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Performance Analysis of Grid Connected 100kWp Solar Rooftop

Manidhar Thula[1*]
Dr. Bishnu Prasad Mishra[2]**
Dr. M. Narendra Kumar[3*]**

Abstract

The PV system performance generally pivots on the location secondly on type of Photo voltaic modules used. IbrahimpatnamTelangana receives an annual average solar radiation of about 5 31 kWh/m2/day which can be used to maximum extent by proper designing of the plant and placing the Photvoltaic modules at proper location. In this work grid connected 100kWp PV system which is installed on rooftop of an educational institution at Ibrahimpatnam Hyderabad India is designed and simulated by software with measured data of the plant location. The energy generated by the PV system over 10 months was analyzed and compared with the actual data.

Keywords:

Solar photovoltaic;
Grid integration;
Simulation;
Renewable energy;
Electricity

Author correspondence:

ManidharThula,
Research scholar
Centurion University of Technology & Management

1. Introduction

The consumption of fossil fuels like coal for power generation is increasing day-by-day which resulting into huge greenhouse gas emissions which affect environment leading to global warming. Thus, there is a need to use cleaner energy sources like solar, wind, biomass and hydro energy as alternative to fossil fuels. These sources are not depleted when used as these are continuously replenished by nature. The exponentially increasing Indian population and rapidly depleting conventional sources of energy make solar energy the only reliable alternative for energy.

Solar energy is one of most promising solutions to the global energy crisis. Solar photovoltaic (PV) systems have emerged reliable for power generation worldwide as extending power lines to rural and remote areas are not economical.

The nature endowed India with enormous solar energy potential. About 5,000 trillion kWh per year energy is incident over India's land area. A fraction of this energy is sufficient to meet all the energy demand of the country given this energy is captured efficiently.

Hyderabad (India) has huge solar potential with average solar irradiation of nearly 5.25kWh/m2/day [1]. To utilize the solar resource efficiently, it becomes necessary to size and simulate the system parameters for efficient energy yield. The energy yield and the required size of PV system can be estimated using simulation software [2]. A number of researchers have used other software's like PV Syst & solar pro to estimate the performance of the system [3]

*ManidharThula, Research scholar , Centurion University of Technology & Management
**Dr. Bishnu Prasad Mishra,Dean,School of Engineering,Centurion University of Technology and Management
***Dr. M. Narendra Kumar, Principal, St.Peters Engineering College, Hyderabad

The aim of this paper is to design, simulate and compare the installed 100kWp rooftop solar photovoltaic system at Ibrahimpatnam, Hyderabad (T.S.), India using software.

In this paper we have used actual measured onsite data as input to the software so that accurate results for the system design and performance analysis are obtained

2. 100 KWP Grid Connected Plant

i)Plant Rating

The system is designed to meet the energy needs of the institution and fed back to grid otherwise.The nominal system generation capacity is 100kWp at standard test conditions (STC). The system gives three phase 415V, 50Hz output which is connected to The nearest point of utility grid. The figure 1 shows Photovoltaic system at location.

Figure1. Installed 100 kWp solar rooftop at the location

ii)Solar radiation

Solar radiation is measured using pyrheliometers and pyranometers. Angstrom and Thermoelectric Pyrheliometers are used for measurement for direct solar radiation and global solar radiation is measured using the Thermoelectric Pyranometer. A Thermoelectric Pyranometer with a shading ring is used for measurement of diffuse radiation. Inverted pyranometers and Sun photometers are used for measuring reflected solar irradiance and solar spectral irradiance and turbidity respectively.Radiation data is available from various sources, such as IMD, NREL, Meteonorm, NASA, WRDC (World Radiation Data Centre) and so on. Some of these agencies provide data free of cost and with others, the data needs to be purchased.

According to the data collected from MNRE, the plant location receives an annual average direct normal irradiance of about 5.31 kWh/m2 a day. The monthly variation of solar irradiance is shown in figure 2. Maximum solar irradiance is observed for the month of February which is 6.73 kWh/m2/day. July month receives lowest amount of solar irradiance. It happens because of the variation in position of the sun with respect to concerned location. The global horizontal solar radiation varies throughout the year from 5.06 to 6.90 kWh/m2/day [1].

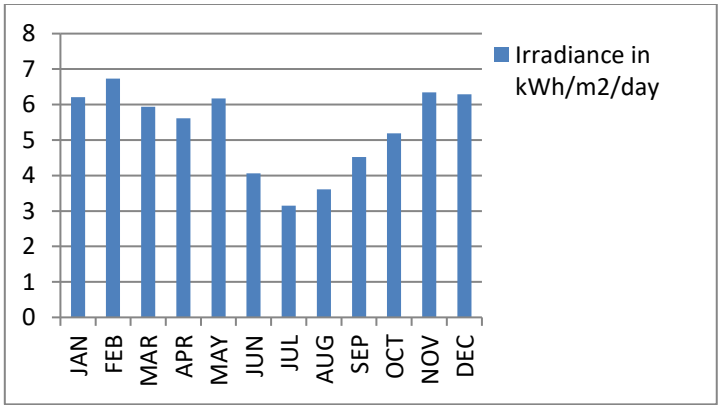

Figure2. Monthly average horizontal irradiation at location

iii)Solar Module and System Design

The photovoltaic system used is multi crystalline solar cell with 72 cell connected in series to form one solar module which will produce a power of 290Wp at STC. In this system, total 21 modules are connected in series to make a single string and total 16 such kind of strings are connected in parallel. Four strings are connected to one inverter of capacity 23kVA and total four inverters are used to connect 16 strings. The single line diagram and satellite view of PV system at location are shown in figure 3.

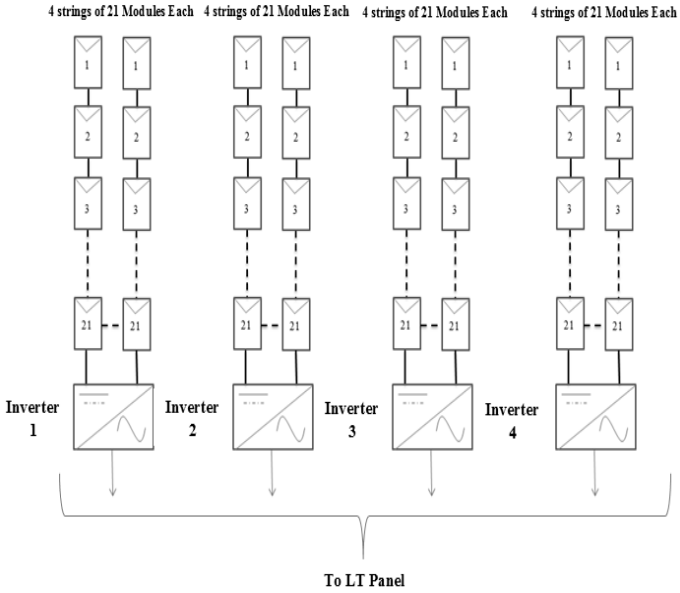

Figure3. Single line diagram of installed PV system

3. Methodology

In this section methodology is described to design and simulate 100kWp rooftop photovoltaic system at the institute, Ibrahimpatnam, Hyderabad (India) using Solar simulation software.

A.Solar pro Software

Solar Pro is futuristic simulation software for photovoltaic system which is capable to simulate electricity generation under different conditions varied by each system so that it allows system designing based on precise data. Additionally, the calculated data come out with persuasive and graphical look. Solar Pro has a large database of meteorological data for a number of sites all over the world. It also provides manual insertion of measured data for sites which are not enlisted in the software. It give out the results in the form of a report which includes specific graphs and tables. The data can be exported for use in other software's. To obtain results, we have to provide some inputs to the software [2].

The main Simulation variables in Solar Pro are:

- Meteorological data
- Solar module data
- Total modules and connections (based on capacity or area)
- Roof type

B.Inputs required

The design of a photovoltaic system is location dependent because every location receives different amount of solar radiation. It happens due to the position of that particular location with respect to sun. This difference of position is observed in the form of unique set of parameters like latitude, longitude and altitude of a location. The some of the most important input parameters for software are given in Table 1 [2].

i)Location

The plant is a situated in southern India at latitude 17.16° N, longitude 78.65° E near Hyderabad (India).

Table 1 Input Parameters for Solar Pro

Latitude	17.16
Longitude	78.65
Roof type	Flat roof
Tilt angle	15^0
Azimuth	0
PV module	Waree WS-290 Multi crystalin silicon
PV system size	100 kWp
Number of Inverters	Advance Energy (4 No.s)

ii) Module and Inverter Specification

For sizing of 100 kWp system at location, we have taken Waree WS-290 multi crystalline silicon modules of 290kWp each. Figure 4 shows the I-V characteristics curve which will affect quantity of power generation in constant 250C cell temperature by different incident irradiance. Four Advanced Energy Inverters of 1 kWp each are used.

The string design is follows

- Total no. of modules in each string: 21
- Total no. of strings per inverter:4
- Total no. of modules per inverter: 84
- Total no. of inverters:4
- Total no. of strings: 16
- Total no. of modules:336

3)Tilt angle

Tilt angle is defined as the slope angle at which solar panels are mounted to face the sun. Generally tilt angle is taken to be equal to latitude of the considered location. Optimum value of tilt angle is required to get maximum amount of sun energy onto the panels. In this paper we have considered tilt angle of 150 [4].

4)Azimuth angle

Azimuth angle defines the direction of sun. It is taken as zero as the panels are mounted facing south in northern hemisphere.

3. Simulation Results and Performance Analysis

A detailed report consisting of various graphs and tables from the report obtained using Solar Pro software and actual plant reports are presented in this section. The location data and other parameters are given as input in the simulation and results for different duration are recorded and compared with actual power generation. The figure 4 shows the 3D design of actual plant using Solar Pro software.

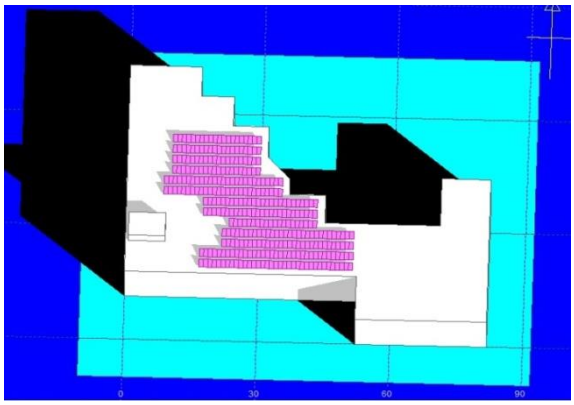

Figure 4. 3D Design of the plant in Solar pro

The software facilitates the simulation for one day to estimate the power generation. The simulation has been done for 26th December and power generation and total irradiation during whole day is shown in figure 5. The actual power generation for the same day has also been recorded. In both results, the peak value of power is going near 63 KW in peak sun hours. The actual power generated for the day is 498 kWh which is nearly equal to the power estimated by simulation. Again the actual power generation of each day depends on the weather condition which can make difference with simulation result.

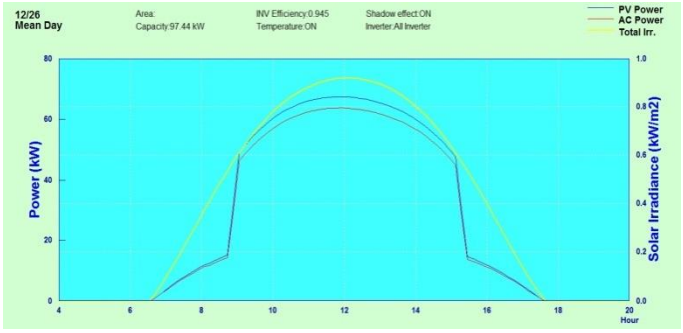

Figure 5. power generation and total irradiation during whole day of 26th October

The simulation is also carried out to approximate the power generation for one month. The simulation is done for October month which includes 31 days and the power generated in each day is shown in graph in figure 6.

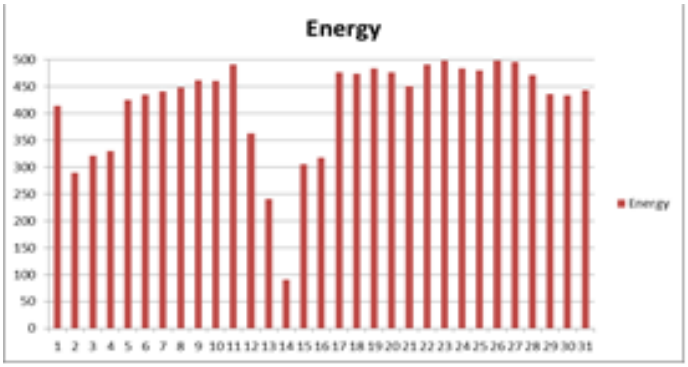

Figure 6. Simulation results for one month (kWh)

To compare the simulated results with actual power generation in same month, the actual result has been recorded as shown in Table 2.

Table 2. Actual Power Generation Per Day

Day	Energy	Day	Energy	Day	Energy
1	414.10	12	363.00	23	498.50
2	289.50	13	241.40	24	483.50
3	321.30	14	90.90	25	480.00
4	329.70	15	306.10	26	498.30
5	425.30	16	317.90	27	495.90
6	434.90	17	475.90	28	471.40
7	441.40	18	473.60	29	436.30
8	448.50	19	483.50	30	433.70
9	461.50	20	477.00	31	443.50
10	460.20	21	451.10		
11	491.50	22	490.90		

According to the simulation, the power generation for the year 2017 up to October is 118943 kWh. The actual power generated in the year 2016 is 116059 kWh.The variation in power generation in each month is compared with simulation result and it is shown in table IV and figure 7. The actual power generated by each month is compared with simulation result.

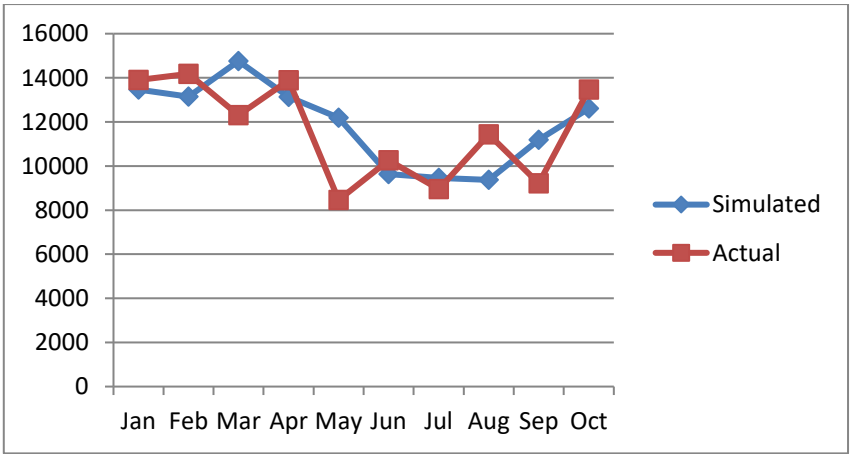

Figure 7. The variation in power generation in each month

3. Conclusion

In this work, efficient rooftop PV system of capacity 100kWP is designed for gridconnected environment using simulation software.When comparing simulated result with actual power generation, it is found that the both results are nearly same for annual power generation. The simulation software is a very good tool for 3D

design and simulation for grid connected PV system that provides any range of duration of simulation for calculating estimated power generation. For the future work, the space available for installation of photovoltaic module can be calculated and power generation can be approximated for this expanded system.

References

[1] www.mnre.gov.in (viewed on 25/10/2017)
[2] www.lapsys.co.jp
[3] PriyaYadav, Nitin Kumar, S.S Chandel., "Simulation and Performance Analysis of a1kWp Photovoltaic System Using PVsyst", International conference on power, energy, information and communication, (IEEE 2015), pp.:0358-0363, 2015.
[4] Ibrahim, D., "Optimum tilt angle for solar collectors used in Cyprus." Renewable energy, vol. 6.7, pp. 813-819,1995.