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Design of Grid Connected PV System Using Pvsyst

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Abstract: Photovoltaic system simulation software is very important in prediction of output electricity from the PV system. In this paper, Grid connected photovoltaic system is simulated using the Pvsyst software. In this study PVsyst software is used to design a grid connected PV system for Madan Mohan Malaviya University of Technology, Gorakhpur in India. Detailed system configuration, system output and system losses are determined in this study. From the simulation optimal size of the PV system is determined that is able to supply the electricity to the university throughout the year. It is founded that 2000 PV module and 10 grid connected inverter is the optimal solution for the load of university. About 901.44MWh electricity will be available to the grid in a year.

Key words: Pvsyst · Grid Connected Photovoltaic system · Pre-sizing · Optimization

INTRODUCTION

Renewable energy technologies are able to provide sustainable and clean energy from the sources such as sun, wind and bio-materials. Photovoltaic system is one of the most important and promising technology that are able to produce the electricity to meet the electricity demand of the whole world [1]. Since the last decade, the photovoltaic industry grows more than 40% per year due to decrease in photovoltaic system cost [2]. There are two type of system employed by PV technology first is Stand Alone PV system and second one is Grid Connected PV system. Grid connected PV system is connected to the grid where as standalone system does not connect with the grid and directly supply to the load. In grid connected photovoltaic system PV module generate DC power which is converted into AC by the use of inverter. AC power is fed to the grid and load is connected to the grid. There are some advantages in grid connected PV system such as environment friendly [3], less maintenance and extra electricity can sold to the grid [4] that reduces the system running cost.

Accurate sizing of the grid connected system is very important as improper size of the system leads to have over sizing or under sizing of the system by which system cost and system performance is affected. Various size of PV module and inverter is available in the market still there is difficult to select the best combination of PV module and inverter that meet the relative parameter. Hence, a pre sizing of PV module and inverter is very important before installation of grid connected PV system. Here is some literature survey in which sizing of the PV system done. P. Karki *et al*. [5] do an analysis for grid connected PV system in Kathmandu and Berlin by the use of PVsyst software. In the simulation it was founded that electricity will be produce more in Kathmandu compared with Berlin with the same system. Hence it was founded that Kathmandu is more solar energy capacity then Berlin. S.K. Kyprianou *et al*. [6] do a techno economical analysis for a 150kW solar power plant. For the result it is found that Cyprus has a high number of sunny days in a year hence investment on solar power plant on that place is beneficially. Y.M. Irwan *et al*. [7] do a study to analysis the output electricity from the stand alone system for powering household load at Kangar, Malaysia using the Pvsyst software. From the simulation it was founded that 736kWh electricity will be produced by the proposed system in a year. Elieser Tarigan *et al*. [8] simulate a grid connected photovoltaic system for the household load for Surabaya, Indonesia using the Pvsyst software. From the simulation it was founded that 1366 kWh electricity will be produced by the proposed system. From the literature survey it was founded that Pvsyst is the best software that is able to calculate the proposed output power and do accurate sizing of the system [9].

In this paper sizing and calculation of output power of grid connected photovoltaic system is done for the Madan Mohan Malaviya University of Technology,

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Fig. 1: Google Map of MMMUT

Gorakhpur, India. In this analysis Pvsyst 6.41 software is used. The system is designing to provide the electricity to the university for all over year and excess electricity will be sold to the grid [10].

Data Set: For development of the grid connected photovoltaic system, it is very important to collect important data that effects performance of the system. There are two data set that are effect the system parameter one is geographical data and another is load data.

Geographical Data: Madan Mohan Malaviya University of Technology, Gorakhpur is situated at India. Figure 1 shows the map of the MMMUT. It lies on 26.7°N latitude and 83.4° E longitude, 59 meters above sea level. Solar and temperature data is taken from the solar radiation resource assessment setup placed on the roof of the electrical data of MMMUT. Global irradiance is maximum on the May (225.1 kW/m^2/month) and minimum on December (124.3kW/m^2/month). Total global irradiance in the whole year is 1938kW/m^2. Average temperature of the site is 24.3°C.

Figure 2 shows sun path for the Gorakhpur location. From the figure it is shown that sun shine is higher in the summer session where as sun shine is lower during the winter session. Hence solar radiation is highly available in summer session in the site location.

Load Data: In grid connected photovoltaic system calculation of load data is very important to avoid over sizing or under sizing of the system because it leads to increase the cost of the system [10]. One year load data is taken from the substation of the university. Peak load of the university is about 500kW. Therefore, 500kW solar power plant will be sufficient to provide electricity to the university throughout the year.

System Configuration: It is very important to select the best components in the system to achieve a cost efferent and reliable system [11]. All the components of the system are selected on the bases of their parameter and characteristics.

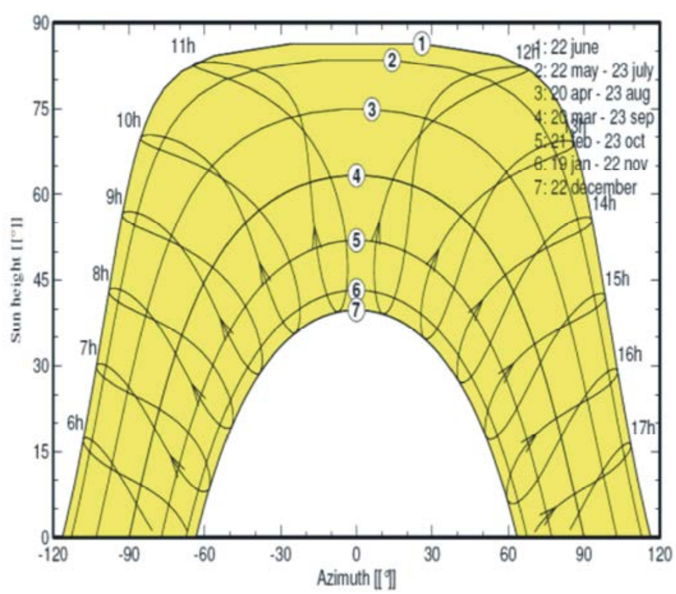

Fig. 2: Sun path for the MMMUT

Table 1: PV module specifications

Specification	Parameter
Module Name	SU-250
Technology Used	Poly-Crystalline
Rated Power	250W
Short Circuit Current	8.36 A
Open Circuit Voltage	37.8 V
Maximum Current	8.14 A
Maximum Voltage	30.72 V

Table 2: Inverter Specifications

Specification	Parameter
Rated Power	50 kW
Maximum DC power	56 kW
Maximum DC current	130 A
Rated Voltage	400 V
MPPT range	420- 850 V

PV Module: Photovoltaic module is most important component of the grid connected PV system as PV change the solar radiation energy into electrical energy. Numbers of PV modules are connected to form a solar array to increase the output power. PV array must be properly sized to supply the load throughout the year. In our study 250 W SuKam PV module is selected for this study, parameters of proposed module is given in the Table 1 [12].

It is required to fix the panel in a certain fixed angle to received maximum amount of solar radiation. For the optimal solar radiation panel is need to fix at south facing. From the Literature [7] it is founded that for the maximum solar radiation panel is fixed at angle equal to altitude of the site location. For the MMMUT panel is fixed at 26.7° tilt angle.

Inverter: Inverter is also a very important component of grid connected PV system. Inverter converts the DC power from the PV module into the AC power supply. It is very important to meet the inverter specification with the PV specification to rum the system properly. The inverter used for study has inbuilt MPPT technology which will increase the system efficiency. Sukam grid tie 50kW inverter is selected for this study [12]. The specification of the inverter is given in the Table 2.

RESULT AND DISCUSSIONS

PV module and inverter specification is optimized by the PVsyst software for appropriate sizing of the grid connected system. From the simulation system specifications, system output power and loss of the system are found.

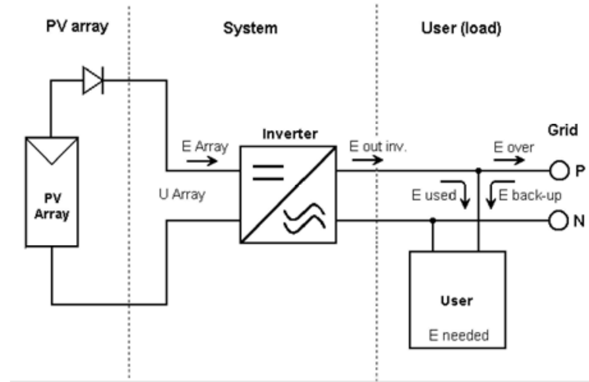

Fig. 3: Block Diagram of Grid Connected PV System

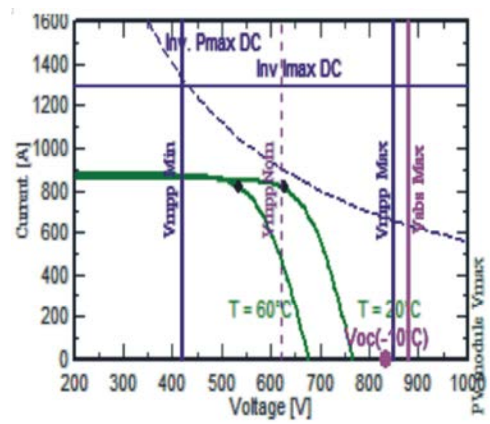

Fig. 4: PV Array Voltage-Current Characteristics

System Configuration: Grid connected photovoltaic system for 500kW power plant is simulated in the PVsyst software. From the simulation it is found that 2000 module and 10 inverters are required. Figure 3 shows the block diagram of the grid connected PV system. 20 PV modules are connected into series and form a string. 10 string of 20PV models are used in the system. For the placement of the modules 3280m^2 area will be required. At the maximum power point current of the system will be about 818 A.

The output of the PV system depends upon the received solar radiation and temperature. Figure 4 shows the voltage-current diagram of the photovoltaic module. At the 60°C temperature maximum power point voltage will be 534 V whereas at the 20°C temperature maximum point voltage will be 626 V.

Energy Production: A high amount of radiation of about 2108.5 kW/m2 energy is received on the PV array in a year. By the proposed grid connected system 935.46MW electricity will be generated out of that 901.22MW electricity is available to the grid. 901.22 MW electricity will be sufficient to supply the electricity to university

Table 3: Energy produced by the grid

Month	Effective global Irradiance (kWh/m^2)	Energy outpour from array (MWh)	Energy injected to grid (MWh)
January	170.8	78.61	75.75
February	182.6	81.80	78.88
March	220.3	95.07	91.67
April	211.1	90.05	86.74
May	202.2	87.16	83.97
June	159.3	70.65	68.04
July	128.8	57.91	55.59
August	133.6	60.20	57.84
September	140.5	62.86	60.47
October	190.6	84.30	81.28
November	191.7	85.87	82.86
December	176.6	80.98	78.12
Year	2108.2	935.46	901.22

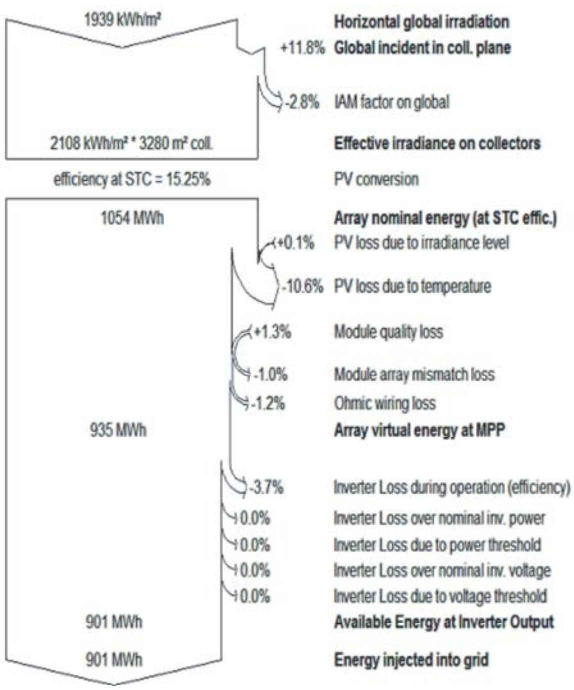

Fig. 5: Detailed System Losses

throughout the year. Table 3 shows the monthly electricity production by the proposed system. From the simulation it is found that performance ratio of the system is 83.1 %. System will produce 4.94kWh/kWp electricity in a day that is available to the grid.

System Losses: PV system is not able to convert 100% energy received from the solar radiation because of various losses. Figure 3 represents detailed losses occur in the proposed grid connected PV system. Firstly about 1939 kWh/m^2 radiation is incident on the solar panels. Biggest losses are done during PV array electric production. Su-250 module has 15.25 % efficiency at the STC. By this, 1054 units of the electricity will be produced in a year by the PV array. After that due to the PV panel losses, Inverter losses and wiring losses about 901.22 units of electricity is available to the grid in a year.

CONCLUSION

Grid connected photovoltaic system for the load of MMMUT is designed using the Pvsyst software. By the help of PVsyst software PV system configuration, output electricity and system losses are analyzed. The whole study is focused to design a grid connected photovoltaic system for Madan Mohan Malaviya University of technology, Gorakhpur, India. By this accurate size of the GCPV system is determined and suitable PV mode and inverter are selected. It is founded that 2000 PV panels of 250W solar panel and 10 grid tie inverter of 50kW are the optimal solution for supplying the load of MMMUT throughout the year. From the proposed system 901.44MWh electricity will be generated in a year and it will be available to the grid. Performance ratio of the system is about 83.1%.

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