Design and Performance Analysis of 120 KW Grid Connected Rooftop Solar PV System at Suresh Gyan Vihar University, Jaipur: A Case Study

[*]Jitendra Singh Hada, [#]Hari Kumar Singh

Center of excellence renewable and sustainable energy studies, SGVU, Jaipur, India.

[*]1992jitendra@gmail.com, [#]harisingh027@gmail.com

Abstract – Most of the Public and Private technical universities in India have considerably large free roof area which could be a better place for equipping the renewable energy. The main objective of this paper is to analysis the feasibility of installed solar PV plant of 120 KWp capacity at Suresh Gyan Vihar University, Jaipur.

In this paper to study the technical viability of the installed crystalline technology based PV plant, Fixed Mounting Structure and grid connected inverters. The technical, economic, and environmental aspects of the installed plant are analyze by the generation, radiation and standard data and parameters.

The installed plant of 120 KWp can generate around 170 MWh of electricity per annum with a GHG emission reduction of 139 tco_2 per annum.

Key words – Crystalline, Fixed mounting structure, GHG Emission, Grid connected, PV Plant, Radiation.

I. INTRODUCTION

Energy is the essential and most all inclusive proportion of all sorts of work by person and nature. The level of advancement and human advancement of a nation is controlled by the measure of energy used by people. Electrical energy need is expanding step by step because of increment in populace and their institutionalization, urbanization and industrialization. As we probably aware of non-renewable energy source is the primary fuel for warm power, there is a dread that they will get depleted in the end in the following century. Accordingly other creating plant framework dependent on non-traditional and inexhaustible sources is being attempted by different nations from decades ago. These are sun oriented energy, wind energy, ocean, geothermal and biomass are perfect, limitless and condition inviting assets [1].

Solar energy has the greater capacity of the considerable number of sources of sustainable power source and if just a little measure of this type of energy could be utilized, it will be a standout amongst the most imperative supplies of energy particularly when other sources in nation have exhausted step by step. The sun gives us 1000 steady rate, because of mists, winds, fog, and so forth however there are restricted uses of this age sources in the electric power. Sun is accessible at day time just; henceforth we require the off-time additional energy stockpiling gadget to satisfy the need. In this paper, lattice associated solar power framework is presently being thought about [2].

Solar PV modules produce DC electricity. They may be used in single-module and multiple-module systems to meet the current or voltage requirements of a wide range of applications with its nominal power, it's well-suited to utility grid systems and traditional applications of photovoltaic such as Telecommunications, grid connect and standalone systems. Inverter does the function of converting DC energy produced by Solar modules to AC energy along with many other supporting operations required for proper functioning of solar power system & export power to Grid.

This case study highlights the details of installed plant, site facilities, features of the power plant, generated energy, radiation, safety aspects and cost estimation of the grid connected rooftop PV system.

II. SITE CHARACTERISTICS

The site selection for a Solar Power Plant is predominantly determined by solar insolation availability. This installed plant situated at the location of Suresh Gyan Vihar University, Jaipur, in Rajasthan state of India.[3] For designing solar PV plant geographical details and weather data of the site is required. Table 1 and Fig. 2 provides a monthly average radiation data for the Jaipur city which is located at 26.9260°N, 75.8235°E in Rajasthan state of India (Synergy Enviro Engineers). Fig. 1 provides the location of Jaipur city in Rajasthan and its global daily radiation data.

Table 1 Solar radiation data for Jaipur

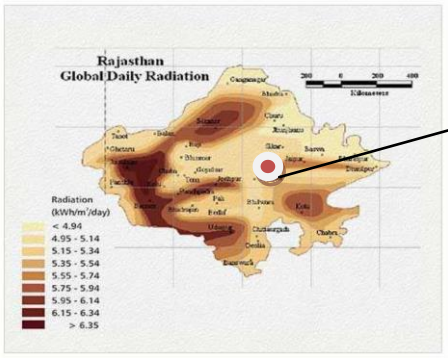
Month	Average (kWh/m^2)
Jan	4.19
Feb	5.00

 DOI : 10.18231/2454-9150.2019.0553

Mar	6.09
Apr	7.08
May	7.23
Jun	6.64
Jul	5.15
Aug	4.81

Sep	5.42
Oct	5.00
Nov	4.27
Dec	3.68

Annual Average 5.3 (kWh/m^2)



Jaipur City Location In Rajasthan with its Global Daily Radiation Values (5.30-5.74 kWh/m^2/day)

Fig 1 Global daily radiation in Rajasthan.

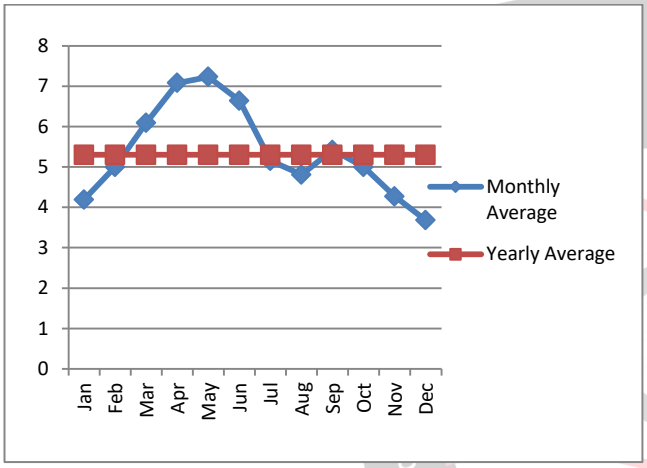


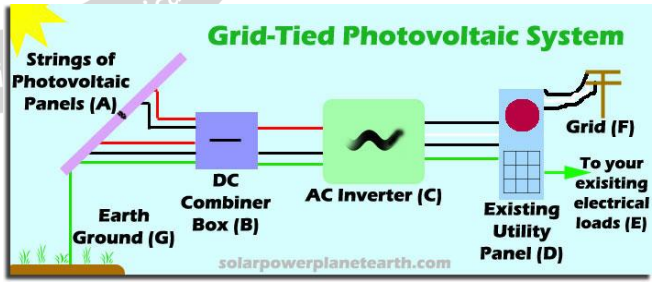
Fig. 2 Monthly solar radiations variations in Jaipur city

III. PROJECT SUMMARY

Project: - Design, Manufacture, Supply, Installation and commissioning of 120 KW Solar PV rooftop plant at Suresh Gyan Vihar University, Jaipur India.

1	Name of the company	GreenFirst Power Ventures Pvt. Ltd.
2	Installed Project location	Suresh Gyan Vihar University Jaipur
3	Power Plant Capacity	120 KW
4	Technology	Solar Photovoltaic
5	System Type	Grid Connected Solar PV
6	Type of module	Poly Crystalline
7	Type of Inverter	Grid Tie string inverter
8	Total inverter capacity	4 unit of 30 KW Each
9	Single panel output	300w

3.1 Block Diagram



3.2 List of Components

Sr. no.	Description	Qty.	unit
1	300 Wp Solar module (Alpex Solar)	400	Nos.
2	String Inverter 30 KW Each (SMA)	4	Nos.
3	PV Junction box	4	Nos.
4	Module Mounting Structure (GI)	120 KW	sets
5	DC Cable 4sqmm Cu (Siechem)	1200	Mtrs.

 DOI : 10.18231/2454-9150.2019.0553

6	AC Cable 4C 16 sqmm Cu (Polycab)	60	Mtrs.
7	AC Cable 4C 120 sqmm Al (Polycab)	100	Mtrs.
8	ACDB 200 Amp. (Onexis)	1	Nos.
9	Earthing Kit (Gel Chemical)	3	Sets
10	Lightning Arrestor	1	Sets
11	Solar – Net Meter (Secure LT)	1	Sets

IV. PERFORMANCE ANALYSIS

Performance Ratio (PR) of a solar PV plant for a period of month =Energy measured (kWh) per month / (Irradiance(kWh/m2) average * area of PV module (meter^2) * efficiency of one module)

Capacity Utilization Factor(CUF) =Energy measured (kWh) / (number of days x 24 x total capacity of the plant).

So on one side, PR is a measure for the performance of a PV system taking into account environmental factors (temperature, irradiation, etc.) and on the other side is CUF that completely ignores all these factors and also the de-rating or degradation of the panels [4].

Some other points that can also be important when comparing Performance Ratio vs. C.U.F: – PR will depend on the availability of the grid, CUF won't. – PR will depend on the minimum level of irradiation needed to produce electrical energy, CUF won't. – PR will depend on the radiation levels at a given period of time, CUF won't.

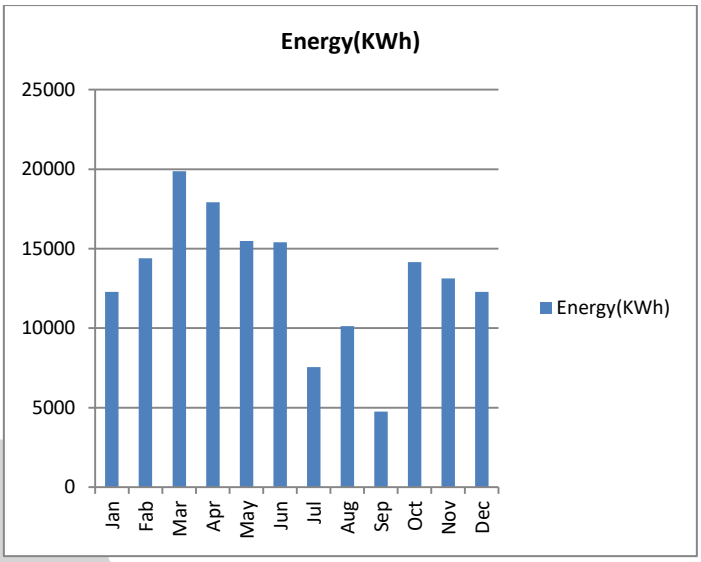
Performance Ratio can be used as a tool to compare different solar Photo Voltaic systems with each other – even if they are located at different places since all environmental factors will be taken into account. Hence only the design parameters and the efficiency of the system to convert solar photo voltaic energy into electrical energy will be compared with each other.

Therefore we are not convinced that the CUF is a good tool to provide performance of a solar Photo Voltaic system [5].

Performance figures of year 2017

Sr. No.	Month	Generated energy (KWh)	PR IN %	CUF
1	Jan	12280	65.72	0.1375
2	Feb	14400	80.35	0.1785
3	Mar	19880	82.26	0.2226
4	Apr	17920	65.91	0.2074
5	May	15480	53.95	0.1733
6	Jun	15400	60.39	0.1782
7	Jul	7560	36.99	0.846
8	Aug	10120	53.02	0.1133
9	Sep	4760	22.87	0.550
10	Oct	14160	71.37	0.1586
11	Nov	13120	80.01	0.1518
12	Dec	12276	84.06	0.1375

PERFORMANCE GRAPH



V. RESULT

This paper has attempted an performance analysis of a solar PV plant installed at Suresh Gyan Vihar University in Jaipur city.

- The 120 KWp System installed at library building
- In this plant 400 modules of 300Wp with an array containing 20 modules each
- In this study the CUF and PR for every month of year2017 have been calculated
- Maximum energy fed into the grid is observed in month of March while the minimum in month of September due to fault in AC cable.
- Tilt angle for modules in existing system is 25^O which is fixed. Efficiency can be improved by using seasonal change in tilt angle or by using single axis tracking system.
- The total energy generated by installed plant in year 2017 is 157356 kWh and reduced CO_2 emission around 126 tCO_2.

VI. CONCLUSION

Proper utilization of renewable energy sources is extremely necessary worldwide particularly within the developing countries like India. The Gyan Vihar University has taken the initiative for installation of 120 KWp rooftop grid connected solar plant in university campus under capital subsidy scheme of MNRE. This Plant generates around 170 MWh of energy every year but due to inverter and cable fault in month of July and September of year 2017 the energy reduced to 157 MWh for year 2017.

REFERENCES

[1] Hari Kumar Singh, D. Buddhi,``Experimental investigation on CaCl2.6H2O for sub cooling behavior

 DOI : 10.18231/2454-9150.2019.0553

and its correction for low temperature thermal energy storage,``IJAER Vol-13,Issue-11,PP 1-12, (2018).

[2] Indrajeet Kumar, Hari Kumar Singh, D. Buddhi,``Detailed Water Audit Report of Thermal Power Station,``CASS, Vol-02,Issue-02,PP: 1-21, (2018).

[3] Hari Kumar Singh, D. Buddhi,`` Experimental Investigations of PCM based thermal battery for temperature management of building in hot and dry climate of India ,``IJAER Vol-11,Issue-11,PP: 14-22, (2018).

[4] Navneet Kumar Sharma , Hari Singh ,Madan Kumar Sharma, B. L. Gupta, "Performance Analysis of Vapour Compression and Vapour Absorption Refrigeration Units Working on Photovoltaic Power Supply", IJRER, Volume 6 Issue 2, PP: 50 – 54, March (2016).

 DOI : 10.18231/2454-9150.2019.0553