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COMPARATIVE STUDY OF MAXIMUM POWER POINT IN BOTH FULL SUN RAYS AND CLOUDY WEATHER CONDITION BY MATLAB SIMULATION

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ABSTRACT
Renewable energy is the alternative source of energy corresponds to the conventional energies to mitigate the power demand for large population in the world. Fuels available in the world are constant. After a few decades it will be unavailable for mitigating the large demand. On the other hand conventional energy is much more harmful for polluting the environment. So the world is concern with on alternative energy sources which are nonconventional energy such as wind energy, geothermal energy, tidal energy, hydro energy and solar energy. All of indicated sources of energies are more environmental friendly and infinite. However, this paper deals with the solar energy. In previous study, latest information on about solar energy conversion efficiency is only about 16%. So if it is possible to increase this efficiency to as high as possible then it will be more expected to all. For this reason the focus on this paper is to extract maximum power from the solar panel in different temperature condition. Here PV system is modeled and simulate to track maximum power point available from the system. This research work has been carried out with the modeling of solar panel and makes its approximation in both full sun rays and partial cloudy weather condition and simulate it using MATLAB coding. Finally the outcome of this work is mostly satisfactory and encouraging.

***Keywords*:** Maximum Power Point (MPP), MATLAB Simulation, Renewable Energy, Photovoltaic System

NOMENCLATURE

I	: Light generated current (A) [without Rs/ Rsh]
I_o	: Diode saturation current (A)
R_s	: Solar cell series resistance (Ω)
R_{sh}	: Solar cell shunt resistance (Ω)
T	: Cell temperature in Kelvin (K)
V	: Solar cell output voltage (V)
q	: Electron charge (1.6×10^{-19} C)
K	: Boltzman constant (1.38×10^{-23} J/K
I_{pv}	:PV panel current
V_{pv}	:PV panel voltage
N	:Number of series cells per string
λ	:Material coefficient of PV cell
I_{sc}	:Short circuit current
I_o	:PV saturation current
M	:Number of parallel string
R_s	:Series resistance of PV cell

1. INTRODUCTION
Solar energy is one of the most important renewable energy sources and photovoltaic energy is very much important for metigating power demand in isolated region and urban area also. Progressive declining of conventional energy implies a promising role for PV power-generation systems in the near future. However, photo voltaic (PV) system has some advantages such as no moving part, little maintenance, diffuse radiation posing no health or environmental hazards, low noise and overall environmental friendly, so it is a great option to choose solar energy as an alternative good. But it has a great disadvantage that it cannot be produced power same in different weather conditions and different time of the day. The power will be more generated if photons of the solar energy strike on the PV panel with more energy. More energy will strike on the PV panel more temperature will be generated and electron-hole pairs. So we see temperature dependency of the PV panel. In order to maximize the power derived from the solar panel it is important to operate the panel at its optimal power point. However, due to the nonlinear nature of PV systems the current and power of PV array depends on the array terminal operating voltage. To develop the model of the PV it is important to gather knowledge about parameters of solar cell material, weather condition, illumination factor and temperature. At times due to lack of this information, the derived mathematical model may be inaccurate. An important consideration in achieving high efficiency in PV power systems is to match the PV source and load impedance properly for weather of full Sun ray's and cloudy condition, thus obtaining maximum power generation. Photovoltaic energy is subject to weather changes, and the amount of electricity produced by solar panels is highly unpredictable throughout the day. So maximum Power Point Tracking is very much important to get the optimul solution. To ensure MPPT it can be follow different control topologies as like; perturb and observe method, Constant voltage method and incremental conductance method (Hohm and Ropp, 2003), (Hohm and Ropp, 2000), (Faranda and Leva, 2008). Comparison Study of Maximum Power Point Tracker Techniques for PV Systems are discussed in (Zainudin and Mekhilef, 2010), (Moubayed et al, 2009), (Kumaril and Babu, 2011). Different algorithm for MPPT in rapid change of weather conditions are elaburated in (Tung et al., 2006), (Hussein et al., 1995). In these paper we develop the modeling equation of PV

panel and is approximted for both full sunrays and cloudy weather condition and finaly it is simulated in MATLAB coding for comparative study.

2. EQUIVALENT CIRCUIT OF THE SOLAR CELL

Solar panel cells are constituted with a p-n semiconductor junction and when exposed to the light, a DC current is generated. The generated current varies linearly with the solar irradiance [4] The equivalent electrical circuit of an ideal solar cell can be treated as a current source parallel with a diode shown in figure 1. The I-V characteristics of the equivalent solar cell circuit can be determined by following equations [4]. The current through diode is given by:

$$I_d = I_o\,[\,\exp\,(q(V + I\,R_s)/KT)) - 1] \qquad (1)$$

The solar cell output current:

$$I = I_L - I_d - I_{sh} \qquad (2)$$

By putting the value of equation (1) into (2), we get,

$$I=I_L-I_o[\exp(q(V+IR_s)/KT))-1]-(V+IR_s)/R_{sh} \qquad (3)$$

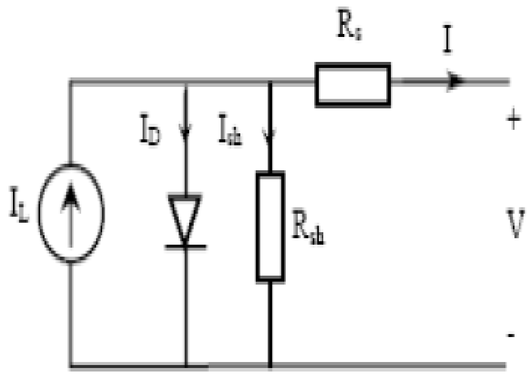

Figure 1 Equivalent electrical circuit of a solar cell.

3. MODELLING OF PV SYSTEM

The P-V characteristic of the solar panels is modeled by the following equation [7].

$$V_{pv} = N\lambda\,\ln\left(\frac{I_{SC}-I_{pv}+MI_O}{MI_O}\right) - \frac{N}{M}R_S\,I_{pv} \qquad (4)$$

This modeling equation is very complex to simulate and time consuming but more accurate [5]. For the simplicity of the simulation it is require to approximate the above equation. Due to temperature dependancy of the PV panel we approximate the model equation for both full Sun ray's and partial cloudy weather environment in different photo voltaic current level demand. The aproximate models are as follows:

Full Sun Ray's Condition: (Approximation)

$V_{pv} = -0.625*I_{pv}^2 + 45$; For $I_{pv} \leq 4$

$V_{pv} = -140*(I_{pv} - 4)^2 + 35$; For $4 \leq I_{pv} \leq 4.5$

$V_{pv} = 0$; For $I_{pv} \geq 4.5$

Partial Cloudy Condition: (Approximation)

$V_{pv} = -1.11*I_{pv}^2 + 42$; For $I_{pv} \leq 3$

$V_{pv} = -128*(I_{pv} - 3)^2 + 32$; For $3 \leq I_{pv} \leq 3.5$

$V_{pv} = 0$; For $I_{pv} \geq 3.5$

4. SIMULATION RESULTS OF THE MODELLING PV SYSTEM

For MATLAB simulation, we let the number of cells per string is 10, material coefficient is 3, short circuit current is 3.8A, saturation current is 0.000001A, series resistance of PV cell is 1Ω, number of parallel string is 16 to get the P-V characteristics. PV characteristics simulation result of the modeling equation is presented in figure 2.PV characteristics simulation result for the approximate modeling equation for full sun ray's condition presented in figure 3(a) and figure 3(b). PV characteristics simulation result for the approximate modeling equation for partial cloudy condition presented in figure 4(a) and figure 4(b).

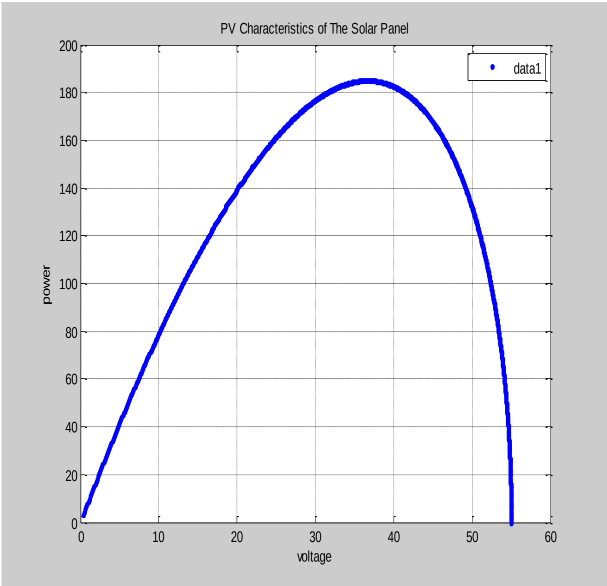

Figure 2 PV characteristics of the photo voltaic solar panel.

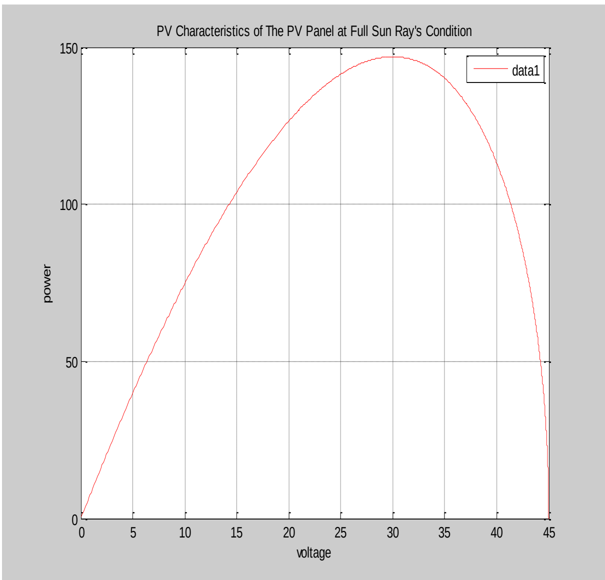

Figure 3(a) PV characteristics of the PV panel at full sun ray's condition for $I_{pv} \leq 4\ A$

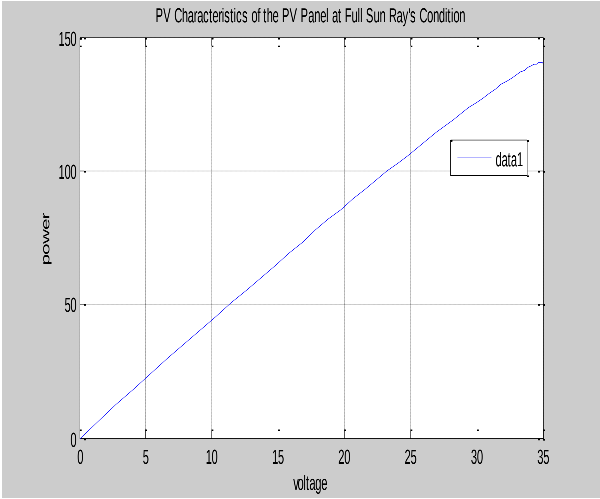

Figure 3(b) PV characteristics of the PV panel at full sun ray's condition for $4 \leq I_{pv} \leq 4.5$ A

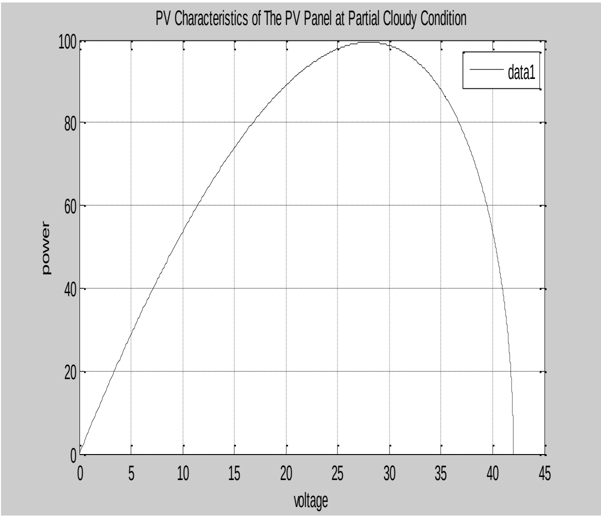

Figure 4(a) PV characteristics of the PV panel at partial cloudy condition for $I_{pv} \leq 3$ A

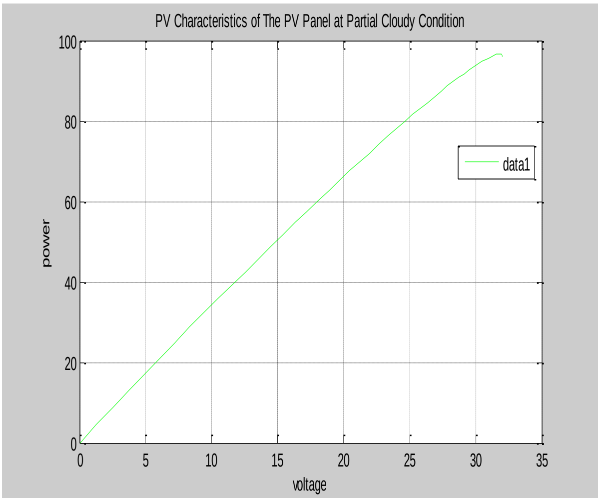

Figure 4(b) PV characteristics of the PV panel at partial cloudy condition for $3 \leq I_{pv} \leq 3.5$ A

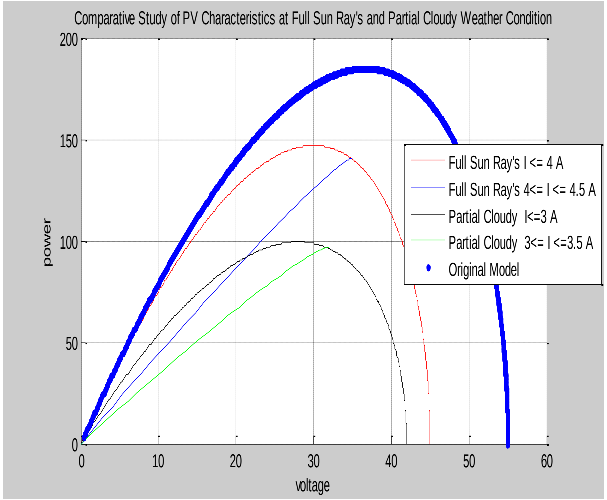

Figure 5 Comparative Study of PV Characteristics between Full Sun Ray's and Partial Cloudy Weather Condition.

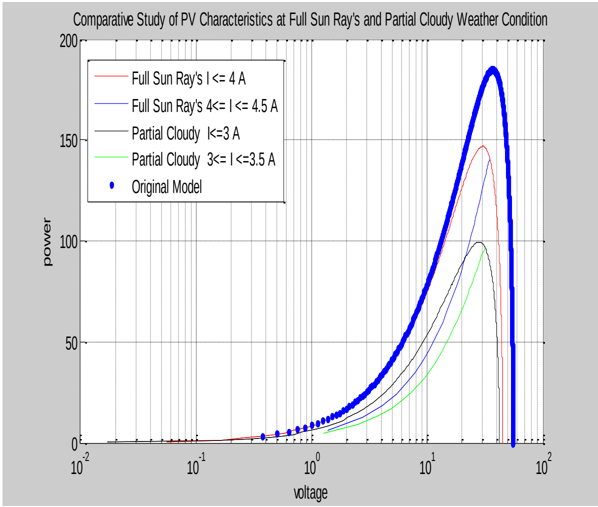

Figure 6 Comparative Study of PV Characteristics between Full Sun Ray's and Partial Cloudy Weather Condition in Logarithmic Scale

5. COMPARATIVE STUDY OF MATLAB SIMULATION RESULT BOTH FOR FULL SUN RAYS AND PARTIAL CLOUDY CONDITION

From the simulation result it is found the significance comparison in PV characteristics which are presented in figure 5. Also Comparative Study of PV Characteristics between Full Sun Ray's and Partial Cloudy Weather Condition is shown in figure 6 as Logarithmic Scale. From figure 5, the maximum power P_{max}= 185 *W* with respect to V_m=35 *V*. However it is time consuming to get maximum power from the original equation because it is very complex to calculate and coding. So it is needed approximation of the modeling for compensating time and effort. From the figure 5, the simulation result of approximated modeling and get maximum power generation 148.6 W with respect to voltage level 30 V in full sun ray's condition. On the other approximation, maximum power 100W generates corresponding to 28 V for partial cloudy weather condition. In different load demand MATLAB simulation are executed and find out the significance and satisfactory result. For simulation of the PV characteristics modeling equation we have to use some parameters which are enlisted in table 1.

Table 1 PV panel parameters for simulation

SL. No	Parameter	Value/ Quantity
1.	Number of Series Cells Per String	10
2.	Material Coefficient of PV Cell	3
3.	Short Circuit Current	3.8 A
4.	PV Saturation Current	0.000001A
5.	Series Resistance of PV Cell	1 Ω
6.	Number of Parallel String	16

6. CONCLUSION

This study presents a simulated comparison of the maximum power point tracking efficiencies in between full sun ray's and partial cloudy conditions.This paper has presented for modeling of maximum power point of PV arrays by combining source modeling one structure. From the analysis it can be found that in full sun ray's condition, 48.6 W more generation of power existed comparative to the partial cloudy condition by increasing only 2 V. Actually, from the simulation result we can focus that, in real modeling simulation we get higher power generation about 190 W and in approximation simulation, we get less power generation comparative to first one. Lastly at partial cloudy approximation very less amount of power we get comparative to first two cases which are actually tuned or obey the practical cases.

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