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GRID-INTERACTIVE SPV ROOFTOP PLANTS: AN OPTION FOR INDIA GROWING ENERGY DEMAND

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ABSTRACT

There is a large potential available for generating solar power using unutilized space on rooftops and wastelands around buildings. Small quantities of power generated by individual households, industrial buildings, commercial buildings or any other type of buildings can be used to partly fulfil the requirement of the building's occupants and surplus, if any, can be fed into the grid. This is possible, if the distribution company of that area is willing to allow power to be fed into the grid and has the necessary arrangements including availability of meters. In order to utilize the existing roof space of buildings, the roof-top SPV systems on buildings can be installed to replace diesel Gensets installed for minimum load requirement for operation during power outages.

The cost of generating solar power at present is a little higher than the tariff charged from consumers by Discoms in most cases. However, if we take into the account the average tariff for consumers in the next 20 years and look at the cost for next 20 years, it can very well be seen that power generated from solar plants installed today would be cheaper than the average tariff for consumers in the next 20 years.

If capital subsidy (up to 30 percent or so) is given on this, it may be possible to generate power at Rs. 5 - 6 per cent kW for the next 20 years. This electricity would be cheaper than the diesel Genset based electricity and this could also be cheaper than the cost at which most Discoms would make power available to the same consumers. Accelerated depreciation to beneficiaries is also available which would bring the cost further down. If a large number of rooftop solar installations are clubbed together into one and a single developer or system integrator is given an order of more than 5 MW, the cost per KW can be brought down to about Rs. 80,000 - 90,000.

Keywords*: *Gensets , Discoms , Tariff , Depreciation etc.

I. INTRODUCTION

The Indian solar PV market has seen significant growth with the installed solar PV capacity rising from under 40 MW to more than 2,000 MW in the last four years. The total installation capacity of solar power generation is expected to be 12,500 MW by 2016-17, whereas only roof top solar generation is estimated to be 4,000 MW by 2016- 17. It is also expected that distributed generation (rooftop SPV) at the consumer end will drive solar power capacity additions given the acute power shortage scenario in several states along with associated transmission and distribution losses. Globally, PV installed capacity has reached more than 100 GW in 2013.

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Countries with large capacities in PV installations are Germany, Italy, Japan, USA, China, Spain and Australia. In these countries rooftop SPV installation has major contribution in the total installation.

Fig .1 Roof Top village in Rajasthan

II. DIFFERENT METERING ARRANGEMENTS

The rooftop SPV system can be installed in two configurations, namely (a) as a standalone system or (b) as a grid interactive system. In urban areas the grid interactive system is more feasible than the standalone system as almost all locations are connected by grid and also grid act as storage for an intermittent source of generation. In the grid interactive system also there can be a number of schemes depending on the reliability of supply to the loads and the consumer needs. Wherever the battery is not envisaged, the solar system can be directly connected to consumer AC bus and the total energy of the solar system will be supplied to consumer/grid depending upon the requirement of the consumer.

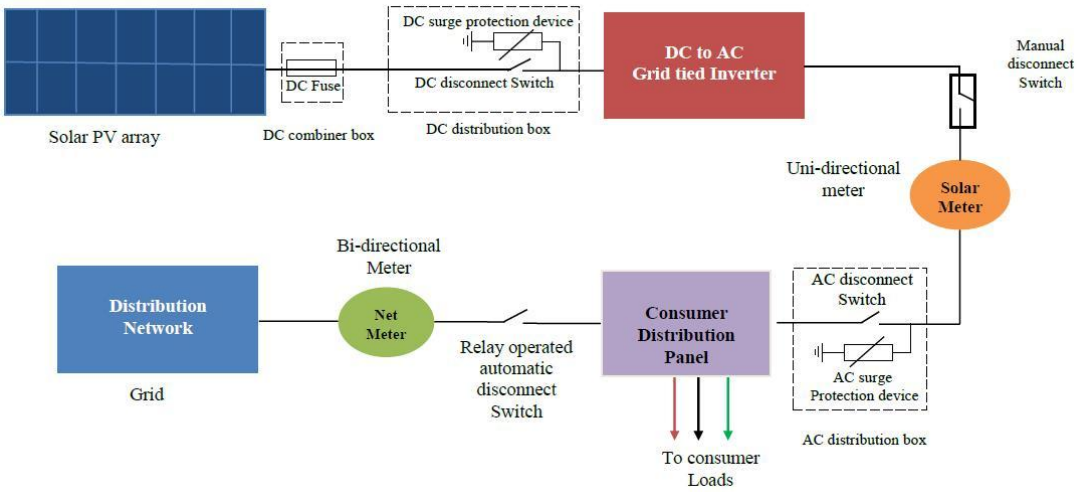

Fig .2 How NET Metering Works?

2.1 Gross Metering

Gross metering arrangement doesn't affect consumer's existing electrical connections. Electricity generated from rooftop SPV system is directly fed to the grid and consumers get electricity supply from the utility grid.

There are two separate energy meters to read solar energy generation and the consumer's electricity consumption from the utility grid.

2.2 Net Metering

Net metering arrangement allows consumers to use solar electricity for meeting end use loads. In this case simple energy meter is replaced by a bidirectional meter. The flow of energy in a grid interactive rooftop SPV system under different operating conditions is given below:

f. AC electrical output of inverter consumed by loads or AC current is fed back to grid

f. For generation > consumption, |PV-Load|= Net Export

f. For generation < Consumption, |PV-Load|=Net Import

f. Feed-in-Tariff (Fit) paid to customer based on Net Export

III. CENTRAL AND STATE GOVERNMENT SCHEMES

The PV market in India is driven by a mix of national targets and support schemes at various levels.

Currently, MNRE is providing 30% subsidy for SPV rooftop systems and Solar Energy Corporation of India (SECI) is also promoting grid connected rooftop systems (100- 500kWp) under RESCO model.

Apart from central policies, various states have also announced their state specific policies for rooftop SPV. Different states in India are promoting basically 3 kinds of rooftop SPV implementation schemes-.

* Gujarat is the front runner for implementing Gross metered Roof rental model: This model does not promote self-consumption of SPV electricity

* Tamil Nadu, Andhra Pradesh & Uttarakhand have recently launched their policies promoting net metering mode of implementation: This model promotes self-consumption of SPV electricity. Tamil Nadu is the first state who started implementing the policy.

* Kerala is promoting off-grid rooftop SPV systems for residential consumers

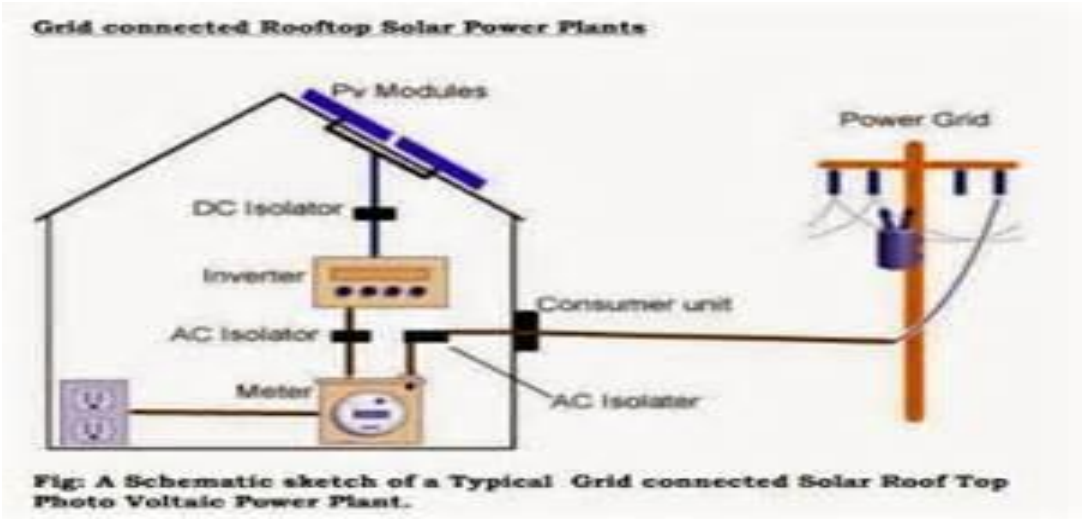

Fig .3 A Schematic Sketch of A Typical Grid Connected Solar Roof Top Plant

IV. ROOFTOP GRID INTERACTIVE SPV SYSTEM

In grid interactive rooftop or small SPV system, the DC power generated from SPV panel is converted to AC power using power conditioning unit and is fed to the grid either of 33 kV/11 kV three phase lines or of 440/220 volt three/single phase line depending on the system installed at institution/commercial establishment or residential complex. They generate power during the day, which is utilized fully by powering captive loads and feed excess power to the grid as long as grid is available. In case, where solar power is not sufficient due to cloud cover etc., the captive loads are served by drawing power from the grid. The grid-interactive rooftop system can work on net metering basis wherein the beneficiary pays to the utility on net meter reading basis only. Alternatively two meters can also be installed to measure the export and import of power separately. Ideally, grid interactive systems do not require battery back-up as grid acts as the backup for feeding excess solar power and vice-versa. However, to enhance the performance reliability of the overall systems, a minimum battery back-up of one hour of load capacity is recommended. In grid interactive systems, it has, however to be ensured that in case the grid fails, the solar power has to be fully utilized or stopped immediately feeding to the grid (if any, in excess) so as to safeguard any grid person/technician from getting shock (electrocuted) while working on the grid for maintenance etc. This feature is termed as 'islanding protection'. The sketch diagram of the solar PV grid connected rooftop system

4.1 Spv Grid- Connected Rooftop World-Wide

Germany, the USA and Japan are leaders in adopting grid-connected SPV rooftop systems.

Germany has highest PV installed capacity of 33 GW of which 70 per cent is in rooftop segment (as on 31.03.2013). Italy has 12.7 GW PV installation with over 60 per cent rooftop systems. In Europe, of the total 50.6 GW PV installation, over 50 per cent is in the rooftop segment. Feed-in-tariff is the norm in Europe, while net-metering is popular in the USA. In the USA, net metering is operational in 43 states but specific rules def defer from state to state. The Energy Policy Act 2005 mandates all public electricity utilities to make net metering options available to all customers. California has maximum installed onsite customer generated solar capacity of 991 MW with 1,01,284 net metering consumers from 115000 sites.

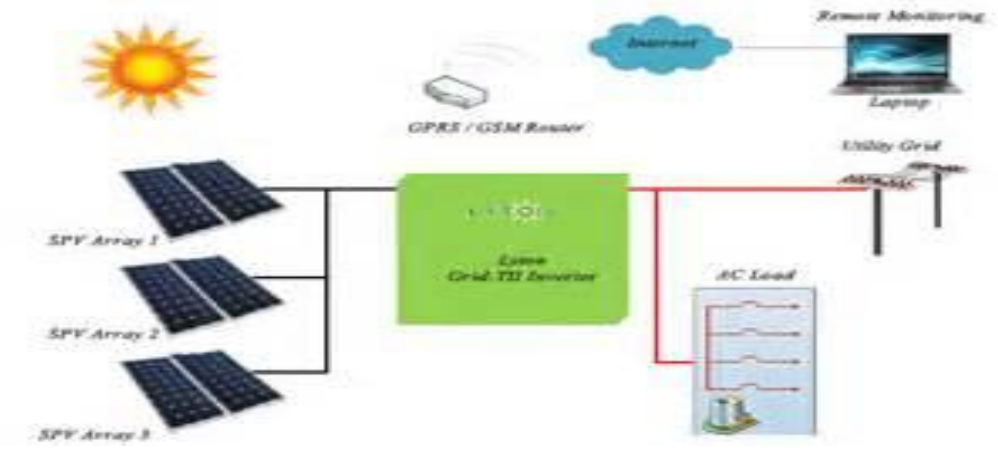

Fig.4: Grid Connected Roof Top SPV

4.2 SPV Grid Connected Rooftop in India

Andhra Pradesh, West Bengal, Gujarat, Karnataka, Tamil Nadu, Uttarakhand, Uttar Pradesh and West Bengal have initiated actions for promoting the SPV grid connected rooftop projects. In West Bengal, grid connected rooftop is allowed only for institutional consumers with 2-100 kW size. Connectivity is allowed at low or medium voltage (6 kV or 11 kV) of distribution system and solar injection is permitted only up to 90 percent of annual electricity consumption. Net energy supplied by the utility will be billed as per existing slab tariffs and the solar generation will offset consumption in the highest tariff slab and then the lower slab. As per recent policy all existing and upcoming commercial and business establishments having more than 1.5 MW contract demand to install SPV rooftop systems are required to meet at least 2 percent of their total electrical load. All existing and upcoming schools and colleges, hospitals, large housing societies, and government establishments having more than 0.5 MW contract demand are required to install SPV rooftop systems to meet at least 1.5per cent of their total electrical load. The Policy targets 16 MW of rooftop and small PV installations by 2017. In Gujarat, Gandhinagar has initiated a 5 MW (4 MW in government buildings and 1 MW in private homes) rooftop PV programme based on FIT/sale to utility. Two project developers for 2.5 MW each have been selected through reverse bidding with GERC cap of Rs. 12.44/kW. Torrent Power will buy from developer (AzurPower) @ Rs. 11.21/kW for 25 years and Azure Power will pass on Rs. 3.0/kW to rooftop owner as roof rent. Recently 5 more cities Bhavnagar, Mehsana, Rajkot, Surat and Vadodara have started installing pilot rooftop projects.

In Karnataka, as per new RE policy 2009-14, the State will promote rooftop with net metering. System size to be 5-100 kW and interconnection at 415 V, 3 phase or 11 Kv have been allowed. Maximum energy injection allowed is upto 70 per cent of energy usage at site from Discom. Energy injection will be settled on net basis in each billing period, no carry forward is allowed.

In Tamil Nadu, as per 'State Solar Policy 2012' 350 MW SPV rooftop has been

targeted during 2012-2014.50 MW rooftop, which will be supported through GBI @ Rs. 2/kW for the first 2 years, Rs. 1/kW for the next 2 and Rs. 0.50/kW for other 2 years. Net metering will be allowed at multiple voltage level. The interconnection will be as follows:

< 10 Kw - connection at 240 V

10 to 15 kW - connection at 240/415 V

15 to 50 kW - connection at 415 V

50 to 100 kW - connection at 415 V

100 kW - connection at 11 kV

Exemption from payment of electricity tax will be allowed for 5 years for 100 percent solar electricity used for self/sale to utility. All new government/local body buildings shall necessarily install PV rooftops.

In Chandigarh, about 3.0 MW projects of SPV grid connected PV rooftops projects have been sanctioned for the model solar city which are under installation of which 150 kW have been commissioned. Discoms has agreed to purchase power and the rates are being finalized. Solar Energy Corporation of India has been entrusted with the execution of 16.6 MW plants by the Ministry in the country under the funding received from National Clean Energy Funds. The projects are under implementation.

V. BUSINESS MODELS FOR ROOFTOP AND SMALL SCALE SOLAR POWER PLANTS

For the success of smooth operation of rooftop and small solar power plants, various situations and conditions need to be worked out to make it a workable business model. There can be many possible business models, some of which can be considered are as follows:

■ Solar installations owned by consumer

■ Solar rooftop facility owned, operated and maintained by the consumer(s).

■ Solar installations owned, operated and maintained by 3rd party The 3rd party implements the solar facility and provides services to the consumers. The surplus electricity may be injected to the electricity grid. The combinations could be :

■ Arrangement as a captive generating plant for the roof owners: The 3rd party implements the facility at the roof or within the premise of the consumers; the consumer may or may not invest as equity in the facility as mutually agreed between them. The 3rd party may also make arrangement of undertaking operation and of maintenance of the facility. The power is then sold to the roof owner.

■ Solar lease model, sale to grid: The 3rd party implementing the solar facility shall enter into a lease agreement with the consumer for medium to long term basis on rent. The facility is entirely owned by the 3rd party and consumer is not required to make any investment in facility. The power generated is fed into the grid and the roof top owner gets a rent.

■ Solar installations owned by Discoms

■ Solar installations owned operated and maintained by the Discom: The Discom may own, operate and maintain the solar facility and also may opt to sub contract the operation and maintenance activity. The Discom may recover the cost in the form of suitable tariff. The electricity generation may also be utilized by Discom for fulfilling the solar renewable purchase obligation.

■ Distribution licensee provides appropriate viability gap funds: The Discom may appoint a 3rd party to implement the solar facilities on its behalf and provide appropriate funds or viability gap funds for implementing such facility. It may also enter into an agreement with the 3rd party undertaking the operation and maintenance of the solar facilities.

VI. PREREQUISITES FOR PROMOTION OF ROOFTOP AND SMALL SOLAR PLANTS

■ **Feed-in-tariff:** Since, the grid interactive rooftop and small solar plants have an impact on the revenue earnings of the Discoms, the provision should be made in such a manner that it provides a safeguard to all stakeholders including Discoms. The tariff should be such that it is attractive for the roof owner and does not put too much burden on the Discoms. Therefore regulators have to come up with feed-in-tariff for roof tops with and without MNRE subsidy.

■ **Necessity of connectivity regulations:** Central Electricity Authority (CEA) has formulated draft "CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations, 2012", which is expected to be notified by the Ministry of Power shortly. The announcement of such standards will provide necessary guidance to Discoms and also shall provide the transparency in the process and encourage consumers for installing such solar plants.

■ **Availability of electricity grid:** The availability of electricity grid near the solar installation is an essential component which needs to be provided by the concerned agencies.

■ **Eligible capacity for participation:** Eligible capacity limit needs to be specified in order to avoid the grid congestion by the very small capacity solar plants.

■ **Capacity building of Discoms:** The Discoms staff needs to be trained to take up these activities and should be favorably inspired.

6.1 Suggested Modus o Operandi

■ The project site/rooftops at office buildings, commercial buildings, residential complexes etc., can be selected on the basis of the total energy requirement of the premise and the area available for installation of roof top solar PV system.

■ Solar PV system on the roof top of selected buildings can be installed for meeting the requirement of the building as much as possible.

■ Though rooftop systems shall be generally connected on LV supply, large solar PV system may have to be connected to 11kV system. Following criteria have been suggested for selection of voltage level in the distribution system for ready reference of the solar suppliers:

■ In up to 10 kW solar PV system, low voltage single phase supply shall be provided.

■ Thereafter up to a level of 100 kW solar PV system, three phases low voltage supply shall be provided.

■ In case load is more than 100 kW and does not exceed 1.5 MW, SPV system connection can be made at 11kV level.

■ In case load is more than 1.5 MW PV system and does not exceed 5 MW, SPV system connection can be made at 11kV/33 kV/66kV level or as per the site condition.

■ Export-import meters/two way meters can be installed with the facility of net metering. Two way meters can also be used as they are cheaper and give better idea about power exported. The meter may also be finalized in consultation with the Discom.

■ The billing of buildings by Discom can be done on the basis of net energy drawn from the grid during the month on the tariff prescribed by the Regulatory Commission for commercial consumers or as finalized with the Discom.

■ MNRE may provide one time subsidy up to 30 per cent of the benchmark cost of the project. The present proposed benchmark cost is given in Table 1 above.

■ A power purchase agreement (PPA) needs be signed between the owner of building, 3rd party and the Discoms as applicable.

■ An agreement between Discom and the owner of building/premise/SPV plant needs to be signed for the net metering and billing on the monthly/bi-monthly basis as applicable. Suitable payment security mechanism is to be provided by the Discom/state nodal agency/utility.

The above options/procedure are suggestive in nature and it needs to be left to the wisdom of the implementing agency, user, Discoms and states to suitably modify it depending upon the prevailing conditions. There is also a need to formulate a separate policy on grid interactive rooftop and small solar plants by states.

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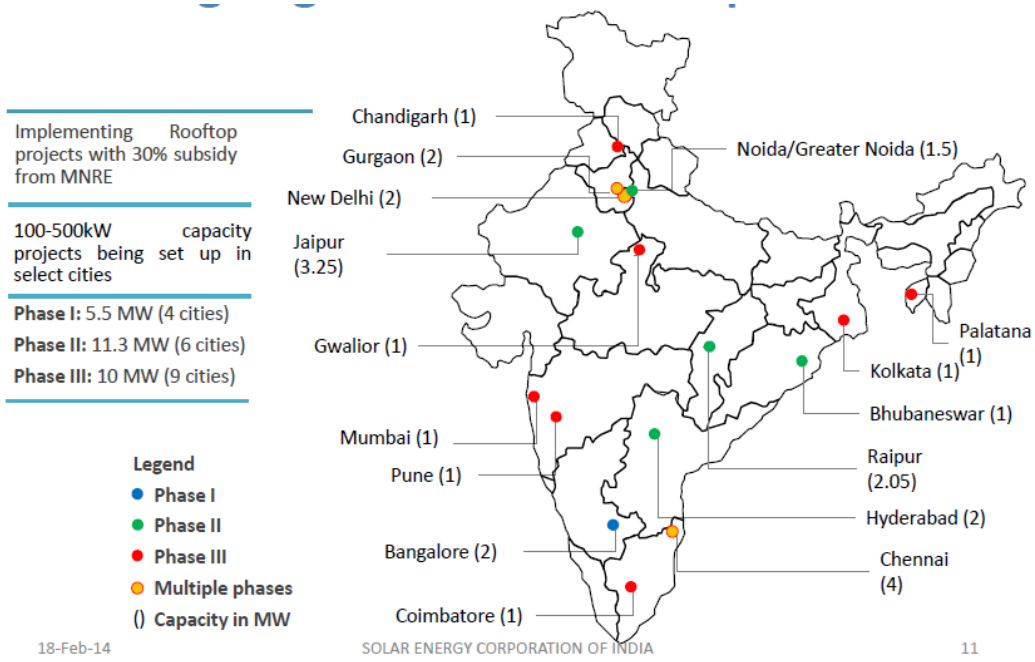

Fig.6 Ongoing Projects in India

VII. SUBMISSION OF PROPOSAL

■ The proposal can be submitted in the prescribed format for installing the stand alone SPV power plant for maximum capacity of 100 kW .

.■ For the trade of the electricity an agreement needs to be signed with Discom for which the consent letter or no objection letter from the concerned Discom should be attached with the proposal.

■ A sketch diagram indicating the metering arrangement with location, type and no. of meters used, grid connection etc., should be attached.

■ The details of proposed business model should be given indicating the pay-back period; consent from the concerned parties/user should be given.

■ The proposal can be submitted through the state nodal agencies channel partners. The government departments/PSUs/government institutions can submit the proposals directly to the Ministry.

VIII.CONCLUSION

Thus the SPV gird connected rooftop systems are being seen as the great future market in India. It can only develop if the distribution companies come out with a suitable mechanism for grid connectivity, power purchase agreements and the trade of solar electricity. The success of the program lies with the grid parity price of solar electricity. With about 30 percent government subsidy, or even without subsidy it can be a win-win situation for both the players i.e., the end user and the Discom.

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