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Life Cycle Cost of Solar Power Systems for Institutional Campus

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Abstract- Global installed capacity of renewable energy technologies are growing rapidly. The ability of renewable technologies to enable a rapid transition to a low carbon energy system is highly dependent on the energy that must be "consumed" during their life-cycle. Energy scarcity is one of the major problems every developing country is facing. Renewable energy is a promising source to solve energy related problems of the developing nations and help to accelerate growth. The present study is focused on the financial aspects of a 54KWp solar PV system in Gujarat. Financial analysis has been performed with present cost of the system and energy cost on life cycle basis.

Keywords— Solar Rooftop power plant, Institutional campus, Life cycle cost

INTRODUCTION

In India about 96.7% of villages have been electrified till May 2015 out of which 30% of the households get less than 12 hours of electricity supply with 23% of the households getting less than 8 hours of supply and the balance of 11% had either not supply or were getting just less than 4 hours of supply every day. The demand for electricity is increased by 28% from 2009 to 2015 and is expected to increase at the rate of 1.2% per year. The State of Gujarat has commissioned Asia's largest solar park at Charanka village. The park is already generating 2 MW solar powers out of its total planned capacity of 500 MW.

The best suited solar system suited for Indian condition is Photovoltaic (PV) based panel. Generally, there are two types of solar PV systems; Standalone system and a Grid connected. In grid interactive solar PV power systems, the DC power generated is converted to AC power using an inverter and is fed to the grid. The grid connected system works on net metering basis where in the consumer pays to the utility on net meter reading basis only.

SOLAR ENERGY

Sunlight is a renewable energy source which can be converted into usable energy by solar panels.There are two main types of solar energy. Solar photovoltaic (PV) panels directly convert solar energy into a usable form of energy using a PV cell containing a semiconductor material. CSP (concentrating solar power) on the other hand, concentrate energy from sunlight to a heat receiver which transforms energy from heat into mechanical energy, and in turn, solar thermal electricity. Solar i.e. energy from the sun provide consistent and steady source of solar power throughout the year. As our non-renewable resources are set to decline in the years to come, it is important for us to move towards renewable sources of energy like wind, hydropower, biomass and tidal. The main benefit of solar energy is that it can be easily deployed by both home and business users as it does not require any huge set up like in case of wind or geothermal power. Solar energy not only benefits individual owners, but also benefit environment as well. Solar energy is one of the most widely used renewable energy source.

STUDY AREA PROFILE

Solar Power, a clean renewable resource with zero emission, has got tremendous potential of energy which can be harnessed using a variety of devices. With recent developments, solar energy systems are easily available for industrial and domestic use with the added advantage of minimum maintenance. Solar energy could be made financially viable with government tax incentives and rebates. With about 301 clear sunny days in a year, India's theoretical solar power reception, just on its land area, is about 5 Peta hour/year (i.e. = 5000 trillion kWh/yr ~ 600 Tera Watt). The daily average solar energy incident over India varies from 4 to 7 kWh/m2 with about 2300-3200 sunshine hours per year, depending upon location. This is far more than current total energy consumption.

For example, even assuming 10% conversion efficiency for PV modules, it will still be thousand times greater than the likely electricity demand in India by the year 2015.Exploitation of the abundant solar energy resources available in our country is therefore, being accorded a high priority by the Ministry of New and Renewable Energy. The Ministry has come forward to support Solar PV based Power Plants in big way throughout the country with a host official incentive. For encouraging investment by the private sector in power generation through renewable energy, MNRE has formed nodal agencies in all the states, and has issued a set of guidelines for their consideration.

SOLAR POSSIBILITIES & ESTIMATION

The proposed Power Plant will have Solar PV modules, String Inverters as the major components & other accessories for the Power production. To address your requirements, we suggest the following identified possibilities for project

Table 1 Solar Possibilities & Estimation

Item	Description
Capacity	54 kWp
Technology	Solar Poly-crystalline Photo-Voltaics
Location	Jagana, Gujarat, India
Area Type	RCC Flat Terrace
Grid Connection	Net Meter 400 V (or 11 kV if required)
Accelerated Depreciation	NA

Item	Amount	Factor
Plant Parameters		
Plant Size	54.000	kWp
Plant Cost		
Cost of Machinery (Type 1)	3,402,000	INR
Annual O&M	2.00%	of Capital Cost
Escalation in O&M	2.00%	Annually
Inverter Replacement (FV)	0.00%	of Capital Cost
(10% applicable in case of Type II systems)		
Total	3,402,000	INR
Financing Costs		
Loan (Debt)	-	INR
Interest on Loan	13.00%	
Equity (Self Investment)	3,402,000	INR
Performance Parameters		
CUF (First Year)	18.00%	
Performance Ratio	78.00%	
Performance Degradation	0.80%	Annually
Self Consumption	0.20%	of net generation
Avg. Units Generated - Y1	86,400	kWh
Revenue Parameters		
Unit Price	3.5	INR/kWh
YoY Increase	3%	
Financial Indicators	25 Years	
Return on Equity (ROE)	**25.02%**	
Breakeven Period	**6-7**	Years

Considering the good potential of Solar Power generation, proposing to set up 54 KWp (half of the demand charge) Roof Top Solar PV based Power Plant. This Technical Proposal highlights the implementation of 54 KWp Solar PV based Power generation project.

COST PAY BACK TIME

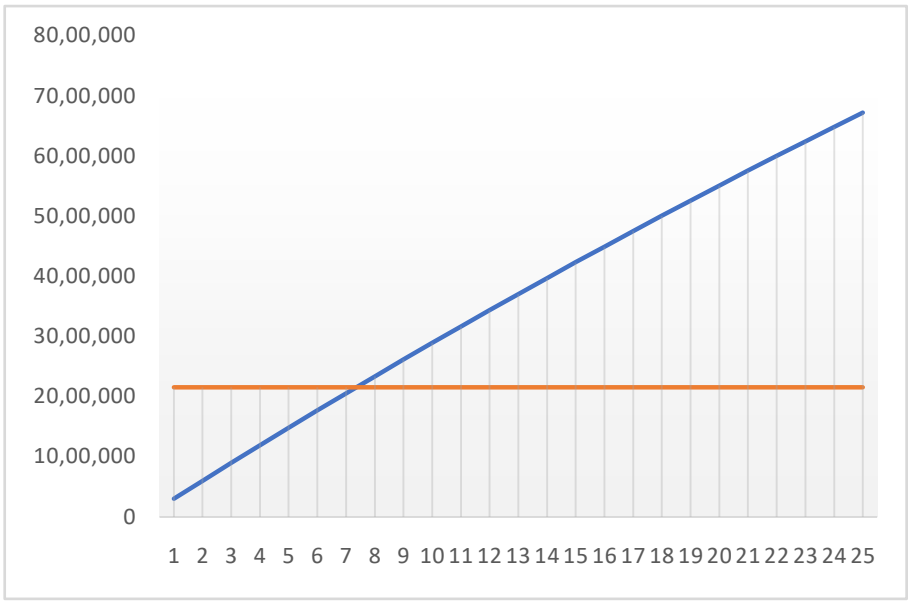
Capital has received the risk-adjusted, expected return. In short, all costs that need to be paid are paid by the firm but the profit is equal to Zero. CPBT is the period in which, we will be able to recover the investment cost of the plant.

From the calculation shown above,

Cost payback time of 3 kw power is 6 years

Table 2 Life cycle cost analysis

Year	Net Generation (kWh)	Unit Price (kWh)	Revenue (Rs.)	Cumulative
1	86,400	3.5	302,400	302,400
2	85,536	3.5	299,376	601,776
3	84,681	3.5	296,384	898,160
4	83,834	3.5	293,419	1,191,579
5	82,995	3.5	290,483	1,482,061
6	82,166	3.5	287,581	1,769,642
7	81,344	3.5	284,704	2,054,346
8	80,530	3.5	281,855	2,336,201
9	79,725	3.5	279,038	2,615,239
10	78,928	3.5	276,248	2,891,487
11	78,139	3.5	273,487	3,164,973
12	77,357	3.5	270,750	3,435,723
13	76,584	3.5	268,044	3,703,767
14	75,818	3.5	265,363	3,969,130
15	75,060	3.5	262,710	4,231,840
16	74,309	3.5	260,082	4,491,921
17	73,566	3.5	257,481	4,749,402
18	72,830	3.5	254,905	5,004,307
19	72,102	3.5	252,357	5,256,664
20	71,381	3.5	249,834	5,506,498
21	70,667	3.5	247,335	5,753,832
22	69,960	3.5	244,860	5,998,692
23	69,261	3.5	242,414	6,241,106
24	68,568	3.5	239,988	6,481,094
25	67,883	3.5	237,591	6,718,684
Total	1,919,623		6,718,684	



CONCLUSION:

The stages of life cycle that incurred major investment in setting up a 2 KWp and 3 KWp Solar PV plant and PV panels. the break-even point has been found to be 4.17 years for 2KWp and 7.36 years for 3KWp. Improvements in conversion efficiencies of Solar modules may reduce the BEP in future.

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