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An Experiment on Solar Photovoltaic Arrays in Fixed Mode, For Highlighting the Importance of Solar Tracking

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***Abstract*— The tremendously increasing demand for energy, the drastic and continuous reduction in the existing sources of fossil fuels and the growing concern regarding the environmental pollution has forced mankind to explore new technologies of solar energy, wind energy and biomass etc. An experiment was performed at Sardar Patel Renewable Energy Research Institute in the month of January this year to practically analyze the various electrical parameters of solar photovoltaic panel. This study of the solar photovoltaic panel in its fixed mode aimed at understanding the various interrelationships among solar radiation with various times of the day along with power output and input with time. The main goal was to understand the concepts of the system and to highlight the fact that why tracking is important for the photovoltaic panels.**

***Index Terms*—Pyranometer, Data Logger, Battery Bank.**

I. INTRODUCTION

The astonishing thing about solar power is that all the electricity is generated from the material of the solar panels and the energy from the sun. Extracting useable electricity from the sun was made possible by the discovery of the photoelectric mechanism [1].The solar panels are mainly made out of semiconductor material, Silicon being the most abundantly used semiconductor. The benefit of using semiconductor material is largely due to the ability of being able to control its conductivity whereas insulators and conductors cannot be altered. The electrons of the semiconductor material can be located in one of two different bands: the conduction band or the valence band. The valence band is initially full with all the electrons that the material contains. When the energy from sunlight, known as photons, strikes the electrons in the semiconductor, some of these electrons will acquire enough energy to leave the valence band and enter the conduction band. When this occurs, the electrons in the conduction band begin to move creating electricity. As soon as the electron leaves the valence band, a positively charged hole will remain in the location the electron departed. When this occurs, the valence band is no longer full and can also play a role in the current flow. This process basically describes how Photovoltaic (PV) systems function. However, PV systems further enhance the rate at which the electrons are sent into the conduction band through the process of doping.

II. EXPLANATION OF THE EXPERIMENTAL SET

The schematic diagram of the experimental set is shown in Fig.1, the main components shown in the diagram highlights, P.V arrays which has total 12 P.V panels each panel has 36 solar cells, each cell of 2 W capacity so the total capacity of the 36 cells are 72 W and the total capacity of 12 panels results to 864W.The panels are manufactured by Tata BP solar India limited. A pyranometer is placed over the P.V array to measure the solar radiation at various time of the day and it is further connected to the data logger for recording the values of solar radiation throughout the day at various instants of time. The MCB (Miniature Circuit Breaker) is used for protecting the rest of the circuit, in case any fault occurs. DC energy meter gives the values of various electrical parameters like current, voltage, power output etc. The parameter range of the DC energy meter is 0-60 V for voltage and 0-75 mV corresponding to shunt. The shunt is mainly used for giving the value of current to the DC meter. The P.V array is feeding a set of battery bank which then feeds to the Solar Energy division mains of Sardar Patel Renewable Energy Research Institute by using an inverter for D.C to A.C conversion. The inverter has the capacity of 3.5 KVA.

III. COLLECTION OF THE DATA AND PLOTTING THE GRAPHS

After the experimental set-up was completed the readings were collected manually for two days 13th and 14th

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January 2013. The graphs were plotted accordingly and were studied thoroughly to make conclusions.

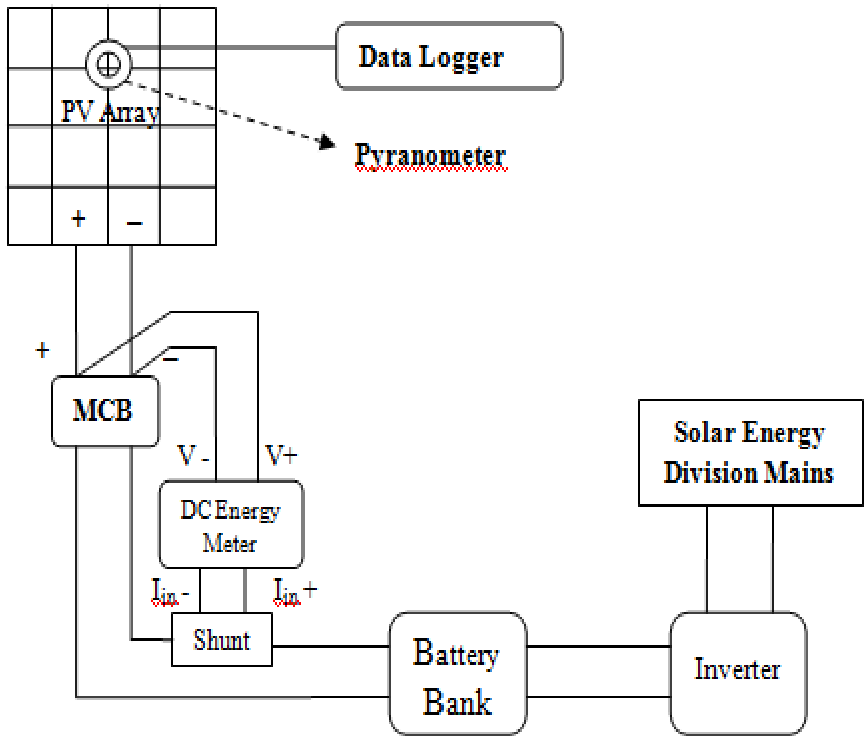

Fig.1 The main experimental set up

On 13th January the readings were taken from morning 10 am to 5 pm and on 14th January it was from 9 am to 5 pm at the interval of every 5 minutes.

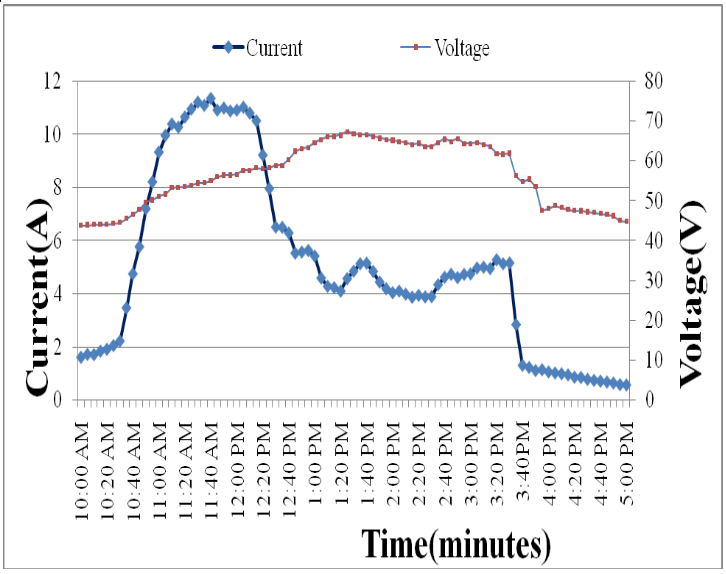

Fig.2 Variation in current and voltage with time (on 13th January 2013)

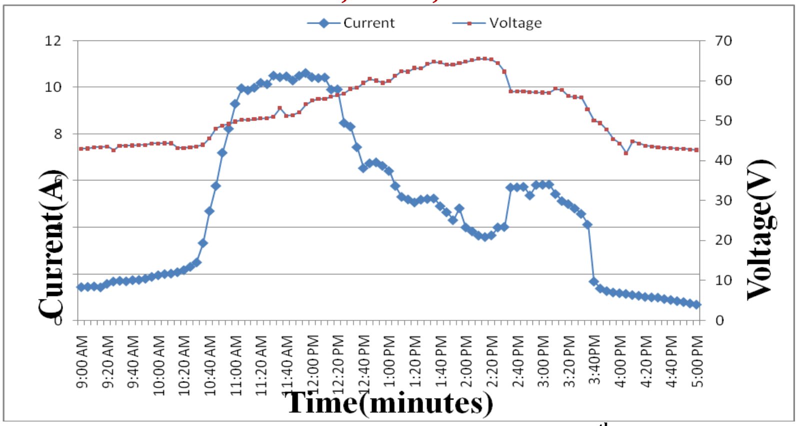

Fig.3 Variation in current and voltage with Time (on 14th January 2013)

The Fig. 2 and 3 shows the variation of current and voltage respectively the pattern of both the parameters observed on both the days is same but we can very well observe that voltage is remaining nearly constant but change in current is quite drastic. Fig 3and 4 shows the variation of solar radiation with time at various instant of time.The data of the solar radiation is obtained by the pyranometer which was connected to the data logger for recording the value. If some light is thrown on the Fig.3 it is observed that the solar intensity is maximum in the noon time but it then starts to decrease then suddenly increases around 3:30 pm then again decrease so we can assume that there is passing of cloud or due to shadowing effect it took place. Similar pattern is also observed on the next day during the experiment process. Thus the shadowing effect and the passing of clouds causes hindrances to the amount of solar radiations reaching to the fixed P.V panel.

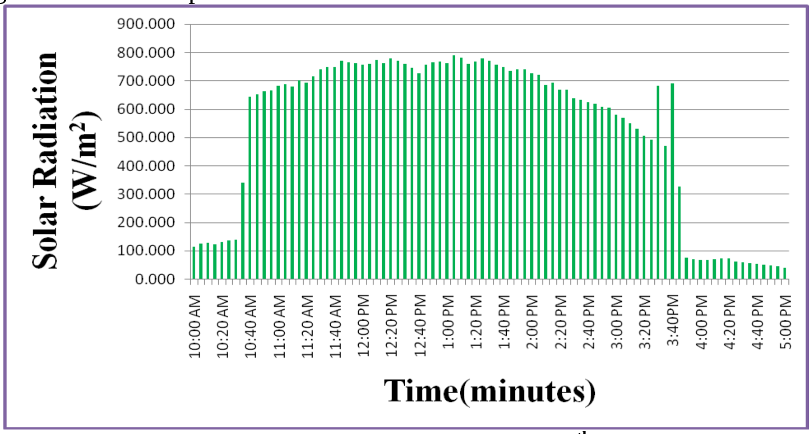

Fig.4 Variation of solar radiation with time (on 13th January 2013)

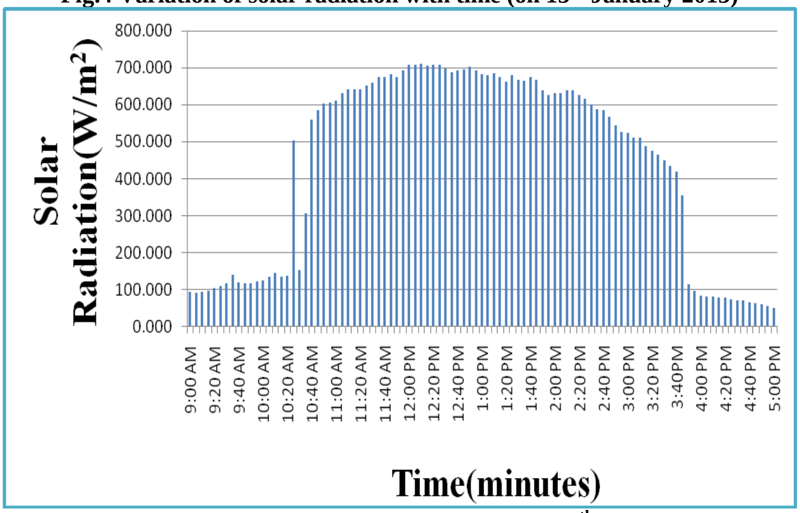

Fig.5 Variation of solar radiation with time (on 14th January 2013)

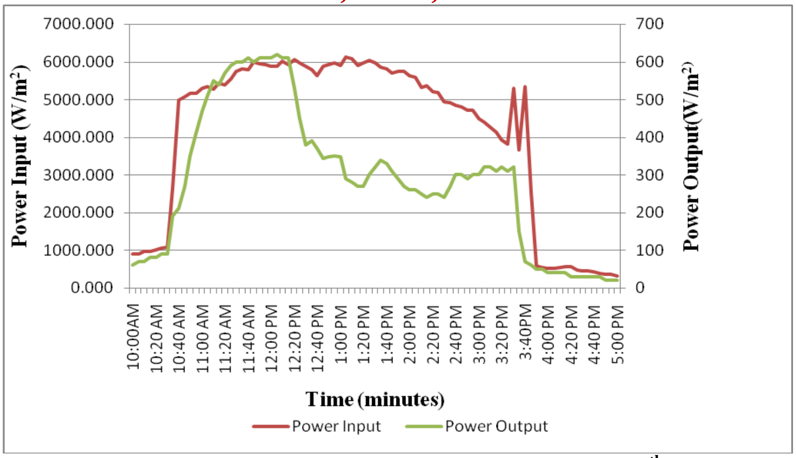

Fig.6 Variation of power input and power output with time on (13th January 2013)

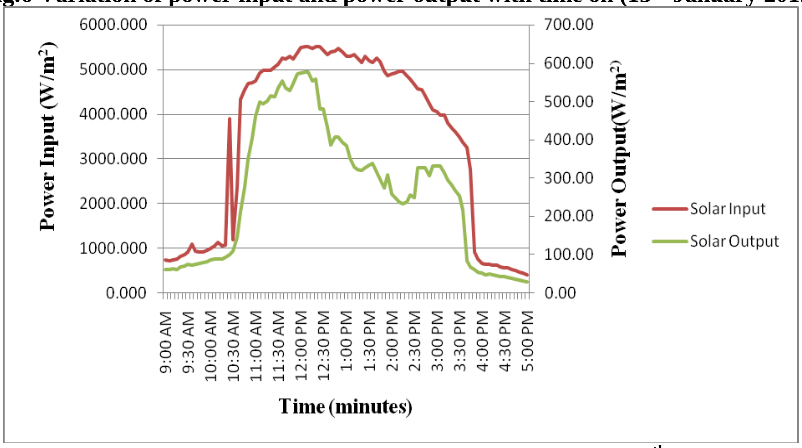

Fig.7 Variation of power input and power output with time on (14th January 2013)

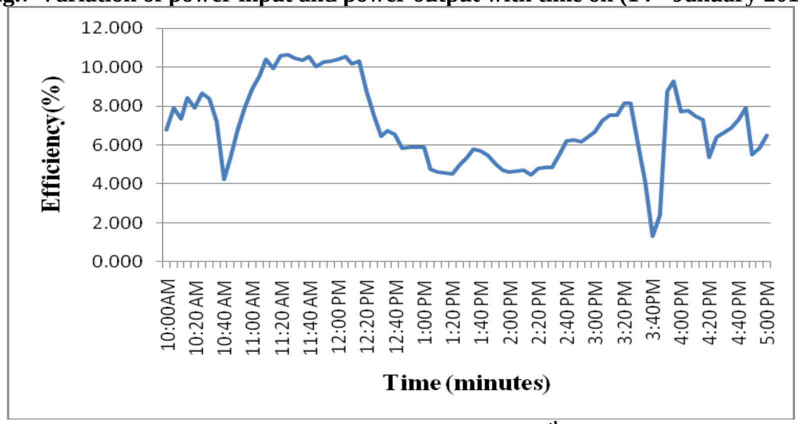

Fig. 8 Variation of efficiency with time on (13th January 2013)

The variation of power input and power output along with time is shown in the Fig. 6 and 7. The power input is calculated by multiplying the area of the photovoltaic panel area without the metallic frame which is 7.765 m^2 along with the value of solar radiation obtained from the pyranometer stored in the data logger. The solar radiation unit is $W/m^{2,}$ when multiplied by area we get power input in W. It can be noticed from both the graphs that the slope of the power input and the power output has a distance between them that signifies the fact that the input power is good because the slope of the input power is less as compared to the output power that is because the panel is kept in fixed and has lack of tracking. If we impart tracking facility to the panel then the output power graph will cover larger area under it and will be nearer to the input power graph. This employs the fact that while tracking the panels will be able to catch the diffused rays which are caused because of shadowing effect or passing of clouds. In order to produce a low cost solar tracker, material being used must be appropriate for structure design that will lead to higher reliability and life span of the tracker [4]. The efficiency graph is shown in Fig.8 highlights the point that the efficiency reached is up to 10%. The panel is of 2003 manufactured and developed by Central Institute of Agricultural Engineering (CIAE), Bhopal and the rated efficiency is 12%.

IV. Conclusion

From the above experiment and subsequently by doing the result analysis it is very clear that the in a fixed mode solar panel the power output of the panel is less. As per the experimental set up described battery bank is connected as the load so when the battery is getting fully charged the current is dropping significantly. It is also verified and observed that the panel is giving a good efficiency of 10% near to its rated value. The input power to the panel is also proportional to the amount of solar radiation incident to the panel. This experiment helped, to realize that fixed mode panels should be facilitated with tracking to enable it to maximize power per unit area and able to grab the energy throughout the day and subsequently increase the solar panel output. In order to ensure maximum power output from PV cells, the sunlight's angle of incidence needs to be constantly perpendicular to the solar panel [3]. Therefore solar trackers are getting popularized around the world in recent days to harness solar energy in most efficient way [2].

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