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DESIGN & SIMULATION OF STANDALONE SPV SYSTEM WITH MPPT ALGORITHM

[1]**Sachin Pachauri, MIEEE**
Rajkiya Engineering College Mainpuri Mainpuri, India sachin.pachauri@ieee.org

[2]**Aseem Chandel, SMIEEE**
Rajkiya Engineering College Mainpuri Mainpuri, India aseemchandel@ieee.org

[3]**Shamsher Ansari**
Rajkiya Engineering College Mainpuri Mainpuri,India way2ansari214@gmail.com

Abstract— For Efficiently utilization of PV system Maximum Power Point tracking (MPPT) play an important role. MPP(Maximum power Point) of PV system varies with meteorological parameters like solar irradiance and temperature etc. A Simulated model of Solar Photovoltaic system with battery storage system compare load(AC&DC) characteristics with different algorithm to achieve maximum power using most preferable MPPT techniques like P&O and I&C. Comparison of these techniques for Standalone Photo Voltaic system with ac and dc loads has been simulated under various conditions like with solar irradiations, without solar irradiations and partial shading condition at constant temperature.

Index Terms— Maximum Power Point tracking (MPPT), PV(Photovoltaic), P&O(Perturb and Observe), I&C(Incremental and conductance)

I.INTRODUCTION

PV system is most widely used and handy available source of renewable energy and it contributes pollution free and clean to the environment [1]. However, to get maximum power from PV system under different meteorological condition like irradiations and temperature is very difficult because major component of standalone systems are DC-DC converter, Inverter and battery storage system [2]. There are many MPPT algorithms being used with the DC-DC converters to get Maximum Power point of PV systems [3]. In P&O operating point of PV system is perturb due to rise and fall of operating point according to that point control parameter PV output can change [4]. In I&C, control parameter will change according to change in the instantaneous conductance that can compare with the incremental conductance [5]. Most of the researchers works to implement different types of MPPT techniques but their performance comparison has been rarely conducted, so this paper presented, validated and simulated to compare the performance of P&O and I&C algorithms with different condition like in irradiation, without irradiation and partial shading condition.

In the further sections Modelling of PV modules, Formulation of work, Result and Discussions and Conclusion has been discussed.

II.MODELLING OF PV SYSTEM

PV module of is described with a single cell with series and parallel resistances.

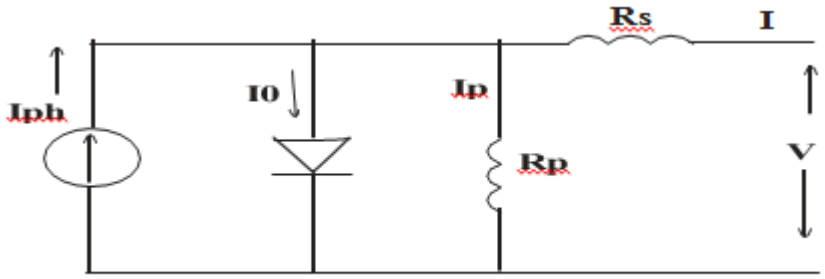

Fig.1 PV cell module

$$\mathrm{I} = I_{Ph} - I_o\left[\exp\left\{\frac{q(\mathrm{V}+\mathrm{I}*\mathrm{ns}*Rs)}{N_s AkT}\right\} - 1\right] + \frac{\mathrm{I}*\mathrm{ns}*.55+\mathrm{V}}{Rp}$$

PV model output current I express in terms of output voltage (V), series resistance Rs and Parallel resistance Rp along with number of cells in series as well as parallel. Light generated current (Iph) with depend upon wheatear condition. Where Io is cell saturation current, k is Boltzmann constant(1.3805*10-23Nm/K), q is electron charge whose value is 1.6*10-19. A is ideality factor is 1.6. Cell operating temprature(T) in kelvin.
By this equation we simulate a 250W PV system and this convert into 5000W system with increase the number of series and parallel cell whose value is 10 and 2 respectively.

III.FORMULATION OF WORK

Maximum power from Standalone 5KW system will be achieve with the help of MPPT algorithm. MPPT algorithm may identify the MPP and force the PV system to operate that point [6]. Basic Block diagram of standalone system with converter, inverter and battery storage system shown in figure 2.

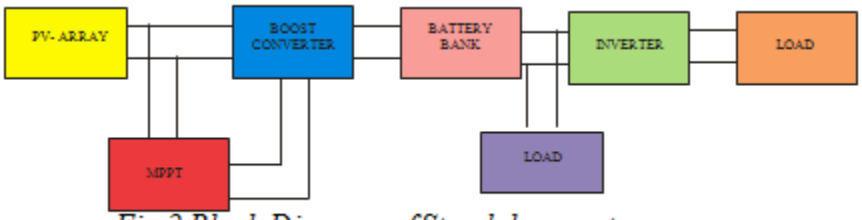

Fig.2 Block Diagram of Standalone system

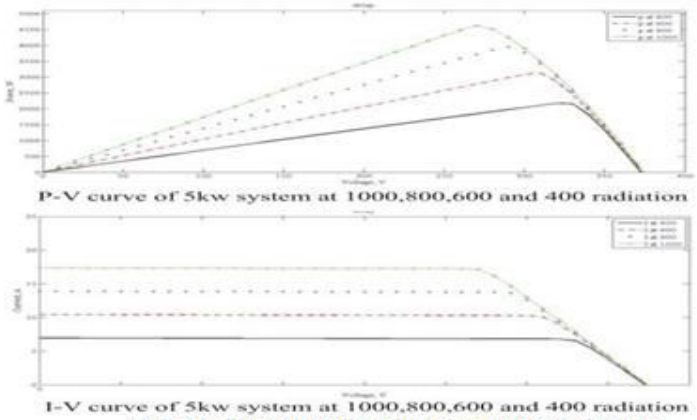

Fig.3 PV and IV characteristics of 5KW PV system

A.Perturb and Observe Technique

In the P&O MPPT technique, we can reach our maximum power point by a change in operating voltage periodically increase or decrease and this is achieved by comparing the amount of power present to past instants. If the current instant power is increased than the previous value, the perturbation is persists in the same direction in the next perturbation cycle, otherwise, the path of perturbation direction is reversed [7]. Flow chart of this technique is described

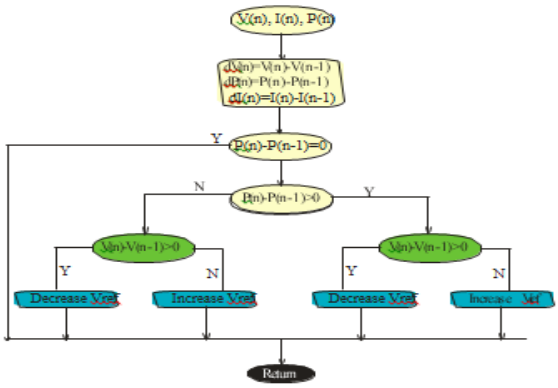

Fig.4 Flowchart of P&O technique

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B.Variable step Incremental and Conductance

I&C MPPT technique maximum power point terminal voltage always adjusted. The basic idea is that at the Maximum Power of Point the derivative of the power with respect to the voltage vanishes because the Maximum Power of Point is the maximum of the power curve. It is noted that the slope of dP/dV negative on the right side and positive on the left side of the curve [8]. Incremental conductance (IC) locates the maximum power point when

$$\frac{dP}{} = I + V\left(\frac{dI}{}\right) = 0$$

this leads to

$$\frac{dI}{dV} = \frac{\Delta I}{\Delta V} = -\frac{\mathrm{Im}\,pp}{Vmpp}$$

$$\frac{dP}{dV} = 0 \quad \text{at MPP}$$

$$\frac{dP}{dV} > 0 \quad \text{Left of MPP}$$

$$\frac{dP}{dV} < 0 \quad \text{Right of MPP}$$

the PV array terminal voltage can be changed by measuring incremental and instantaneous array conductance (dl/dV and I/V) relative to the Maximum Power Of Point voltage. The algorithm begins its cycle by obtaining the present values of I0 and V0, then using the respective values stored at the end of the preceding cycle, I0 and V0, the incremental changes are approximated as dI=I(n)-I0 and dV=V(n)-V0. The key test is carried out by comparing dl/dV to - I / V, and according to the result of this test, the duty cycle D can be changed to move the array terminal voltage towards the MPP voltage. No control action is required at the MPP dl / dV =-I / V, so the adjustment stage can be by passed and the algorithm can update the stored parameters as normal at the end of the cycle.

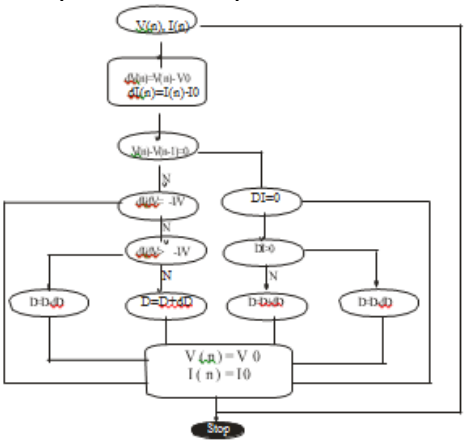

Fig.5 Flowchart of I&C technique

C.Partial Shading

In partial shading condition irradiation may vary according to methodological condition and different condition like tree shadows, nearby building, tower and poles etc [9]. On panel board some area may have more irradiations and

some may not. On those area where irradiation are different are discussed here. In our simulation partial shading condition arise by different irradiation like 1000, 800 and 400 respectively with indefinite time interval.

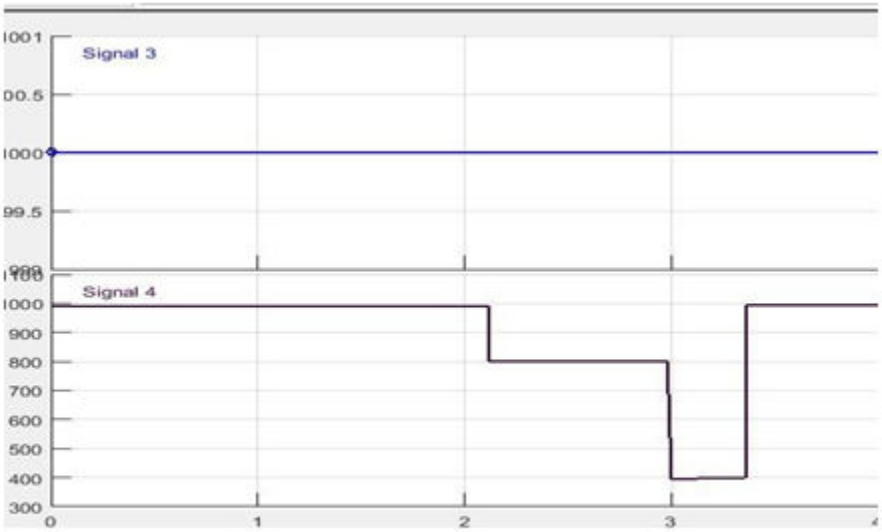

Fig.6 Signal generator with different radiations

IV.RESULT AND DISCUSSION

A. Simulation result at DC converter terminal

In this part we analyze DC power, Current and Voltage at converter terminal with irradiation and partial shading condition with both MPPT technique (P&O and I&C). Partial shading condition analyzed by the signal generator according to irradiations.

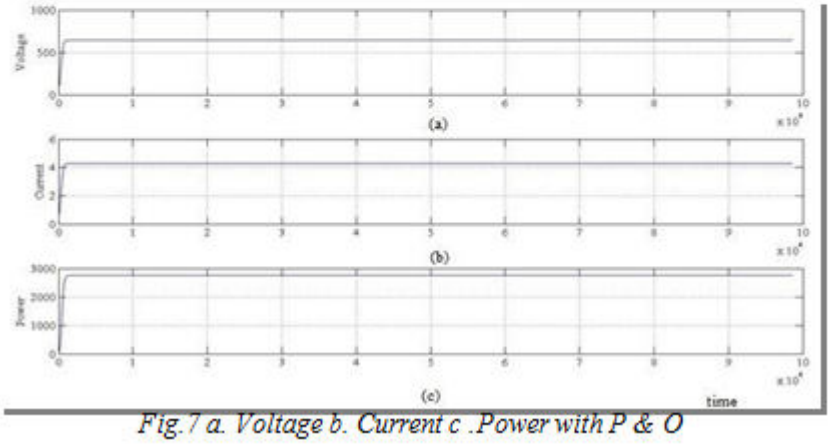

Fig.7 a. Voltage b. Current c .Power with P & O

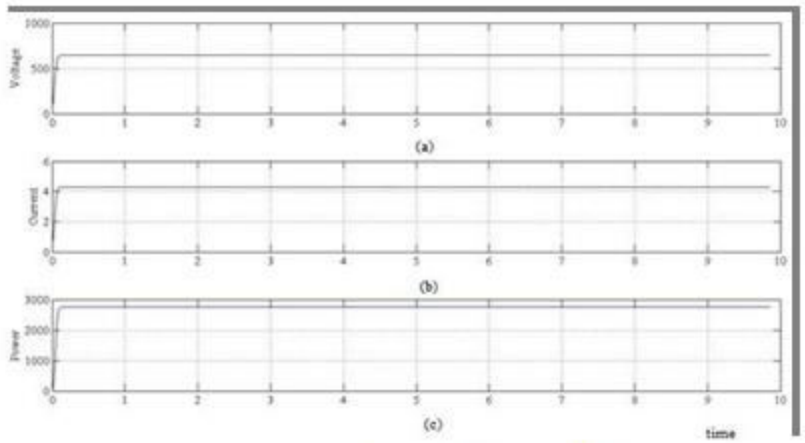

Fig. 8 a. Voltage b. Current c. Power with I&C

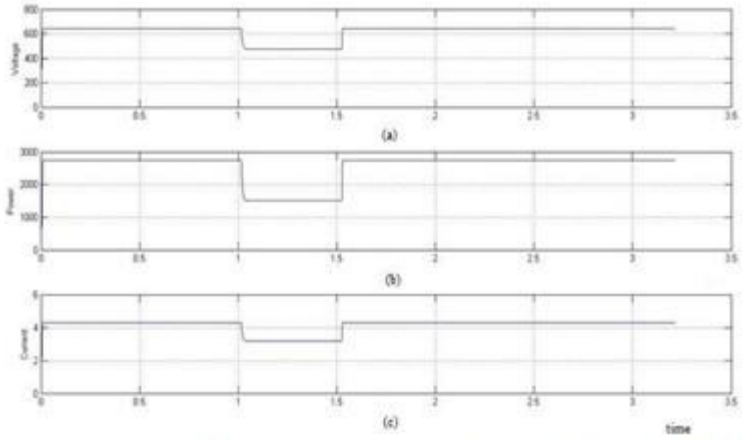

Fig.9 Voltage, Power and Current with Partial Shading with P&O

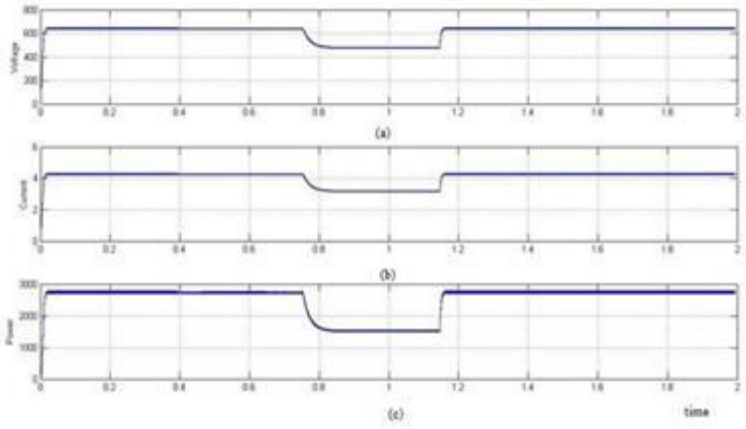

Fig.10 Voltage, Power and Current with Partial Shading with I&C

B.Simulation result with P&O technique

In this, we get AC and DC power, current and voltage at load terminal that is connected before and after the inverter. These parameters can be found in different metrological conditions like in irradiation, without irradiations and partial shading conditions.

1. In Irradiations

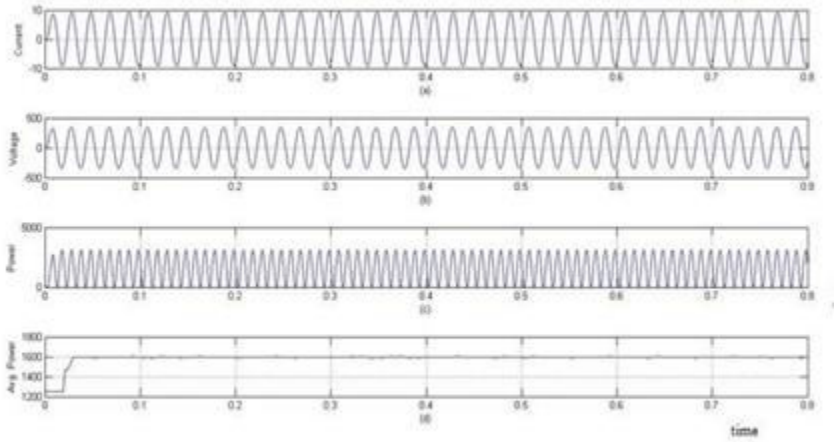

Fig. 11 a. Current b. Voltage c. Power d. Avg. Power for AC load

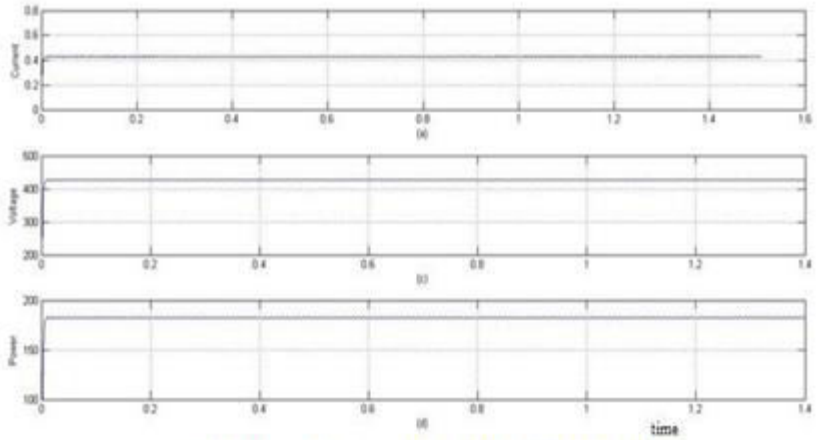

Fig. 12 a. Voltage b. Current d. Power for DC load

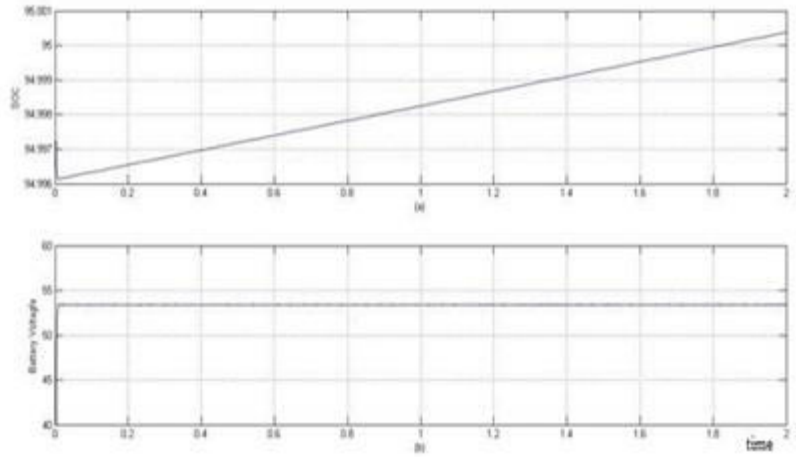

Fig. 13 a. State of charging b. Battery Voltage

2. Without irradiation

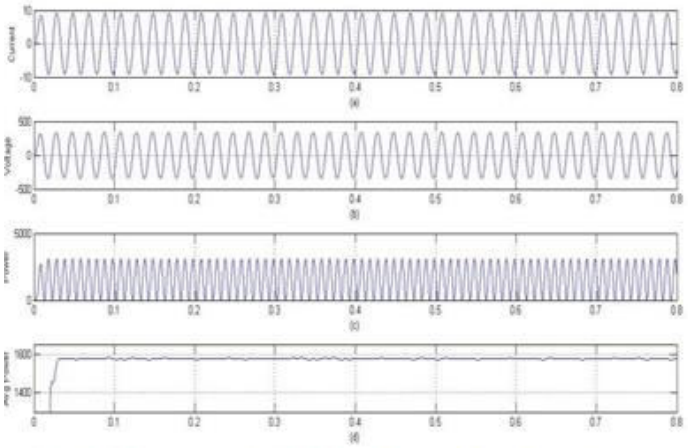

Fig. 14 a. Current b. Voltage c. Power d. Avg. Power for AC load

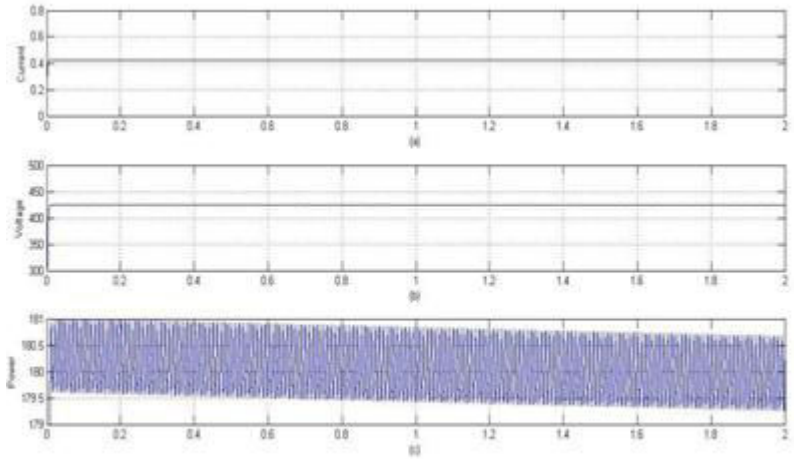

Fig.15 a. Voltage b. Current c. Power for DC load

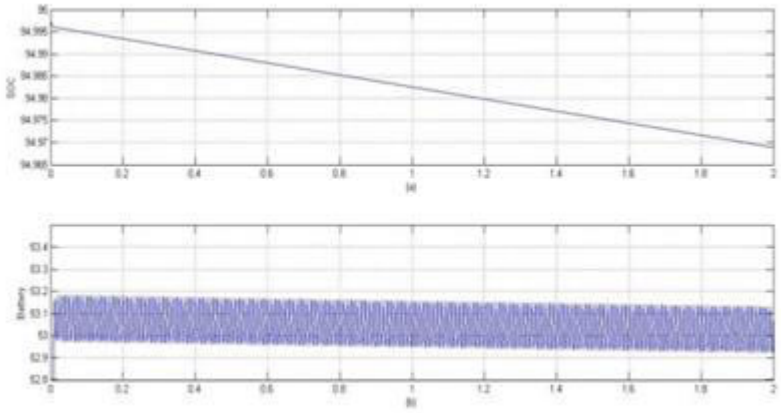

Fig.16 a. State of Discharging b. Battery Voltage

Output characteristics of the system in partial shading condition for ac load and dc load and battery voltage and condition of charging and discharging. In which, power battery may charge or discharge depending upon wheatear condition

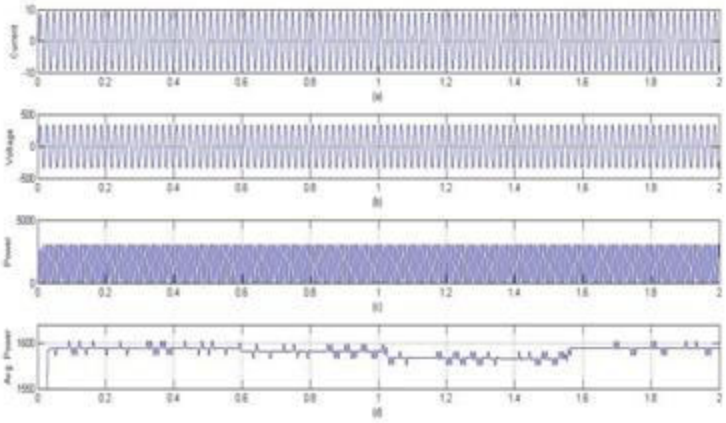

Fig.17 a. Curr. b. Volt. c. Power d. Avg. Power to AC load

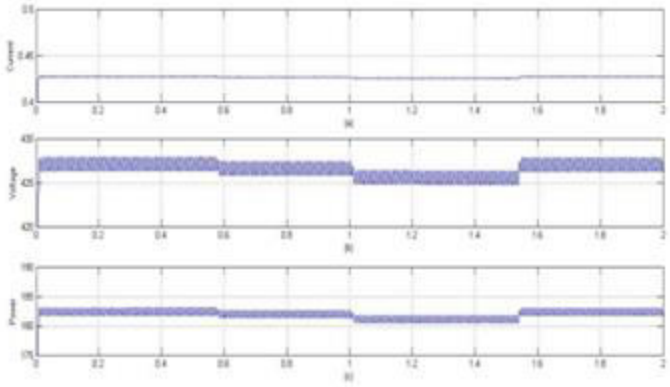

Fig. 18 a. Curr. b. Volt. c. Power to DC load

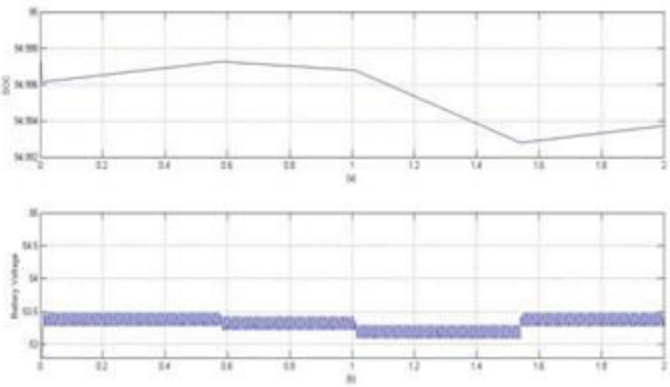

Fig. 19 a. State of charging &discharging b. Battery Voltage

C Simulation Result with the I&C technique.

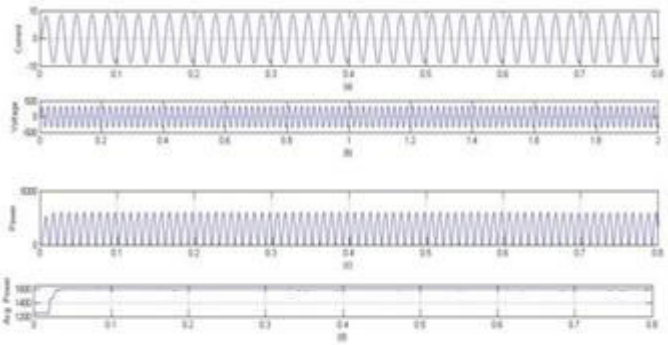

Fig 20 a. Curr. b. Volt. c. Power d. Avg. Power to AC load

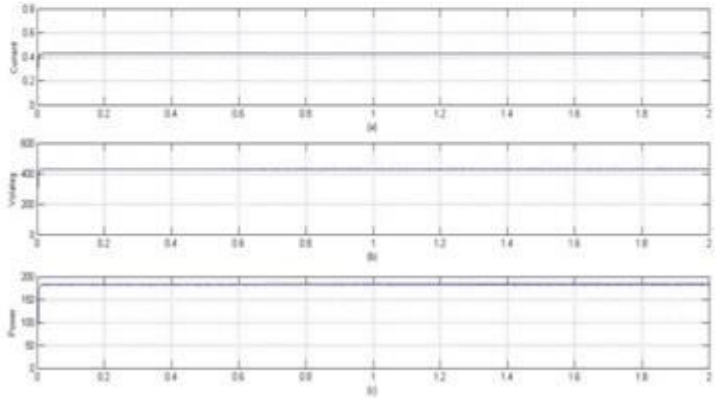

Fig. 21 a. Curr. b. Volt. c. Power to DC load

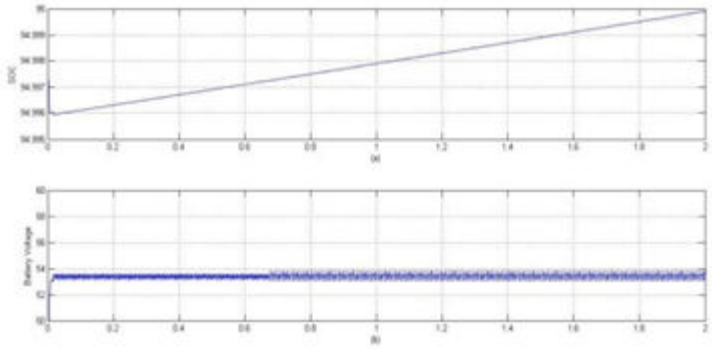

Fig. 22 a. State of Charge b. Battery Volt.

Output characteristics of the system in without Irradiations condition for ac load and dc load and battery voltage and condition of discharging in without irradiations. In which power is given by battery because in this condition battery may discharge.

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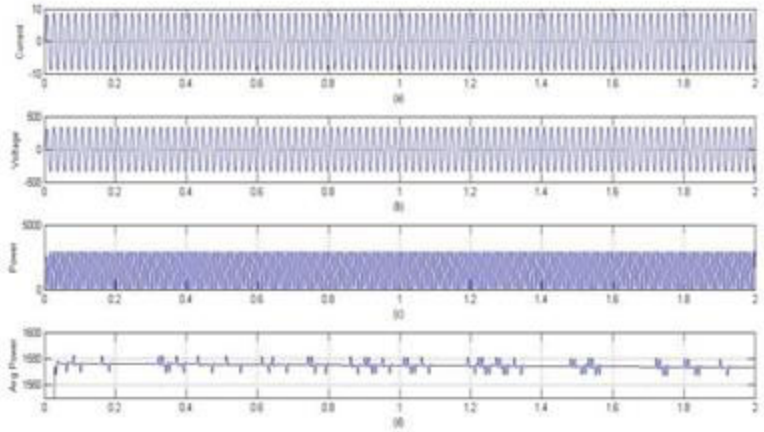

Fig. 23 a. Curr. b. Volt c. Power d. Avg. Power to AC load

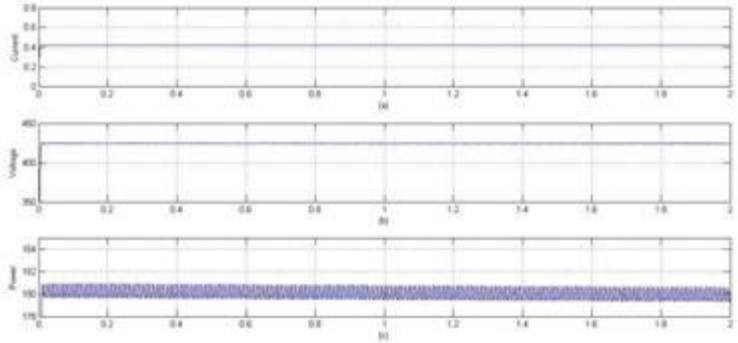

Fig.24 a. Curr. b. Volt. c. Power to DC load

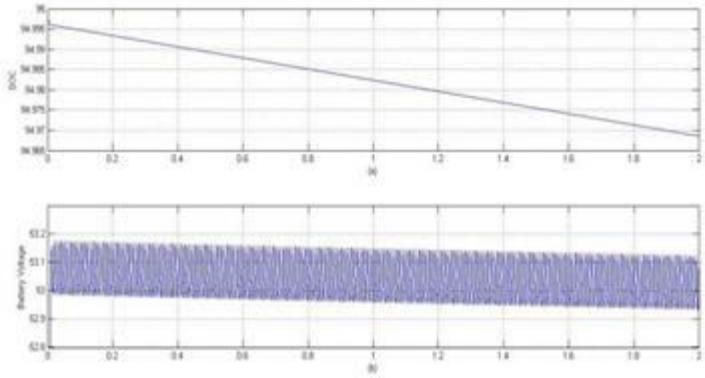

Fig. 25 1. State of Discharge 2. Battery Volt.

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Output characteristics of the system in partial shading condition for ac load and dc load and battery voltage and condition of charging and discharging. In which power battery may charge or discharge depending upon wheatear condition

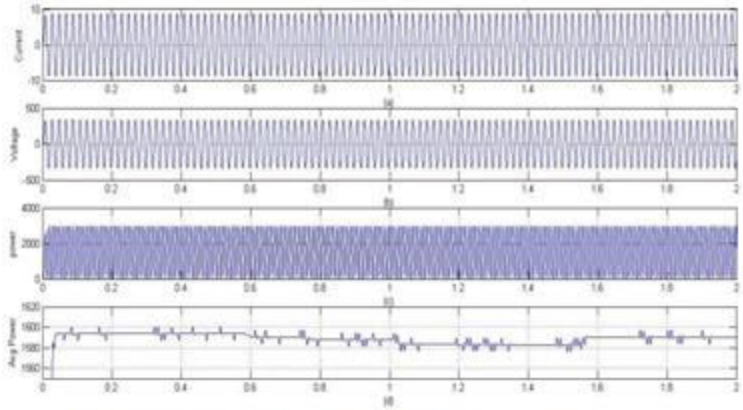

Fig.26 a. Curr. b. Volt. c. Power d. Avg. Power to AC load

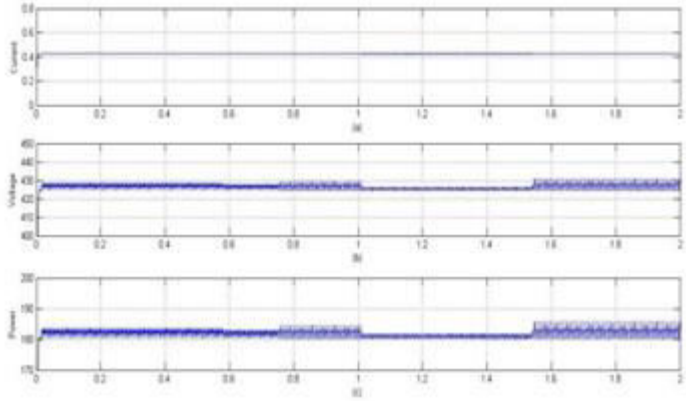

Fig.27 a. Curr. b. Volt. c. Power to DC load

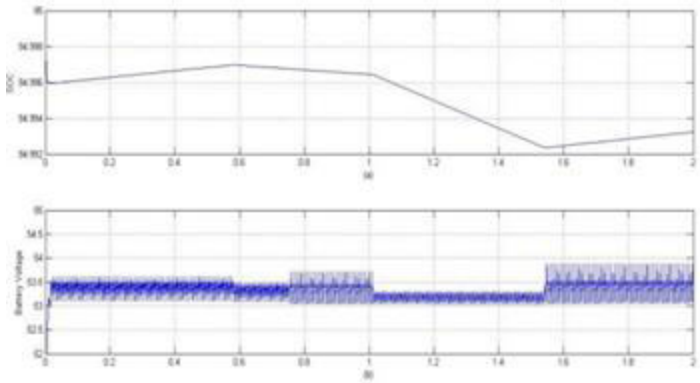

Fig. 28 a. State of charging & discharging b. Battery Voltage

C.CONCLUSION

A single-Phase standalone system with battery energy storing system is analyzed with different MPPT algorithm such as Variable step Incremental and Conductance (I&C), Perturb and Observe (P&O) in different metrological condition like in irradiation, without irradiation and partial shading condition. The various performance parameters like generated power, voltage and current have been analyzed and compared with the aforementioned MPPT algorithms.

SN	Parameter	Average Power		Voltage		Current	
		AC	DC	AC	DC	AC	DC
1	P&O	1592 W	195.5 W	339 (p-p)	442 V	9.21 (p-p)	0.4425 A
2	I&C	1594 W	180.5 W	338 (p-p)	424.5 V	8.85 (p-p)	0.425 A

Table 1 Comparison study of different algorithm

The presented results and discussions make it conclude that Variable step I&C is batter in terms of performance comparison to the P&O algorithm. However, we find that generated power output is more and under partial shading condition I&C technique is superior. The integration of the charge controller in the system with the battery bank makes the system more reliable.

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