

“Net Metering for Rooftop Solar System: A Review”

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Abstract: Net metering mechanism usages of a bidirectional meter which has feasibility to record both import and export energy values. In net metering, prime focus is on utilizing self-produced electricity by renewable energy sources and excess sold to grid. It results into reduction of electricity bills. Solar photovoltaic system is used significantly in net metering. Solar energy is clean, inexhaustible and environment friendly resources among all renewable energy options. In this paper, concept of net metering through solar system and analysis of data carried out is explored for the beneficial of consumers for studying the feasibility of net metering in India. The study also analyzes the annual saving of electricity and economic feasibility of electricity and economic feasibility in solar rooftop photovoltaic system.

Keywords: Net meter, Solar panel, Inverter, Charge controller, Battery.

I. INTRODUCTION

Today entire globe facing fossil fuel deficit, energy shortage, hazardous effects due to increasing level of Green House Gas (GHG) emission, drastically increasing oil prices. Therefore, it is prime necessity to develop an alternative energy resources with high efficiency and low emission. Among the several renewable energy resources, energy generated by solar photovoltaic (PV) system can be considered the most essential sustainable resource because of the clean, inexhaustible and environment friendly resources among all renewable sources. India is facing several power shortage. In country like India, growth crippling power cuts are commonly occurred in most of the parts. The peak power shortage is 6103 MW with 4.5 % in 2014. In some regions such as in state of Maharashtra, it is 1655 MW with 8.6 %.

on building's roof top to minimizes the load requirement. The key significance of solar energy is that they are renewable sources, providing energy without pollutants and GHG emissions.

In solar PV system, module consists of solar cells which are either connected in series or parallel. Then these modules are combines to form array and interconnected with other electrical and electronic components like converter, inverter, batteries and charge regulators to create a photovoltaic system.

The solar systems either have grid connectivity or stand alone.

Electricity generated during peak hours is primarily consumed by the building and then excess gets fed into the grid. Electricity is drawn from the grid during the hours of insufficient power generation. In such a case, captive loads are served by drawing power from the grid. For such a system, grid acts like its battery back up. Agreement for imported or exported energy from grid is done by mechanism[1]. Ideally, grid connected solar PV system do not require battery back up as grid acts as the back up for feeding excess power and vice-versa. There is a strongly recommendation of a minimum battery back up of one hour of load capacity for the improvement of reliability performance of the overall system.

Net metering is an electricity policy which allows utility customers to offset some or all of their electricity use with self produced electricity from the system of renewable energy sources for power generation[2] [3]. Net metering works by utilizing a meter that is able to spin and record energy flow in both directions [4]. The concept of net metering involves measuring the net energy between the export of generated energy and import of energy from distribution licensee for a given period of time [1]. This can be done by using bidirectional meter which has the facility to record both import and export of energy. When the generation is more than the consumer's requirement, excess energy generated is fed to the grid.

Here meter runs backwards to credit the consumer account [5]. Instead of storing excess energy in batteries or have excess go to waste net metering can be put into practices. Energy is drawn from the grid; when there is a shortfall in power generation. At the end of billing period, distribution licensee pays the consumer with a pre-determined price if more the export of energy to the grid than the import. Likewise, if energy imported from the grid is greater than the energy export to the grid then consumer pays the distribution licensee at a pre-determined price [6]. This price rate usually varies from state to state.

II. NET METERING CONCEPT

Net metering is an electricity policy which allows utility customers to offset some or all of their electricity use with self-produced electricity from PV systems. Net metering works by utilizing a meter that is able to spin and record energy flow in both directions. The meter spins forward when customer is drawing power from the utility grid (i.e. using more energy than they are producing) and spins backward

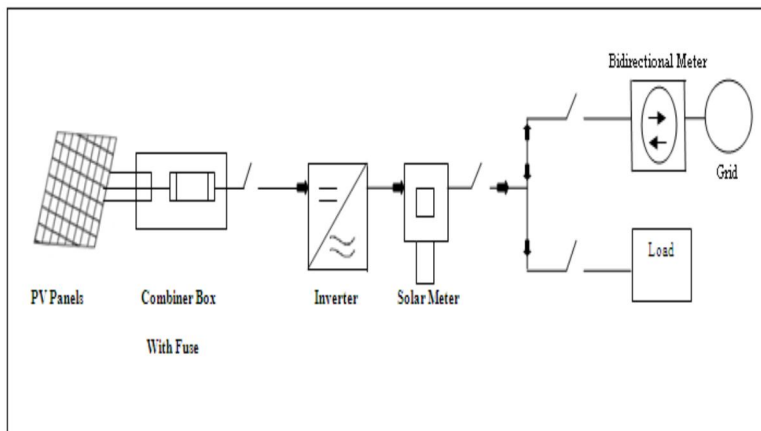


Fig.1 Block Diagram of Net Metering

when energy is being sent back to the grid (i.e. using less energy than they are producing). At the end of a given month, the customer is billed only for the net electricity used. Net metering works only for grid connected system and what makes it so beneficial, besides offsetting a home's energy consumption with a PV system, is that excess energy sent to the utility can be sold back at retail price. If more energy is produced than consumed, producers receive benefit for this positive balance. Such as, renewable energy credits (REC), which is credited on the customer's account toward the next billing cycle. If at the end of the year a surplus remains, then the customer depending on the utility policy may be paid for total REC collected at avoidance cost rate or retail cost rate, or, the total REC collected can be transferred and could be used as a compensation.

III. IMPLEMENTATION of NET METERING

The first net meter has been installed in the premises of Verdean industries Limited, located in Adhere (Mumbai) by "Tata power company". In March, the civic body had installed 25 kilowatts solar metering at its Vatic Nagar word office and Majiwada, Manmade, it will also introduce this new power generation technique at Umbra and Anandibai Joshi hospital in VartakNager to meet its energy requirements. In continuation with above, following projects are successfully completed by rooftop Urjacompany

- 1) 3KW solar net-metering plant with Backup for Residence at secunderabad, Telangana.
- 2) 15KW solar net-metering plant for a Residence at Mangalore, Karnataka. 5KW solar Net-metering Plant for a Residence at Bangalore, Karnataka.
- 3) 10KW solar Net-metering Plant for a Residence at Bangalore, Karnataka.

Many utilities are permitting to residential PV plants to be connected to grid by implementing a net metering system. The net metering system allows the home owner to sell excess energy being produced by the PV plant back to the utility as the same rate at which the home owner purchases it from the Utility [7]. Japan and several states in United States have implemented the net metering system where energy is self consumed before excess is sold to the grid. On the other hand, Germany is well known for the successful implementation of gross metering concept [6]. It is either self ownership or third party ownership and feed in tariff is provided as incentive. While in Japan, incentives provided as a capital subsidy. In states of Colorado, California and New Jersey in USA, tax rebates is provided as incentives [6]. Billing is based on two methods : Constant rate billing and time of use or time of day (TOD) billing. Commercial settlement is based on TOD meter provided with peak or off peak use [5].

IV. THE SOLAR ROOFTOP POLICIES of INDIAN STATE

India is a tropical country, where sunlight is available for longer hours per day with a great intensity. Therefore, solar energy had great potential as future energy source. It also has the advantage of permitting the decentralized distribution of energy, thereby implement it for the people at the grassroots level. The purpose of the National Solar Mission is to create conditions, through rapid

scale up of capacity and technological innovation to drive down costs towards grid parity. The mission has 3 phase approach [8]. First phase (up to March 2013) consists of grid connected solar power generation to 1000 MW and promoting off grid systems. Second phase (up to March 2017) will be include an additional 3000 MW or more grid connected solar power generation through mandatory use of the renewable purchase obligation by utilities backed with preferential tariff and 1000 MW of off grid applications. Third phase (up to March 2022) will be design of total 20000 MW or more grid connected solar power generation and 2000 MW of off grid applications. Solar rooftop policies for different states in India are discussed below:

In Gujarat, along with the ' Gandhi agar Solar Photovoltaic Rooftop ' program targets to set up 5 MWcapacity (4 MW in government buildings and 1 MW in private homes) grid connecting roof top solar PV systems. This program based on FIT (Feed In Tariff) or sale to utility [9]. This pilot project includes various sizes of the solar PV systems ranging from 1 kW, 5 kW, 10 kW, 20 kW, 50 kW, 100 kW, 500 kW or more. However, the sizes of an individual solar PV system would depend on availability shade free area.

Total capacity is to be categories into subprojects having 2.5 MW capacities of each and out of 2.5 MW, 2 MW capacities solar PV system will be installed on Government Rooftop and 0.5 MW on private rooftop. Recently some more cities started installation of roof top PV system. Cities are Meshing, Bhavnagar, Rajkot, Seurat and Vadodara. As per the RE (Renewable Energy) policy 2009-14, states of Karnataka promotes the rooftop solar PV system with net metering. This solar PV system sizes of 5 to 100 kW and interconnection at 415 V, 3 phase or 11 kV. Allowable maximum energy injection up to 70 % of energy usage at DISCOM side [16]. Injected energy will be settle on the basis of net value in each billing period, there is no carry forward. During next 5 years, Karnataka State Government have net metering target of 25000 PV rooftops of 5 to 10 kip size with potential of 250 MW and generation of 350 MU [9]. Under the Green Energy Fund, priority given to the grid connected PV rooftop projects. Pilot projects may come up in Mysore andHubli- Dharma solar cities [6]. Tamil Nadu have target of 350 MW capacity to beset up through solar rooftop PV systems by 2015. Consumers are facilitated with Generation Based Incentive (GBI) and separate meters for measurement of the rooftop generation are required for consumers who wish to benefit from GBI [5].50 MW rooftop to be supported through GBI at Rs. 2.0 per kWh for the first 2 years and Rs. 1.0 per kWh for the next 2 years and for other 2 years Rs. 0.50 per kWh [10]. Net metering will be allowed at different voltage levels. Table I. shows connecting voltages for various capacity ranges of rooftop solar PV [6]

Table i. Interconnection with respect to capacity range

Capacity Range	Connecting Voltage
Up to 10 kip	240 V
10 to 15 kip	240/415 V
15 to 50 kip	415 V
50 to 100 kip	415 V
> 100 kip	11KV

V. THEOROTICAL ANALYSIS

This paper will present net metering scenarios with commercial buildings which have electricity supply from the Reliance Energy Limited. Depending upon the availability of shed free area, the solar rooftop PV system was designed. Consider 130 ft² or 12 m² shadow free area is required for generation of 1 kW. This rooftop solar PV system will be implemented on 24 different commercial buildings. Some of them are corporate offices, control rooms. Purposefully targeting commercial consumers because of financial viability, tariff structure, adequate shed free area. The feasibility study for a 15 kip is evaluated for one of the commercial building i.e. Reliance Energy Management Institute which have electricity consumption of 437940 units for the year 2013-14 [17]. Figure 2 show annual electricity consumption patter.

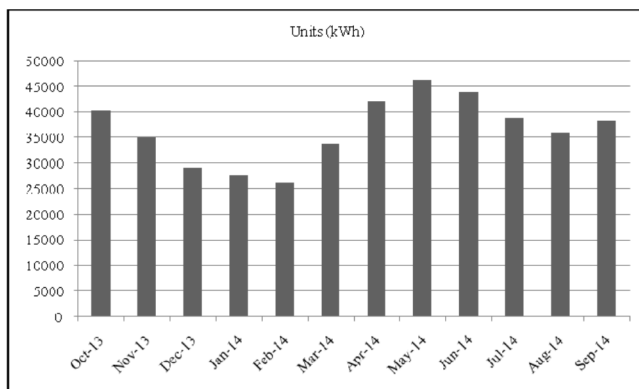


Fig.2 Annual electricity consumption pattern for year 2013-2014.

Average daily solar radiations incident on one square meter area is accounted by considering an average sun accounts hours of 5 to 6 hours per day. Average daily solar radiation is about 5900 Who /m2 /day. Figure 3 shows the solar irradiations for the year 2014 [18]. Electricity tariff for Reliance Infrastructure is shown in table below [19]. Here non residential or commercial consumers are considered only.

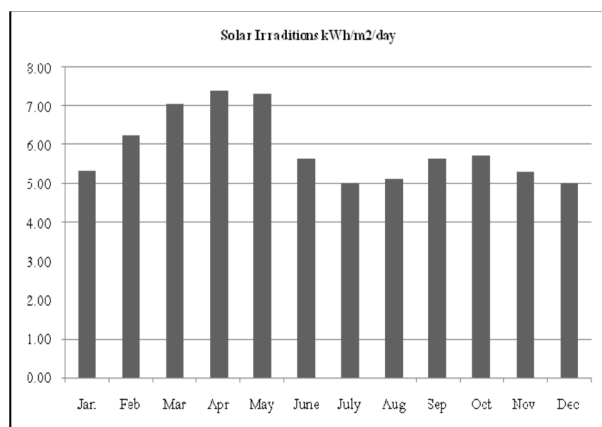


Fig.3 Average daily solar radiation incident in kWh/m2/day for year 2014

VI. ADVANTAGES OF THE DESINDED SYSTEM

- A. Net metering makes residential solar energy system ownership even more attractive and affordable for many families. It can save homeowners hundreds more dollars per year on their utility bills, and it makes the process of accounting for the energy flowing to and from the utility simpler and easier to administer.
- B. The system is easy and cheap in cost. It enables people to get real value for the electrical energy they produce, without having to install a second meter as well as an expensive battery storage system.
- C. Net metering allows you to receive credits for any energy that your system produces but your home doesn't use. The policies for your utility's net metering program may vary a bit, however most utilities allow you to roll over the credits each month. Then, at the end of the year if you still have leftover credits, you can choose to receive a check for the amount of energy your panels produced, or continue to roll the credits over.
- D. It encourage energy consumers to play an active role in alternative energy production, which both protects the environment as well as helps preserve natural energy resources.

VII. CONCLUSION

This paper mainly concentrates on green energy which is more focused for the power generation nowadays, because of the lack of conventional resources. As it is based on the availability of the resources, the generation will be done in the distributed manner. To get benefit out of the generation net metering concept is emerging area. The concept states that classification of consumers based on their production and utilization will gave their payback period. More is the generation, less utilization then payback period will be low. Over all net metering gives the picture of clean energy and development of the sustainable society.



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