International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 08 | Aug 2021 www.irjet.net p-ISSN: 2395-0072

CASE STUDY ON ROOFTOP SOLAR PANELS

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Abstract - *Green power, environment protection and CO2 emission reduction are key factors in today's world that are considered while designing any system. This can be achieved by using more of renewable energy sources. To date, solar power has been accepted worldwide as a high potential energy. Current surveys have indicated that solar photovoltaic technology belongs in the most rapid increasing and most promising renewable energy for electricity generation. In the following paper we have filed a case study on one of this renewable energy source i.e. solar energy. Since sun is the free source of energy and shines for 12 hours a day, this energy can be used for the implementation of gaining energy out of it. We are conducting case study on 64 solar panels which are mounted on the roof top of the Yashwantrao Bhonsale Polytechnic. We have majorly concentrated on the solar power station implemented on our college and its various working parameters along with its benefits of saving the environment. On the other hand we have also studied the nature of these solar panels and gave some inputs on how we can make them work more efficiently.*

Key Words: Photovoltaic, cell-module-array, solar panels, solar efficiency, azimuth angle.

1. INTRODUCTION

Burning of fossil fuels is what is obtained as a byproduct for generation of energy. The coal that's wont to generate energy results into deforestation and hence increases the speed of carbon emission increasing heating .Thanks to an overuse of fossil fuels they're on the verge of depletion. Since energy use has become an integral part it becomes necessary that the availability that we get is sustainable, secure, economical, and free from losses and most significantly eco-friendly. Hence to beat of these and meet the ever increasing demands of energy, 'Going Solar' is that the only best choice.

With the recent rise in energy costs many of us are looking to alternative sources of energy. One among the best energy sources (our sun) is quickly available for the consuming. Harnessing its power is the only thing that we need to do. Since, sun is that the never ending source of energy and is completely free. It's a clean energy and is eco-friendly. It's a really large source of energy. The facility from the sun that the world receives per day is about 1.8×1011 MW which is many thousand-fold larger than our current power consumption from all the sources. 1000KW of energy is produced by burning 100L of oil which successively is produced by 1sqm of an efficient panel.

The amount of electricity a solar array produces depends on three main things

- The dimensions of the panel
- The efficiency of the solar cells
- The quantity of sunlight the panel gets

Since solar power focuses on the foremost threatening issues like carbon emission, heating , reduction within the consumption of fossil fuels it are often termed as sustainable energy.

2. ALL ABOUT SOLAR PHOTOVOLTAICS

Solar module, commonly called Photovoltaic module, is the core component used to convert sunlight into electricity. Solar modules are made from semiconductors that are very almost like those wont to create integrated circuits for equipment. The foremost common sort of semiconductor currently in use is formed of silicon crystal which are thus made by stacking p-type and n-type layers on top of every other. Electricity is generated when the Light strikes the crystals and induces the effect called 'photovoltaic effect'. The electricity produced is named DC (DC) and may be used immediately or stored during a battery. For systems installed on homes served by a utility grid, a tool called an inverter changes the electricity into AC (AC), the quality power utilized in residential homes.

2.1 Solar Cell:

A photovoltaic cell converts light energy into the electricity. A photovoltaic cell is essentially a contact diode and uses photovoltaic effect for its conversion of electricity from the sunlight.

2.2 Photovoltaic effect

When sunlight hits the semiconductor, an electron springs up and is attracted toward the semiconductor unit. This causes more negatives within the n-type semiconductors and more positives within the p-type, thus generating a far better flow of electricity. This is often the photovoltaic effect.

2.3 Construction of photovoltaic cell.

Although this is often basically a junction diode, but consistent with the development it's bit different form conventional contact diode. A really thin layer of semiconductor device is grown on a comparatively thicker semiconductor device. We offer few finer electrodes on the highest of the semiconductor device layer. These electrodes don't obstruct light to succeed in the skinny p-type layer. Slightly below the p-type layer there's a contact. We also provide a current collecting electrode at rock bottom of the n-type layer. We incorporate the whole assembly in a thin glass to guard the PV cell from any mechanical injury.

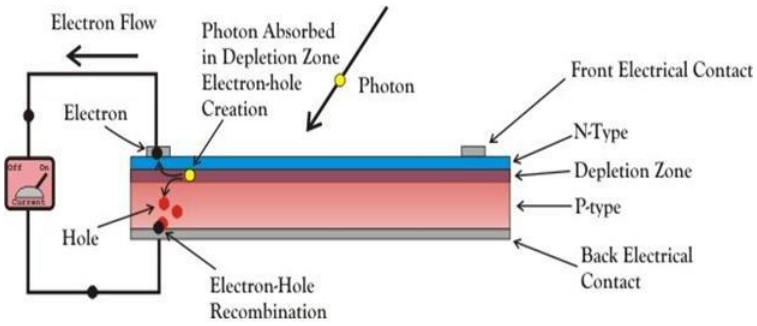

Fig 1: Construction of solar modules

2.4 working rule of photovoltaic cell

The sunshine photons can easily enter within the junction when light reaches the contact, through very thin p-type layer. The sunshine energy, within the sort of photons, supplies sufficient energy to the junction to make variety of electron-hole pairs. The incident light breaks the equilibrium condition of the junction. The free electrons within the depletion region can quickly come to the n-type side of the junction. Similarly, the holes within the depletion can quickly come to the p-side of the junction.

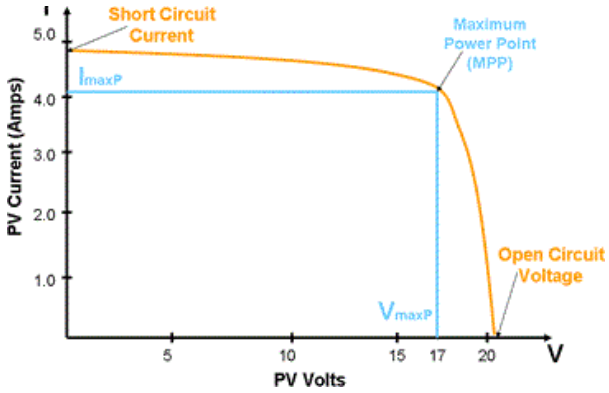

Fig 2: V-I Characteristics of solar modules

When the free electrons which is newly created comes into the n-side it cannot further cross the junction due to its barrier potential. Similarly, when the newly created holes enter p-side they cannot further cross the junction due to its barrier potential. the concentration of holes in the n-side of the junction becomes excessive that is because the concentration of electrons becomes higher in one side i.e. n-type side of the junction and concentration of holes becomes more in another side i.e. the p-type side of the junction, the contact will behave sort of a small battery cell. A voltage is about up which is known as photo voltage.

3. CELL, MODULE, ARRAY

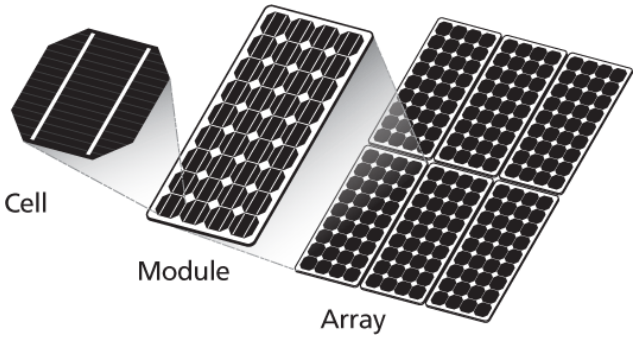

Fig 3: Cell, Module Array

3.1 Solar Cell

A solar cell is that the most elementary unit of a solar PV system - solar cells are often either mono-crystalline or poly-crystalline, and their key characteristic is that they produce a voltage output when exposed to light. It's important to notice that although they're normally called "solar cells", they will answer any sort of light.

3.2 Photovoltaic Module

A Photovoltaic Module consists of multiple PV cells connected serial to supply a better voltage output. PV modules are manufactured in standard sizes like 36-cell, 60-cell and 72-cell modules. The term solar array is usually used interchangeably with solar module. The most difference is that some solar panels models are composed of multiple modules mounted together.

3.3 Photovoltaic Array

Photovoltaic Array may be a system composed of multiple PV modules. They will be connected in one or more series circuits, which are connected to a combiner box to supply one direct-current output. This output are often wont to charge batteries, power DC loads, or fed to an inverter to supply an AC voltage for home appliances or exporting to the electrical grid.

Generally, to boost their utility value, individual Photovoltaic cells are interconnected together, weather-proofed and sorted into package called a Panel or simply a Module. For instance, A 12 V Panel (Module) will have 36 cells connected serial and a 24 V Panel (Module) will

have 72 PV Cells connected serial. To realize the specified voltage and current, Modules are wired serial and parallel into what's called a PV Array.

4 CALCULATIONS AND CASE ANALYSIS

The system was implemented in my college wherein roof-top arrangements were used

4.1 Calculation of Load

The entire load of the polytechnic college is 33.316KW so as to fulfil this load there was an enormous expenditure required but now after installing the panel's this has eventually dropped down.

4.2 Generation by the plant

The solar panels were installed on 26th of July 2017 and by far till the end of 3rd Feb we had generated of about 1044MWhrs of units. The generation by the panels depends maximum upon the climatic changes as well as the sunlight to be incident on the panels.

4.3 Payback Period

This is clearly stated and seen above that we have generated 10440 units. The price of installation is 18 lakhs. Hence the payback period can be calculated by the following steps

Cost of 1unit= 6.20Rs for the first 1 Lakh unit and Rs 6.80 for the consumption above 1 Lakh units

Hence total savings for 6 months = 10440×6.8
= Rs 68904

Hence monthly savings is given by = 68904/6
= Rs 11484

Payback period= 18 lakhs / 11484
= 156.73 ~ 157 months
= 14 years

4.4 Direction of facing the panels

The panels are installed facing the South-West direction to 2230

4.5 Angle of Mounting the Panels

Angel of mounting the panels is a crucial parameter that decides the speed of generation. Maximum generation is feasible when the absorbing surface of the panel is perpendicular to the solar rays. This is often considered by considering the Azimuth and Zenith angle of the sun with reference to the panels.

- **Azimuth Angle**: it's the angle subtended by the sun from its rising direction that's within the East to its direction of settling that's within the West.
- **Zenith Angle:** it's the angle subtended once we search at the sun from the horizontal position that's here the panel surface.

The angle of mounting of panels are often calculated by knowing the latitudinal extent of a specific place. This latitudinal extent changes with the weather. Here we consider Maharashtra hence its latitudinal extent is 34.04820 for summers and on a mean in winters. If the angle is to be taken in:

- **Summer:** Subtract 150 from this latitudinal extent hence the angle of mounting the panels now becomes 19.04820 that's 200.
- **Winter:** Add 12.0250 from this latitudinal extent hence the angle of mounting the panels now becomes 46.0732 that's 470

4.6 Environmental Aspects

- **Carbon Emissions:** It becomes necessary to quote that by installing this plant we have in all saved 4,152.08Kgs of CO_2 emissions
- **Trees Planted:** Saving Carbon emission it promptly states that we have equivalently planted 14 trees in 5 months.

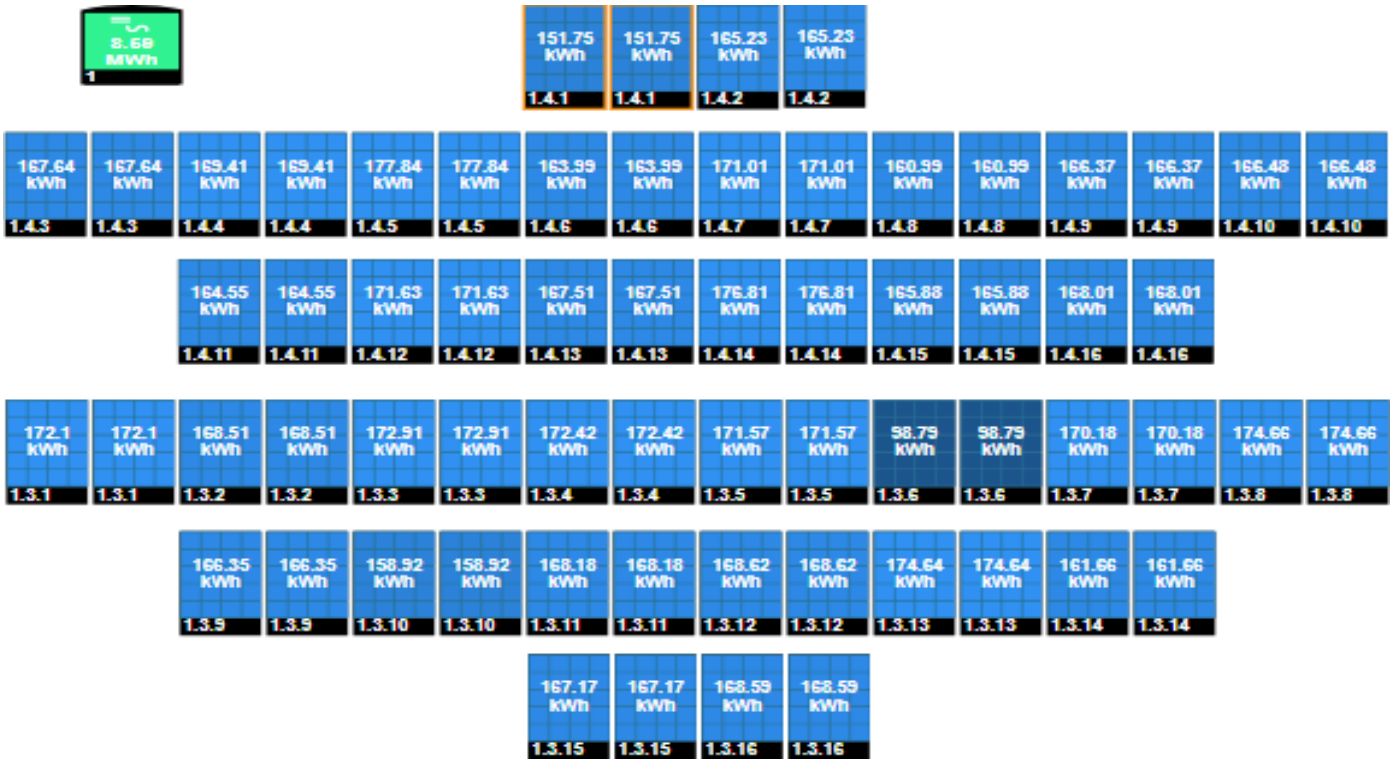

Fig 4: Arrangement of panels

5. FEATURES

5.1 Advantages

- Renewable Energy Source

  Among all the benefits of solar panels, the foremost important thing is that solar energy could also be a very a renewable energy source. It are often harnessed altogether the areas of the planet and is out there energy today which too in abundance. We cannot run out of energy, unlike a number of the opposite sources of energy. Solar power are becoming to be accessible as long as we've the sun; therefore sunlight are becoming to be available to us for a minimum of 5 billion years when consistent with the scientist the sun goes to die.

- Reduces Electricity Bill

  Since the energy that we consume will now come from our solar generation the energy bill will drop. The saving on your bill are going to be hooked in to the dimensions of the solar array system and our consumption. Moreover not only there's a discount within the bill but if there's a further Energy that's remaining after a private usage then the remaining energy are often exported back to the grid and bonus within the payment is received.

- Diverse Applications

  Solar energy are often used for diverse purposes. You'll generate electricity (Photovoltaic) or heat (Solar thermal). solar power are often produced into electricity within the areas where there's no access to energy grid, to distill water in the regions with limited clean water and power to satellites in space.

- Low Maintenance Cost

  The panels generally don't require frequent and regular maintenance, the only need is to keep them relatively cleaner for better efficiency. Most reliable solar array manufacturer provides a warranty of about 20-25 years warranty. Also, as there aren't any moving parts, there is no wear and tear. The inverter is that the only part that must be changed after 5- 10 years since it's within the continuous working conditions.

- Technological Development

  Technologies in the sector of solar are experiencing a solid increase and its advancing as the time progresses and will lead to an intensified study-research topic in the future. Innovations on the grounds of nanotechnology and physical sciences can potentially increase the effectiveness of solar panels and thus will lead to increase the electrical input of the systems.

5.2 Dis-Advantages

- Cost of the Panels

  The initial cost involved in purchasing and installing a system is comparatively high. The value includes paying for solar panels, inverters batteries, wiring and for the installation, nevertheless solar technologies are constant developing, so it's safe to assume that prices will go down within the future.

- Weather dependent:

  Even though solar energy can still be harnessed during cloudy and rainy days but its efficiency drops .Solar panels are enthusiastic to sunlight to effectively gather solar energy. Therefore few cloudy rainy days can have a clear effect on the energy which may have an overall effect on the energy system.

- solar power Storage is expensive:

  Solar energy possesses to be used directly or it are often stored in large batteries. These batteries utilized in off-the-grid system, are often changed during the day in order that the energy is employed in the dark. this is often an honest solution for using solar energy all day long but also it quite expensive, In most cases it's smarter to only use solar energy during the day and take energy from the grid during the night luckily our energy demand is typically higher during the times so we will meet most of it with solar power

- Use lot of space:

  The more electricity you would like to supply the more solar panels you'll need because you would like to gather the maximum amount sunlight as possible .Solar panels require tons of space and a few roofs aren't large enough to suit the numbers of solar panels that you simply would really like to possess .An alternative is to put in a number of the panels in your yard but they too have access to sunlight ,anyways if you don't have the space for all the panels that you simply wanted ,you can just get fewer and that they will still be satisfying a number of your energy needs.

6. Conclusion

The main conclusion that I derived from this case study was that, today the solar power is the global need. The consumption of energy is increasing day by day and so follows with creating the burden for energy generation hence this results into burning of large amount of fossils fuels leading them to depletion. Hence to overcome all this solar energy is the best source of energy since it mainly achieves advantages like- use of the free renewable energy source that is the sun, reduction in the CO2 emissions, reduction in electricity bills which makes it economical and reduces the payback period. This makes it more vital among all the other renewable energy sources. The research for the enhancement of solar panel was conducted, in order to utilize the solar panels after their warranty period finishes and are on the verge of replenishing it stated that the solar panels can be recycled and can be utilized back and works with almost the same efficiency. Although there are a few disadvantages rather limitations that can be overcome unlike by using sun tracker, MPPT, use of proper absorbing surface, reducing the coefficient of reflection etc. The following data represents the study on the generation by solar power station mounted on the roof of the Yashwantrao Bhonsale College.

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