Performance Study on a 35 kW Roof Mount Residential Photovoltaic System

Kiran Dere[1], Kalyani Badakh[2], Sanchita Deore[3]

Department of Electrical Engineering

PES Modern College Of Engineering

Shivajinagar Pune-05, Maharashtra, India

Prof. S.A.Chaugule

(Project Guide)

PES Modern College Of Engineering

Shivajinagar Pune-05, Maharashtra,India

Abstract - *Industrial development and population growth have led surge in the global energy demand for energy .Moreover steady progress in renewable energy technologies, are opening up new opportunities for utilization of renewable energy resources. Solar energy is the most abundant, inexhaustible and clean of all the energy resources till the date. Energy from the sun can be considered as main source of all type of energies. The ability to generate electricity from sunlight is a relatively new and exciting technology that offers many new opportunities in generating green 'electricity. This technology is called solar photovoltaic. [1] PV offers the ability to generate electricity in a clean, quiet and renewable way. It makes use if the abundant energy from the sun, to generate electricity without the production of harmful carbon dioxide (CO2) emissions, one of the main gases affecting climate change. The major objective of this review study is to distinguish between different kinds of material like polycrystalline, monocrystaline and thin film with their properties and working efficiency. Also this paper helps to detail study about requirement of solar panel installation for residential purpose and case study of residential building [3]*

***Key Words*: Renewable energy, Solar Panel, PV material, Roof mounts system, 35kw.**

1. INTRODUCTION:

Energy is required for wide range of application. It can have much form like heat, electrical, chemical, light and so on. Since the use of energy has become integral part of our life its supply should be secure and sustainable. Therefore, development of clean, secure, affordable energy should be our priority. Government of India target of 100GW of solar energy by 2022.The major states involve up rise the solar status are Rajasthan, Madhya Pradesh, Gujarat, Uttar Pradesh and Kerala. Small player companies are focusing major on Solar Roof top as major population in India searching for cheap and long lasting electricity and doesn't want to purely depend on grid connected system. [1]. A PV system on the rooftop is an easy and cost-effective way which allows consumers to independently meet a part of own electricity need. From an economic and financial Perspective, consumers reduce the electricity bill and save money. From a social perspective, consumers exploit renewable energy sources, so contributing to the environmental preservation by reducing the greenhouse gas emissions. So solar roof top can play as by using wasteland, building roofs top, and hilly are as by using wasteland, building roofs top, and hilly areas to install solar pv system [2]

2. SOLAR PV MATERIAL:

Solar PV materials are classified as follows:

1. Polycrystalline PV material
2. Mono-crystalline PV material
3. Thin film PV material

1)Polycrystalline PV material

Also sometimes known as multicrystalline cells, polycrystalline silicon cells are made from cells cut

from an ingot of melted and recrystallized silicon. The ingots are then saw-cut into very thin wafers and assembled into complete cells. They are generally cheaper to produce than monocrystalline cells, due to the simpler manufacturing process, but they tend to be slightly less efficient, with average efficiencies of around 12%.

2) Mono-crystalline silicon PV panels

These are made using cells sliced from a single cylindrical crystal of silicon. This is the most efficient photovoltaic technology, typically converting around 15% of the sun's energy into electricity. The manufacturing process required to produce mono-crystalline silicon is complicated resulting in slightly higher costs than other technologies.

3) Thin film PV panel

A number of other materials such as cadmium telluride (CdTe) and copper indium diselenide (CIS) are now being used for PV modules. The attraction of these technologies is that relatively inexpensive industrial processes, certainly in comparison to crystalline silicon technologies, can manufacture them yet they typically offer higher module efficiencies than amorphous silicon. Most slightly lower efficiency: CIS is typically 10-13% efficient and CdTe around 8 or 9%. A disadvantage is the use of highly toxic metals such as Cadmium and the need for both carefully controlled manufacturing and end-of-life disposal; although a typical CdTe module contains only 0.1% Cadmium, which is reported to be lower than is found in a single AA-sized NiCad battery. The table No. 1 will give you a comparison between various types of solar photovoltaic panels. [4]

In India, the most commonly available panels are polycrystalline/ multi-crystalline.

TABLE I Comparison Of different PV Material

Sr. No	Property	Polycrystalline	Mono Crystalline	Thin Film
1	Efficiency	Moderate (13-15%)	Highest	Lower
2	Cost	Moderate	Highest	Lower
4	High Temperature Performance	Poor	poor	Better
5	Generation in diffused light	Average	Average	Better

TABLE 2 Factors Affecting on Solar pane Output

Sr no	Factors	Remarks
1	Direction	For panels that have fixed position without any sun tracking mechanism, They should face south direction for better output throughout the year.
2	Tilt/ Angle of inclination	Preferably according to the latitude of the place.
3	Shading	Even a small part of shaded panel, affects the entire output of the panels largely. Even a single partially shaded panel affects the output of all other solar panels in the system. Also, ensure that there is no dust etc on the panel to avoid shading.

4	Temperature	Higher the temperature, lower will be the output from solar panels. Usually, panels are rated according to standard test conditions (i.e temperature: 25 degree Celsius, insolation 1000W/m2, Air Mass: 1.5). Hence, if temperature is higher than this, your panels may give less than rated output.

3. CASE STUDY:

- Location Of site: Pimple Gurav,Pimpri Chinchwad, Pune
- Fronious Inverter/ power conditioning unit size 35 kw total capacity.
- Solar pv module each of capacity 330wp. Total System capacity is 35kw.
- Polycrystalline silicon material
- Module mounting structure Aluminium Galvanised M.S Structure
- Tilt with 18 Degree
- Inverter efficiency 98%
- DCDB 5 Input 5 output
- ACDB
- Dc & Ac cables of 4 mm^2 & 6 mm^2

In most cases, system components, other than the PV modules, like batteries, charge controller, inverters, etc. are required to achieve reliable sources of power. Figure 1 shows the rooftop connection.

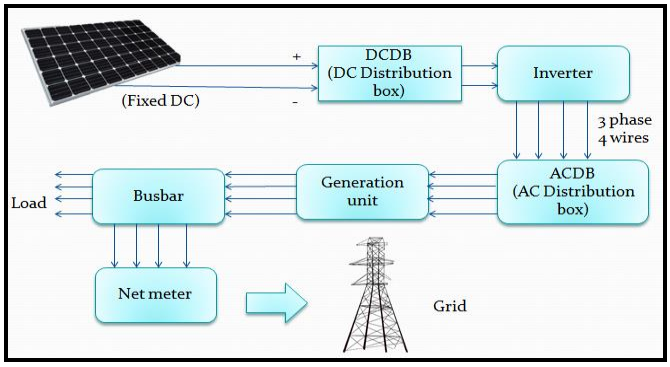

Fig.1 Rooftop Connection of Solar PV module

4. DESIGN CALCULATIONS:

At the site, there are 6 areas on which solar panels are to be mounted. Out of them 4 areas (1,2 & 5,6) are having approximately same dimensions.

Area=30ft*17ft=510 sq. ft. As 1kw=100sq.ft X=510sq. ft. i.e. X=5kw. (Where, X is energy to be generated from respective Area) Each module has rating of 330wp.

No. of modules required= 5000/330=15 nos Area=43ft*19ft=817sq.ft X=817sq.ft.=8.17k No. of modules required= 8170/330=25 nos

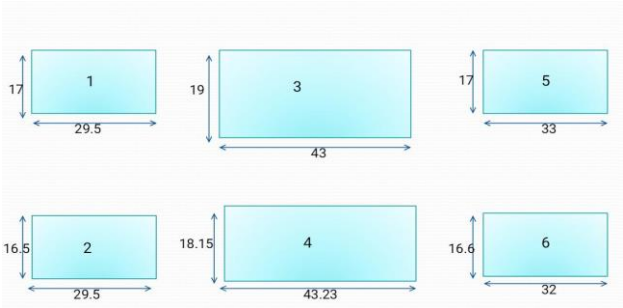

Fig 2 Rooftop Connection of Solar PV module

4. COMPONENTS:

- Inverter:

The inverter used here is Fronius grid tie inverter. The power generated by solar PV cells i.e. DC voltage is converted into Ac.

- Solar ACDB:

It gives extra protection to the system in case of failure. ACDB is made up of breaker, isolator, voltage and current monitoring etc. Along with fuse, it has provision for surge protection. ACDB consist of energy meter, which gives information about usage of energy.

- Solar DCDB:

For protecting the DC side against any fault causing failure, DCDB is used. It is very crucial part of solar PV system because adequate protection is must on DC side. It consist of isolator which protects the system under faulty condition, energy meter which gives information regarding exact PV array voltage and current obtaining.

- Net Meter:

Net-meter is the bidirectional meter, which record the energy imported from the grid to fulfil the load demand and excess of energy that is exported energy to grid after self-consumption.

- Mounting Structures:

There are various mounting structure for solar module like, Rooftop, Tin, shade, single pole, Ground Mounted structure out of this rooftop mounting structure is used in which solar panel are mounted on rooftop with few inches gap with surface of roof and in parallel with it. This structure is easy to install as it uses only mechanical system of assembly with use of nut and bolt. This is highly durable with the use of Pre-galvanized steel for purlins and Aluminum clamps for module.

5. RESULT & DISCUSSION:

TABLE 3 Total unit Generated by system over the year

Month	Solar Radiation (KWh/m^2 /day)	AC Energy (KWh)	Value ($)
January	6.42	4,932	14,797
February	6.97	4690	14,071
March	7.19	5,197	15,590
April	6.98	4.856	14,569
May	6.64	5,002	15.007
June	5.02	3,895	11,684
July	4.51	3,739	11,217
August	4.48	3,717	11,151
September	5.42	4,205	12,614
October	6.01	4,643	13,930
November	5.79	4,379	13,138
December	6.02	4,635	13,905
Annual	5.95	53,890	$ 161,673

TABLE 4 System Parameters

Location and Station Identification	
Requested Location	Pimple Gurav, Pune
Weather Data Source	Lat, Lon:18.55, 73.85 3.4m
Latitude	18.55^{0}N
Longitude	73.85^{0}E
PV System Specification (Residential)	
DC System Size	35kW
Module Type	Standard
Array Type	Fixed(roof mount)
Array Tilt	18^0
Array Azimuth	180^0
System Losses	14%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2
Economics	
Average Retail Electricity rate	3.000$/kWh
Performance Metrics	
Capacity	17.6%

6. CONCLUSION:

In this paper, a basic parameter analysis was conducted for PV systems integrated into Pimple Gurav, Pune residential building's rooftop. This will help to discover how to achieve optimal energy production using the given system. For this purpose, simulations of roof-mounted PV systems were conducted using PV Watt calculator. The study shows that, proposed 35 kW PV system performs better by recording annual energy generation as 53891 kWh/year and with a capacity factor as 17.6%. Finally, the paper is concluded by highlighting the outcomes that would help the installers, industrialists, and academician to understand better about the performance of the pv system.

REFERENCES

[1] Dr.B.N.Chaudhari1,Neeraj Kumar Singh2 Ramjee Gupta3, Arpit Jain4, Shilpa Badge 51,2 Department Of Electrical Engineering,PES College of Engineering, Aurangabad431004,Maharashtra,IndiaA **review on Solar Photovoltaic Technology and FutureTrends, Conference paper** April 2018

[2] **Solar Energy and PV Systems in Smart Cities** Daniele Menniti,1 Angel A. Bayod-Rújula,2 Alessandro Burgio,1 Diego A. L.García,3 and Zbigniew Leonowicz4 University of Calabria, Rende, International Journal of Photoenergy,Volume 2017.

[3] 2017 Third International conference on **Science Technology Engineering & Management.**