A REVIEW: 3 KW GRID TIED PV SYSTEM USING NET METERING

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ABSTRACT

In India the available energy sources proved fail to meet the energy demand, which makes it important for people to think about other alternatives, such as non-conventional energy sources to meet their energy requirement. India is having the potential of producing huge electrical power using solar radiations when it is exploited efficiently. Whole world is in the middle of an energy revolution in order to promote utilization of non-conventional energy sources by using SPV with net metering system. In net metering system whenever surplus power is available that power sell to grid and when sun intensity is in bad condition we can buy the power from a grid. Keeping this in mind, governments and manufacturers are encouraging research and development in this field. This paper presents the study and analysis of 3kw grid tied SPV system installed at roof-top of commercial buildings using net metering system.

Keyword:-*SPV, Net Metering, Grid.*

1. INTRODUCTION

India is one of the most emerging countries in the sector of utilization of non-conventional energy sources. The total power generation capacity of India across remarkable value of 300GW in which 42GW is actually the contribution of removable energy source. Due to high demand of electricity and crises in natural resources, conventional method in India is lagging in heavy short fall in generation. According to the world environmental act, every country has to reduce the Pollution level [1]. From the recent analysis India is on third position in case of pollution. In order to reduce this pollution government of India is increasing eco-friendly electric generation like, hydro power, wind power plant, solar power, bio gas and bio-mass. Out of which bio-mass and bio-gas has limitation of generation capacity [6]. Whereas hydro power plant cannot be installed in every city or house and produces electricity with lot of wastage of water where and about wind as is everywhere available in the world but cannot flow in same velocity everywhere. Solar is only one natural resource which abundantly available in India, hence government is promoting the individual generation for residential, commercial, agricultural and industrial sectors.

In case of solar source, India is facing short fall with heavy capacity around 5 to 7% of total generation hence to overcome this situation government of India incorporate with 'MEDA'(Maharashtra Energy Development agency) promoting solar rooftop system with Rs18000 per kW subsidy and also given 125 solar water heater at a nominal cost of 7000/-rs in metropolitan cities. This not only helps in reducing the pollution but also promote citizen of India to go eco-friendly generation and to make earth pollution free i.e. eco-friendly green earth [2]. However the various points that are been observed as a problems in this system is identified as given below. According to Indian electricity act before 2015, no one has permission of generation/selling of electricity except government authorize agency like Maharashtra Electricity Board' in Maharashtra. Netherland and Denmark are the country which has 100% generation through solar and wind, looking to these approaches; India is also promoting individual owners to build solar rooftop system of these own sanction load capacity in which PPP (public private partnership) and rooftop solar system private owners are included [4].

2. ROOFTOP SOLAR POWER

Today's electricity demand has been increased extensively in many cities and towns in India. Electricity

suppliers, government and researchers are finding difficulty on incremental demand resulting in electricity shortages. The unused space at the rooftop of the building can be utilized by promoting roof-top SPV systems on buildings to replace available sources [8]. A roof top SPV system is categorized into on grid, off grid and grid- interacted solar system. Net metering system is used in grid tied type of system.

2.1 Roof top potential in India

India is having 330 million houses out of them 166 million are electrified, 1.08 million houses are using solar for lighting. 140 million houses with proper roof. 1-3kW of power can be generate from the average house in India. Greater the rooftop area the large power can be generated.

2.2 States initiatives

• Maharashtra: Allows a maximum power of 1 MW capacity installation, while the minimum requirement is 1kW.
• Gujarat: Started 5MW Rooftop Project in Gandhi Nagar. 25 MW in 5 other cities is also announced.
• Andhra Pradesh: Solar Policy 2012 also promoting rooftop solar projects.
• Rajasthan: Promoting rooftop solar policies in cities.
• Kerala: 10,000 rooftop power plants program for 2012-2013 has been started.
• West Bengal: Working on self-consumption of electricity by using solar rooftop model.

3. TYPES OF SPV SYSTEM

3.1 Grid tied SPV system

In On-grid or grid-tied type of PV system, the SPV system is attached to the supply grid. When the developed power by using SPV system is larger in amount than that of the consumption, home owners can then sell the excess energy to the supply grid. 2) Grid interactive SPV system:-During the failure of power, the grid interactive type of SPV system feeds the load by using batteries or diesel generator.

3.2 Off-Grid SPV System

In this type of SPV system electricity from the supply grid is not used, rather the batteries are used to house the load.

4. WORKING

In a 3 kw rooftop solar system before connecting solar, the grid is only source of power and all the load of the system are run by it. After connecting solar PV system on the rooftop the power required by the load is supplied by the solar or both together. The working of an on-grid system generally can be explained in 5 simple scenario as mentioned below [2],

Scenario 1: Solar generation = load requirement (Import -Export Nil) the loads are completely run by the solar power, the grid is available but power from it is not required at this time.

Scenario 2: Solar generation > load requirement (solar generation export to Grid) the generated solar power will support the existing load first and the excess will be given to the grid. This is called as export to the grid.

Scenario 3: Solar generation < load Requirement (load import from Grid) When the load requirement is greater than the solar generation all solar power will be self-consumed by the loads meanwhile the grid will join to support excess load demand.

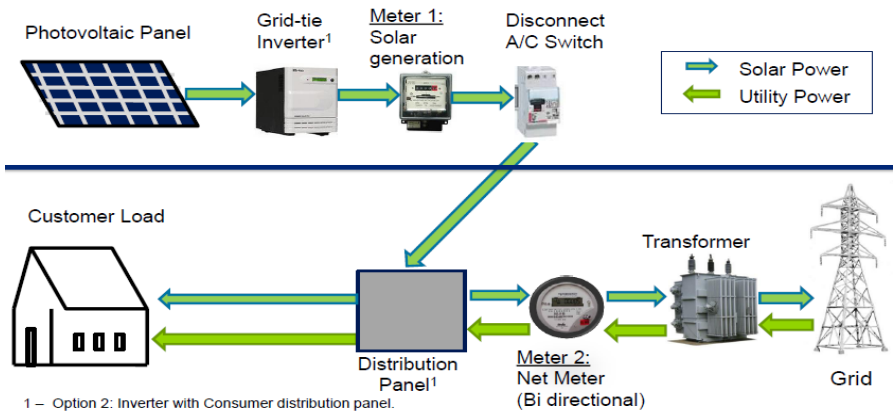

Fig -1: Grid tied SPV system with net metering

Scenario 4: Solar generation = zero (Night hrs.)
Typically during night time when there is no solar generation the grid will supply power to meet the load requirements. This is called import from the grid.

Scenario 5: Grid not available (No solar Generation) In the absence of the grid that is during the power cut the solar inverter shuts down. This is for the safety of the staff working on the grid for maintenance.

The daily, weekly and monthly power generation from the proposed solar rooftop system is as shown in the graphs below respectively,

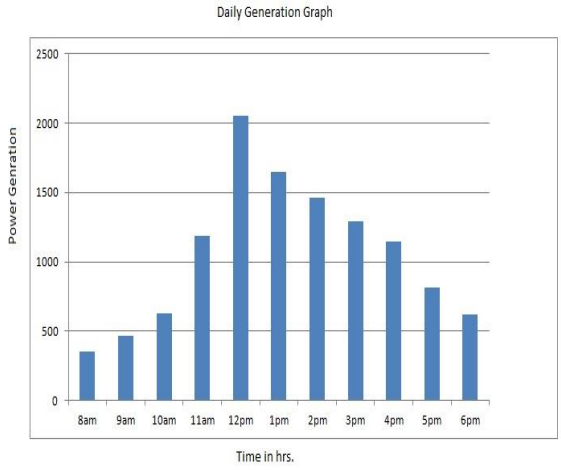

Fig -2: Daily power generation

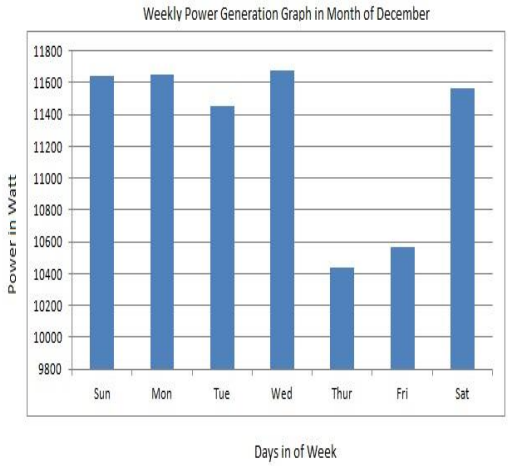

Fig -3: Weekly power generation

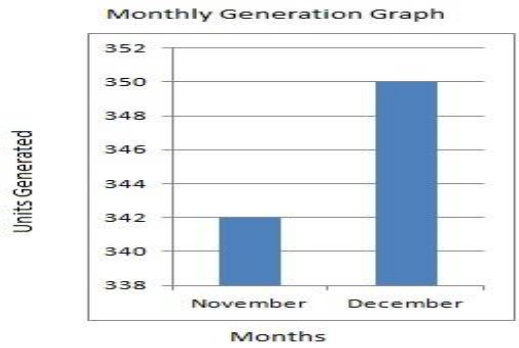

Fig -4: Monthly power generation

5. PARAMETERS FOR SYSTEM DESIGN

The main target is to design and install 3KW solar rooftop solar power plant [5].

5.1 Key facts of solar rooftop power plant

Plant capacity in W: 3KW Rooftop Solar power plant
PV Technology/Module: Poly crystalline modules
Power conditioning unit: 4.5KVA
Power evacuation: 230V AC, Single phase, 50HZ

5.2 Number of PV panels for the system

Capacity of each module: 250WP
Number of PV panels or modules required = 12
Module area = 27.87m^2
Nominal PV Power = 3KWP
Maximum PV Power =3KWdc
Fixed Tilted plane = Tilt 22^0

The electrical characteristics of the modules used in the plant are given below in the table,

Table -1: Electrical characteristics of module

Electrical Characteristics	
Rated Maximum power (Pmax)	251.739W
Maximum power voltage (Vpm)	30.384 V
Maximum power current (Ipm)	8.2853A
Open circuit voltage (Voc)	37.507V
Short circuit current (Isc)	8.8325A
Module efficiency	15.50%
Operating temperature	- 40°C to +85°C

The maximum power of this module is 3KW, hence it requires 12 modules to design 3KWP PV system. The selected PV is manufactured by Goldi Green Ltd.

Specification and dimensions of the module are given below,

Table -2: Specifications and dimensions of module

Specifications and Dimensions of PV module	
Solar cells	Multi crystalline solar cells
Solar cell size	156 mmx156 mm(6 inx6 in)
Number of cells(pieces)	60 (6x10)
Module dimensions	1m x 1.6m
Weight	18.8 kg
Front glass	3.2 mm tempered glass
Frame	Anodized aluminium alloy
Protection degree	IP 65
High efficiency	17.4%
Grid connection	On grid
No. of PV modules/panels	12

5.3 Grid connected PV Inverter

Model: X1-3.0-T-N
Specification class – I
Over voltage category – 3 Mains, 2PV
Inverter Topology – Non Isolated
Grid Monitoring – AS/NZS4777.2;2015
IEC 61727;VDE4105
EN50438;2013
IEC 62116

Table -3: Inverter Rating

Max. Recommended dc power	3250 W
Max. dc voltage	600 V
Rated dc voltage	360 V
MPPT voltage range	125-580 V
Max. dc current	12 A/12 A
Max. dc short circuit current	15 A/ 15 A
Nominal ac apparent power	3000VA
Nominal ac voltage	220/230,240 V
Max. ac current	14 A
Adjustable power factor	0.8 Leading Apprx-0.8 Lagging
Nominal ac frequency	50/60 Hz
Operating temperature range	-20^0c - $+60^0$
Protection degree	IP 65

6. ESTIMATION OF FINANCIAL BENEFITS

For the 3 kw grid tied rooftop solar system proposed in this paper, the cost behind one kw of power is estimated to be Rs85/W having the total costing of Rs255000. By considering the subsidy of Rs54900 (Rs1800 x 3kw), the total expensive for the installation of this plant would be around 200100Rs including 5% GST. Also the payback period of this system is around 5-6 years, so the consumer can earn profit over the present tariff scheme.

7. ADVANTAGES

- Self-power generation.
- Total cost cutting in electricity bill.
- Life of project in about 25year.
- Reduces the heating of roof of house.
- Payback period is very less up to 7 year.
- Help in reducing pollution through conventional energy source.
- User friendly generation.
- Maintenance free generation.
- Low cost as batteries are not included.

8. CONCLUSION

In this paper, a 3 kW PV system is studied for commercial building along with performance of the system and cost analysis for the design and implementation. The desired SPV system generates 5400 kWh/year solar energy. The energy produced by the PV system is also calculated 450 units month wise with the daily generation of 15 units which is sufficient to feed average house, also the net metering system has been introduced for export and import purpose.

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