Life Cycle Cost of Residential Solar Power Systems in Gujarat

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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 2KWp & 3KWp solar PV system in Gujarat. Financial analysis has been performed with present cost of the system and energy cost on life cycle basis.
Key words: Solar Power Systems, Solar Energy

I. 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.

II. WHAT IS 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.

III. ADVANTAGES OF SOLAR ENERGY

A. Renewable Energy Source:

Solar energy is a truly renewable energy source. It can be harnessed in all areas of the world and is available every day. Solar energy is a renewable source of energy as it can be used to produce electricity as long as the sun exists. Sunlight is available everywhere on the Earth. Solar energy from sun is consistent and constant power source and can be used to harness power even in remote locations.

B. Reduces Electricity Bills:

Since you will be meeting some of your energy needs with the electricity your solar system has generated, your energy bills will drop. How much you save on your bill will be dependent on the size of the solar system and your electricity or heat usage. Moreover, not only will you be saving on the electricity bill, but if you generate more electricity than you use, the surplus will be exported back to the grid and you will receive bonus payments for that amount (considering that your solar panel system is connected to the grid).

C. Diverse Applications:

Solar energy can be used for diverse purposes. You can generate electricity (photovoltaics) or heat (solar thermal). Solar energy can be used to produce electricity in areas without access to the energy grid, to distill water in regions with limited clean water supplies and to power satellites in space. Solar energy can also be integrated in the materials used for buildings. Not long ago Sharp introduced transparent solar energy windows.

D. Low Maintenance Costs:

Solar cells generally don't require much maintenance and run for a long time. You only need to keep them relatively clean, so cleaning them a couple of times per year will do the job. Most reliable solar panel manufacturers give 20-25 years' warranty. Also, as there are no moving parts, there is no wear and tear. The inverter is usually the only part that needs to change after 5-10 years because it is continuously working to convert solar energy into electricity (solar PV) and heat (solar thermal). So, after covering the initial cost of the solar system, you can expect very little spending on maintenance and repair work. Apart from this, solar panels does not create any noise or release any toxic substances.

E. Non-polluting:

Solar energy is an alternative for fossil fuels as it is non-polluting, clean, reliable and renewable source of energy. It does not pollute the air by releasing harmful gases like carbon dioxide, nitrogen oxide or Sulphur oxide. So, the risk of damage to the environment is reduced. Solar energy also does

not require any fuel to produce electricity and thus avoids the problem of transportation of fuel or storage of radioactive waste.

F. Easy Installation:

Solar panels are easy to install and does not require any wires, cords or power sources. Unlike wind and geothermal power stations which require them to be tied with drilling machines, solar panels do not require them and can be installed on the rooftops which means no new space is needed and each home or business user can generate their own electricity.

G. Can Be Used in Remote Locations:

Solar energy can be of great boon in areas which have no access to power cables. It works great in remote locations where running power lines would be difficult or costly. Solar panels can set up to produce solar energy there as long as it receives the sunlight.

H. Long Lasting Solar Cells:

Solar cells make no noise at all and there are no moving parts in solar cells which makes them long lasting and require very little maintenance. Solar energy provides cost effective solutions to energy problems where there is no electricity at all.

IV. How to Avail Subsidy for Solar Energy in Gujarat?

Gujarat government has recently announced a scheme of subsidy for promoting installation of grid connected Solar Rooftop System by private residential consumers across the state, with following terms & conditions:

1) A subsidy of Rs 10,000/- per kW would be disbursed through GEDA after successful installation and commissioning of Rooftop Solar systems by private residential consumers with maximum limit of Subsidy of Rs 20,000/- per consumer.
2) This scheme will be limited to installation of 2 kW rooftop solar system only. Capacity of installed plant may be higher subject to a ceiling of 50% of contracted load. However, per consumer, maximum subsidy available shall be Rs. 20,000.
3) The scheme would be applicable to the Rooftop Solar Power Generators, set up and commissioned during the operative period of Solar Power Policy-2015
4) As per the Solar Power Policy 2015, the consumer should install only new plant and machinery and should not shift the plant to other location. Also the consumer should be a client of the local DisCom and the premises where the rooftop system is based should be connected to the local Discom's Grid system.
5) The beneficiary should own the rooftop solar system, and also should be in the legal possession of the premises including the rooftop and terrace on which the plant is installed.
6) GEDA would be the nodal agency for this scheme. Only after certification by GEDA and concerned Distribution Company (DisCom) about the successful installation and commissioning of the system; GEDA will release the amount of subsidy to the applicants.
7) Central government's benefits for rooftop solar like 30% subsidy etc. are still applicable but no other state government benefit for rooftop solar will be applicable if this scheme is availed
8) This scheme is only for household rooftop projects.
9) If a project was registered under the new Gujarat Solar Power Policy 2015 even before this scheme came out, then that project would be eligible to claim this benefit provided the project satisfies other parameters of the scheme and Solar Power Policy-2015

V. Life Cycle Cost of Solar Energy

A subsidy of Rs 10,000/- per kW would be disbursed through GEDA after successful installation and commissioning of Rooftop Solar systems by private residential consumers with maximum limit of Subsidy of Rs 20,000/- per consumer. Capacity of installed plant may be of 50% of contracted load. Central government's benefits for rooftop solar like 30% subsidy are still applicable.

1) For 1kw power 60 to 80 sq. ft. area required, Total roof area of site is 1479.28 sq. feet hence power generation capacity of terrace is 18 kw.
2) Dimension of solar panel is 5 x 3 foot & 60 cell and 72 cell available in Indian market and each cell 3.9 to 4.5-watt energy produce hence panel of 60 cell is around 240 to 260-watt energy produce & panel of 72 cell is around 300 to 325-watt energy produce. Installation cost of the plant =Rs.75000 per KW.
3) sanctioned load of tower is 5KW. Subsidies available for 50% of sanctioned load.

A. Solar for 2 Kw Power:

1) According to Ahmedabad condition sun light in 6 to 8 hr. We are taking 7 hr. sun light every day and taking 300-day sun light in year.
   – Energy produced per hour: - 2 unit /hr.
   – Energy produced per day: -14 unit/day
   – Energy produced per year: - 4200 unit/year
2) Revenue generated (at the rate of present selling price of Rs. 4.9) = 4200 x 4.9 = Rs. 20580
3) The generation efficiency of the solar PV system is expected to decrease by 0.5% in every 5 years:
4) Total units produced in 25 years' life time = (1+0.995+0.99+0.985+0.980) x (4200 x 5) = 103950 kWh
5) Total revenue generated by plant in 25 years' life time (based on present selling price Rs. 4.9) = 103950 x 4.9 = Rs. 509355/-
6) 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 0.

Total revenue in 25 years = Rs. 509355/-

Installation cost of 2 KW plant =Rs.75000 X 2 =150000

Installation cost of 2 KW plant	75000 X 2 =150000
Subsidies for solar by state government	20000
30% of subsidies by central government	150000 x .30 = 45000
Total cost of 2 kw power plant	85000 Rs.

Table 1: Installation cost of solar

CPBT is the period in which, we will be able to recover the investment cost of the plant.

Total revenue in 1 years = Rs. 509355 / 25 = 20374.2
So, CPBT = 85000/ 20374.2 = 4.17 year
So, cost payback time of 2 kw power is 4.17 year

B. Solar for 3 Kw Power:

1) According to Ahmedabad condition sun light in 6 to 8 hr. We are taking 7 hr. sun light every day and taking 300-day sun light in year.
– Energy produced per hour: - 3 unit /hr.
– Energy produced per day: -21 unit/day
– Energy produced per year: - 6300 unit/year
2) Revenue generated (at the rate of present selling price of Rs.4.9) = 6300 x 4.9 = Rs. 30870Rs
3) The generation efficiency of the solar PV system is expected to decrease by 0.5% in every 5 years:
4) Total units produced in 25 years' life time = (1+0.995+0.99+0.985+0.980) x (6300 x 5) = 155925 kWh
5) Total revenue generated by plant in 25 years' life time (based on present selling price Rs. 4.9) = 155925 x 4.9 = Rs. 764032.5/-
6) Cost Pay Back Time

and 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 0.
Total revenue in 25 years = Rs. 764032.5/-
Installation cost of 3 KW plant =Rs.75000 X 9 =225000
CPBT is the period in which, we will be able to recover the investment cost of the plant.
total revenue in 1 years = Rs. 764032.5 / 25 = 30561.3
So, CPBT = 225000/ 30561.3 = 7.36 year

So cost payback time of 3 kw power is 7.36 year.

VI. CONCLUSIONS

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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