TO STUDY AND ANALYSIS OF 21 KW SOLAR PHOTOVOLTAIC POWER PLANT INSTALLED IN ADHISH INDUSTRIES GOVINDPURA, BHOPAL (M.P.)

Neha Nidhi, Santosh S Negi

Neha Nidhi Student, Power Electronics, R.K.D.F. Institute of Science & Technology, Bhopal, India

Santosh S Negi Assistant Professor, Electrical & Electronics Engineering, R.K.D.F. Institute of Science & Technology, Bhopal, India

ABSTRACT

Solar energy is radiant light and heat from sun. Solar photovoltaic is a technology that converts sunlight into direct current by semiconductors using photovoltaic effect. Solar PV has wide applications in Industrial, social, commercial and residential sectors. Global growth of Solar PV has set an exponential growth between 1992 to 2019. The top installers are China, US and India. There are more than 24 countries around the world with a cumulative capacity of more than one Giga watt. India has huge potentials of harnessing the solar energy with 300 clear sunny days and annual temperature in the range of 25 to 27.5^{o}C. In central India also scope for solar PV generations are high with solar potential of about 5.5 kWh/m^{2}/day. A study relating the estimation of power generation before installation and its validation with actual generation is necessary to make this technology widespread. In this thesis, we have evaluated the performance of a 21kW solar photovoltaic power plant installed at the roof of Adhish industries situated at JK road, Govindpura Industrial area, Bhopal, (M.P.) by monitoring its actual monthly generation data and comparing it with the simulation results of predicted generation of two software BlueSol PV and Helioscope. The results obtained in all the cases indicated that the simulation results of both the software programs are not hypothetical. They have a close resemblance with the actual generation data of the site obtained after recording the generation units from inverter or generation meter.

Keyword : -

EV	*Electric Vehicles*
PHEV	*Plug In Hybrid Electric Vehicles*
BEV	*Battery Electric Vehicles*
PFC	*Power Factor Converter*
FBC	*Fly Back Converter*
BL	*Bridgeless*
FLC	*Fuzzy Logic Controller*

PI	*Proportional Controller*
PWM	*Pulse-Width Modulation*

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INTRODUCTION

1.1 ENERGY TECHNOLOGY

Energy is a quantitative property that enables a physical system to perform work or to transfer heat. Energy is a conserved quantity as LAW OF CONSERVATION OF ENERGY states that "Energy can neither be created nor be destroyed it can only be changed from one form to another" .Energy is available in universe in various forms for desirable use of energy it needs to be converted from one form to another

Energy Technology is a scientific method of extraction, conversion, storage and usage of available energy in most efficient, safe and economical way such that it causes negligible effect to environment.

1.2 SOURCES OF ENERGY

1.2.1 Renewable Energy Sources

Renewable energy sources are those which are virtually inexhaustible and they can be replenished again and again, these sources include solar, wind, water, geothermal, tidal , biomass e.t.c .

1.2.2 Non Renewable sources

These are the energy sources which are exhaustible and cannot be replenished after use. These are developed over a long period due to physical, chemical and biological actions below earth surface. These include fossil fuels such as coal , oil and natural gas.

1.3 SOLAR ENERGY

Solar energy is radiant light and heat from sun, more specifically the sun's energy that reaches the surface of earth. Sun has greatest potential of all non conventional energy sources .if we can use only 5 percent of the total solar radiation ,it can fulfill total world's energy requirement for 50 times .As sun is expected to provide this energy at constant rate for billions of year it is considered inexhaustible. Solar energy originates in sun as a result of thermonuclear fusion reaction. Sun can be considered as a large sphere containing helium gas which is continuously producing hydrogen through fusion reaction and liberating a large amount of heat energy. This energy is radiated by sun in the form of electromagnetic radiation of which 99 percent have their wavelengths in the range of 0.2 to 0.4 μm. The mean diameter of sun is 1.39×10^6 km while that of earth is 1.27×10^4 km .The mean distance between the two is 1.5×10^8 km. Although the sun is large it subtends an angle of only 32 minutes at earth's surface, this is because it also at a very large distance, thus beam radiation received from sun on earth is almost parallel. Solar power reaching the top of atmosphere is about 10^{17} watts and that on earth's surface is 10^{16} watts, while total power requirement of the world is 10^{13} watts .So if we can use only 5 percent of this energy , it will be 50 times more than our requirement. Solar energy received in form of radiation can be converted directly or indirectly in other forms of energy such as heat and electricity.

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter different literatures focusing on the performance evaluation, performance prediction, performance analysis, performance comparison, experimental validation, modeling, numerical and computer aided simulation of Photovoltaic power plants of different capacities located at different parts of country as well as various locations in the world will be studied. which must be performed to make solar PV more accessible and reliable to the users of Central India. The aim is to recognize the parameters which are needed to be evaluated for designing a Solar photovoltaic power plant and the effects of various parameters on its performance. As well as to know

about various methods, techniques, process and software which are used in various locations to predict the performance and to get an idea about the new work.

2.2 LITERATURE SURVEY

Mavuto H. Banda, Karidewa Nyeinga, Denis Okello[1] (2019)

In this paper Performance evaluation of 830 kwp grid connected photovoltaic power plant at kamuzu International airport in Malawi is done on monthly and annual basis. The PV array comprises 3540 solar modules of hetero junction with intrinsic thin layer (HIT) technology rating of each module 235 w and tilted at 30 degree .the four year average annual efficiencies are:
Array efficiency-15.3, Inverter efficiency- 95.2 and Overall efficiency-14.6 percent. Comparison of performance parameters which are obtained from monitored data are done with with simulated data considering same parameters are done using PV SYST software. The grid connected PV power plant operated nearer to predicted performance. The normalized mean bias errors, which in most cases are within $\pm$ 5 percent. This result clearly shows that simulation done are reliable and useful.

OBJECTIVE

3.1 PURPOSE OF RESEARCH

The main purpose of this work is to develop an appropriate reference framework for the viability of Solar Photovoltaic Power plant in Central India so that the local residents, businessman and industrialist of this area can have a proper and detailed knowledge of the solar PV installation techniques and various parameters which are needed to be considered for checking the viability of solar PV plant in their location and finding its performance probability before installations by having the knowledge of simulation software which can be used for performance evaluation and performance prediction as the installation of a solar power plant of even a small KW requires a huge amount of investments. By the help of this study the purpose is to increase the belief of the local residents living in the conditions of Central India towards the performance prediction techniques and software so that the capital investments in solar project installations in this area increases rapidly and thus contributing towards increasing the Energy security of the nation.

The main objective of this study are as follows:

- To study about Solar system and Solar Photovoltaic power plant.

- To perform experimental analysis of 21 KW Solar Photovoltaic Power plant installed in Adhish industries Govindpura , Bhopal.

- To perform software simulation using BlueSol PV and Helioscope software for 21 KW solar power plant installed in Adhish industries.

- To compare the experimental and simulated result and propose best solution for solar power plant installations.

APPROACH AND METHODOLOGY

4.1 APPROACH

Theoretical, practical, observational and simulation research work has been conducted to develop a reference model for identifying the feasible system for appropriate forecasting of performance of a solar photovoltaic power plant irrespective of its indicative performance parameters, the following work has been done:

1. The conclusions drawn from the theoretical research work have provided a basis for identification of

parameters which are important for performance evaluation and their impact on final results are studied in detail.

2. A site for performing the research work is identified and its performance outputs for a year are recorded on monthly basis, which includes;

- Detailed study of plant site is performed and complete information about various equipments, instruments, devices, panels, generators and other mountings installed on the site including their configuration, specification, model, brand, sizing, layouts, arrangements, orientation and various environmental and climatic aspects of the sites is recorded,.

- The simulation of available data for prediction of plant performance is performed on two software.

- The data of various performance indicators and environmental parameter are recorded on monthly basis for a year.

- Comparison of simulated data is done with site monitored data.

SOLAR SITE SETUP & INSTALLATIONS

5.1 INTRODUCTION

A Solar Photovoltaic Power plant located at Bhopal (M.P.) with nominal power of approximately 21 kW is connected to electrical distribution grid in medium voltage three phase in alternating current of type tri A 440 V under the responsibility of grid operator.
The characteristics of the system are summarized below, the photovoltaic system consist of:

- 4 strings of 16 modules connected in series
- The group of conversions formed by one inverter three-phase
- The group of interface
- The systems of conversions of energy

Installation site details	
Location	11, JK Road, Apsara complex, Sector A, Govindpura, Bhopal, Madhya Pradesh, 462022
Latitude	23.27^0
Longitude	77.46^o
Altitude	40 feet
Maximum temperature	37.97^o
Minimum temperature	13.25^o
Global irradiation on a horizontal plane	$5.08 kWh/m^2$
Albedo	20%

RESULTS AND DISCUSSIONS

In this chapter the results obtained by the theoretical, practical and simulation research work done on two different power prediction software and the solar power plant site are presented and comparisons between these three results are conducted to obtain the desired thesis objectives . The plant performance is first evaluated by using a software called BlueSol PV by providing all the input parameters and then the performance is evaluated by using another software program called Helioscope which demands all the input parameters for providing the results. Then the actual or practical monthly generation of the plant is noted by inverter output of the site.
These three results are then compared with each other and the variation obtained are presented

6.1 Simulation results of BlueSol PV software

As the plant will be installed in central India when we start the designing of the power plant in the BlueSol PV software firstly we will choose our site location in the software by using Google map.When we select the geographical location of the site all the related geographical parameters of the site such as Latitude Longitude temperature etc.

6.1.1 Geographical results of the Site

The table below shows the geographic data of the site obtained from the software

6.1.1 Geographic data of site	
Location	11,JK Rd Apsara Complex, Sector A, Govindpura , Bhopal , Madhya Pradesh 462022
Latitude	23.27^{o}
Longitude	77.46^{o}
Altitude	40 feet
Maximum Temperature	37.97^{o}C
Minimum Temperature	13.25^{o}C

6.1.2 Table representing daily irradiation on a horizontal surface obtained according to source NASA SSE

Month	**Diffuse daily [kWh/m^2]**	**Direct daily [kWh/m^2]**	**Global daily [kWh/m^2]**
January	1.02	3.48	4.50
Febuary	1.24	4.01	5.25
March	1.53	4.54	6.07
April	1.86	4.73	6.59
May	2.17	4.35	6.52
June	2.46	3.00	5.46
July	2.39	1.72	4.11
August	2.23	1.47	3.70
September	1.99	2.78	4.77
October	1.45	3.70	5.15
November	1.08	3.56	4.64
December	0.97	3.23	4.20
Yearly	**1.70**	**3.38**	**5.08**

CONCLUSION & RECOMMENDATIONS

7,1 Conclusions

Solar energy is radiant light and heat from sun. Solar photovoltaic is a technology that converts sunlight into direct current by semiconductors using photovoltaic effect. Solar PV has wide applications in Industrial, social, commercial and residential sectors. Global growth of Solar PV has set an exponential growth between 1992 to 2019. The top installers are China, US and India. There are more than 24 countries around the world with a cumulative capacity of more than one Giga watt. India has huge potentials of harnessing the solar energy with 300 clear sunny days and annual temperature in the range of 25 to 27.5^{o}C. In central India also scope for solar PV generations are high with solar potential of about 5.5 kWh/m^{2}/day.

A study relating the estimation of power generation before installation and its validation with actual generation is necessary to make this technology widespread. In this thesis, we have evaluated the performance of a 21kW solar photovoltaic power plant installed at the roof of Adhish industries situated at JK road, Govindpura Industrial area, Bhopal, (M.P.) by monitoring its actual monthly generation data and comparing it with the simulation results of predicted generation of two software BlueSol PV and Helioscope. The results obtained in all the cases indicated that the simulation results of both the software programs are not hypothetical. They have a close resemblance with the actual generation data of the site obtained after recording the generation units from inverter or generation meter.

Following conclusions can be drawn from the thesis work we have performed:

- The energy generation varies monthly according to temperature, climate and weather conditions.
- The predicted generation data of two software programs BlueSol PV and Helioscope have a close resemblance with the actual generation data of the site and are not completely hypothetical.
- The monthly variations in the actual generation of energy with prediction results of BlueSol PV are in the range of 10% to 25% with an annual variation of about 17.82%.
- The monthly variations in the actual generations of energy with the predicted results of Helioscope software program are in the range of 0 to 10% for most part of the year except in the month of July and August with variations of 16.78% and 23.54% respectively probably due to uncertain raining patterns in concerned year with an annual variation of about 5.43%.
- The variations in predictions results of both the software programs is in the range of 0 to 25% with most variations in the months of winter season which are November, December and January with variations of about 24.56%, 24.24% and 24.3% respectively with an annual average of about 13.1%.
- The generation data predicted by the simulation results of Helioscope software program is more identical and relevant for the climatic conditions of central India.

Thus the performance of this plant is satisfactory with about 80-95% of the actual power generation with respect to predicted performance of two software programs BlueSol PV and Helioscope.

SCOPE FOR FUTURE WORK

In this study we have selected a site in central India where a 21 kW solar power plant is installed and connected to grid system. We have conducted a design operation in two different softwares named BlueSol PV and Helioscope and they predicted the energy generation values for this site on monthly basis and then we recorded the actual or practical values from this site . A comparison of results produced by both the software is performed and the results are stated

As this study can provide frame work for the users to install solar powerplants in central India but there are many other works which can be performed to make this study more detailed, promising and diversified for the users . There are many scope for further studies in this topic by using different conditions, resources and methods.

Some of the works which can be done in future are as follows:

- The software programs used in this study are BlueSol PV and Helioscope . There are many other softwares available so the studies of this site by simulation with other softwares can be performed to give broad overview of different softwares .
- This study is performed at a site which is at a roof of a industry at about 40 feet above the ground, a study on the plant which is installed on the ground surface can also be performed to know about the variations in both the cases.
- This study focuses mainly on the variations in generation of energy in practical and simulated conditions by

using the BlueSol PV and Helioscope software programs , a different study about various loses incurred in power generation can also be performed as these losses can be obtained practically by calculating the loss in energy transmission from one point to another and simulation softwares also provide the data for these losses.

- This study is performed at a location in central India by using two different software programs, a study for the performance analysis can be performed for two different location by using a single software to check the variations in result of the software with the change in location.
- There are negligible shading loses in this site as this site is at very high position above the ground , so a study of the site having shadings of trees , buildings etc can also be performed to know about the accuracy of softwares prediction in case of considerable amount of shading in the plant site.
- This study is performed on grid connected solar power site , a study on the offgrid solar power site can also be performed to check the variations in both the cases.
- This study is performed on a plant site in which solar panels follow fixed tilt raking system, a study on the plant which follows single axis or dual axis tracker system can also be performed to check the viability and suitability of the softwares for these types of power plants .
- As the orientations and placements of solar panels and string combinations can be selected by the designers so expected power generations in different orientations can be evaluated by a study and an appropriate installation configuration can be developed.
- As the simulation results obtained in winter season (November, December , January , February) by both the software programs have a huge difference , so a study regarding simulation results of the software's , according to different seasonal and climatic conditions can also be performed .
- As the BueSol PV software provides a detailed report on economic parameters , electrical device as well as cables of the systems so a study on the cost for installations and operations of a project and its economic viability can be evaluated
- A study of savings of economy in using both the software's can also be performed and compared for better solutions.

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