

Grid Connected Roof Top Solar Power Generation: A Review

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Abstract - India is blessed with rich solar energy and if exploited efficiently, the country has the potential of producing trillion-kilowatts of electricity. Sunlight is converted to electricity directly when made to fall on solar photovoltaic (SPV) modules. Systems /devices are made for various applications based on SPV modules connected with suitably designed power conditioning units for meeting electricity requirements. These systems/devices are designed to work in off-grid mode (usually supported with batteries to allow use when sunlight is low or during night). In recent years solar PV systems became viable and attractive. Utility scale plants are being set up worldwide with promotional mechanisms which are set up on ground surface. Available roof-top area on the buildings can also be used for setting up solar PV power plants, and thus dispensing with the requirement of free land area. The electricity generated from SPV systems can also be fed to the distribution or transmission grid after conditioning to suit grid integration. Currently, whole world is in the midst of an energy revolution that is fundamentally changing the future of rural electrification. So we present a review in this paper on today's policy and status of grid connected roof top PV system in Rajasthan.

Keywords - Grid Connected Roof Top PV, PV Solar Power, Renewable Energy, JNNSM.

I. INTRODUCTION

India has tremendous potential to emerge as one of the leaders in solar power generation. According to the Government of India's policy for the solar sector – Jawaharlal Nehru National Solar Mission (JNNSM) – a target of 20 GW of solar installations by 2022 has been set. India is endowed with vast solar energy potential, About 5,000 trillion kWh per year energy is incident over India's land area with most parts receiving 4-7 kWh per sq. m per day. Roof top system out of sight out of mind on of the best features of rooftop solar PV systems is that they can be permitted and installed faster than other types of renewable power plants. They are clean, quiet, and visually unobtrusive. The benefits of rooftop solar PV systems worldwide Not only do they realize financial returns based on the solar systems installed on their premises, but also the tremendous PR equity that comes with environmental leadership. Rooftop PV systems may be installed on top of most large (40,000+ square feet), single-story buildings or parking canopy structures, so long as the roof is in good condition (generally, those less than 7 years old). We utilize both penetrating and non-penetrating roof-mount systems and will design the solar PV system to protect your assets while delivering maximum value to you. The roof top solar PV systems • Are easy to install and maintain and Have long life of 25 years.

II. GRID CONNECTED SOLAR DEVELOPMENT

Globally, grid-connected solar project development has followed 2 broad routes:

- Utility driven solar project development: Large MW-scale centralized solar projects developed to meet renewable purchase obligations (RPO) of the utilities – either developed by utilities themselves or by third parties for their procurement.
- Customer driven solar project development: Small-scale decentralized projects developed by electricity consumers on their own premises. Interest fueled by the declining cost of solar energy, fiscal incentives like feed in tariffs, net metering and tax rebates, coupled with the increase in the cost of grid based conventional energy. Several hybrids of the above routes have emerged in specific markets, depending on the regulations, market opportunities and role of intermediaries.

III. ROOF TOP SOLAR POWER

Every building whether home, industry, institution or commercial establishment can generate some solar power by installing PV panels on the rooftop. Some Key Benefits:-

- Photovoltaic roof-top installations at the tail-end of the grid can enhance grid-stability and reduce losses
- Savings in land requirement and costs
- Savings in development of new transmission infrastructure
- Creation of value from under-utilized /unutilized rooftops
- Good choice for distributed power generation system

A. How does it Work?

Based on available roof area solar PV panels will be installed on the roof of the building. The output of the panels (DC electricity) connect to the power conditioning unit / inverter which converts DC to AC. The inverter output will be connected to the control panel or distribution board of the building to utilize the power. The inverter synchronizes with grid and also with any backup power source to produce smooth power to power the loads with preference of consuming solar power first. If the solar power is more than the load requirement, the excess power is automatically fed to the grid. For larger capacity systems connection through step up transformer and switch yard may be required to feed the power to grid.

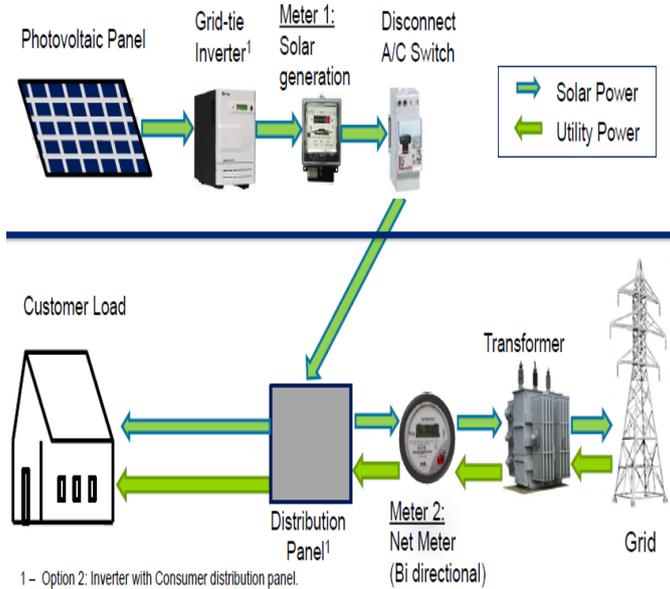


Fig. 1 Gross Metered Rooftop solar



Fig. 2 Net-Metered Roof Top System-1

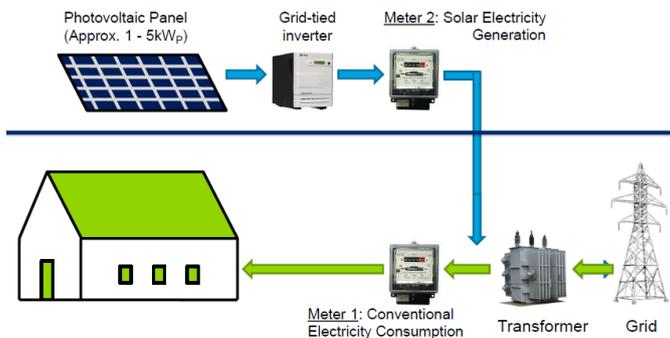


Fig. 3 Net-Metered Roof Top System-2

B. Types of Roof-Top Solar PV Systems

Rooftop solar PV systems are of 3 types:

1. Grid tied – These rooftop systems are primarily designed to supply the generated power to the grid and also power the load. These systems will NOT generate power during a power failure as the inverter shuts down the system to stop sending power into the grid and avoids the risk of electrocuting utility personnel who are working to repair the grid
2. Grid interactive – This system works in conjunction with either a battery backup or diesel generator to support the load even during a power failure.
3. Off grid – This system does not work with the grid and is designed to work only with a battery backup or diesel generator in offgrid applications

There are no moving parts in the system and it requires only minimal attention. Depending upon the dust level, the system requires periodic cleaning.

IV. MONITORING & IMPLEMENTATION

For all projects, a third party monitoring mechanism shall be introduced to ensure timely execution and achievement of deliverables and also to allow any mid course correction, if desired. For this, a panel of experts and organizations would be identified by the concerned Group/Division in the Ministry in consultation with the concerned RDPACs and with the approval of Secretary, MNRE. The expert / organization for monitoring purposes shall be identified at the time of consideration of the proposal by RDPACs/RDPACs. Each project would be required to be visited at least once in a year, and a report on the status of activities and achievements vis-à-vis. the sanctioned objectives/ deliverables and milestones would be prepared and submitted to the Ministry.

A. Govt. Initiative For Roof Top Solar

The Ministry of New and Renewable Energy (MNRE) has set a target of 40,000 MWp of Grid Interactive Solar Rooftop systems during the next 5 years. However, it has proposed to reduce the capital subsidy for Solar PV for Rooftop systems from 30% to 15%, citing reduced cost of Solar PV panels and a competitive tariff of Rs. 7 per unit that can be achieved without subsidy. This is applicable for Systems ranging between 1 KWp to 500 KWp. The ministry has asked project developers to go ahead with their projects without waiting for subsidy allocation via Aadhaar Linked Account or interest subvention. As per the current Home Loan and Home Improvement Loan schemes, Solar PV is not covered among items against which loan can be availed. The Ministry of Finance has issued following advisory to all Public Sector Banks: All banks are advised to encourage the home loan/ home improvement loan seekers to install rooftop solar PVs and include the cost of such equipment in their home loan proposals just like non solar lighting, wiring and other such fittings. This will reduce the dependence on private investors who are little hesitant towards investing in Solar projects, and will enable owners to plan their Home loan with inclusion of capital cost for installing Solar Rooftop, based on the available space and requirement. This is mainly aimed at encouraging residential, commercial, industrial and institutional setups to adopt viable Grid Interactive Solar Rooftop Systems for their own consumption, and inject surplus electricity into the grid. Solar Rooftop Regulation/Policies/Schemes in states like Delhi, Rajasthan, Haryana, UP, Uttarakhand, Kerala and Karnataka will further attract investors and residential consumers towards Solar Rooftop Power. 30% subsidy on the project cost is available from Ministry of New and Renewable Energy, Government of India, through Solar Energy Corporation of India (SECI). The balance cost is to be met by the consumer. The project would be implemented through vendors shortlisted by SECI after competitive bidding.

B. Estimates of Financial Benefits

System size	100 kWp
System cost	0.8 -0.9 crore
Subsidy	30%
Expected electricity generation	140000 – 160000 units
Payback period @ Grid electricity cost	5-6 years
Payback period with Accelerated Depreciation	4-5 years
Pay back @ diesel power cost	3-4 years
Plant life	25 years

Developments on cheap solar technology are considered as a potential alternative that allows an electricity infrastructure comprising of a network of local-grid clusters with distributed electricity generation. That could allow bypassing, or at least relieving the need of installing expensive, and lossy, long-distance centralised power delivery systems and yet bring cheap electricity to the masses. 3000 villages of Odissa will be lighted with Solar power by 2014. The off-grid and rooftop segments will grow exponentially as price parity with consumer tariffs makes solar power an economically viable alternative, particularly for urban and semi-urban consumers. Distributed generation in rural areas and support for latent urban demand has the potential to reach 4 GW by 2020 and increase rapidly to more than 10 GW over the next three to four years. Our 285 roof top project commissioned in 2014 and Tamilnadu is largest rooftop project 50 MW. Total installed capacity in industrial and commercial segment is 173 MW.

1.5 GW of cumulative rooftop solar capacity is expected to be installed in India by 2018

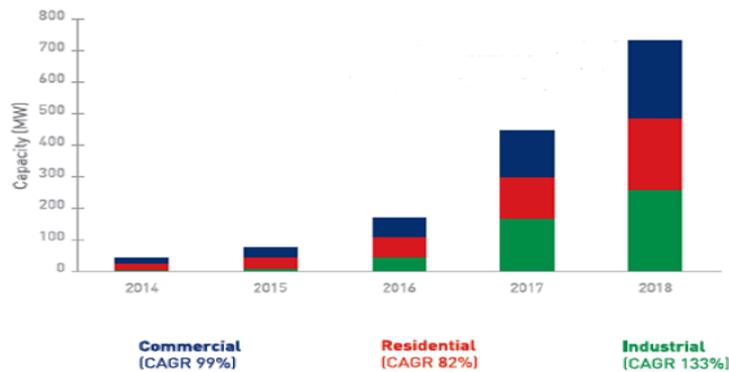


Fig. 4 Graph for MW Capacity per Year

C. Advantages

The grid connected roof top solar PV system would fulfill the partial/full power needs of large scale buildings. The following are some of the benefits of roof top SPV systems:

- Generation of environmentally clean energy.
- Consumer becomes generator for his own electricity requirements.
- Reduction in electricity consumption from the grid.
- Reduction in diesel consumption wherever DG backup is provided.
- Feeding excess power to the grid.

V. Smart Grid-Connected Roof Top

Smart Grid-connected solar PV system ensures with its modular design that system operators can individually determine to what extent they want to carry out energy management. This kind of solution applies to existing and new systems, for a wide range of power classes and to individual storage solutions. Smart Grid-connected solar PV system is primarily based on its essential functions as “intelligence”, automatic load control, temporary PV electricity storage and thermal use of solar power. Thus, everyone can take part in the energy transition.

VI. Solar Power Projects in Rajasthan

"India is blessed with rich solar energy and if exploited efficiently, the country has the potential of producing trillion-kilowatts of electricity. With the recent budget's emphasis on renewable energy and initiative of setting aside Rs 500 crore for ultra-mega solar power projects in many states, the future of solar power is very promising. This was the first time we had bid for any government tender and we are honored to bag the project of SECI for execution of solar rooftop projects in Rajasthan. Their trust in us has boosted our morale and commitment towards development of many more solar plants and projects across the nation." The implementation of 500kW grid connected rooftop solar power projects in Rajasthan. Different company plans to begin the development in August-September at Jaipur, Jodhpur and Neemrana cities in Rajasthan. This particular project is part of the fourth phase of project allocations under the Rooftop Photovoltaic (PV) projects scheme of the Solar Energy Corporation of India (SECI). As per the report released by SECI, the corporation had invited RfS for allocation of 50 MW of solar photovoltaic (PV) rooftop projects in 21 Indian states in 2014 under two models - Part-A (CAPEX) and Part-B (RESCO). However for India to emerge as a global leader in the solar power segment, it needs to address the key restraints hindering its progress and march towards grid parity through long term policies, large-scale deployment, aggressive research and development (R&D), and domestic production of essential products and components.



Fig. 5 Roof top Village in Rajasthan

A. Setting up of Roof Top PV Solar Power Plants Connected to LT Grid

The state will promote development of roof top pv solar plants connected to LT under net metering schemes as per guidelines of RERC. The state govt shall allow the net metering mechanism for grid connected system to the consumer of the Discoms installing such systems subject to technical consideration and execution of net metering agreement between such consumers and Discoms. The discoms will develop a suitable and comprehensive consumer friendly application in this regard.

B. Decentralized and Off -Grid Solar Application

The state will promote and incentivize decentralized and off grid solar applications, including hybrid system as per guidelines issued by MNRE to meet various electrical and thermal energy requirements for domestic and commercial use. The state will promote setting up of solar power plant for sale of power to individuals through its own distribution system and also promote setting up of local solar grid and standalone solar system to provide electricity to remote village and dhani for the use of SPV technology as power source for irrigation uses by installation of SPV Pumping Systems.

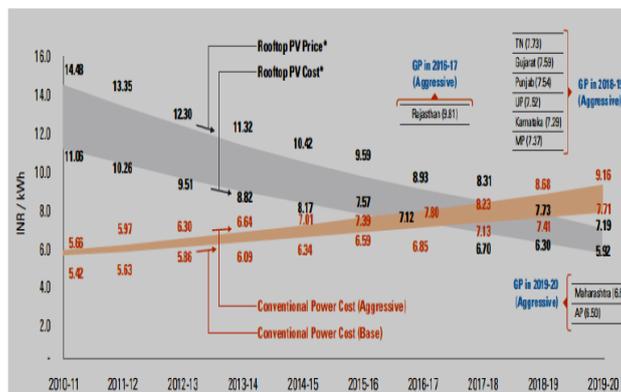
C. Roof Top Potential in india

India is having 330 million houses. 166 million electrified houses. 76 million houses uses kerosene for lighting. 1.08 million houses are using solar for lighting. 140 million houses with proper roof (Concrete or Asbestos / metal sheet). 130 million houses are having > 2 rooms.

- Average house can accommodate 1-3kWp of solar PV system.
- The large commercial roofs can accommodate larger capacities.
- As a conservative estimate, about 25000 MW capacity can be accommodated on roofs of buildings having > 2 rooms alone if we consider 20% roofs.

D. States Initiatives in Roof Top

- Gujarat: Initiated 5MW Rooftop Project in Gandhi Nagar in PPP model. 25 MW in 5 other cities also announced
- Tamil Nadu: Has come up with a draft order on Net-Metering & REC
- Andhra Pradesh: Solar Policy 2012 also promoting rooftop solar projects
- Rajasthan: has come up with rooftop solar policy in solar cities
- Kerala: Launched its 10,000 rooftop power plants program for 2012-2013. Apart from the MNRE’s 30% capital subsidy, the state also offers discount
- West Bengal: Initiated a net-metering solar rooftop model promoting self consumption
- Uttarakhand: Attractive feed-in-tariff by Electricity Regulatory Commission
- Maharashtra: Solar policy is under draft stage.



Source: KPMG

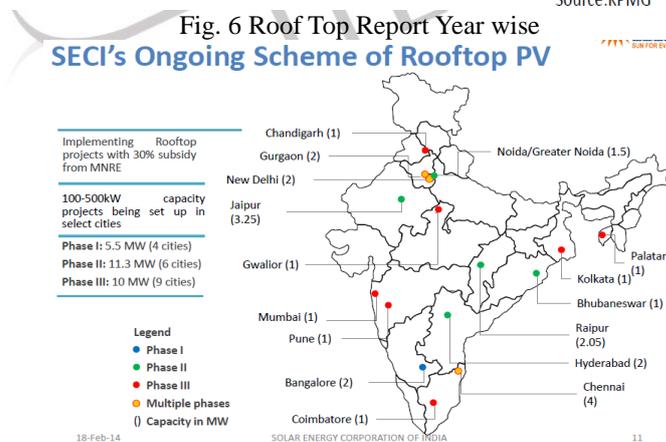


Fig. 7 Ongoing Project In India

VII. CONCLUSIONS

New and Renewable Energy dept. has been making serious efforts in promoting renewable in various sectors including corporate houses. We have mentioned all of critical success factors for Roof Top Program and Implantation it in state. The pace of development of solar energy systems with grid connected requires special enabling environment for success. Hopefully state government will be prepared to exploit the opportunity provided the challenges we described here are addressed quickly and appropriately.

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