Performance Assessment of A 100kW Solar Rooftop Photovoltaic System at NGF College, Haryana

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***Abstract*— Due to continuously increase in cost of fuel and various disadvantages like pollution of fuel based power plants; we find an alternative source of power generation which works on solar energy that is solar power plant. NGF engineering college setup there own roof top solar power plant. This is the first phase of solar power generation which include various advantages like no pollution and less maintenance etc. The 100 KW photovoltaic solar power plants becomes the source of income if the solar PV system is connected to a grid to supply power back under no load or low load conditions. In these types of cases the overall energy bill comes different from the known existing solar power plant. NGF engineering has decided to build the second phase of solar power plant with the capacity of 100kw such that the maximum lighting and fan loads can be obtained from solar power plant.**

Keywords*— *Solar PV , Grid Connected , Net metering ,Power Electronics devices.

I. INTRODUCTION

Now a day's our focus is on renewable energy sources to obtain pollution free response and highly desirable i,e why we have switched to renewable energy .Among renewable energy sources we focus on solar energy. Solar energy is converted to electrical energy by the help of photovoltaic system. All the calculations is taken from a 100kw solar rooftop PV system built on NGF college, Haryana. By the help of this solar PV system the college has created a green environmental field such that to reduce the use of Diesel generator. As the data India has increased solar power generation of 2,660 MW (Data obtained on 26 May 2014) to over 20 GW (Data obtained on 31 January 2018).This includes solar rooftop power generation also. There are various states like Haryana, Rajasthan etc which have already developed their own solar photovoltaic power generation systems(solar PV system also) in order to meet energy demands. As MNRE which stands for (ministry of New and Renewable energy) has already recognized the potential of various states that have the ability to generate a large amount of power from solar energy. The state Haryana is located at the Northern part of Indian an identified state. As per data available solar power potential of Haryana is 14,346MW(approx.) and that of the solar PV rooftop potential is 6187MW. The demand of power in Haryana state has increased by 11% as increase in industrial as well as domestic loads.

As per the data available the demand is of more than 3200MW and would rise to around 6000MW of electricity by 2020-21 that is why we mostly focus on solar rooftop system.

The power generation by solar pv system greatly provides a better backup and also economical support .This paper presents the performance assessment of 100kw solar rooftop photovoltaic system which is installed at NGF Engineering college, Palwal, Haryana, Due to this paper the performance of various components in the system like PV arrays, net metering etc can be analyzed and also the performance of the pv system can be investigated. Various experiments has been conducted on 100kW PV system installed at the NGF Engineering college, Palwal, Haryana gives a relationship between the annual output energy of the PV system and the temperature coefficient of the conversion efficiency and was estimated not only that various curves like cost curve , load curve consumption curve and maximum demand curve are obtained.

II. DESIGN OF VARIOUS COMPONENTS AND THEIR FEATURES.

A. Site selection or site information

Fig 1. Site map taken from Google map

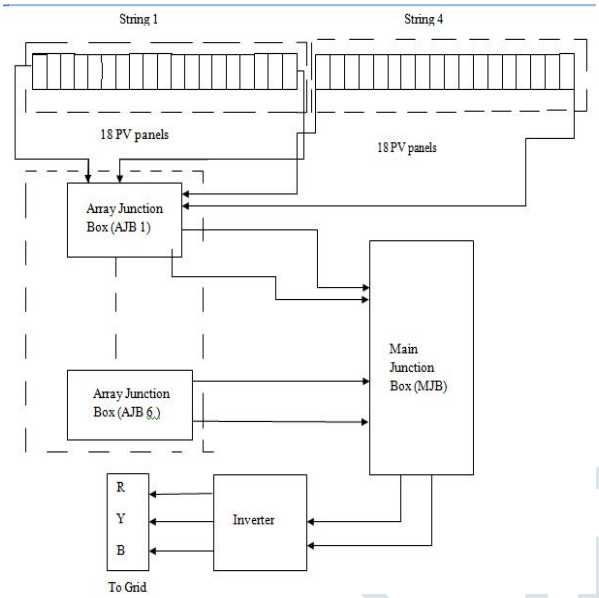


Fig 2.Block diagram of solar PV system

The above mentioned solar power plant is of 100kw and is basically composed of three sub-parts i.e. 50kw, 30kw and 20kw. Theirs coupled by two power conditioning units i.e., inverter of capacity 100KW is used.

B. Structure of PV module

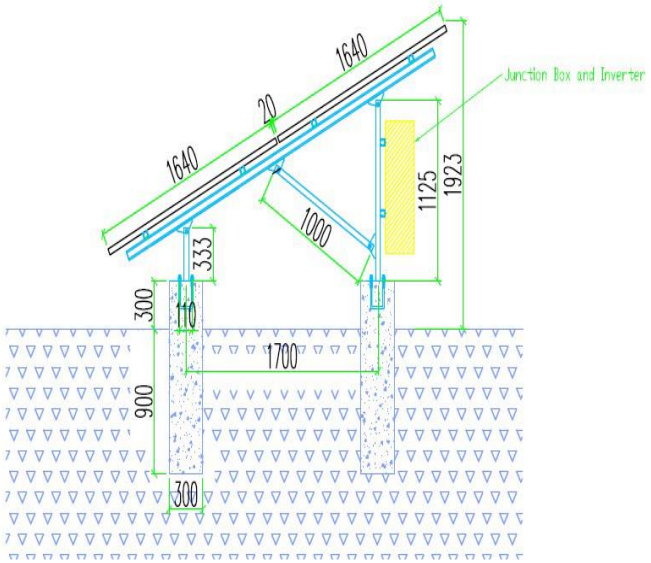


Fig.3 Structure of PV module

All the modules are placed on the rooftop of NGF College at an tilt angle is 26 degree.

A. Single line diagram of solar PV system

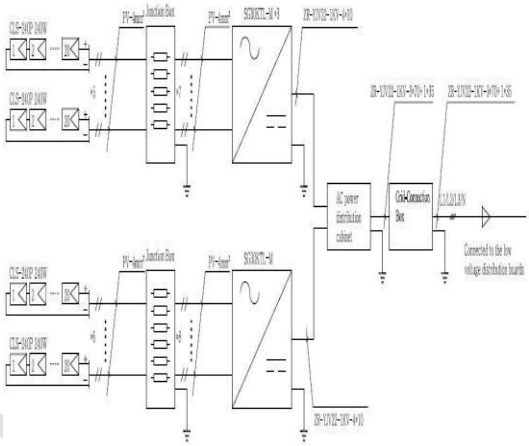


Fig4. Single line diagram of 100kw solar PV system

Our 100kw solar PV system consists of 315 solar modules each module has capacity of 315 watt.

The total peak power will be 99.25kw or approx. 100kw.There are 15 to 20 modules placed in series and the output is taken to the array junction box with the help of 4mm2 dc cable

III. PERFORMANCE EVALUATION PROCEDURE , DATA COLLECTION BY VARIOUS TECHNIQUES

Various terms regarding solar are mentioned bellow and can be calculated by using approximate values and data obtained from 100kw solar rooftop photovoltaic system, these terms are final yield, reference yield, performance ratio ,capacity factor, overall system efficiency

$$Y_a = E_{Aday}/P_o \quad (1)$$

$$Y_F = E_{UsePV}/P_o \quad (2)$$

$$Y_R = H_I/G_{stc} \quad (3)$$

$$L_C = Y_R - Y_A \quad (4)$$

$$L_S = Y_A - Y_F \quad (5)$$

$$PR = Y_F / Y_R \quad (6)$$

$$E_{SA} = H_I \times A_A \quad (7)$$

$$\eta_{total} = E_{usePV}/E_{SA} \quad (8)$$

IV. DESIGN ANALYSIS AND CALCULATION

Total no. of modules = 432

For 30kW solar module system:

Open Ckt Voltage rating of 30kW inverter used = 550V

Panel open ckt voltage (V_{oc}) = 37.5V

No: of panels connected in series are = 13
Panel working voltage = 30.5V
Series Panel Working Voltage = 13×30.6 = 397.8V
Total power = (V×I) = 30kW
Total power = (V×I) = 30kW -------- (1)
From equation (1)
Working current is calculated as = 75.414A
From the panel details we get $I_{sc(\text{ short circuit})} = 8.18A$
No: of panels connected in parallel = 10
Now
For 10kW solar module system:
Obtained Voltage ratings is given = 240V
No. of panels connected in series = 10
(Inverter Voltage)/(Panel voltage) = 7.8 ≈ 7
Panel Working Voltage = 30.6V
Series Panel Working Voltage = 7×30.6 = 214.2V
Total Power = (V×I) = 10kW
Working Current = 46.68
No of panels connected in parallel = 5.70 ≈ 6
Therefore, for 30kW inverter, we connect the panels as 13×10(i.e. 13 panels are connected in series and 10 in parallel respectively)

V. VARIOUS PERFORMANCE LIST AND VARIOUS CURVES ARE DRAWN ON THE BASES OF ABOVE CALCULATION

Electricity Consumption Pattern-Inhouse Solar Panel

Duration	Unit Generated by DHBVN	Unit Generated by Solar	Total Consumption (DHBVN+Solar)
May-17	52539	11167	63706
Jun-17	61761	10466	72227
Jul-17	18747	9727	28474
Aug-17	38700	9341	48041
Sep-17	49500	9750	59250
Oct-17	35100	9254	44354
Nov-17	19200	7031	26231
Dec-17	24300	7751	32051
Jan-18	13800	6612	20412
Feb-18	16800	8931	25731
Mar-18	18900	11722	30622
Apr-18	36600	10199	46799

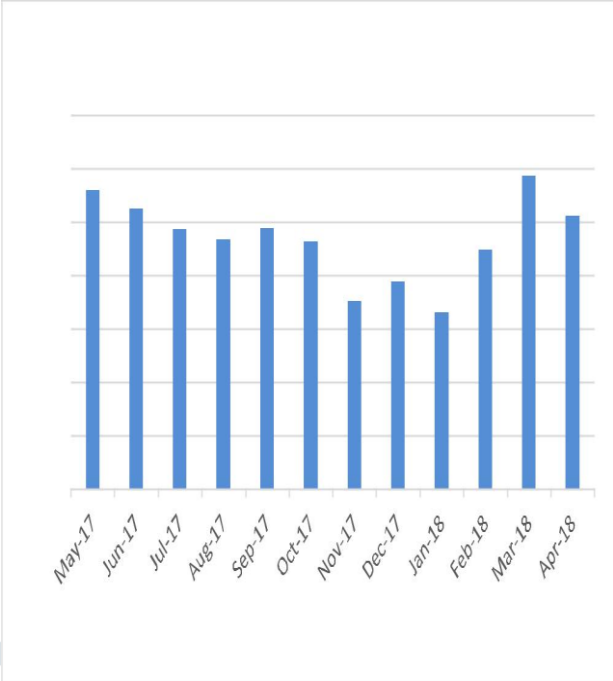
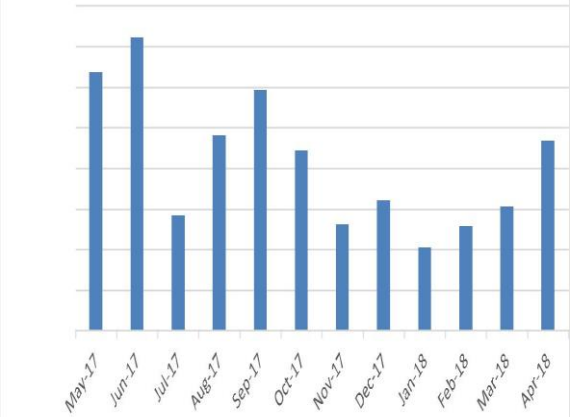


Fig. 6 Units generated by solar PV system

Fig 7.Total consumption curve



Average power consumption per month is 33854 KWH, while average maximum demand is 92.90 KVA and Average monthly energy bill is Rs 3,45,834/-. Actual number of units consumed shows a spike in the months of May, June, July and September which are the peak summer months is Palwal region and air conditioning requirements are very high. It can be seen that during July and August there is dip in energy consumption, as during this period college is non functional. Also the total power drawn from the grid is reduced since April 17 as in house solar plant was Commissioned.NGF College of Engineering and Technology is getting power supply from DHBVN through one energy meter. The supply company charges HV tariff on

the basis of KVAH. Analysis of energy bills for last two year was done and it was found that power factor was varying between 0.90 to 0.98No penalty is charged by DHBVN for maintaining low power factor but tariff is charged on basis of KVAH.As the power factor reduces KVAH shall increase. It is recommended that power factor shall be maintained at 0.999 for maximum saving.

Following saving shall have been achieved if power factor was maintained at 0.999 for last 2 year

Months	Current KVAH	Current Power factor	Current KWH	KVAH If PF was 0.99	Saving in KVAH
Jan-16	18123	0.98295	17814	17994	129
Feb-16	22530	0.981358	22110	22333	197
Mar-16	24975	0.973093	24303	24548	427
May-16	57579	0.985255	56730	57303	276
Jun-16	68370	0.988811	67605	68288	82
Jul-16	33417	0.987342	32994	33327	90
Aug-16	23790	0.979445	23301	23536	254
Sep-16	45702	0.987922	45150	45606	96
Oct-16	62865	0.990838	62289	62918	-53
Nov-16	39861	0.988259	39393	39791	70
Dec-16	30729	0.98272	30198	30503	226
Jan-17	27693	0.977901	27081	27355	338
Feb-17	21444	0.951175	20397	20603	841
Mar-17	26235	0.982047	25764	26024	211
Apr-17	33705	0.979261	33006	33339	366
May-17	53505	0.981946	52539	53070	435
Jun-17	62760	0.984082	61761	62385	375
Jul-17	19956	0.939417	18747	18936	1020
Sep-17	41400	0.934783	38700	39091	2309
Oct-17	52500	0.942857	49500	50000	2500
Nov-17	38700	0.906977	35100	35455	3245
Dec-17	22800	0.842105	19200	19394	3406
Jan-18	26100	0.931034	24300	24545	1555
Feb-18	15000	0.92	13800	13939	1061
Mar-18	17700	0.949153	16800	16970	730
Apr-18	20400	0.926471	18900	19091	1309
May-18	37200	0.983871	36600	36970	230
Total saving in KVAH					21723.85
Cost per unit (In Rs)					10.21
Total Saving in Rs with average cost of unit ₹					221800

Total saving of ₹ 110900 shall be achieved per annum.

It is recommended to install alarm system for power factor so that if power factor is falling below the defined value i.e. 0.99 immediate preventive measures can be taken.

i. CONCLUSION

After installation of 100kW solar rooftop PV system ,on The basis of design and capacity of 100 KW solar power plant we put only fan and lighting loads on it such that the system can run maximum devices at a time without any overload on the system.NGF engineering college is planning to build a second phase of rooftop solar power plant with a capacity of 100kw so that the dependency on grid power may be reduced . Also by doing a little modification i.e by replacing CFL lamps by LED will cause more saving in economy Hence installation of such a renewable power generation plant not only helps in achieving economic benefits but also reduces impact on the environment by reducing pollution, and implications due to climate change.

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