1}^N \frac{C_t}{(1+i)^t}}$$

Cost Concept for Electricity Generating System

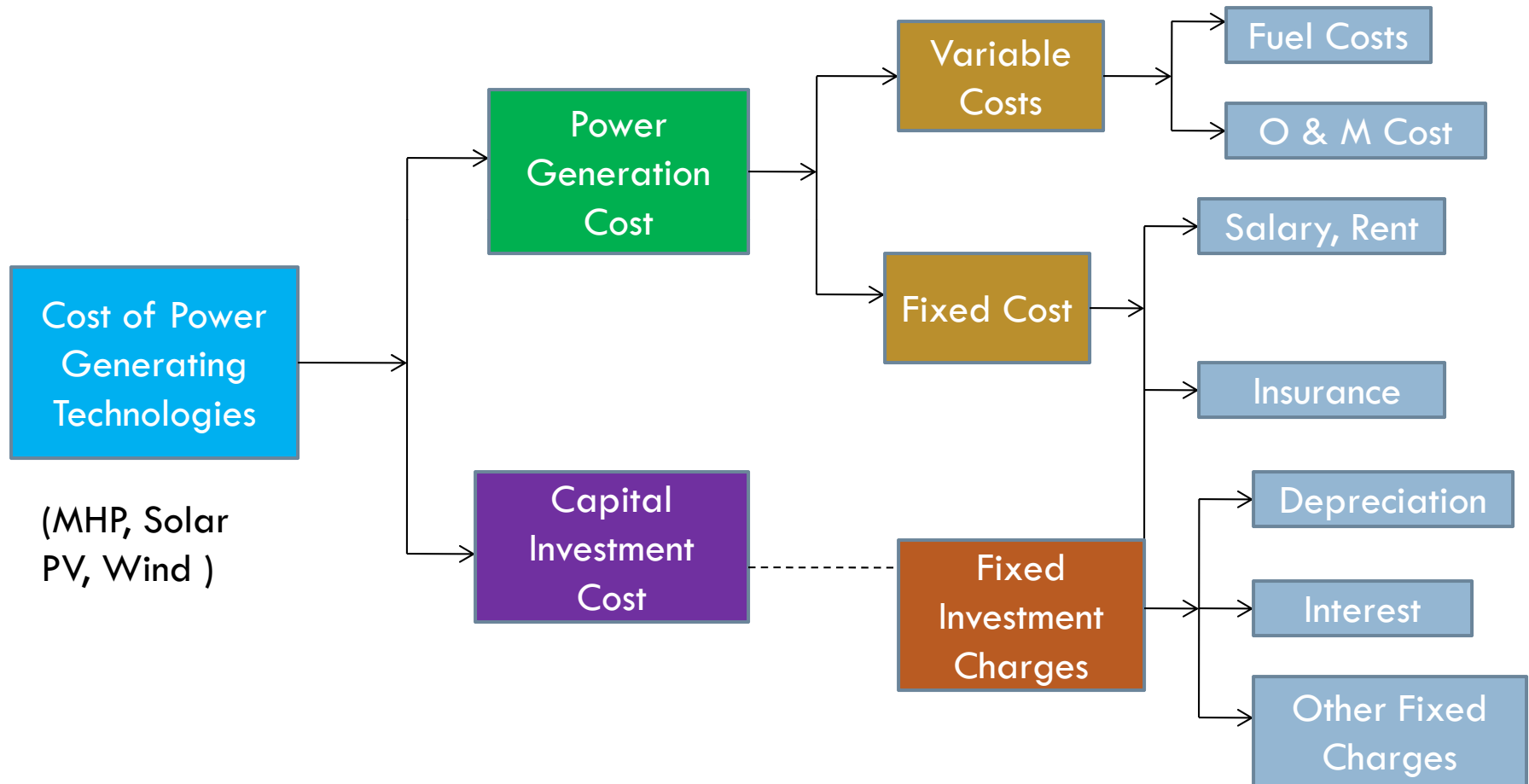


Figure: Cost for power generating technologies

Levelized Cost of Electricity

- The cost of electricity generation varies from year to year due to changes in fuel price, price escalation, tax, depreciation etc. So it is difficult to compare the cost of per unit electricity generation with alternative technologies.
- Hence, the concept of 'Levelized Cost of Electricity (LCOE)' is used. It helps to compare the cost of various energy generating technologies.
- The LCOE is the ratio of PV of the all costs occurring over the life time of a technology to the PV of the number of units of electricity generated over the lifetime of a technology.

Levelized Cost of Electricity

$$LCOE = \frac{\sum_{t=1}^N \frac{I_t + M_t + F_t}{(1+i)^t}}{\sum_{t=1}^N \frac{E_t}{(1+i)^t}}$$

Where, LCOE = Levelized Cost of Electricity (NRs/kWh)

I_t = Investment expenditure in year t

M_t = O & M expenditure in year t

F_t = Fuel cost in year t

E_t = Electricity generation in year t (kWh)

i = Discount rate

N = Economic life of technology (years)

Levelized Cost of Electricity

Components of levelized cost of energy

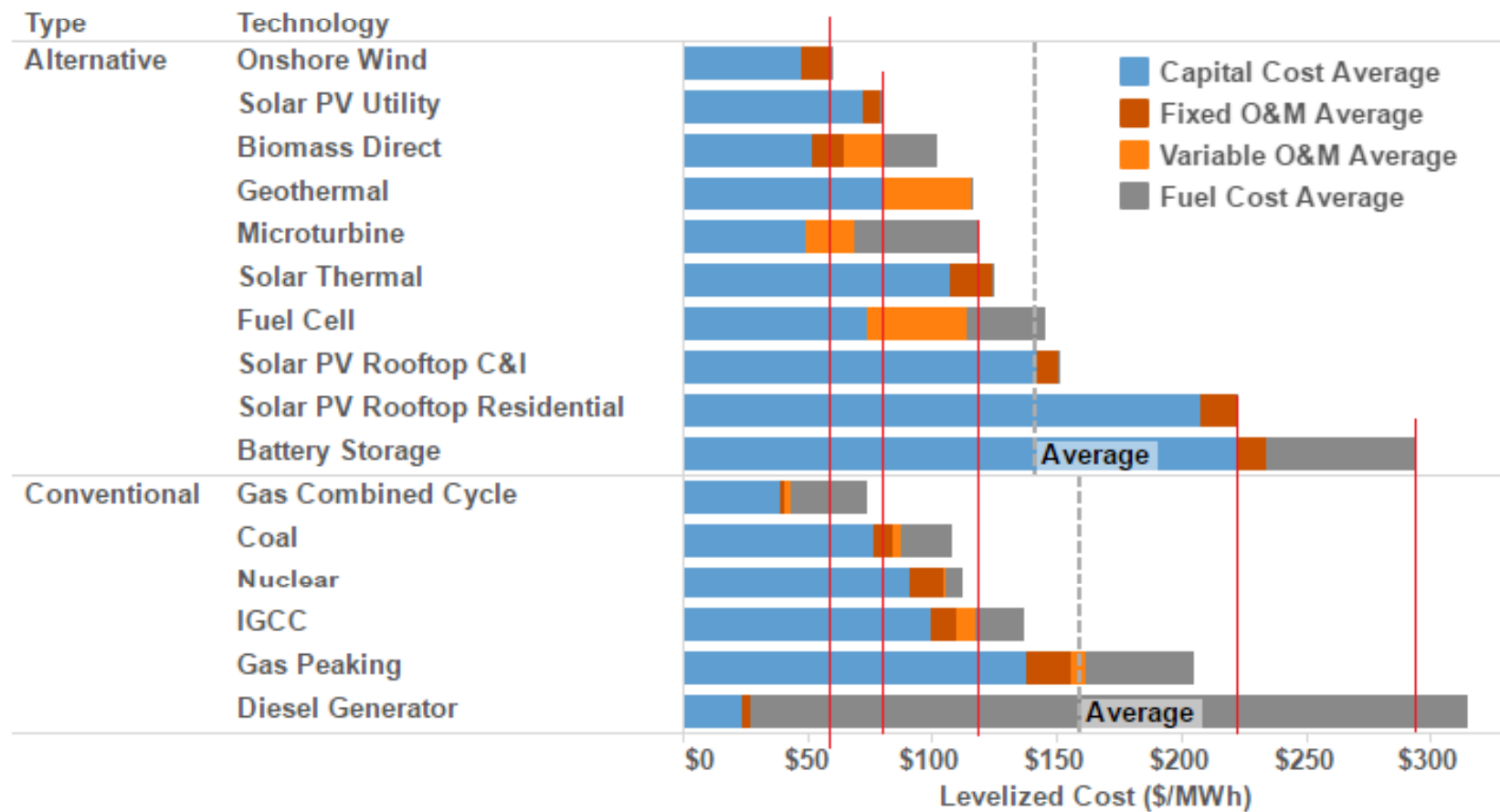


Figure : LCOE of different technologies (Source: www.energyinnovation.org)

Levelized Cost of Electricity

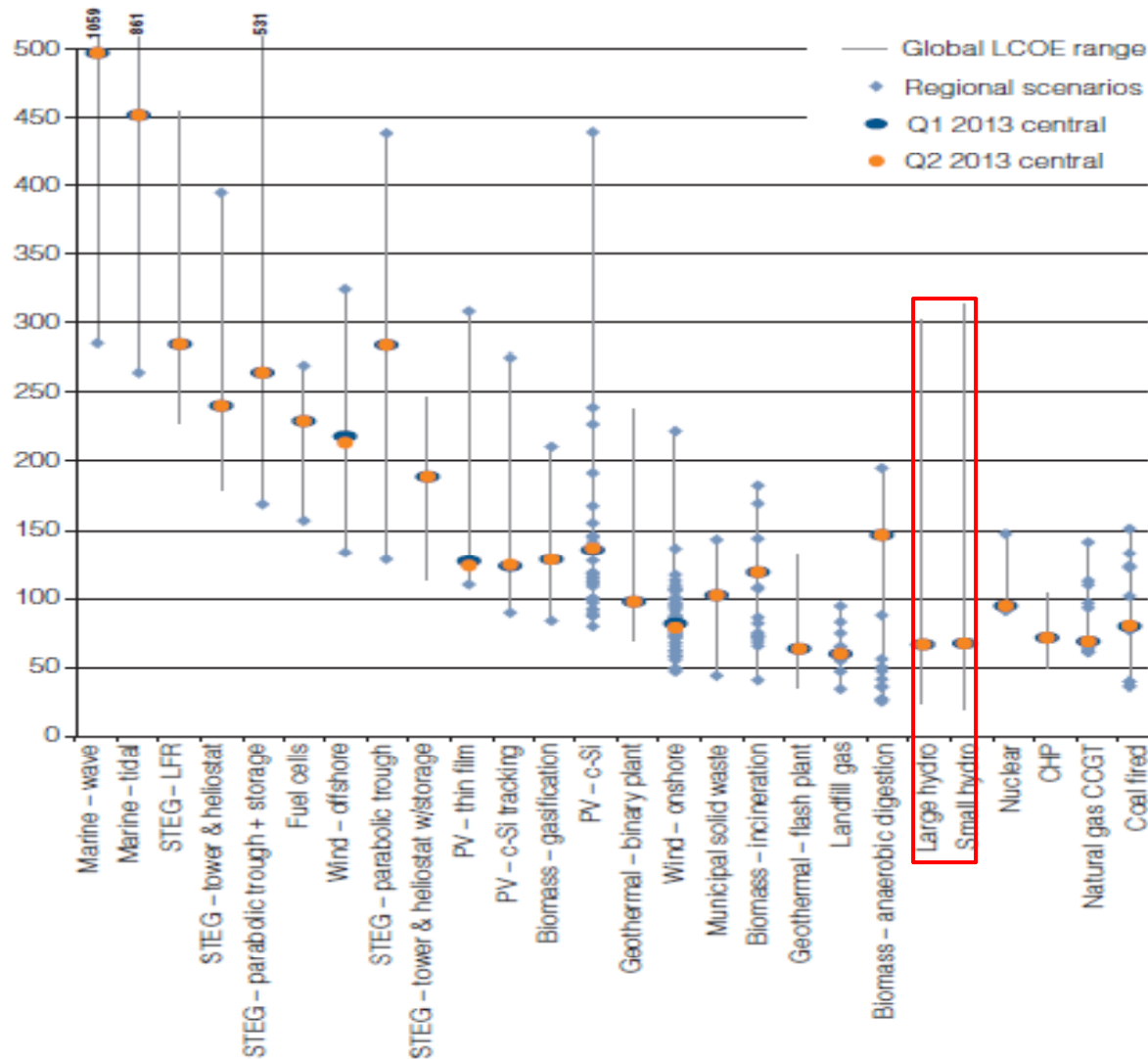


Figure: LCOE of different technologies (Source: World Energy Council 2013)

Example of Financial Analysis of CET

- Different Types of Clean Energy Technologies
 - 1) Micro Hydro Power (MHP)
 - 2) Solar PV
 - 3) Biomass
 - 4) Wind Power
- Example of Financial Analysis for MHP [Financial Analysis MHP.xlsx](#)

Barriers for CET Implementation

- High initial cost per kilowatt of power
- Community people find difficulty to collect the necessary financial resources.
- Not economically viable without subsidy
- Revenue generation (energy tariff) is insufficient to pay debt charges.
- Unwillingness of commercial banks to invest on RET
- Policy barriers for private investors & service providers to access government subsidy
- Low capacity factor of plant
- Intermittent in nature like solar and wind power. So some back-up power is required, which increases cost.
- Limited only for lighting purpose and low scale economic activities.
- Expansion is difficult when demand increases.
- Lack of technical skill for repair and maintenance
- Lack of managerial skill for management of plant

Micro-Financing



- Dictionary Meaning: Microfinance refers to an array of financial services, including loans, savings and insurance, available to poor entrepreneurs and small business owners who have no collateral and wouldn't otherwise qualify for a standard bank loan.
- Most of the micro-financing has been mobilized in income generating activities but the investment in RET is still inadequate in Nepal.
- Micro-financing can increase the access of poor rural people to use RET.

Micro-Financing



- There is huge investment potential for Micro-Financial Institutions in RET sector.
- More than 150 MFIs have been financing biogas and other renewals.
- Examples: Nirdhan Utthan Bank, Purbanchal Grameen Bikash Bank, Sahara Savings and Credit Cooperative, Karnali Savings and Credit Cooperative are good examples of MFIs involved in RET financing.

Micro-Financing

Table : Micro-financing potential for RET in Nepal

Technology	Potential	Installed	Annual Target	Total investment/year (NRS ,000)	Subsidy/year (NRS ,000)	Potential for loan/year (NRS ,000)
Biogas	1.9 million	184,000	22,000	550,000	176,000	374,000
SHS	2.4 million	95,000	20,000	500,000	200,000	300,000
Solar Tuki	2.4 million	60,000	25,000	112,500	31,250	81,250
IWM	25,000	2800	1255	37,650	15,060	22,590
Micro Hydro		10 MW	3,250KW	650,000	276,250	373,750
Total				1,850,150	698,560	1,151,590

(Source: Basnet & Subedi, Winrock International Nepal)

Micro-Financing

- Different Methods of Micro-Financing:
 - 1) **Franchising**: The MFI provides loan origination and administration services on behalf of the bank, and functions within a clearly defined guideline framework. Practiced by ICICI Bank in India.
 - 2) **Vendor Financing**: Energy service providers sell the system in credit and collect regular installments from users. This model has been used to finance SHS in various countries. Grameen Shakti Bangladesh has already installed 100,000 SHS in rural areas in Bangladesh.
 - 3) **Leasing**: Energy services allows consumers to pay monthly fee for the energy services rather than buying the system. The system service provider provides guaranteed maintenance and reliable energy services.

Subsidy



- Government of Nepal provides subsidy through AEPC to communities who want to build renewable energy based power project.
- RET Policy 2073 provides the policy guidelines for granting the subsidy.
- [RET Subsidy Nepal.pdf](#)

RE Subsidy Policy 2072



□ Major Highlights:

- 1) Subsidy amount varies according to geographic area.
- 2) Subsidy amount generally covers 40% of total cost, 30% should be managed from credit and another 30% from private sector investment or community or households in kinds or cash.
- 3) Subsidy is prioritized to least cost energy output technology among the available technology.
- 4) Mini/micro hydropower is taken as the basic infrastructure necessity for rural electrification

RE Subsidy Policy 2072

- Mini/Micro Hydropower and Improved Water Mills:
 1. Subsidy will be provided to mini/micro hydropower with capacity < 1000 kW in areas without national grid access on the basis of actual power generation or actual energy consumption.
 2. Subsidy is provided for the portion of power generation for the projects with possibility of grid supply & local distribution.
 3. Subsidy will be for distribution network based on actual household connected.

RE Subsidy Policy 2072

- Subsidy for Community/Cooperative/Private/PPP owned Mini/Micro Hydro:

Subsidy Category Off-grid mini/micro (10 kW-1000 kW)	Subsidy Amount in Rs.			
	Humla, Dolpa and Mugu districts where goods transport is only possible by air	Category "A" Regions except Humla, Dolpa and Mugu Districts	Category "B" Regions	Category "C" Regions
A) Subsidy on the basis of project				
Distribution (per HH)	35,500	32,000	30,000	28,000
Generation – Equipment (per kW)	125,000	95,000	85,000	80,000
Generation – Civil (per kW)	80,000	30,000	25,000	20,000
But, the maximum subsidy amount per kW for generation and distribution will not exceed Rs. 382,000; Rs. 285,000; Rs. 260,000 and Rs. 240,000 for Humla/Dolpa/Mugu, Category "A", Category "B" and				

Source: RE Policy 2072, AEPC)

RE Subsidy Policy 2072

Category "C" regions respectively. Distribution subsidy will be provided to a maximum 5 households per kW but distribution to household is not a requirement to qualify for generation subsidy.

B) Subsidy on the basis of energy consumption

Energy Consumption (per kWh)	55%	50%	45%	40%
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Subsidy for energy consumption will be paid to the concerned project operator over a period of five years only based on actual energy consumption.

RE Subsidy Policy 2072

- Mini/Micro Hydropower for Productive Use: Purpose is replace the use of fossil fuel in tourism, mining, marble cutting, irrigation, pumping , agro-processing etc.
- 1. Subsidy for Pico hydro up to 10 kW capacity

Subsidy Category	Capacity	Subsidy Amount in Rs.		
		Category "A" Regions	Category "B" Regions	Category "C" Regions
Distribution (per HH)	Up to 10 kW	11,500	10,500	10,000
Generation (per kW)	Less than 5 kW	70,000	60,000	50,000
	5 kW to 10 kW	95,000	85,000	75,000

But, for systems having capacity less than 5 kW, the maximum subsidy per kW will not exceed Rs. 185,000; Rs. 165,000 and Rs. 150,000 for Category "A", Category "B" and Category "C" regions respectively. Similarly, for systems from 5 kW to 10 kW, the maximum subsidy per kW will not exceed Rs. 210,000; Rs.190,000 and Rs.175,000 for Category "A", Category "B" and Category "C" regions respectively. However, in case of individual developers, conditions as specified in the Subsidy Delivery Mechanism should be fulfilled to be eligible for subsidy.

Source: RE Policy 2072, AEPC)

RE Subsidy Policy 2072

□ Solar PV Home System

Subsidy Category	Subsidy Amount in Rs.		
	Category "A" Regions	Category "B" Regions	Category "C" Regions
10 - 20 Wp Small SHS (per HH per system)	5,000	4,800	4,500
50 or more than 50 Wp SHS (per HH per system)	10,000	9,000	8,000

Source: RE Policy 2072, AEPC)

RE Subsidy Policy 2072

- Solar Mini Grid System: Subsidy up to 1000 kWp system in areas not connected by grid

Subsidy Category	Subsidy Amount in Rs.		
	Category "A" Regions	Category "B" Regions	Category "C" Regions
A) Subsidy on the basis of project			
Distribution (per HH)	32,000	30,000	28,000
Generation – Equipment (per kWp)	175,000	165,000	150,000
But, the maximum subsidy amount per kW for generation and distribution will be maximum of 60% of the system costs but not exceeding Rs. 495,000; Rs. 465,000 and Rs. 430,000 for Category "A", Category "B" and Category "C" regions respectively. Distribution subsidy will be provided to a maximum 10 households per kW.			
B) Subsidy on the basis of energy consumption			
Energy Consumption (kWh)	60%	60%	60%
Subsidy for energy consumption will be paid to the concerned project operator over a period of five years only based on actual energy consumption. However, irrespective of whatever is stated above, financial support more than the subsidy amount mentioned above can be provided for pilot projects as per the understanding between GoN and DPs.			

Source: RE Policy 2072, AEPC)