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BUILDING THE LOW CARBON ENTERPRISE

Rooftop Solar and Net Metering in India - A Detailed Analysis

White Paper from EfficientCarbon

Introduction

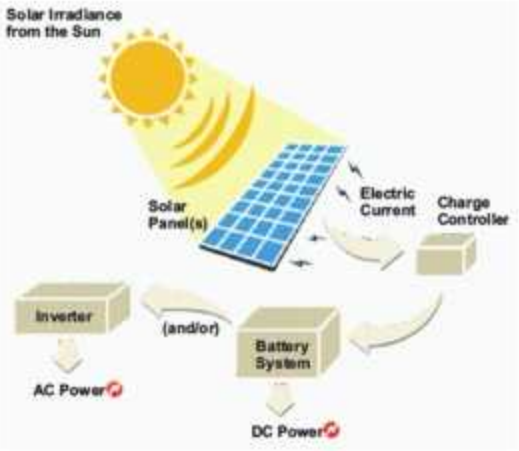
Energy demand in India – both in urban and rural areas in continuously increasing, however the electricity utilities are unable to meet this rapidly increasing demand. This is the reason why most of the commercial buildings such as hospitals, offices, malls etc. as well as residential buildings in the country are opting for back-up power systems. These back-up power systems are usually diesel generators and sometimes more than one generator is installed to meet their electricity demand.

With rising costs and environmental awareness, many of these buildings are opting for Solar Photo Voltaic (SPV) systems as back-up power in order to reduce their dependency on diesel generators. These SPV systems which convert sunlight into electricity, are usually installed on the existing roof-top space of buildings to meet the minimum load requirement. A typical roof-top SPV system consists of all or some of the following components depending on its type:

- Photovoltaic modules
- Charge controllers
- Inverters
- Module mounting structures
- Evacuation switchyard
- Wires
- Metering system

Apart from these components, an important requirement is availability of shadow-free roof-top space. Minimum shadow free area required to install a typical 1kW system on rooftop is about 30 sq. m. There are two types are such roof-top SPV systems – grid independent systems and grid connected systems. Grid independent systems come with either with or without battery back-up. Batteries are used to store the excess electricity generated during the day to be used at night or when insufficient solar power is generated due to cloud cover etc. Given below is a typical illustration of battery back-up solar roof-top system.

Batteries are often not opted for as - they are expensive requiring high investment and also they need to be periodically replaced. Hence, depending on the size of the system and its requirement, a building opts for a battery back-up system or without battery back-up. In the second case, the system is generally sized such that electricity generated during the day from this SPV is utilized to meet its power requirement and



the night time or when there is insufficient power generated, electricity is drawn from the grid or diesel generator.

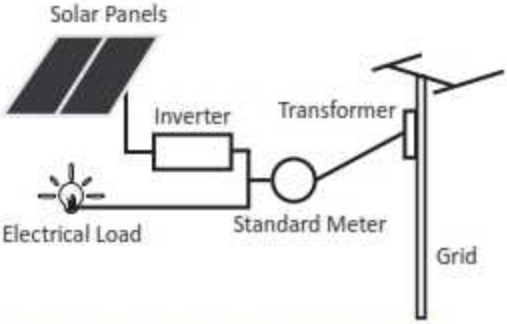
In the grid connected systems, the DC power generated is converted into AC power and is then fed into the grid. Electricity generated in this case during sunshine hours is primarily consumed by the building and excess in fed into the grid. However during the hours of insufficient power generation, electricity is drawn from the grid. For such systems, the grid acts as its battery back-up. Settlement of the energy imported to or exported from the grid is done by mechanisms such as:

Feed-in Tariff
Net metering
Signing a Power Purchase Agreement.

Net Metering

The concept of net metering involves recording the net energy between export of generated energy and import of energy from distribution licensee for a given period of time. This involves the usage of a bi-directional meter which has the facility to record both import and export values.

Under the net metering system, the excess energy generated by the solar photovoltaic plant at a given point of time is exported to the grid instead of being stored using a battery. However when there is a deficit in the power generated by the solar panels either during the night or a cloudy day, energy is drawn from the grid. At the end of the billing period,



Typical Net Metering Grid Connection System

if more energy is exported to the grid than imported, then the distribution licensee pays the consumer at a pre-determined price. On the other hand if more energy is imported from the grid than exported, then the consumer pays the distribution licensee at a pre-determined price. These prices usually vary from state to state.

Solar Rooftop Policies of Indian States

Tamil Nadu

Tamil Nadu in its State solar policy announced a target of 350 MW capacity to be set up through solar roof-top systems by 2015. Of this capacity, it envisions 50 MW to be set up via Generation Based Incentive (GBI) route. GBI is proposed to be provided for six years with the following break up for solar or solar-wind hybrid rooftops installed before 31st March, 2014:

First two years – Rs. 2/unit
Next two years – Re. 1/unit
Last two years – Re. 0.5/unit

Consumers who wish to avail GBI are required to install separate meters to measure rooftop generation. Net metering mechanism has also been proposed to set up solar rooftop systems. Net metering will be allowed for commercial establishments and individual homes to feed excess power generated back to the grid with 'power credits' accruing to the power producer. Suitable voltages are suggested below:

Solar PV System Size	Grid Connected
<10 kWp	240 V
10 kWp to <15 kWp	240 V / 415 V
15 kWp to <50 kWp	415 V
50 kWp to <100 kWp	415 V
>100 kWp	11 kV

Kerala

Kerala launched its 10,000 roof-top power plants programme for 2012-13 targeting a capacity of 10 MW. Since the per capita limit is small, this programme targeted households and small cottage industries. Each applicant is eligible to apply for 1kW system. Also apart from MNRE subsidy of 30% project cost or Rs. 81,000 per system, the state offers a discount of Rs. 39,000 per system

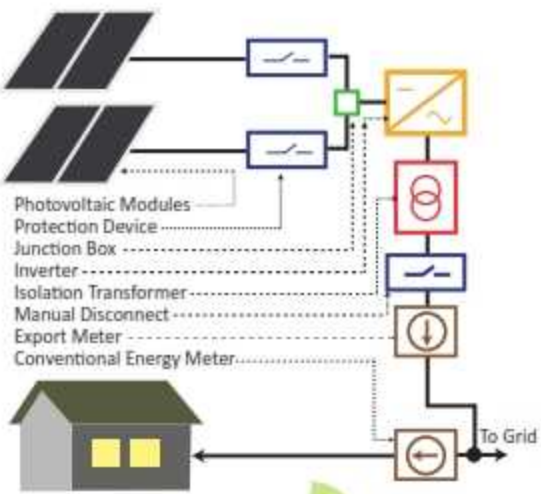
Gujarat

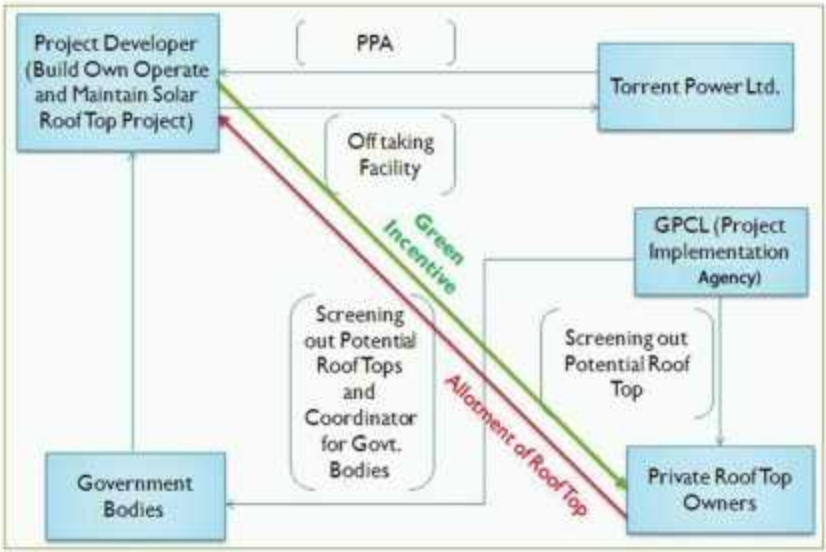
Gujarat thought its 'Gandhinagar Solar Photovoltaic Rooftop' programme targets to set up 5 MW capacity grid interactive roof-top SPV systems.

Under this pilot project, SPV systems of various sizes ranging from 500 kW, 100 kW, 50 kW, 20 kW, 10 kW, 5 kW, 1 kW or more are expected to be set up on roof-tops. However the size of an individual SPV system would depend on the shadow-free rooftop space available. Total capacity is to be divided into two sub-projects having 2.5 MW capacity each and out of 2.5 MW, 2 MW capacity SPV systems will be installed on Government Rooftops and 0.5 MW on private roof-tops.

The proposed metering system for these projects is the Feed-in metering system. As per solar tariff order, 2012, for solar PV rooftop projects levelized tariff for 25 years:

Projects availing accelerated depreciation – Rs. 10.36/kWh
Projects not availing accelerated depreciation – Rs. 11.57/kWh





Implementing Structure of solar rooftops in Gujarat

Karnataka

Karnataka's released a tender this year in January targeting a capacity 1.3 MW to be set up through 0.5 – 1 kW household solar systems across 1943 houses in several cities. The total cost was specified as Rs. 34 crores. Tariff of Rs. 3.4/kWh along with net metering facility was proposed for such SPV systems.

Rajasthan

Rajasthan through its state Solar Policy announced in 2011 aims to promote the setting up of roof-top plants connected to LT/11 kV grid as per the MNRE guidelines under Rooftop PV & Small Solar Generation Programme (RPSSGP) of the National Solar Mission. Accordingly PPA shall be executed with the concerned Discom of Rajasthan with metering arrangements made as per the CERC regulations.

Haryana

Haryana's solar policy targets commercial and industrial entities and it has approved two pilot projects of 100 kW providing financial assistance of Rs. 75 lakhs each.

Chhattisgarh

Chhattisgarh in its solar policy (2012-17) mentioned that solar roof-top plants can be set up under supported types of power generation plants. Under this policy, the total grid connected capacity target is 500-1000MW by 2017 to be set up through grid connected plants including solar roof-top plants.

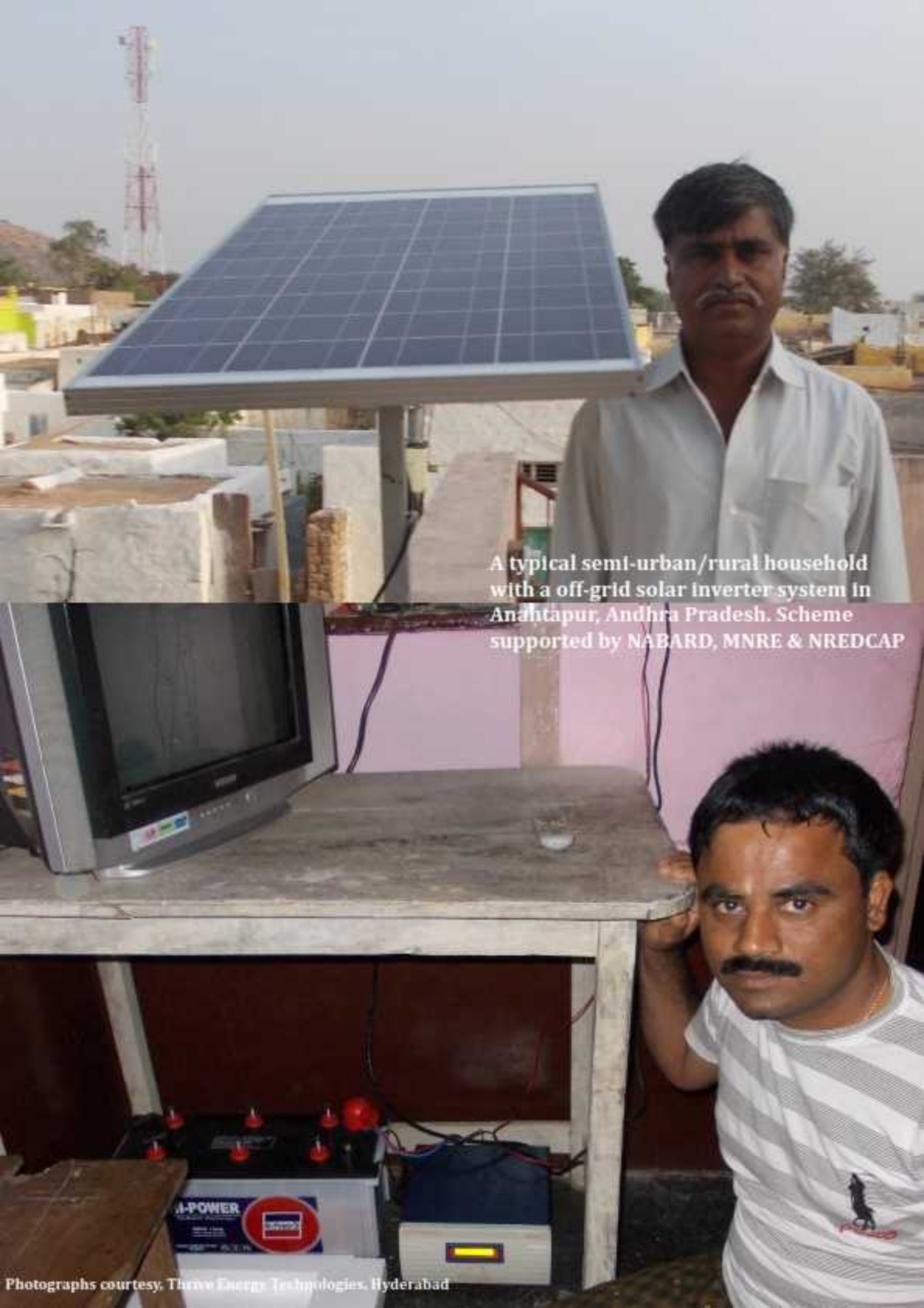
Andhra Pradesh

Following the AP Solar policy, the Government released an order for setting up net metering facility in the state. This was done to encourage setting up solar PV plants on rooftops.

As per G.O.Ms.No.22 for excess energy imported from the DISCOM, the consumer is expected to pay the DISCOM as per applicable retail supply tariff decided by the regulator commission. This settlement is done on a monthly basis. For excess energy exported to the DISCOM by the consumer, no payment will be made by the DISCOM. The generator is also required to bear the entire cost of metering arrangement provided including its accessories.

Changes were made to this order in G.O.Ms.No.27, wherein the state Government decided to make payment for the surplus energy injected into the grid by a generator. This payment will be made at pooled cost as may be decided by APERC for that year. This cost will be made effective for a period of 7 years from the date of establishment of such SPV plant and the settlement of this surplus energy will be carried out on a half yearly basis.

Along with this the Government will provide 20% subsidy from the State budget to be paid for installation of rooftop system (up to 3 kW capacity) in domestic sector only. This subsidy will be provided in addition to the eligible Central subsidy.



A typical semi-urban/rural household with a off-grid solar inverter system in Anahtapur, Andhra Pradesh. Scheme supported by NABARD, MNRE & NREDCAP

Photographs courtesy, Thrive Energy Technologies, Hyderabad

Payback Periods for a Typical Solar Rooftop - Net Metering System

Since we have a clear-cut GO issued along with a tariff announced for Andhra Pradesh, we are taking this example for AP alone. Similar values, when they are announced, can be substituted for different states while calculating the payback periods for those states.

In order to get maximum returns from a SPV - Net Metered system, sizing is very important. To illustrate this,the following cases have been worked on to calculate the payback period in each situation. This is done for a 3 kW system which generates 12 units/day. Such a system costs close to Rs. 3,00,000 and after MNRE and State subsidy is provided it's cost comes down to Rs. 1,50,000. Settlement of electricity is done as per the G.O. Additionally, we could factor Rs 10,000 as additional expenses.

Please note that we have not taken any battery back-up into consideration and hence the low costs for the system. The payback period

Case 1: Monthly production is more than the monthly consumption

Generation:
Units/month = 360 kWh

Consumption:
Units/month = 300 kWh

Electricity Bill paid normally:
0 - 100 units = Rs. 2.60 / kWh
101 - 200 units = Rs. 3.60 / kWh
201 - 300 units = Rs. 5.75 / kWh

So, total bill = Rs. 1195

Since the production is 360 units, net consumption is - 60 units. Hence the entire bill is waived off and the generator gets Rs. 3.50 / kWh.

So, monthly net benefit for the generator:
Waived off bill = Rs. 1195
Add payment for units generated = Rs. 210
Total benefit per month = Rs. 1405
Total benefit per year = Rs. 16,860

Payback period for the investment = 9.48 years

Case 2: Monthly production is equal to the monthly consumption

Generation:
Units/month = 360 kWh

Consumption:
Units/month = 360 kWh

Electricity Bill paid normally:
0 - 100 units = Rs. 2.60 / kWh
101 - 200 units = Rs. 3.60 / kWh
201 - 300 units = Rs. 5.75 / kWh
301 - 360 units = Rs. 6.75 / kWh

So, total bill = Rs. 1600

Since the production is 360 units, net consumption is 0 units. Hence the entire bill is waived off and the generator gets no aditional benefit

So, monthly net benefit for the generator:
Waived off bill = Rs. 1600
Add payment for units generated = Rs. 0
Total benefit per month = Rs. 1600
Total benefit per year = Rs. 19,200

Payback period for the investment = 8.33 years

Case 3: Monthly production is more than the monthly consumption

Generation:
Units/month = 360 kWh

Consumption:
Units/month = 400 kWh

Electricity Bill paid normally:
0 - 100 units = Rs. 2.60 / kWh
101 - 200 units = Rs. 3.60 / kWh
201 - 300 units = Rs. 5.75 / kWh
301 - 400 units = Rs. 6.75 / kWh

So, total bill = Rs. 1870

Since the production is 360 units, net consumption is 40 units. Hence the entire bill is waived off and the generator gets no aditional benefit while he has to pay the bill for the additional 40 units consumed at Rs. 2.60 / kWh.

Actual bill = Rs. 104

So, monthly net benefit for the generator:

Waived off bill	= Rs. 1870
Subtract Actual bill paid	= Rs. 104
Add payment for units generated	= Rs. 0
Total benefit per month	= Rs. 1766
Total benefit per year	= Rs. 21,192

Payback period for the investment = 7.55 years

Please note:

Here, we are not
Adding fixed demand charges
Adding FSA charges &
Adjusting for increase in electricity prices

If we take all these factors into account, the approximate payback periods could be:

For Case 1 = 7.5 years
For Case 2 = 6 - 6.5 years
For Case 3 = 5 years

Looking at these payback periods, it would be worthwhile to invest in setting up a Solar PV power pack on rooftops with net metering facility. With a lifetime of more than 20 years and minimum maintenance, grid synchronised Solar Power plants are the way to go for the future.

Conclusion

The purpose of this document was to give Solar PV system integrators, companies looking to enter the rooftop solar market and potential customers a low down on the policies and where the market is heading. Looking at the proactive approach being taken up by MNRE and various nodal agencies, grid synchronised, net metered or captive rooftop solar PV will see a major growth and will help our country in achieving energy independence from fossil fuel based electricity.

About EfficientCarbon

EfficientCarbon is a consulting firm focusing on providing specialist advisory solutions to companies in the areas of Sustainable Development, Climate Change strategy, Carbon Management and Renewable Energy. With integrity, efficiency and diligence, EfficientCarbon strives to help its clients companies manage their environmental and social impacts and become totally Sustainable organisations in the truest sense.

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