Performance Analysis of 5MW Solar PV Grid Connected Power Plant at Shivanasamudram using PV Watts and PV System

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***Abstract*— Solar energy in one form or other is the source of nearly all energy on the earth. Humans, like all other animals and plants, rely on the sun for warmth and food. People also harness the sun's energy in many other different ways. Photovoltaic is a simple and elegant method of harnessing the sun's energy. PV devices are unique in that they directly convert the incident solar radiation into electricity, with no noise, pollution or moving parts, making them robust, reliable and long lasting.The depletion of fossil fuel resource on the world wide based as necessitated and urgent search for alternative energy source to meet up the present day demands. Solar energy being a clean, inexhaustible and environment friendly potential resource among all renewable energy options. But in the demands the combinations of solar and environmental conversion units are now being implemented as grid connected energy system.**

The favorable climate conditions of the place called Belakavadi of Mandya district in the state of Karnataka and the recent legislation for utilization of renewable energy sources provide a substantial incentive for installation of photovoltaic power plants. In this paper, the grid connected solar photovoltaic power plant established by Karnataka Power Corporation Limited, is presented, and its performance is evaluated. The photovoltaic power plant has a solar radiation of 5.26 kWh/sq.mt/day spread over 25 Acres of land. Operating module temperature varies from 15 to 40 degree centigrade, with a tilt angle of module 15 degree and guaranteed energy generated is 8.3224MU/Annum with 19% CUF. The plant has been in operation since 2012. The power plant is suitably monitored during 7 Months, and the performance ratio and the various power losses (temperature, soiling, internal, network, power electronics, grid availability and interconnection) are calculated. The final yield (YF) ranged from 1.96 to 5.07 h/d, and the performance ratio (PR) ranged from 62to 80%, giving an annual PR of 77.36%.

Keywords- solar energy; grid connected; SPV system; photovoltaic; solar radiation;

I. INTRODUCTION

Photovoltaic is the field of technology and research related to the devices which directly convert sunlight into electricity. The solar cell is the elementary building block of the photovoltaic technology. Solar cells are made of semiconductor materials, such as silicon. One of the properties of semiconductors that makes them most useful is that their conductivity may easily be modified by introducing impurities into their crystal lattice.

Photovoltaic's offer consumers the ability to generate electricity in a clean, quiet and reliable way. Photovoltaic systems are comprised of photovoltaic cells, devices that convert light energy directly into electricity. It is anticipated that photovoltaic systems will experience an enormous increase in the decades to come. However, a successful integration of solar energy technologies into the existing energy structure depends also on a detailed knowledge of the solar resource. But to note it is essential to state the amount of literature on solar energy, the solar energy system and PV grid connected system is enormous. Grid interconnection of photovoltaic (PV) power generation system has the advantage of more effective utilization of generated power. However, the technical requirements from both the utility power system grid side and the PV system side need to be satisfied to ensure the safety of the PV installer and the reliability of the utility grid.

1. PV System Types and Their Components

PV systems can be divided into two categories: Grid-connected PV Systems and Stand-alone PV Systems. Grid-connected PV Systems can further be separated into two categories: those that are Directly Connected to the utility and those that are classified as Bimodal PV Systems. Systems that are Directly Connected to the Utility are without a storage system, and systems that are classified as Bimodal PV Systems do have storage systems as shown in figure 1. Stand-alone PV Systems can be divided into three categories: Without Battery, With Battery, and Hybrid PV Systems. Without Battery systems are Direct-Coupled systems, and With Battery systems may include Self-Regulating DC Systems or AC Systems with a charge controller for the battery and load. Hybrid PV Systems may include systems with wind turbines, with hydro turbines, with diesel generators, or with fuel cells or other sources.

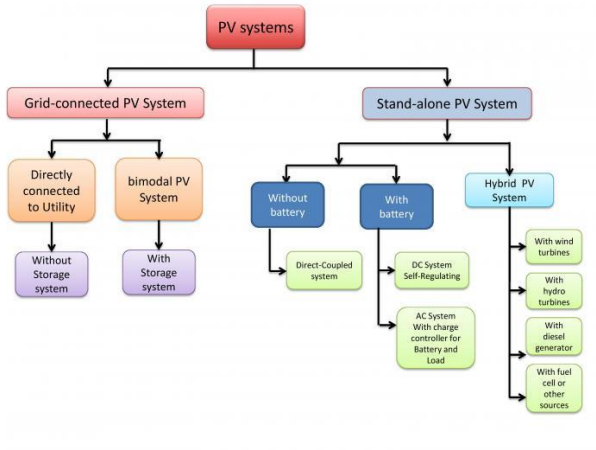


Fig. 2 PV system types.

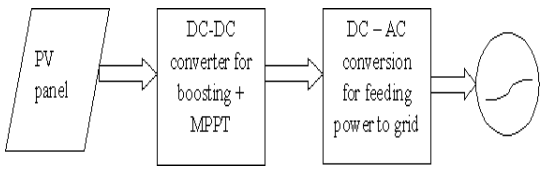
2. *Grid connected PV system*

An electrical grid is an interconnected network for delivering electricity from suppliers to consumers. It consists of generating stations that produce electrical power, high-voltage transmission lines that carry power from distant sources to demand centres, and distribution lines that connect individual customers are power systems energized by photovoltaic panels which are connected to the utility grid. Grid-connected photovoltaic power systems consist of Photovoltaic panels, MPPT, solar inverters, power conditioning units and grid connection equipment as shown in figure 2. Unlike Stand- alone photovoltaic power systems, these systems seldom have batteries. When conditions are right, the grid-connected PV system supplies the excess power, beyond consumption by the connected load to the utility grid. However, the technical requirements from both the utility power system grid side and the PV system side need to be satisfied to ensure the safety of the PV installer and the reliability of the utility grid.

Fig. 2 Schematic diagram of grid connected solar PV system

II. OBJECTIVES

The main objectives of this work is to estimate the performance and evolution of grid connected to 5MW solar PV PLANT using PVWATT and PVSYST software in shivanasamudra mandya district of Karnataka. Performance ratio of 5MW solar plant, rating of plant for 25 sq meters of area, annual energy generation from 5MW grid connected SPV system, some theoretical causes for the losses and suggest. some methods which can reduce the losses and improves the overall efficiency of the plant.



III. SITE AND TECHNICAL DETAILS

The proposed site is located at Belakavadi village in Shivansamudram project in Malavalli taluk of Mandya district (Survey No's 369,370 and 371).

Latitude 12.3^0 and Longitude 77.16^0

Fig. 3 **:** 5MW Solar Plant Location

25 acres of land is identified and is taken to possession of KPCL in survey nos. 369,370 and 371 at a distance of at a distance of 20 Kms from Malavalli taluk. No wild life and no archaeological monument exist at the proposed site.

The site is well connected by rail and road. Mandya is located on Bangalore Mysore highway and nearest airport is located near Bangalore.

TABLE – 1 **:** Technical Details Of PV Module at Shivanasamudram plant.

Sl. no	DESCRIPTION	DETAILS
1	Type of SPV module	Poly crystalline
2	PV module power output	Min 285 Watts 36V
3	Total no. of module used	35840
4	No. of Module per MW	3584
5	Array rating	259.5 KW
6	Details of series/parallel combination	20 Nos. in series 1792 parallel string
7	Tilt angle	13^0
8	Temperature	Min $15\ ^0$C Max $40\ ^0$C

IV. METHODOLOGY

A. *PVSyst Software*

PVSyst contains parameters that can be customized based on the solar module to be modeled. In this paper, we will provide details on how to alter specific parameters to deliver an accurate representation of output from sun Edison silvantis modules. Simulation input files can be created from

measurements of production modules under various conditions of temperature and irradiance. While some manufactures create their own files. These labs measure randomly selected production modules, and then create PAN files using regression analysis techniques.

B. PVwatts calculator

NREl's PVWatts calculates the energy production of grid connected PV energy systems. This service estimates the performance of hypothetical residential and small commercial PV installations. PVWatts version 5 is more updated to the algorithm that were used in previous versions of the PVWatt web services. Compared with PVWatts version 4,the new update will predict roughly7-9% greater energy output for a fixed tilt system given similar assumptions.

PVWatts calculator provides also estimated monthly and annual irradiation and energy production in kilowatts and energy values. users can select a location and choose to use default values or their own system parameters for size, electric cost, array type, tilt angle and azimuth angle. In hourly performance data for the selected location

V. PERFORMANCE EVALUATION

Performance evaluation of Grid Connected Solar PV Plant is based on the parameters namely;

1. Air temperature (°C),
2. Relative humidity (%),
3. Daily solar radiation – horizontal (kWh/m²/d) ,
4. Atmospheric pressure (k Pa),
5. Wind speed(m/s), Earth temperature (^{0}C)

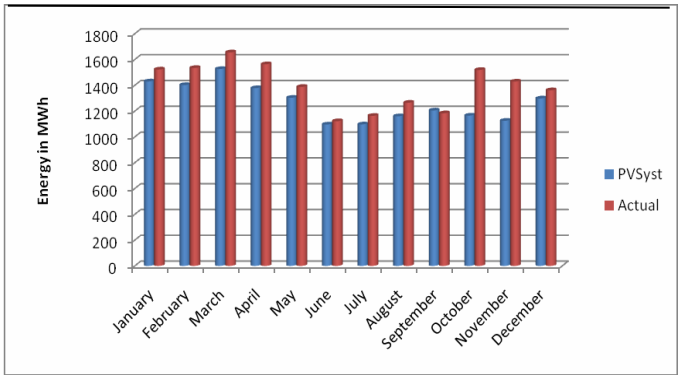


Chart -1: Comparison of PVSyst and actual energy (DC) generation Month wise during year 2018

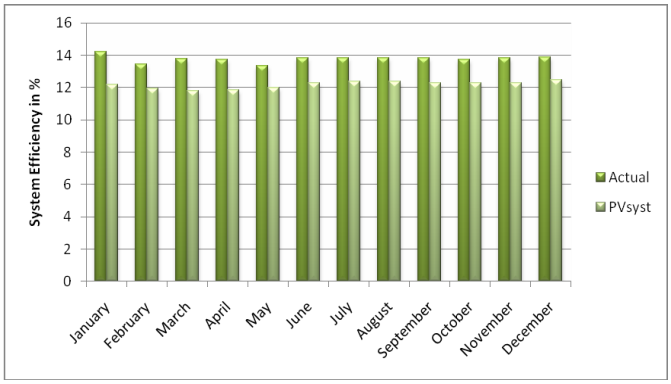


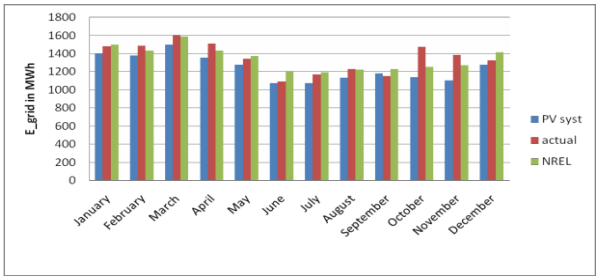
Chart -2: Comparison of PVSyst, PVWatts.

calculator and actual energy (AC) generation month wise during year 2018

Table-2 : Monthly output energy during year 2016 and also PVSyst and NREL software monthly average energy output

Months	PVSyst Energy (DC) MWh	Measured Energy (DC) MWh	PVSyst Energy (AC) MWh	NREL Energ(AC)d MWh	Measured Energy (AC) MWh
January	1430	1522.570	1407	1,499	1483.92
February	1402	1534.22	1380	1,436	1489.743
March	1526	1655.36	1503	1,592	1602.728
April	1378	1563.15	1356	1,432	1513.477
May	1303	1387.62	1281	1,374	1347.14
June	1096	1121.92	1077	1,204	1093.966
July	1097	1162.94	1077	1,195	1,173
August	1160	1264.717	1139	1,226	1233.227
September	1205	1183.193	1185	1,235	1153.257
October	1165	1518.9	1145	1,253	1477.769
November	1125	1428.99	1106	1,274	1390.355
December	1298	1361.44	1277	1,415	1327.466

Chart -3; comparison of PVSyst and actual efficiency month



wise during year 2018

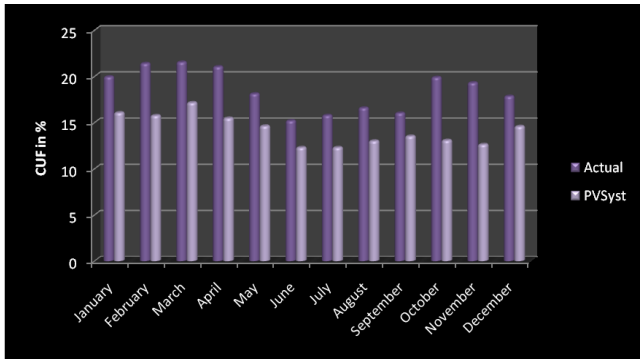


Chart -4; comparison of PVSyst and actual CUF month wise during year 2018

VI. CONCLUSION

Energy generation of 34460 to 53400 KWhr per day at average of 44600 KWhr whole the year is observed

which adversely affect the growth of the country because of the following reasons

During sunny days where the hydro fails and the fossil fuels are gaining the price solar PV plant benefits the human kind with electricity during almost all the seasons in India.

By International standards in generation of 1KWhr of energy the amount of coal used is 1kg and wasted water is 3.3 litres. Whereas in this plant we are generating 44600 KWhr of energy per day hence 44.6 tonnes of coal is being saved and 147 metric tonnes of water every day.

And also in Conventional way of generation i.e. coal generation plants 1kWhr generation produces 1kg of co_2 and 1kg of other GHG .this plant is helping in reducing 44 tonnes of co_2 and same amount of GHG everyday these dangerous gasses into the environment.

Payback period for solar power plant will be below 15 years while it has capacity to generate for 25 years hence for the rest of 10 years energy can be used free of cost. I.e. revenue. Every country should have abundant, affordable and reliable energy. During the past few years, renewable energy sources have received greater attention and considerable inputs have been given to develop efficient energy conversion and utilization techniques. Energy Conservation is the Best Reservation for the Future Generation. Today's clean environment is tomorrow's safe environment and today's world is yesterday's creation, tomorrow's world will be today's conservation. It is the responsibility of the society to conserve energy, energy resources and protect the environment and SAVE THE MOTHER LAND.

VII. RESULTS

It's clear that the PVSyst shows the smaller energy output when compared with Actual generation. Whereas grid side output NREL shows more accurate values compared with the PVSyst software. Actual Irradiation values are more nearer to PVSYs software hence it is more accurate than the NREL software and measured temperature is greater than the PVSyst output temperature.

Efficiency of the system remains almost same during all the months. And PVSyst efficiency is lesser when compared with the actual SCADA output.

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