IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 5, May 2021

DOI 10.17148/IJIREEICE.2021.9553

Design and Installation of Roof Top Solar PV System in India (Case Study)

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Abstract: The process of acquiring photovoltaic power involves designing, selecting and determining specifications depending on a variety of factors, such as geographical location, weather condition, solar irradiance, and load consumption. In this paper a detailed design and selection of a rooftop solar PV system to provide uninterrupted power supply for a college building is presented. It outlines the detailed procedure for spec- ifying each component of the solar PV system and its performance is analysed. Detailed selection of solar panel according to weather conditions according to geographical area of Gwalior and total load is analysed including installation and maintenance of a rooftop solar PV system during its life span has also been carried out. Total units of PV generation and environmental benefit are also highlighted.

Keywords: Solar panel, Photovoltaic, Off grid Solar, Load- consumption.

I. INTRODUCTION

Energy certainly plays a vital role in development of human activity and electricity is one of the main concerns for the rising future of any nation. There exists a direct correlation between the development of a human activity and its consumption of energy. Sustainable social and economic development depends on adequate energy generation capacity of a country . There is no other way for accelerating advance- ment except to increase the power generation by fuel diversification. The solar energy reaching the earth's surface can be utilized in two forms as solar thermal or photovoltaic (PV). A solar thermal system collects the thermal energy in solar radiation and uses it for water and space heating or producing electricity through steam- turbine-driven electrical generators . Solar PV system is more widely used technology all over the world. It is a method of generating electrical energy by converting solar light into direct current (DC) electricity using the photovoltaic (PV) effect . Solar PV energy generation employs solar modules comprising a number of solar cells containing a photovoltaic material. Solar PV applications are classified into two types; grid connected system and stand-alone (off-grid) system . Benefit of standalone rooftop solar PV system has direct usefulness in reducing the peak

TFCTORS AFFECTING SOLAR PV POWER PRODUCTION -
In the tropical region, fixed PV systems consisting of flat type of modules are more widely accepted rather than tracking PV systems that consist of flat type or concentration type modules due to high beam radiation and low humidity . Electrical energy produced by a photovoltaic system depends on several external factor. Foremost of these is the amount of solar radiation impinging on the surface of the PV modules, which depends on the local climatic conditions as well as the mounting of the modules, type of solar panel ,efficiency, inclination angle, etc. . The term irradiance is used to consider the solar power falling on unit area per unit time (W/m2). Solar radiation, selectively attenuated by the atmosphere, which is not reflected or scattered and reaches the surface directly, is beam radiation. The scattered radiation that reaches the ground is diffuse radiation . The small part of radiation that is reflected from the ground onto the inclined receiver is called reflected radiation. These are three components of radiation which together create global radiation.

Factors affecting PV module performance are
Conversion efficiency depends on temperature (which in turn depends on ambient temperature, wind velocity) and irradiance levels
Type of PV solar panel is used according to the geographical conditions
Angle at which the solar panels are placed which changes every month

II. METHODOLOGY

1) Selection of solar panels according Efficiency

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2) Calculation of proper angle of solar panel in different months .
3) Location analysis and Calculation of total load .
4) Calculation of solar panels required and area required for the solar panels.

[1] TYPES OF SOLAR PANEL

Monocrystalline solar panels

If you see a solar panel with black cells, it's most likely a monocrystalline panel. These cells appear black because of how light interacts with the pure silicon crystal.

While the solar cells themselves are black, monocrystalline solar panels have a variety of colors for their back sheets and frames. The back sheet of the solar panel will most often be black, silver or white, while the metal frames are typically black or silver.

Polycrystalline solar panels

Unlike monocrystalline solar cells, polycrystalline solar cells tend to have a bluish hue to them due to the light reflecting off the silicon fragments in the cell in a different way than it reflects off a pure monocrystalline silicon wafer.

Similar to monocrystalline, polycrystalline panels have different colors for back sheets and frames. Most often, the frames of polycrystalline panels are silver, and the back sheets are either silver or white.

Thin-film solar panels

The biggest differentiating aesthetic factor when it comes to thin-film solar panels is how thin and low-profile the technology is. As their name suggests, thin-film panels are often slimmer than other panel ty[es. This is because the cells within the panels are roughly 350 times thinner than the crystalline wafers used in monocrystalline and polycrystalline solar panels.

[1.1] EFFICIENCY OF SOLAR PANELS

Efficiency is how much energy the solar panel can produce from the amount of sunlight it receives. Essentially, efficiency determines how much power a solar panel can produce. The most efficient solar panel is the monocrystalline solar panels. Monocrystalline solar panels can reach over 20 percent efficiency. On the other hand, polycrystalline panels can usually only reach 15 to 17 percent efficiency. This gap between the two panels may be closing in the future as technology improves to make polycrystalline panels more efficient. The least efficient solar panel is the thin-film. Thin-film usually has lower efficiency and produces less power than either of the crystalline options with efficiency at only approximately 11 percent. The power capacity of a thin-film panel can vary though because there isn't a standard size, and some models could produce more power than others.

Table 1.

Solar cell Type	Efficiency in %
POLLYCRYSTALLINE	15-17
MONOCRYSTALLINE	20
THIN FILM	7-10

Table 1. Effiiciency of solar panels according to their type. Resource https://www.8msolar.com/types-of-solar-panels

[2] ANGLE OF SOLAR PANNELS ACCORDING TO LOCATION AND MONTHS

This is generally referred to as the 'tilt' of the solar system. India has 29 states and 6 union territories within the 8°4′ to 37°6′ North latitude and 68°7′ to 97°25′ East longitude boundaries. It means it lies between 8 to 37 degree in india.

In the Northern Hemisphere Solar PV Panel must be south facing and In the Southern Hemisphere Solar PV Panel must be north facing 74

Table 2 .

January	February	March	April	May	June
42	34	26	18	10	2

July	August	September	October	November	December
42	34	26	18	10	2

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Table 2. Optimum Tilt of Solar in Gwalior according to every month. resource: https://www.shaktipumps.com/solar-calculator.php

In India solar angle should be between 8 to 37 degree , in particular Gwalior reason the angles at which the solar panel should be placed . In winter it should be 50 degree, in Summer its should be 2 Degree and in Autumn it should be 26 Degree .

[2.1] WATT/HOUR OUTPUT OF DIFFRENT SOLAR PANELS ACCORDING TO SIZE

We choose solar panel size according to our power consumption and the size of solar panels, we have to use solar panel according the rea which we have there are different different size of solar panels with different size and output so we have to choose a optimum one . According to our data we are using 1000 watt solar panel which are producing about 5 units in a day in anaverage 8 to 9 hours of day. And the size of the panel is about 3m in length and 1m in breadth.

Table 3.

DAILY UNIT COUNT	CAPACITY IN WATT
1	225
2	500
5	1000
10	2500
30	7500

Table 3. Output of solar panel according to size.

[3] LOCATION ANALYSIS AND TOTAL LOAD CALCULATION OF INSTITUTE

Site selected for the case study is based on academic insti-tution campus located in Gwalior, Madhya Pradesh India. Madhav Institute of than 5000 students are in institute building. So the power con-sumption of institution is very high. institution building has an enormous space available on rooftop. The site location is illustrated in. Fig4 Technology & Science (MITS) is one of the largest academic institutes located in central region of India. About more

Fig. 1. Site location – Institute Building, MITS GWALIOR, Madhya Pradesh. Source: https://earth.google.com.

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Table 4

SITE NAME	Institute Building, MITS Gwalior, India
CORDINATES	23.2314^{0}N,5.29^{00} N, 78.2053° E
POWER CONSUMPTION	571KW/DAY
TYPE OF MODULES	Monocrystalline solar panel
LOCATION	Gwalior INDIA

Table 4 . Above data is about specification of location

[3.1] POWER CONSUMPTION THE INSTITUTE

Calculating the total energy consumption of a building is very complicated because there are different types of energy used. In addition, it depends on the purpose of the building, its geographical location, the cultural habits of the users, among many other factors. These papers may be useful. We calculated the data of the institute by collecting the data of several appliance which are used in our institution on regular basis. Calculation of type of appliance swhich are used, there working hours, power consumption, quantity in which they are used and capacity of appliances in watt.Table 5 Load consumption in Institute building

Electrical load and capacity (W)	Quantity	Total capacity in watt (kW)	Hours of operation per day (h)	Energy consumptions in kW h
LED Bulbs : 09 W	500	8	08	36
Fan: 50 W	250	7.2	08	100
Water pump: 1500 W	3	2.24	03	13.5
AC : 1000 W	60	9	04	240
Laptop : 150 W	300	1	04	180
Table Fan : 40 W	100	4.2	05	2
Total energy consumption per day				571.5 kW h

[4] CALCULATION OF NO OF PANELS AND AREA NEEDED

As we are using monocrystalline solar panels of size 3*1 m of 1000 Watt which produce about 5 units of energy in a day on an average basis and we have to produce about 571 units of energy per day so we need about 115 solar panel of size 3 meter square of each size which will consume about 345 meter square Area.

Table 6.

TYPE OF PANEL	MONOCRYSTALLINE
CAPACITY	1000 WATT
UNITS PRODUCTION/DAY	5 UNITS
SIZE OF PANEL	3 METER SQUARE EACH
NO OF PANEL REQUIRED	115
AREA REQUIRED	345 METER SQUARE

Table 6 . Specification of the solar panel.

III. CONCLUSION

This Paper was a case study of a particular institution which is converted into fully solar based system in which monocrystalline solar panel is used , which were selected on the basis of their efficiency and appropriate size according to our need . all the details of the institution was observed like appliances used , type of appliances , quantity, working hours of each appliances their count and by this the calculation of toal power consumption was done and then according to the power consumption the calculation of total solar panel was done and after it according to the size of each solar panel the number of solar panel was calculated which are needed to fulfill our load consumption.

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