International Journal of Scientific Research & Engineering Trends
Volume 5, Issue5, Sep-Oct-2019, ISSN (Online): 2395-566X

Grid Tied One Megawatt Solar Photovoltaic Power Plant at Bhopal: A Study on Performance Analysis Including Efficiency Calculation

Research Scholar Lalit Kumar Goel
School of Energy and Environment Management, Bhopal, India.

Prof. (Dr) Mukesh Pandey
Head of the Department, School of Energy and Environment Management, Bhopal, India.

Assistant Prof. Dr Anurag Gour
School of Energy and Environment Management, Bhopal, India.

Abstract **- The growing energy demand in developing nations has triggered the issue of energy security. This has made essential to utilize untapped potential of renewable resources. India is focusing on development of its own sources of energy. For PV panels, the efficiency of converting solar energy to electricity is around 7%.Average solar radiation incident over India varies from 4kWh/day – 7 kWh/day. Grid connected PV systems have become the best alternatives in renewable energy at large scale. Performance analysis of these grid connected plants could help in designing, operating and maintenance of new grid connected systems. A 1MW photovoltaic grid connected plant commissioned at Bhopal is one of the commercial solar power plants with the site receiving a good solar radiation of 5.61 kWh/m2/day and annual temperature of about 31.2 oC . The plant is designed to operate with a fixed tilt. In this study the solar PV plant aspects along with its annual performance is elaborated.**

Keywords **- renewable, solar radiation, grid, tilt, power, module.**

I. INTRODUCTION

Power sector is a critical infrastructure element for the growth of an economy. The availability of a reliable, quality and affordable power is vital for the rapid growth in agriculture, industry and for overall economic development of a state. Madhya Pradesh is among the fastest growing states in the country. The various initiatives by the state government with respect to the availability of the power for 24x7 has given a new boost to the unconventional sources of power especially, harnessing the solar power through solar power generation plants across the state. This has led to rapid economic development of the state in primary, secondary and tertiary sectors resulting in inclusive development of the state.

PV technology had proven to be valuable type of renewable energy resources due to its zero emission, noise and reliability for the locations. Though high level of radiance due to closeness with the equator impacts negatively on the PV panels, the high intensity of the region's solar radiation on the daily basis makes solar energy economically feasible. A high cell temperature will cause voltage drop across PV cell. This will reduce the overall system performance. With the increase of 10oC causes decrease panel efficiency of about 5%.

II. DESCRIPTION OF PLANT

Latitude	23.28^{o}
Longitude	77.35^{o}
Altitude	527m(1729 ft)
Annual Rainfall	1050mm
Temperature	$10^{o} – 44^{o}$

The 1 MWp grid connected solar PV system was established in Gandhi agar, Bhopal, and a central city of the country at Madhya Pradesh. The plant was commissioned on 05 Dec 2017; this site is aligned in south-north direction. The model mounting structure (MMS) is 28o tilt angle towards North South. The PV models used Poly Crystalline type models and rating of each panel is 310 Wp. This system consists of 20 modules connected in series forming one string. So, 195 strings are connected with up to 15 strings per string connecting box (SCB) and such thirteen numbers of SCB's are connected to inverter but SCB no 12 and 13 has 14 and 16 strings respectively ,

i.e. total 3900 numbers of models are used whose output is DC and fed to one inverter. The inverter used here is air cooled, anti-islanding, IGBT type with MPPT (Maximum power point tracker) technology with average efficiency of 98.6% for extracting maximum available power from PV models. The inverter capacity used is 1000 KW.The transformer rating is 1250KVA and voltage 33000 V. The grid frequency is 49.97 Hz.

There are 3,900 panel of the size 1.955m x 0.982mm.Total array area is 7487m2.

III. PERFORMANCE ANALYSIS

Energy produced from renewable energy sources like solar energy is getting popular as the energy produced is green energy and there are no greenhouse gas emissions. At the same time the energy produced from a raw material is free. The operating and maintenance costs for PV panels are negotiable, compared to the costs of other renewable energy systems. There is a high possibility of obtaining benefits from on-grid solar systems when the consumption is less so that surplus electricity can be sold to the local electricity supply. It is clear that the Grid connected solar PV system can provide some relief towards future energy demands. The results showed promise for solar development in the country.

The main objective of this is to describe the standard performance indices of PV power plants. These performance indices are used for the analytical assessment of performance analysis of the PV power plants in the electricity grid. In the grid operational problems and reliable electric power services, these indices are playing an important role. The performance indices are described in IEC 61724 standard for the performance analysis of grid connected solar PV plant. These parameters are as under:

S No.	Parameters	Notation
(a)	Plant Energy Output	E_{ac}
(b)	Array Yield	Y_a
(c)	Final Yield	Y_f
(d)	Performance Ratio	PR
(e)	Capacity Utilization Factor	CUF

The power generated by the solar inverter on the monthly basis and its daily average is as under:

Month	Monthly Output(kWh)	Daily Output(kWh)
Jul 2018	84,201	112.505
Aug 2018	80,009	107.103
Sep 2018	1,28,304	174.053
Oct 2018	1,78,303	241.413
Nov 2018	1,60,801	220.009
Dec 2018	1,54,105	201.945
Jan 2019	1,55,404	213.714
Feb 2019	1,51,309	232.472
Mar 2019	1,90,207	252.150
Apr 2019	1,71,908	257.398
May 2019	1,42,300	234.202
Jun 2019	1,03,203	200.852

IV. DATA CALCULATION FOR PERFORMANCE AND EFFICIENCY

Average Global Horizontal Irradiance is as under:

Annual Average : 5.66 kWh/m^2/day		**Irradiance per month (kWh/m^2/month)**
Daily Average in a Month (kWh/m^2/day)		
Jul	4.84	150.04
Aug	**4.36**	135.16
Sep	5.46	163.80
Oct	5.86	181.66
Nov	5.02	150.60
Dec	4.51	139.81
Jan	4.72	146.32
Feb	5.70	159.60
Mar	6.66	206.46
Apr	7.27	218.10
May	**7.51**	232.81
Jun	6.12	183.60

V. GRAPHS AND CHARTS

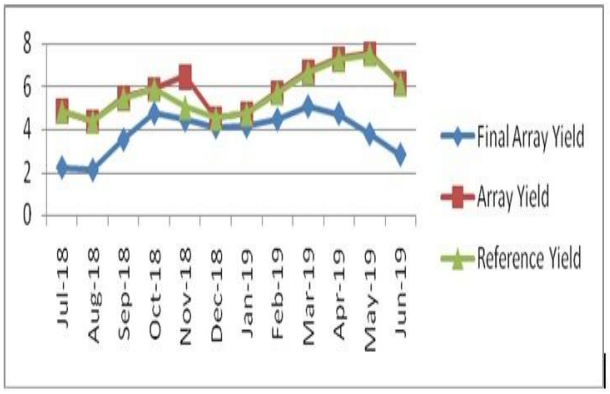

Fig.1.Graphical Representation of the Yields of the PV Power Plant.

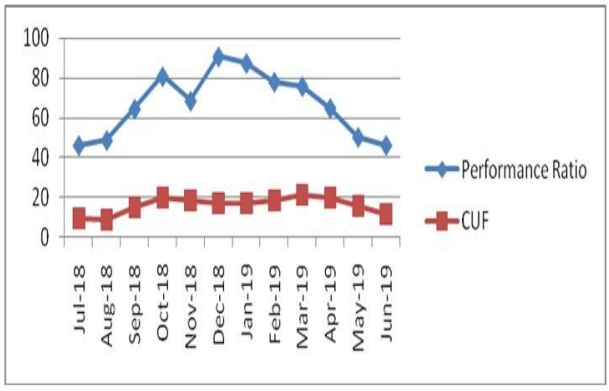

Fig.2. Graphical Representation of the Performance Ratio and CUF.

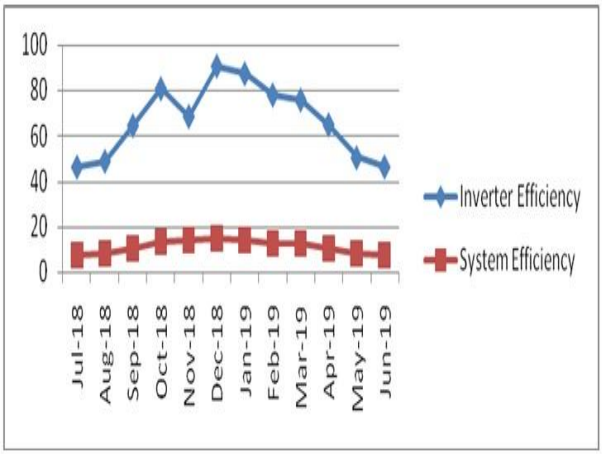

Fig.3. Graphical Representation of Efficiencies.

VI. RESULTS AND DISCUSSION

- Maximum Average Global Horizontal Irradiance is in the month of May of 7.51 kWh/m2/day. Minimum Average Global Horizontal Irradiance is in the month of Aug of 4.36 kWh/m2/day.
- Maximum AC output is in the month of Mar with 1,90,207 kWh.Minimum AC output is in the month of Aug with 80,009 kWh.Maximum performance Ratio achieved is 90.87% in the month of Dec.Minimum Performance Ratio has been is 46.26% in the month of Jul.
- Maximum Array Yield achieved is 7.53 in the month of May. Minimum Array Yield is 4.37 in the month of Aug.Maximum Final Array Yield has been 5.07 in the month of Mar. Minimum Final Array Yield has been 2.13 in the month of Aug.
- Maximum Reference Array Yield is 7.51 in month of May and minimum is 4.36 in month of Aug. Maximum CUF obtained is 21.14% in the month of Mar and minimum has been 8.89% in the month of Aug.Maximum Inverter Efficiency is 90.87% in Dec and minimum being 46.26% in Jul. In the duration of 12 months of study the System Efficiency is 10.98%.

VII. CONCLUSION

A detailed performance analysis based on monitored data and operating experience PV system is required for large scale integration of grid PV system in coming times. The performance of the PV solar plant can be analyzed by the polycrystalline PV panels, performance ratio and other parameters like solar insolation, wind velocity and ambient temperature of the plant. The CUF depends on several factors including the solar radiation, temperature, air velocity apart from the module type and quality, angle of tilt, design parameters to avoid cable losses which can be reduced through proper designing but not completely avoided.

REFERENCES

[1]. Policy for implementation of solar power based projects in Madhya Pradesh 2012.
[2]. Mission document of Government of India as Jawaharlal Nehru National solar mission.
[3]. A portal of Madhya Pradesh electricity regulatory commission.
[4]. www.mnre.gov.in/schemes/decentralised systems/solar systems, Feb 2014.
[5]. www.mnre.gov.in/grid solar demonstration performance, Aug 2013.
[6]. www.wikipedia.com
[7]. Energy report on Performance evaluation of 100MW grid connected solar PV power plant in India by Mr B Shiva Kumar et al, Dec 2015.