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MATLAB IS USED TO CHARACTERISE A SOLAR PANEL

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Abstract
Solar energy now contributes a very small and insignificant amount to global energy supplies, but it has enormous potential. A detailed characterization of photovoltaic solar panels is offered in this paper. To better characterise and study the performance of panels, the properties that act on it the most, for example temperature of panel, solar irradiance, output current, voltage generated, and output of power, are presented.
Keywords: Energy Supplies, Generated Voltage, Panel Temperature

INTRODUCTION

Solar power generation systems harness the energy of the sun and convert it to electricity. The system must be put in a location that allows for natural energy flux. Renewable energy is not the same as traditional fossil-fuel and nuclear power generation. In comparison to conventional and nuclear electricity generation, the solar power producing technology has no fuel expense.

2.PV CELL OPERATION

solar cell is essentially a light-sensitive semiconductor diode with a p-n connection. Solar cells generate a wide range of semiconductors, which are employed in a wide range of industrial applications.Monocrystalline and polycrystalline silicon cells are the only commercially available silicone cells. Silicon PV cells are made with a thin bulk layer Si or a thin Si movie coupled to the power outlets. On one side of the Si plate, the p–n junction is designed. A thin metal grid is applied to the surface of the semiconductor which is facing the sun. Fig.1 represents the physical layout of a PV cell.Fundamental photoelectric effect theorem governs PV cell's operation. The photo-electrical effect is a phenomenon in which sunlight of a specific wavelength causes an electron to be dismissed from the band as a conductor (metallic or non-metallic solids, liquids or gases). The semiconductor material absorbs some of the solar energy that strikes the back of a photovoltaic cell. When the valence band electron's energy exceeds the band gap energy of the semiconductor, it leaps into the conduction band. A pair of hole-electrons is produced by an illuminated semiconductor field.The electrons that were produced in the leading line can now move around freely. These free electrons are forced to pass in a specific direction by the operations of electrical fields present in PV cells.

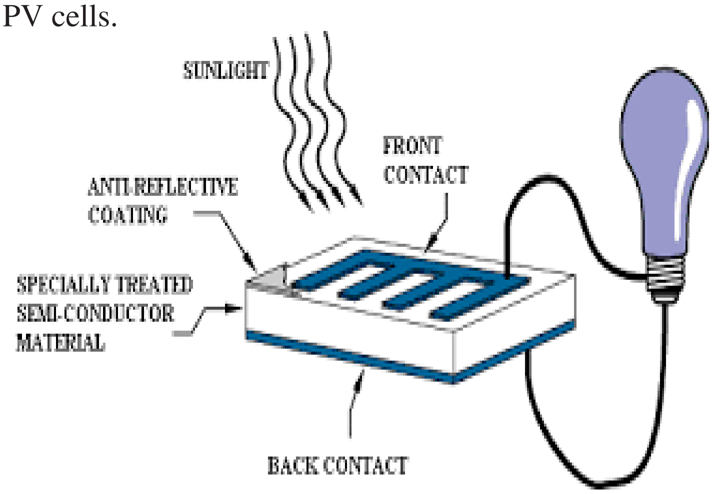

Fig. 1 PV cell

3.PV CELL ELECTRICAL MODEL

PV characteristic has three critical moments: open circuit tension, short circuit current, and full power point are all examples of open circuit tension. When a PV cell is at its most powerful, it can produce the most electricity. These specifications are frequently included in data sheets for the same PV cell or module. We can construct a basic model using these parameters, but we'll need more data to make a precise model.

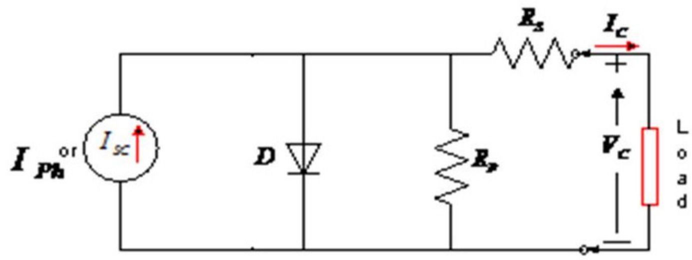

Fig 2: Single-diode photovoltaic cell model

In Fig. 2, the ideal photovoltaic cell is represented by a similar circuit model. The fundamental equation for the I-V characteristic of the ideal solar cell, based on a theoretical semiconductor operation, is:

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

Id is the Shockley diode equation where Ipv, the current created by irradiation with sunlight is referred to as a cell, I0.

3.1 PEAK SUN HOURS (PSH)

The length of the day fluctuates throughout the year. The highest hour of the day is defined as the time of day when the sun's irradiation is comparable to 1000 W/m2. The minimum solar peak hours should be 4 hours for every 200 days in a year, as a rule of thumb. This means that a solar PV plant with a capacity of 1 kWp can generate at least 4 kWh per day.

3.2 SOLAR PANELS TITLE ANGLE

It uses a static panel configuration, in which the panels are set in place with a predetermined alignment and tilt. Numerous studies discuss various methods for calculating this tilt angle. The following formula is used to calculate the tilt angle:

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

Thus, the title angle is chosen as 20°.

3.3 CLEARNESS INDEX (CI)

The solar irradiance obtained on the globe would remove the volume of ambient absorption to the optimum atmospheric state from the frequency of a solar constant. Diffuse sky irradiance and the direct beam component of global solar irradiance are the two basic components of solar irradiance. On a flat surface, a pyranometer and a density of W/solar m's radiation fluid are employed to monitor sun irradiation. The pyranometer data and the clear sky model are used to produce the clarity index (CI). CI will have a value ranging from "zero" to "one." Due to absolute cloud cover, the value 'zero' indicates that there is no radiation on the ground. 'One,' on the other hand, is extremely valuable.The value of 'one', on the other hand, denotes that the entire theoretical volume on the subject has been earned. When CI is utilised in some uncommon instances, the irradiance before dawn and after sunset must be zero, according to the definition CI. Such circumstances may be disregarded in some analyses. The CI calculation equation is provided by Equation (3)

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

is theSolar's actual radiation at times t and is the clear-sky solar irradiance from the solar mode[5] contains 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 in the solar model to determine clear-sky solar irradiance.

3.4SOLAR PV SYSTEM SIZE

A multitude of factors, such as shadowing, albedo setting, and so on, influence the size of the required solar panels. These characteristics, on the other hand, are not covered in this thesis. The insolation levels for each month, as well as the isolation level for a year and the site's stated total load, are used to determine the size of the panels. Under standard working conditions, such as irradiance, s = 1000 W/m2, temperature, T = 25°C, and air mass, AM = 1.2, the successful zone of a solar panel is an area measurement that solar panels should have:

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

where Prated(Panel) is the solar panel rating in Watts, s is the irradiance at standard conditions, and (Panel) is the solar panel quality [4]. The number of panels required on a monthly basis, N Panels, based on the lowest irradiance level, can be estimated using the formula:

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

Where,Theinsolation level in the lowest month (kWh/day/m2) is I lowest, and the solar regulator's productivity is reg.

4.SOLAR PANEL MODEL

By linking solar cells together, A workspace variable is simulated by a single sun cell block. The variable Np Cell controls the number of parallel strings and the working space. The number of series-connected cells is specified in the Ns cell of each array. As the number of elements in a model grows, the parallel connection of several solar cell strings may cause simulation to slow down.To avoid a reduction in output, a regulated current source with a size up to the current is necessary to match the demand for the appropriate number of parallel channels. A current source block is used to model the new source. For varied irradiance and cell temperatures, the diagram depicts current and power as a function of voltage.

5. CONCLUSION

Solar cells are discussed in this study, followed by numerous types of photovoltaic panels available on the market that are now being used in practise.Multi Junctions, Hot-carrier solar cells, and Ultrathin cells have all been studied as different types of photovoltaic panels with different production materials and efficiency enhancement methods.To better characterise and analyse the performance, various graphs were created for features such as panel temperature, solar irradiation, output existing, voltage produced, and output power. The findings show that when the temperature rises, the photovoltaic panel's performance decreases, and that with a higher sun irradiance value, the output power generated increases dramatically.

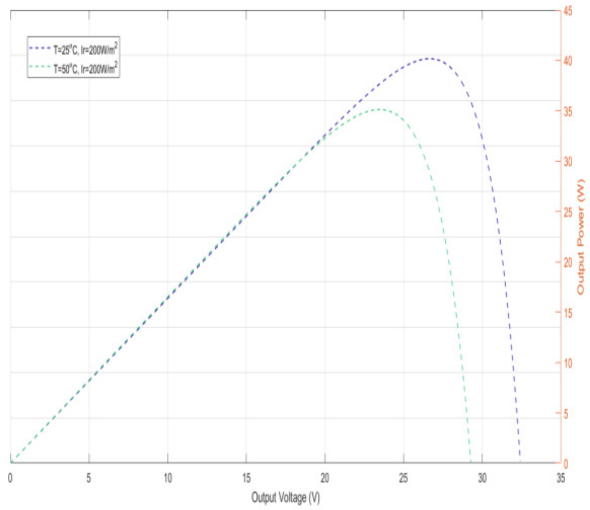

Fig. 3 displays the output power at 25°C and 200 W/m2 irradiance.

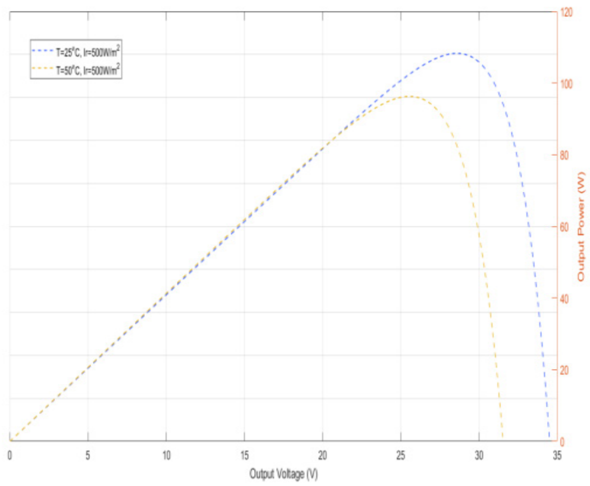

Fig. 4 shows Output Power at temperature 25 & 50 °C for irradiance 500 W/m2

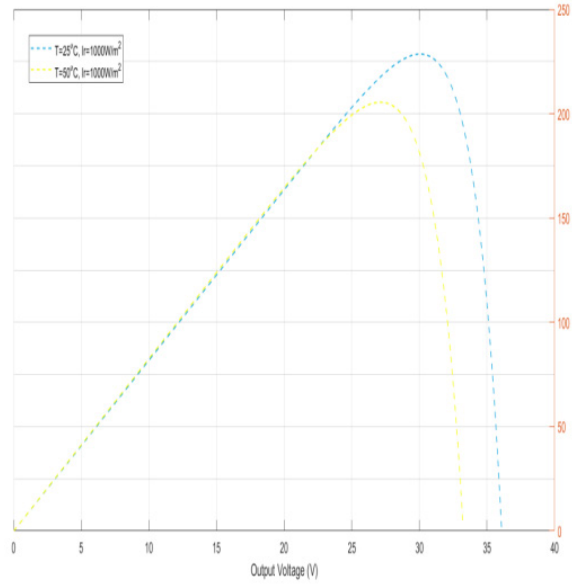

Figure 5 illustrates the output power for irradiance 1000 W/m2 at temperatures of 25 and 50 degrees Celsius.

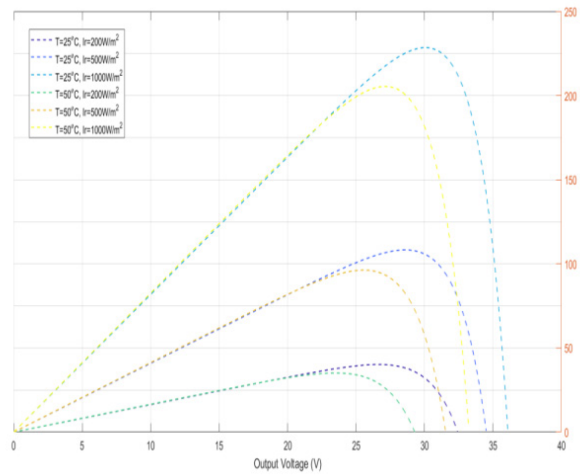

Fig. 6 Comparison of Output Power at different temperature w.r.t Irradiance

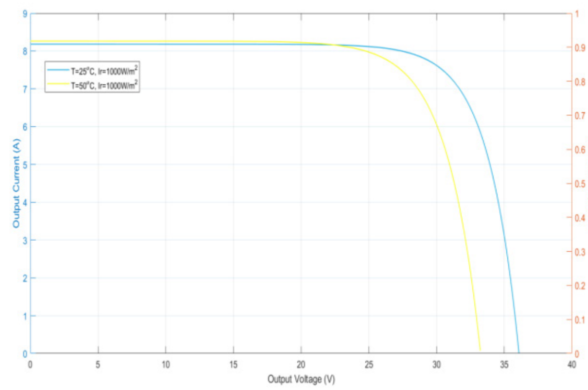

Fig. 7 Output Current at temperature 25 & 50 °C for irradiance 1000 W/m2

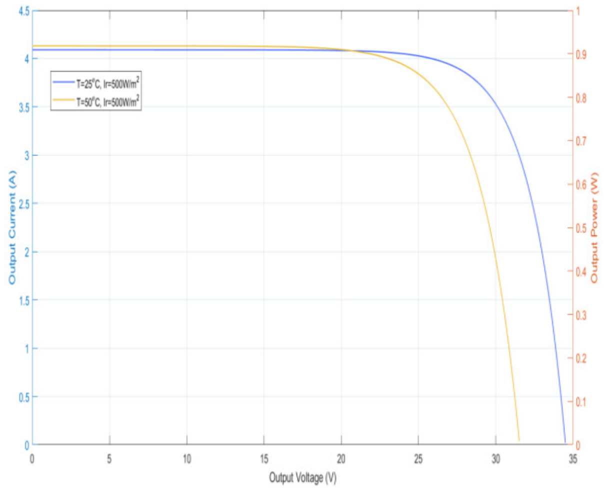

Fig. 8: The Result Current at 25 °C and 50 °C for 500 W/m2 irradiance

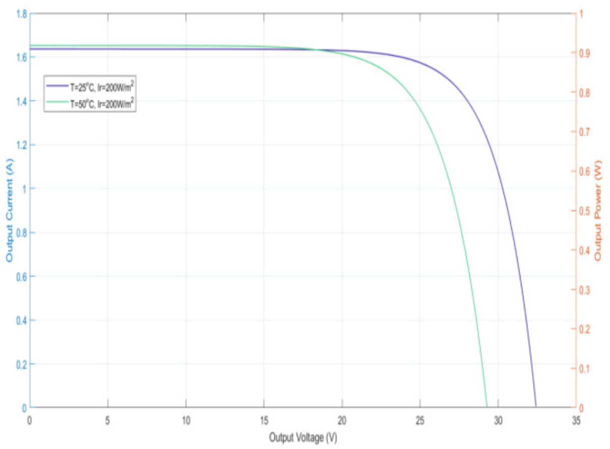

Fig. 9 Output Current at temperature 25 & 50 °C for irradiance 200 W/m2

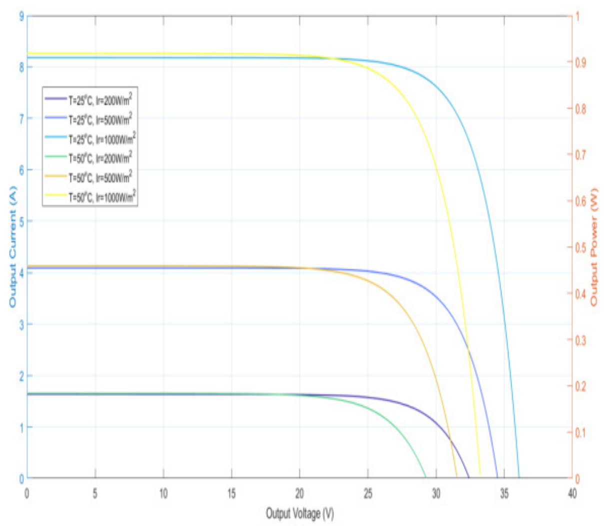

Fig.10 Output Current at temperature at different irradiance w.r.t output power

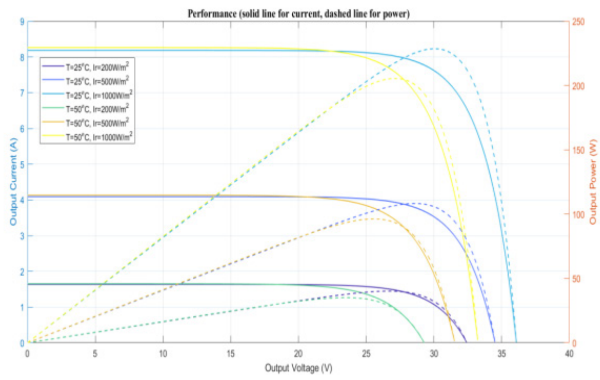

Fig. 11 Comparison of all observed values

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

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