Solar PV Simulation and Designing

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***Abstract* - Solar rooftop PV system is an alluring substitute power source for households and institutions. The capability of solar PV at a given site can be assessed through various software. Electrical energy is a fundamental prerequisite for regular daily existence and its interest is expanding internationally. To meet the rapidly increasing demand without adversely affecting the environment, the world is focusing on renewable energy-based power generation of which solar photovoltaic (PV) based power generation systems are the significant patrons. To exploit the solar energy for electrical power generation, solar photovoltaic technology is used. The performance of the PV system depends not only on geographical location but also on the types of solar modules. The potential of solar PV at a given site can be evaluated through software simulation tools. The efficiency and yield force of PV depend upon the solar irradiance, location, face angle of the PV panel, type of PV (monocrystalline, polycrystalline, micro amorphous silicon, and amorphous silicon), and the efficiency of the components, however the accessible sunlight-based irradiance and location play a significant role. The objective of this project is to evaluate the feasibility of a grid connected rooftop solar photovoltaic system for a household in Safdarjung area, New Delhi.**

I. Introduction

The demand of the electrical power is increasing per day which is supplied by fossil fuels resulting into huge carbon emissions in the atmosphere, which leads the electrical engineers to generate the power by using the renewable energy sources. It is cheapest sources of power in the world, and will continue to spread rapidly in the coming years. With solar panel technology improving each year, the economic benefits of solar improve, adding to the environmental perks of choosing a clean, renewable energy source. There are many ways to use energy from the sun. The two main ways to use energy from the sun are photovoltaics and solar thermal capture. Photovoltaics are much more common for smaller-scale electricity projects (like residential solar panel installations), and solar thermal capture is typically only used for electricity production on massive scales in utility solar installations. In addition to producing electricity, lower temperature variations of solar thermal projects can be used for heating and cooling. Various studies have been conducted in literature on PV system performance investigation. Khatib et.al.(2013) carried out techniques for solar PV systems size optimization that suggest optimization of PV systems strongly depends on meteorological variables such as humidity, wind speed, solar radiation and ambient temperature. So, it becomes important to have a detailed analysis at various locations for accurate results. Saeed et al.(2015) compared the experimental behaviour of these two common PV module technologies (m-Si and p-Si).

II. System Description

The system description is given inTable2. A 6.4 kW p rooftop system is chosen. The PV cell material chosen is mono-crystalline because of the higher efficiency. The system is of fixed stand type and can sufficiently power a household of a small family. The grid connected PV system, consists of solar arrays to absorb and convert sunlight into electricity, a solar inverter to convert DC current to AC current, a mounting, cabling and other electrical accessories. The main component for grid-connected solar PV power systems comprises of: Solar PV modules, connected in series and parallel, depending on the solar PV array size, to generate DC power directly from the sun's intercepted solar power. Maximum power point tracker (MPPT), making sure the solar PV modules generated DC power at their best power output at any given time during sunshine hours (Manju and Sagar, 2017). Grid-connected DC/AC inverter, making sure the generated and converted AC power is safely fed into the utility grid whenever the grid is available (Laib et.al.,2018). Grid connection safety equipment like DC/AC breakers fuses etc., according to the local utility's rules and regulations.

III. Methodology

A. Understanding Software

This is where we start to use the software. It consists of 2 main sections. One is Meteo database from where we can select the sites and get the solar data on that geographical site. The options graphical view of data and comparison of multiple meteo data is available. We can also import the data of our choice if not found in the geographical sites data. The other section is for components database. All the components that needs to be selected can be done form here. This section has classified components into main, grid, standalone and pumping components. The type of components, designing is done through this section.

B. Site Selection

Whenever or wherever we want to set up soalr PV panels, the very first step to do is analyse the amount of solar radiation depending on certain parameters. Things that affect the solar radiation are (1) location (2) local climatic conditions. Selection of location (Site Analysis) to identify area available, is there nearby any big shadings or not. 1. Site Selection is New Delhi/Safdarjung. 2. Latitude-28.58 Degree North 3. Longitude-77.20 Degree East 4. Altitude-212m 5. Geographical Area 135metersquares 2. Available data sources - There are few companies like solar GIS, MNRE which has data for all the locations regarding solar radiation on that location. 1. Available Climate data 2. Month wise weighted mean to average out the data sources and get monthly details about radiation. 3. Units and conversion to measure solar radiation. Usual unit is watt per meter square. But more usable unit is kWh per meter square.

C. Yield Forecasting

The annual baseline and the final yield were simulated using PVSyst software for the proposed system. The yield plot was characterized as normalized production and main results. The reference unit and the final output is expressed in hours per day. We simulated the expected value of the benchmark return and the final return for the month of April as well as for a full year on a monthly basis.

D. Orientation

Orientation means that at what angle should we place PV module from the ground so that we get maximum radiation throughout the year. The field type we have selected is Fixed Tilted Plane. In field parameters we have two types of angles to set. 6. Plane tilt - Tilt angle is set according to the latitude of the location. After doing some research we found that tilt angle is kept same as the latitude. Tilt angle is set to 29.0 degrees. 7. Azimuth Angle – It is the angle of sun's position between the horizontal pane and line to the sun. We set azimuth angle to 0 degrees because we want our modules facing towards south side as the location is in northern part.

E. System Selection

Once the orientation is done, we need to design the components. The planned power is set to 250kWp and area for that is set to 1355 m2 in the pre-sizing help section. According to the power required we select the module and inverter. In designing the array section, we automatically get the number of modules in series, that is, 25 and number of modules in parallel is 33. The number of string inverter is 4 and 33 modules are connected to each string inverter. 50/60 Hz 60 kW ac string inverter is used.

IV. RESULT

A. Solar Resource Potential

Solar irradiation is the most important input for a professional assessment of energy yield of PV system. The performance analysis depends on site-specific meteorological factors (solar irradiance characteristics, wind speed, and ambient temperature) and installation site factors (latitude, longitude, orientation, dust, pollution). The minimum and maximum temperature also influences the power output of the solar photovoltaic system. Likewise, humidity is taken into consideration while determining the power output of the PV plant. High humidity in the atmosphere adversely affects the performance of the PV module as it condenses and forms a deposit on the module during night time.

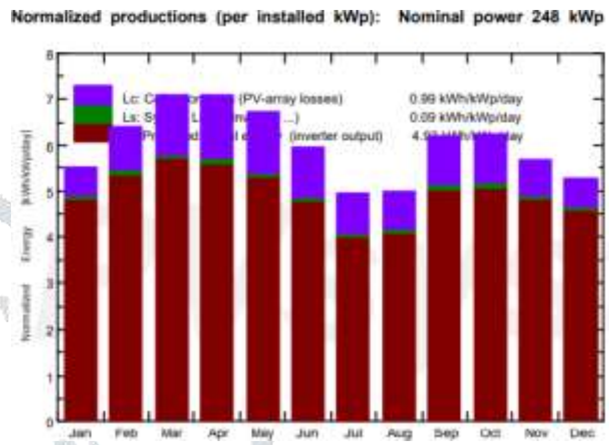

Fig. 1 Normalized productions

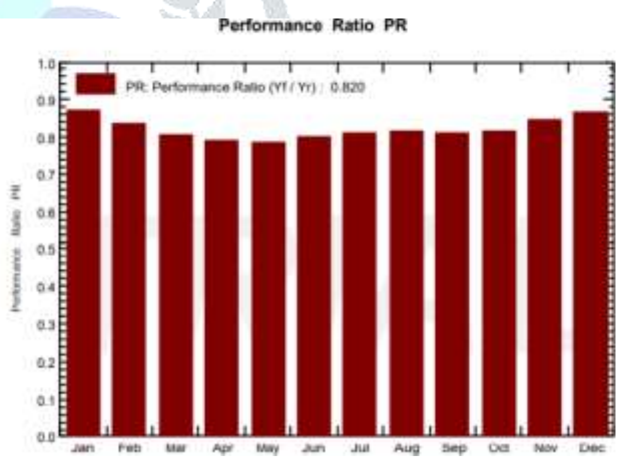

Fig. 2 Performance Ratio

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR ratio
January	117.9	36.9	12.82	171.4	169.4	37.72	37.03	0.873
February	136.4	39.6	17.13	179.6	177.3	37.83	37.14	0.835
March	188.2	50.5	23.39	219.8	216.2	44.60	43.80	0.805
April	206.6	69.3	29.41	213.1	209.3	42.42	41.63	0.799
May	222.3	91.7	32.74	208.9	204.4	41.41	40.66	0.786
June	196.1	103.5	32.26	178.3	174.3	36.06	35.42	0.803
July	166.4	98.3	31.59	153.3	149.7	31.35	30.77	0.811
August	159.7	94.2	30.54	154.9	151.4	31.96	31.37	0.818
September	170.6	73.5	28.82	186.6	183.2	38.11	37.42	0.810
October	158.5	65.5	25.61	193.5	190.7	39.78	39.06	0.816
November	123.6	48.1	19.36	170.7	168.3	36.42	35.78	0.847
December	111.2	41.0	14.56	163.6	161.5	35.79	35.15	0.868
Year	1957.3	812.0	24.89	2193.6	2155.7	453.46	445.22	0.820

Fig. 3 Simulation Variants

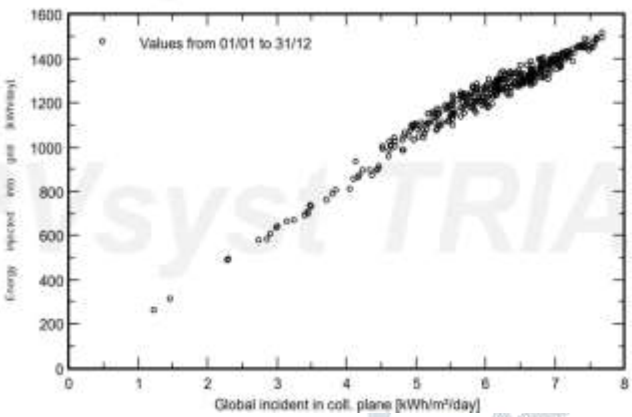

Fig. 4 Daily input/output diagram

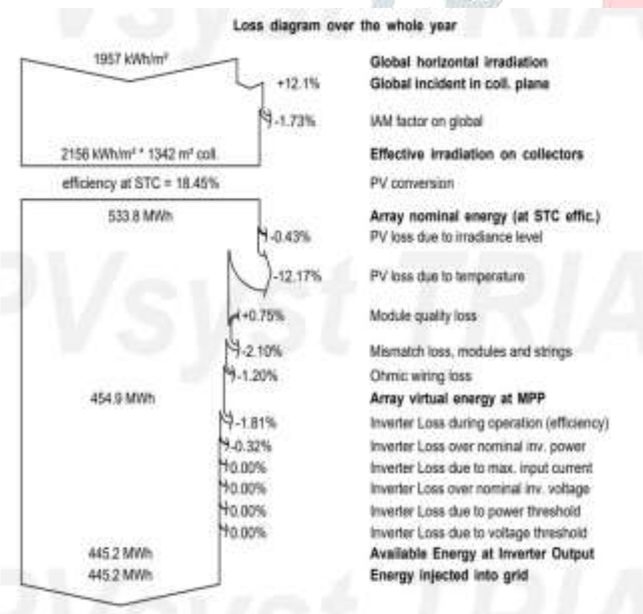

Fig. 5 Loss diagram over the whole year

B. Performance Parameters

The maximum annual production is 445.2 MWh/year. The maximum normalized energy produced is in the months of March and April. The performance ratio is 82.00% , it is a very good ratio. The total global horizontal radiation is 1957.3 kWh/m2. PV loss due to irradiance level is -0.43%. PV loss due to temperature is -12.17%. Inverter Loss during operation (efficiency) is -1.81%. Inverter Loss over nominal inverter power is -0.32%.

V. CONCLUSION

A simulation study was carried out to determine the technical performance of a grid connected rooftop solar PV-system for a household to supply electricity. Mono Crystalline Solar PV modules have been simulated to determine performance ratios, energy consumption and Energy yield. This study suggests that in the Safdarjung region, the PV power generation performance is good with performance ratio 0f 82.00% depending on the availability of rooftop area. The simulated performance can be used to analyze and validate the actual measured solar PV performance data.

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