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PHOTOVOLTAIC PANEL'S PERFORMANCE IN MATLAB

[1]Gohar Rehman, [2]Kiranpreet Kaur
[1]M. Tech Student, [2]Assistant Professor
[1]Department of Electrical Engineering,
[1]Desh Bhagat University, Mandi Gobindgarh, Punjab(147301)

Abstract. Every country is seeking to enhance its energy efficiency and the adoption of innovative and renewable energy technologies in this sector. Solar energy is abundant, and one of them is free of charge. By minimising harmful gas emissions and pollutants in the air, there are also technological advantages that may be utilised to replace the usage of fossil fuels in specific settings with varied electrical and thermal requirements. Solar panels with photovoltaic technology have been characterised. Graphs of current, generated voltage, and power output have been used to examine and analyse the system's performance. The data reveal that when the temperature rises, the photovoltaic panel's performance diminishes, and the output power drops as the amount of solar radiation generated increases.

Index Terms: **Energy Supplies, Generated Voltage, Panel Temperature**

Introduction

Solar energy conversion systems take the sun's energy and convert it to electricity. The system must be installed in an area where natural energy flow can occur. Traditional fossil-fuel and nuclear power generating are not the same as renewable energy. Solar power generating has no fuel costs in compared to conventional and nuclear energy generation. The conversion of light (photons) to electricity is known as the solar photovoltaic (PV) effect (voltage). Photovoltaic technology solar cells turn sunlight directly into energy (electricity). Thin layers of semiconducting material with different charges on the top and bottom layers are used. To surround the semi-conducting component, a sheet of glass and/or a polymer resin might be utilised.

When exposed to sunshine, electrons in semiconducting materials absorb photons and become highly charged. These migrate between the top and bottom surfaces of the semiconducting substance. The flow of electrons produces a current known as a direct current (DC). The electricity is then sent via an inverter, which converts it to alternating current (AC) for use in your home.

Operation of a Photovoltaic Cell

A solar cell is simply a p-n semiconductor diode that is light-sensitive. Solar cells produce a variety of semiconductors that are used in a variety of industrial applications. The only commercially accessible silicone cells are mono crystalline and polycrystalline silicon cells. A thin bulk layer Si or a thin Si movie linked to the power outlets is used to make silicon PV cells. The p–n junction is designed on one side of the Si plate. On the sun-facing surface of the semiconductor, a thin metal grid is placed. The physical arrangement of a PV cell is seen in Figure 1. The PV cell's operation is governed by the fundamental photoelectric effect theorem. The photo-electrical effect is a phenomena in which a wavelength of sunlight causes an electron to be dismissed from the band as a conductor (metallic or non-metallic solids, liquids, or gases)[1]. Some of the solar energy that strikes the rear of a photovoltaic cell is absorbed by the semiconductor material. The valence band electron leaps into the conduction band when its energy surpasses the semiconductor's bandgap energy. An lit semiconductor field produces a pair of hole-electrons. The electrons created in the leading line can now freely travel about. The processes of electrical fields contained in PV cells push these free electrons to flow in a specified direction.

Electrical Model for PV Cells

Open circuit tension, short circuit current, and full PowerPoint are all instances of open circuit tension in the PV characteristic. A PV cell may produce the most electricity when it is at its most powerful. Datasheets for the same PV cell or module commonly include these characteristics. We can build a simple model using these parameters, but a more exact model would require more data. A similar circuit architecture is used to illustrate the ideal solar cell in Fig. 2. Based on a theoretical semiconductor operation, the essential equation for the I-V
characteristic of the ideal solar cell is:

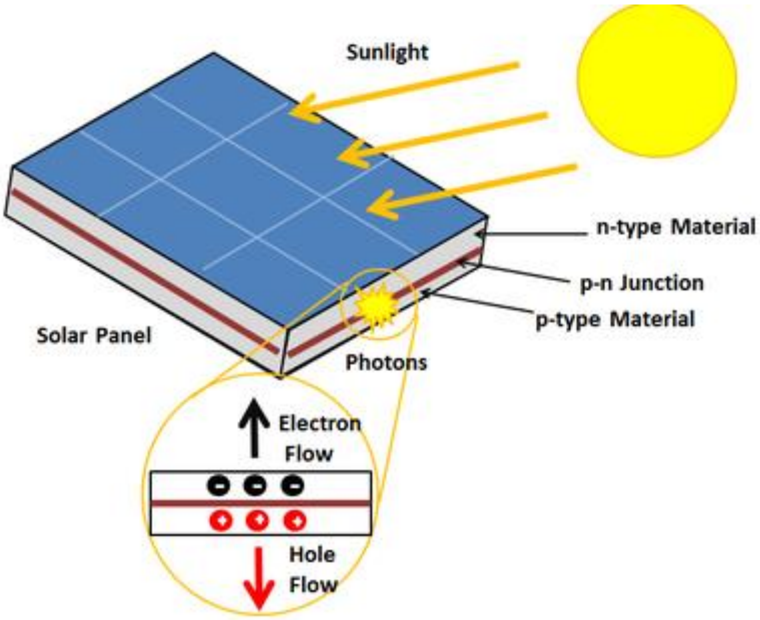

Fig. 1 Photovoltaic Cell

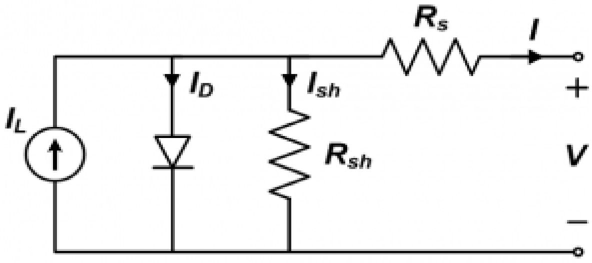

Fig 2: Single Diode Equivalent Circuit Model

$$I = I_{PV,cell} - I_{0,cell}\left[\exp\left(\frac{qV}{akT}\right) - 1\right] \quad (1)$$

It is the Shockley diode equation where I_{pv}, the current created by irradiation with sunlight is referred to as a cell, I_0.

Sun Hours at the Heart of the Day (PSH)

Throughout the year, the length of the day varies. The period of day when the sun's irradiation is similar to 1000 W/m2 is known as the highest hour of the day. As a rule of thumb, for every 200 days in a year, the minimum solar peak hours should be 4 hours. This indicates that a solar PV plant with a 1 kWp capacity can produce at least 4 kWh per day[2].

Title Angle of Solar Panels

The panels are put in place with a predefined alignment and tilt using a static panel setup. Several research have looked into different ways for determining this tilt angle. The tilt angle is calculated using the following formula:

$$Tilt \quad Angle = Latitude \quad \pm 15^{\circ} \quad (2)$$

Thus, the title angle is chosen as 20°.

Index of Clearness (CI)

The volume of ambient absorption to the ideal atmospheric state would be removed from the frequency of a solar constant by the solar irradiance attained on the globe. The two primary components of solar irradiance are diffuse sky irradiance and the direct beam component of global solar irradiance. A pyranometer and a density of W/solar m's radiation fluid are used to detect sun irradiation on a flat surface. The clarity index is calculated using pyrano meter data and the clear sky model (CI). The value of CI will range from "zero" to "one."

The number 'zero' implies that there is no radiation on the ground due to absolute cloud cover. On the other hand, the number 'one' is exceedingly valued. The value of 'one', on the other hand, indicates that the subject's whole theoretical volume has been earned. According to the definition of CI, the irradiance before dawn and after sunset must be zero when CI is used in some unusual situations. In certain assessments, such conditions may be overlooked[3]. Equation provides the CI calculation equation (3)

$$CI(t) = \frac{I_{pyranometer}(t)}{I_{model}(t)} \quad (3)$$

$I_{pyranometer}(t)$ is the Solar's actual radiation at times t and is the clear-sky solar irradiance from the solar mode [5] contain the clearness index for the clear-sky solar irradiance model? The correction factor for solar distance, solar altitude angle, corrective optical air mass for station height, and Rayleigh optical depth are all incorporated into the solar model to determine clear-sky solar irradiance.

Size of Solar PV System

The size of the necessary solar panels is influenced by a variety of parameters such as shadowing, albedo setting, and so on. This theory, on the other hand, does not address these traits. The size of the panels is determined by the insolation levels for each month, as well as the isolation level for a year and the site's stated total load. The successful zone of a solar panel is an area measurement that solar panels should have under typical operating circumstances, such as irradiance, s = 1000 W/m2, temperature, T = 25°C, and air mass, AM = 1.2.

$$A_{eff}\left(Panel\right) = \frac{P_{rated}\left(Panel\right)}{s \times \eta\left(Panel\right)} \quad (4)$$

where P rated (Panel) represents the solar panel rating in Watts, s represents the irradiance
under typical conditions, and (Panel) represents the solar panel quality [4]. The formula may be used to determine the number of panels required each month, N Panels, depending on the lowest irradiance level. Where the solar regulator's productivity is reg. and the insolation level in the lowest month (kWh/day/m2) is I lowest.

$$N_{Panels} = \frac{P_{L_{total}} \times 24}{I_{lowest} \times A_{eff}\left(Panel\right) \times \eta\left(Panel\right) \times \eta_{reg}} \quad (5)$$

Model of a Solar Panel

Solar cells can be linked together to create a larger system. A single sun cell block simulates a workspace variable. The number of parallel strings and the working space are controlled by the variable Np Cell. Each array's Ns cell specifies the number of series-connected cells. The parallel linking of numerous solar cell strings may cause the simulation to slow down as the number of components in a model grows[6]. A regulated current source with a size up to the current is required to satisfy the demand for the right number of parallel channels in order to avoid a drop in output. The new source is modelled using a current source block. The graphic shows current and power as a function of voltage for various irrdiance and cell temperatures.

Conclusion

In this research, solar cells are discussed, followed by a variety of photovoltaic panels now on the market that are being utilised in practise. Multi Junctions, Hot-carrier solar cells, and Ultrathin cells have all been investigated as distinct types of photovoltaic panels with various manufacturing materials and efficiency increase approaches. Various graphs were constructed for features such as panel temperature, solar irradiation, output existing, voltage produced, and output power[7] to further define and study the performance. The data reveal that when the temperature rises, the performance of photovoltaic panels diminishes, whereas the output power generated improves considerably with a greater solar irradiation value.

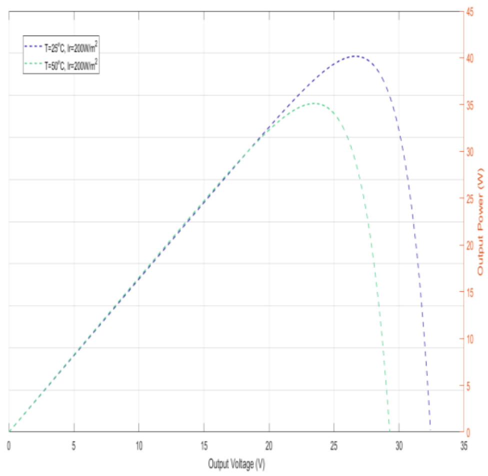

Fig. 3 displays the output power at 25°C and 200 W/m2 irradiances.

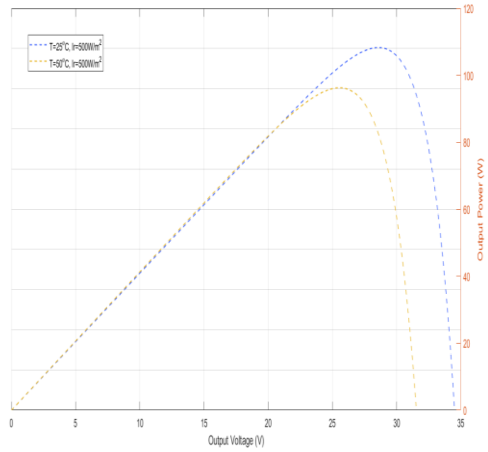

Fig. 4 shows Output Power at temperatures 25 & 50 °C for irradiance of 500 W/m^2

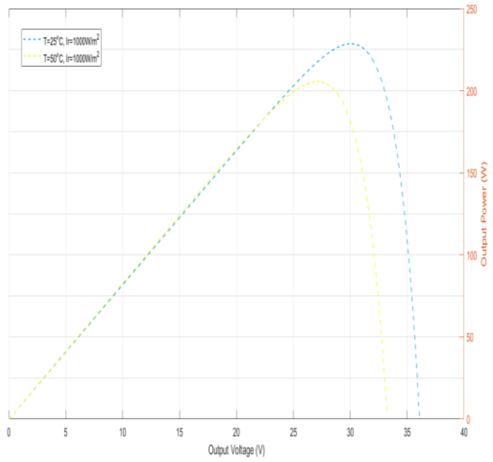

Figure 5 illustrates the output power for irradiance 1000 W/m2 at temperatures of 25 and 50 degrees Celsius.

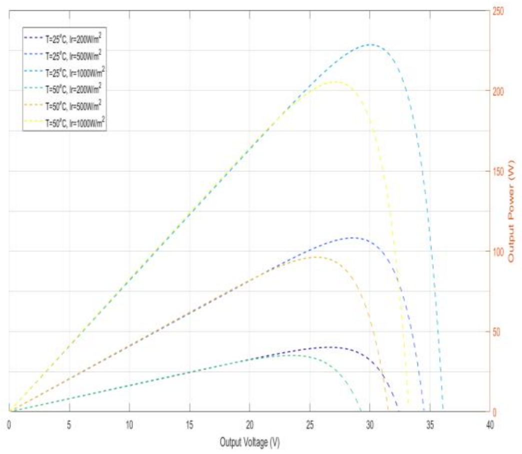

Fig. 6 Comparison of Output Power at different temperatures w.r.t Irradiance

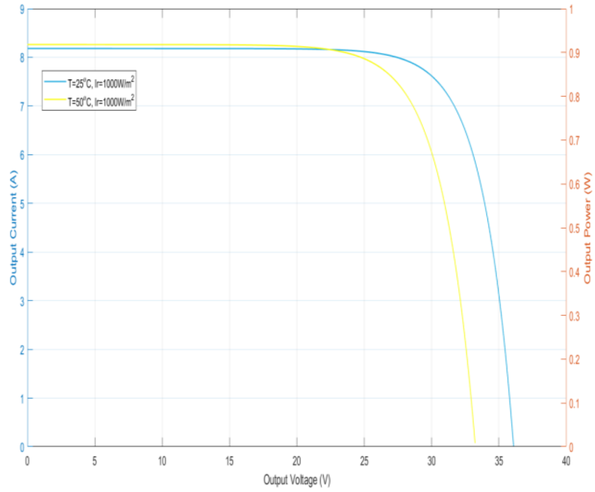

Fig. 7 Output Current at temperature 25 & 50 °C for irradiance 1000 W/m^2

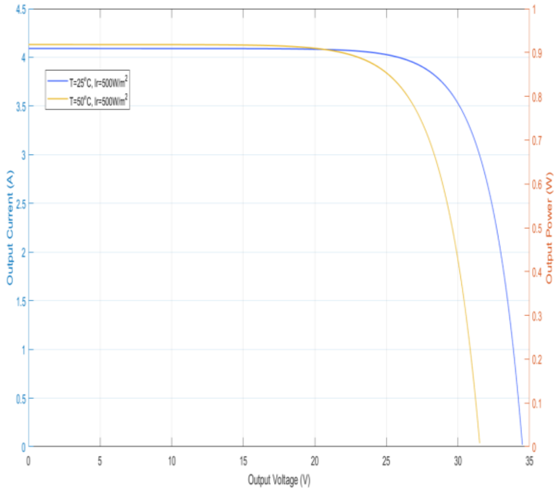

Fig. 8: The Result Current at 25 °C and 50 °C for 500 W/m2 irradiance

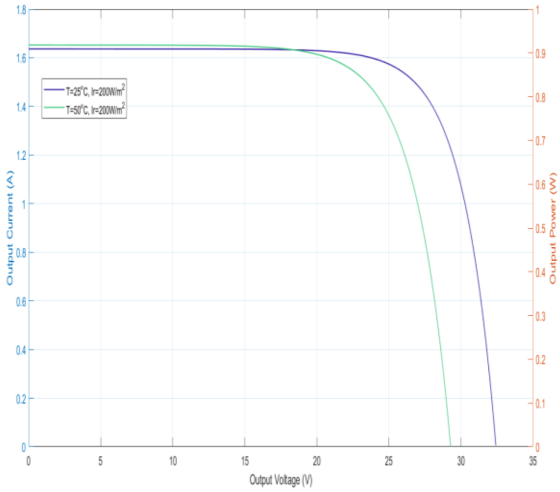

Fig. 9 Output Current at temperature 25 & 50 °C for irradiance 200 W/m^2

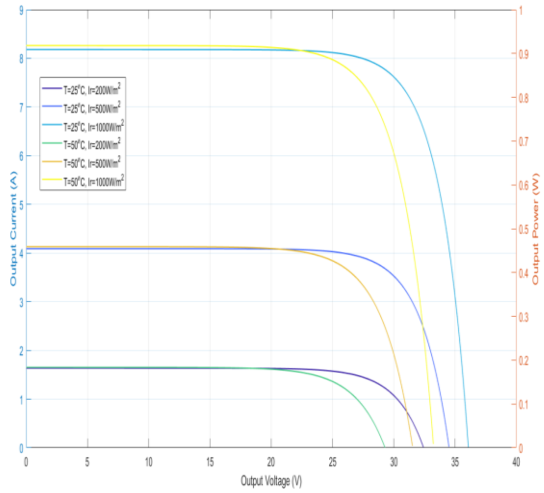

Fig.10 Output Current at a temperature at different irradiance w.r.t output power

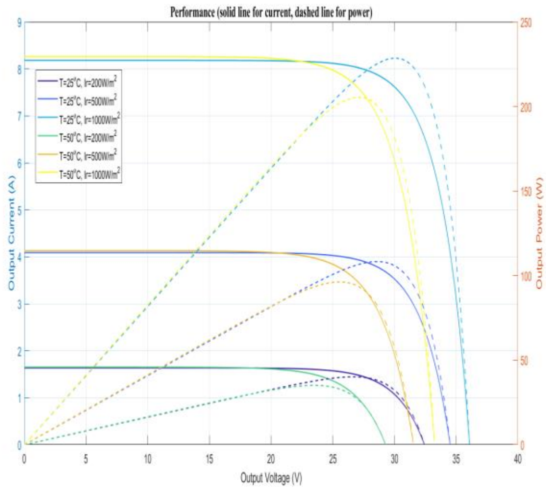

Fig. 11 Comparison of all observed values

Table 1
Shows the peak power values extracted from the plot

Panel Irradiance (W/m^2)	Cell Temperature (^{C})	Maximum Current (A)	Maximum Voltage (V)	Maximum Power (w)
200	25	1.5075	26.644	40.166
500	25	3.7903	28.57	108.29
1000	25	7.6027	30.06	228.54
200	50	1.4958	23.477	35.117
500	50	3.7667	25.557	96.267
1000	50	7.578	27.11	205.44

References

[1] Ackermann, Thomas, and Valery Knyazkin. "Interaction between distributed generation and the distribution network: operation aspects." In *IEEE/PES Transmission and distribution conference and exhibition*, vol. 2, pp. 1357-1362. IEEE, Oct 2002.
[2] Atallah, Ahmed M., Almoataz Y. Abdelaziz, and Raihan S. Jumaah. "Implementation of perturb and observe MPPT of PV system with direct control method using buck and buck-boost converters." *Emerging Trends in Electrical, Electronics & Instrumentation Engineering: An International Journal (EEIEJ)* 1, no. 1 (2014): 31-44.
[3] Faisal, Mohammad, Mahammad A. Hannan, Pin Jern Ker, Aini Hussain, Muhamad Bin Mansor, and Frede Blaabjerg. "Review of energy storage system technologies in microgrid applications: Issues and challenges." *Ieee Access* 6 (2018): 35143-35164.
[4]. Yoldaş, Yeliz, Ahmet Önen, S. M. Muyeen, Athanasios V. Vasilakos, and Irfan Alan. "Enhancing smart grid with microgrids: Challenge sand opportunities." *Renewable and Sustainable Energy Reviews* 72 (2017): 205-214.
[5] Lee, Eun-Kyu, Wenbo Shi, Rajit Gadh, and Wooseong Kim. "Design and implementation of amicrogridenergymanagement system." *Sustainability* 8, no. 11 (2016): 1143.
[6] *Othman, A. M., and H. A. Gabbar. "FACTS-based high-performance AC/DC microgrids." In Smart Energy Grid Engineering, pp. 221-235. Academic Press, 2017.*
[7] Ackermann, Thomas, and Valery Knyazkin. "Interaction between distributed generation and the distribution network: operation aspects." In *IEEE/PES Transmission and distribution conference and exhibition*, vol. 2, pp. 1357-1362. IEEE, 2002.