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Design and Installation of Solar Rooftop Power Plant (Using Pvsyst Software)

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Abstract: Solar rooftop photovoltaic installation is among the most prominent setups in our nation to meet demand for energy in an inexpensive manner, encompassing both ground and roof mounted plants. As of February 28, 2021, the country's installed solar energy capacity was 39,083 MW. The major focus of this article is on the essential features of the design and installation involved in the system setup, including not only the technical design for a PV system, but also other critical components such as installation site appraisal of a particular rooftop to the final cost analysis. As an outcome, the paper's discussion will provide a general grasp of how a rooftop solar system is processed in this nation from an engineer's perspective.

Keywords: Solar rooftop, Photovoltaic, PV system designing, Cost estimation of PV system,

I. INTRODUCTION

Solar energy is the radiant light and heat of the sun, and one of the most widely used renewable energy sources on the planet. Depending on how they gather and distribute solar energy or convert it into solar power, their methods are classified as passive solar or active solar. Because of its widespread availability around the globe, it outperforms other sources like as wind, water resources, and natural heat-generating components. Sunlight based energy is a sort of energy that may be employed as a typical warmth source, such as in concentrated sun operated systems, or as a structure that converts sunlight into electricity, also known as photovoltaic. This study focuses on the latter, since it is more suited in a commercial building arrangement where it would be beneficial to access unlimited sources, primarily to save money on the electricity bill while being more environmentally friendly. When compared to other sorts of inexhaustible sources, photovoltaic powered by the sun has a major advantage in that it produces no pollution during its operation and, on top of that, it produces no harmful greenhouse gas emissions.

Over the last few decades, photovoltaic has progressed from a niche of small-scale uses such as powering a simple calculator or a torch light to a fully established mainstream source of electricity. As a consequence, light energy is transformed into electricity via a solar cell, which is referred to as the photoelectric effect.

The solar cell has been evolving since the 1880s, when Charles Fritts presented it to the world. In the year 1931, Dr. Bruno Lange, a German engineer, developed a photo cell by laying out silver selenide and replacing copper oxide. As a result, in the modern period, efficiency has achieved a new high. This method was not warmly welcomed because it only yielded approximately 1% efficiency, but it represents a turning point in the area of solar cells, with up to 40% efficiency under particular regulated settings. Over time, solar PV systems have advanced in technology, making them more cost effective and efficient in grid applications. Separate systems, as well as stand-alone systems, have been in use since the 1990s. In the year 2000, the German-based Eurosolar organisation was a pioneer in mass-production of solar PV.

1. India Scenario

1. As of February 28, 2021, the country's installed solar power capacity was 39,083 MW. The total installed solar capacity is 41 GW. In the first quarter of 2021, India added 2,056 MW of solar energy to its installed capacity.
2. Rooftop solar electricity accounts for 2.1 GW, with 70% of it being used for industrial or commercial purposes. According to a recent analysis by renewable energy consultant firm Bridge to India, the rooftop solar business is likely to take up in the first quarter (Q1) of 2021, adding 475 megawatt (MW) capacity.
3. Solar electricity has been widely deployed in Gujarat and Rajasthan. According to the study, Gujarat was experiencing a severe power shortage, which was entirely filled by solar energy.

2. Problem Formulation

The unavailability of suitable land is a big issue with this technology in India. For every 40 to 60 MW generations, nearly 1 km-2 km of land is required. That is why solar rooftop systems have emerged, which not only create the

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essential power for a building, but also efficiently utilize the barren space that is now underutilized. The rooftop solar power generating system connected to the local grid would be the appropriate option for the Indian context. The second problem is increasing demand of electricity to run various devices because our focus shifted toward technology to fast and easy our livelihood. The third problem is various losses occurred in this system. As rising demand leads to rising electricity bills is also the biggest problem for all the section of society. The stages involved in a typical rooftop solar installation in an Indian setting will be discussed in depth in this paper, including installation site appraisal, preliminary design, necessary load calculation, accurate design, installation, and cost estimates.

II. PHOTOVOLTAIC SYSTEM DESIGNING

1 Site Evaluation

The first step is to evaluate the site, which allows a PV designer to get a rough idea of the size of the project. Calculate the amount of electricity needed for a entire building because it will provide us with a carpeted area allowing the builder to measure the size of the rooftop the approximate number of solar panels (with a fixed dimension)that must be installed on the structure .

The measurements of other facilities, such as water tanks and structure that provide power, are the next step in the site assessment. The building's aesthetics, and so on, so that a concept can be calculated in order to avoid shadows falling onthe panel away from those systems in order to avoidmaintaining a fair level of productivity in shading the panel's ability to generate power. The next step in the site study is to choose the best location for a solar inverter and distribution boxes so that the DC line is as short as possible. The losses rise as the DC wires become longer. As a result, an ideal design would prevent the DC wires carrying the output from the panels from travelling a lengthy distance to a distribution box, but to be short in length and provide a scope for minimum losses The next stage is to choose the best position for the meter room for local grid installation, so that it can accommodate a net meter and allow the designer to calculate the AC run from the inverter. Because the grid meter is often installed at the ground level of a building structure, the site inspection must also identify the height of the structure in order to establish the length of cables needed to go from the rooftop to the meter room.

2. Preliminary Design

Following the site assessment, a designer creates a structure in a design tool (PVsyst) to realistically mimic the building and offer a preliminary placement of the chosen solar panel, taking into account shadows and other factors. The available solar irradiance, the albedo factor, and certain solar angle values derived for the rooftop coordinates are the most common parameters. This allows the designer to provide the maximum power output that can be taken from the panels that will be erected, giving us an estimate of how many panels can be installed on the rooftop.

3. Load Calculation

This procedure necessitates the calculation of the real load amount used in the building and the extraction of the specific kWh value required for the structure. This is done using a standard computation that adds up all of the AC loads used in a day, identifying peak hours of use and length of use of the electrical equipment in the building. The usual technique of estimating the typical load is to utilize the building/previously house's incoming power bills, although the process is straightforward for the reader's convenience. The estimation is made by multiplying the equipment's output wattage by the number of days it operates every day. Thus, we may obtain a Watt Hour or unit and convert it to the standard kilowatt hour by dividing the result by 1000 and referring to it as a unit of power for a home. In India, for instance, an air conditioner and refrigerator use 1500 W and 300 W of power, respectively, and if they operate for 6 hours each day, the unit is [(1500 x 6) + (300 x 6)/1000] kWh, or 10.8 kWh or 10.8 units. Accordingly, the same calculation must be made for all buildings/houses with electrical equipment, such as lifts, lighting, and so on.

4. Design

This is next important step where a main designer actually designs for the setup. The process includes a drawing with actual dimensions, optimum placement of panels keeping in mind the shadows and space available, calculation of the number of strings in an array, determination of the accurate size of the inverter, optimum placement of the inverter along with the solar meter and the distribution boxes, as well as cable size selection, AC and DC runs, and the net metering procedure. As previously said, the optimal setup is the first stage. This necessitates a basic building layout diagram, as well as the rooftop geometry (precise dimensions) and proper panel measurements, all of which must be scaled correctly.

The determination of the strings is the next phase. This may be done with the use of data sheets from both the panel and the inverter. The math isn't that difficult. For example, a 20-kW system with a 330-watt panel would necessitate the installation of 62 panels. We now separate the ideal values for the string's length, say 31 and 31, which add up to 62. According to the data sheet, the maximum voltage range for the selected inverter and module is 300 to 1200V, while

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the maximum voltage of the panel is 38V. As a result, 31 x 38 equals 1178V each, both of which are inside the inverter's range, allowing for a string configuration. For a 100kWp configuration, notice that the string is computed not just in these terms, but also in terms of practicality, DC run reduction, and other criteria, with the basic aim being to identify the optimal string. The next step is to decide the size of the inverter. Normally, we can utilise a 10KW inverter for a 10kW system; however, depending on the site geometry or the cost of installation, we can split up the needed number of inverters. This inverter, together with the DC and AC distribution boxes, is now positioned optimally to allow the installer to maintain financial stability.

The next step is to figure out how big the wire should be to handle the DC and AC loads. Because current flowing through resistive losses in the conductors and dielectric losses through the insulation both cause the cable to generate heat, the most important electrical calculation for cable sizing notes that sizing a cable based on a current rating would result in a better understanding. As a result, the smaller the resistive losses, the greater the cross sectional area. A simple formula can explain this. Where Lc is the installed current rating in amperes, Lb is the base current rating, and Kd is the product of all derating factors, Lc =Lb x Kd For instance, if the base current is 100A and the total derating factors are 0.5, the installed rating is 100 x 0.5 = 50A. Based on the cable material, duration, and installed rating, we can now refer to a table that determines the ideal cross section necessary for our installation. Calculating the DC and AC runs is a simple process. The distance between all of the modules and the DC distribution box is known as the DC run while The AC run is the required cable distance between the AC distribution box and the grid-connected meter. Finally, net metering is a simple technique that allows users who generate extra solar energy and pay it to the grid to reap the benefits. It's the difference between the quantity of solar power produced and the quantity of power consumed by the client during a month's billing cycle.

Whole virtual simulation done in PVSYST software

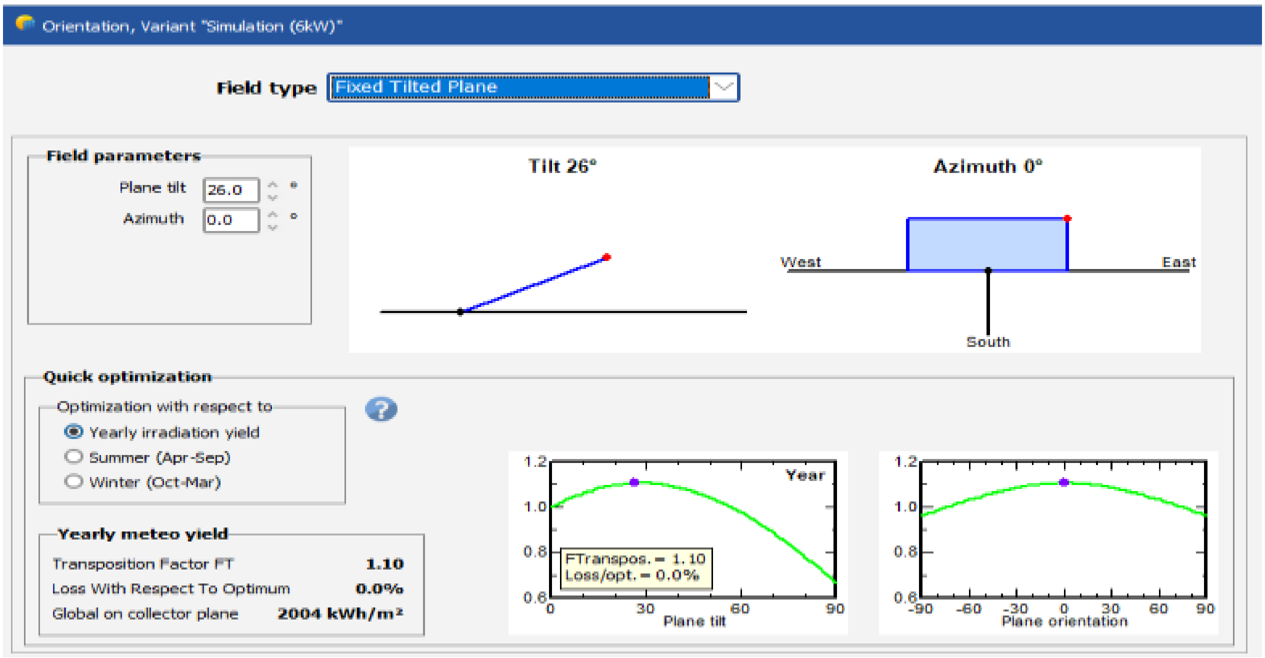

Fig. 1 Defining the tilt angle.

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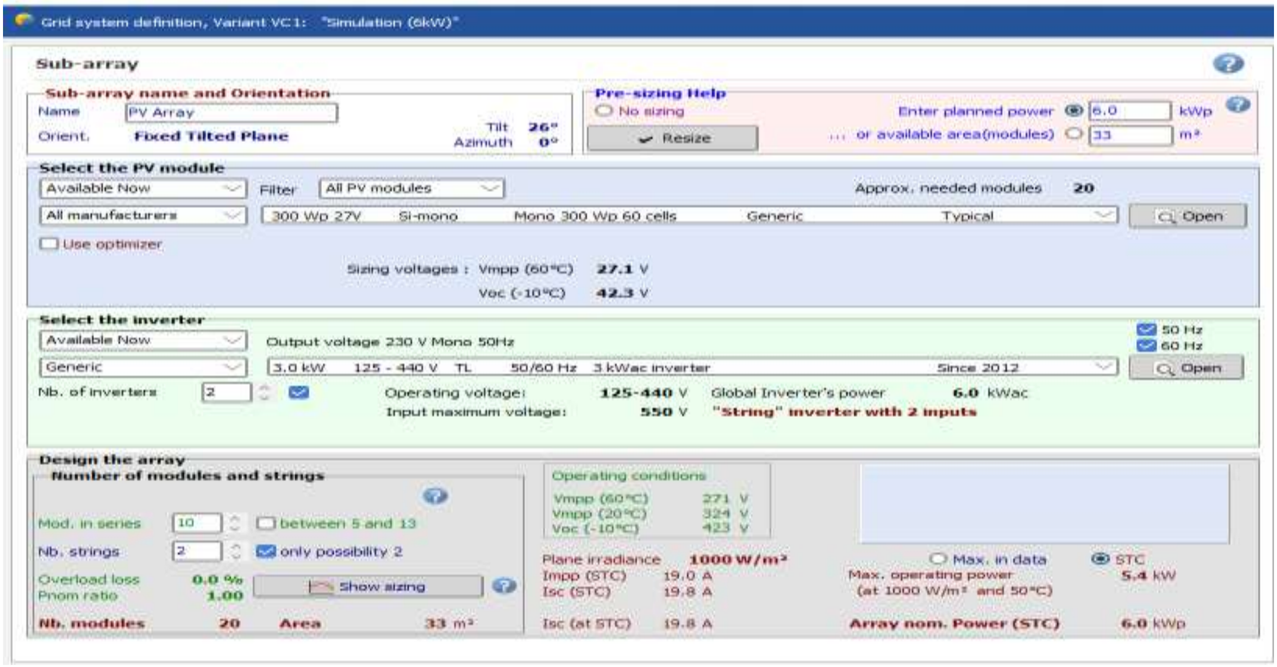

Fig.2. In the software, system parameters are defined.

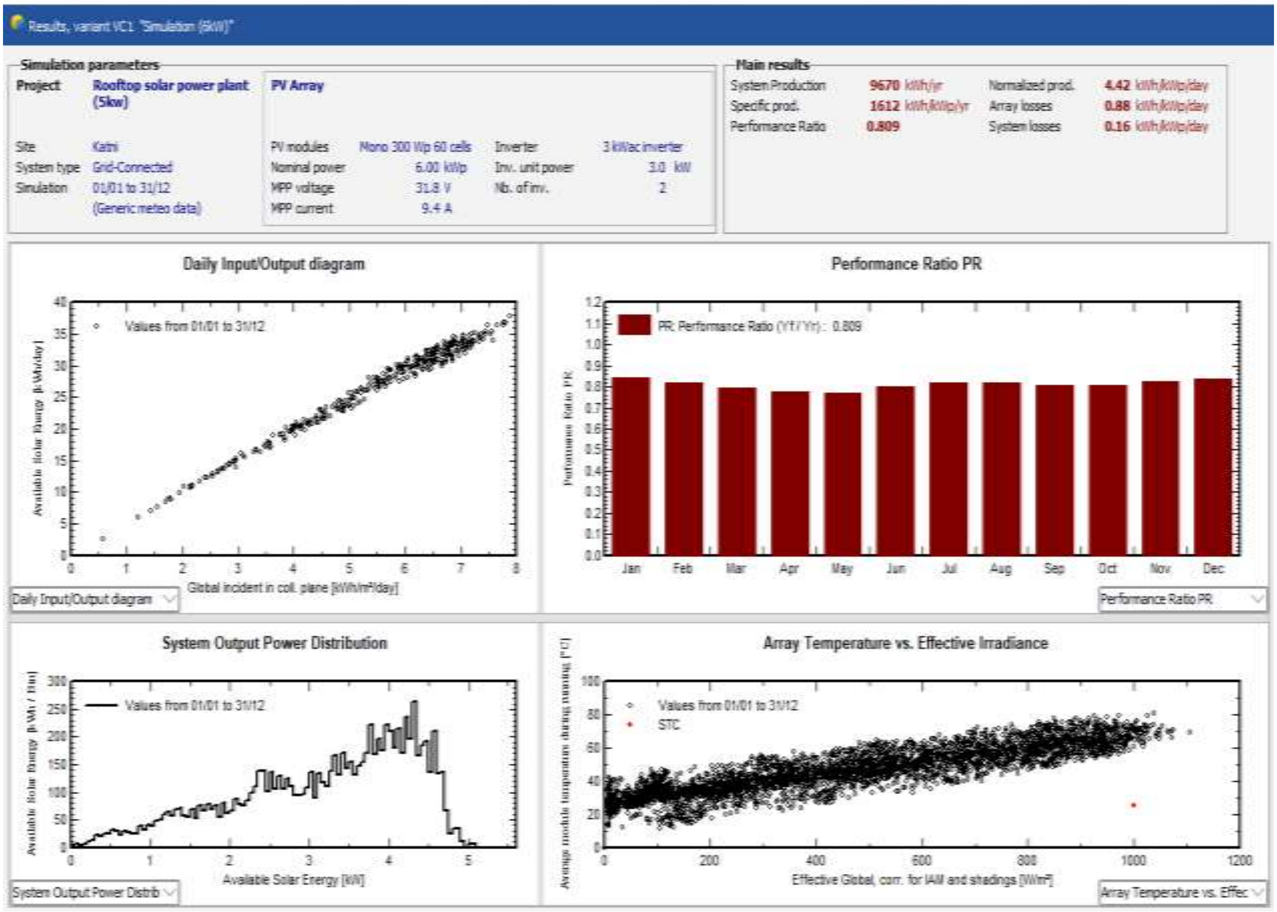

Fig.3. Report created by software.

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5. Installation

The acceptance of the design enables the site engineer to supervise the installation of the structure on roofs with the fewest potential faults, ensuring that the customer receives the efficient system promised.

6. Cost Estimation

Each energy-producing company has its own cost per unit of power, which is determined based on the company's profit margin. However, without taking into consideration the debt, equity, or taxes, I will provide the most basic notion on which a unit rate may be determined. Let's look at a 5kW ON-Grid Solar setup with 330W panel.

Table I. THE CAPITAL COST ANALYSIS (UTL SOLAR COMPANY)

PARTICULARS	DESCRIPTION
Solar System	5kW
Solar Panel Quantity	330 watt × 15 No.
Solar inverter	5kW (On grid)
Accessories	Complete accessories included structure, wires, ACDB/DCDB, etc.
Warranty	5 years system , 25 years for solar panel
MRP (Inclusive of all taxes)	Rs. 2,23,630

Produced nearby 20 units/day, For 1 years 19×365=6935units for 5years it is about 34675units.

Table II. PERFORMANCE AFTER YEAR

e	TOTAL NO. OF UNITS	RATED CAPACITY
1-5	34,675	100%
6-10	31,878	92%
11-15	29,452	85%
15-20	27,027	78%
20-25	24,601	71%

Total Production in 25years = 147,633 units.
Considering the generation for 25 years with additional maintenance of Rs.100000 (at max), cost per unit of electricity generated would be = Rs. 323630 ÷ 147633= Rs. 2.19/unit.

III. CONCLUSION

As observed from the cost analysis and the efficiency of the PV system, that's no doubt one of the greatest power generating systems available today. A cost of Rs. 2.19, plus taxes and other components, must be added to the basic computation, amounting to approximately Rs.3 per unit. Using software for virtual designing of plant rectifies various losses. The Ministry of New and Renewable Energy encourages the use of solar photovoltaic to a large extent by providing solar subsidies. The total installed solar capacity is 41 GW. According to a recent analysis by renewable energy consultancy firm Bridge to India, India added 2,056 megawatts (MW) of solar energy in the first quarter (Q1) of 2021, and the rooftop solar industry is likely to ramp up in the first quarter (Q1) of 2021, adding 475 megawatts (MW) capacity. As a result, solar PV systems are gradually becoming more popular in our country, particularly rooftop PV systems, which are mostly found in metropolitan areas. As energy consumers, it is critical that we become acquainted with this technology in order to make the transition to a greener world.

REFERENCES

[1]. Sivaraman, Karthik, and Aniket Rawool. "A Brief Study of an Installation of a Rooftop Solar PV System in India." *Journal of Energy Research and Reviews* (2019): 1-6.
[2]. Sharma, Naveen Kumar, Prashant Kumar Tiwari, and Yog Raj Sood. "Solar energy in India: Strategies, policies, perspectives and future potential." *Renewable and Sustainable Energy Reviews* 16.1 (2012): 933-941
[3]. Solar Installed capacity. Available: https://www.thehindubusinessline.com/economy/agri-business/india-adds-205-gw-of-solar-capacity-in-cy-q1-2021/article34651608.ece
[4]. Roof top solar installed capacity. Available: https://energy.economictimes.indiatimes.com/news/renewable/rooftop-solar-expected-to-add-475-mw-capacity-in-q1-2021-report/81276693
[5]. Pvsyst Software. Available: https://www.pvsyst.com.
[6]. Solar power. Available: https://en.wikipedia.org/wiki/Solar_power

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[7]. Ministry of New and Renewable Energy Source, Policy support for grid interactive renewable power. Available: http://www.mnes.nic.in
[8]. Solar Energy Industries Association. Available: https://www.seia.org/initiatives/solar-technologies
[9]. UTL solar company estimate. Available: https://www.upsinverter.com/utl/on-grid-solar-system/

BIOGRAPHY

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I am final year student of Electrical Engineering, I have completed several courses during my graduation some of them (NPTEL recognized by IIT) are Introduction of Smart Grid, Sensors and Actuator and Introduction of Internet of Things.