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Effects of Radiation Variation and cloud moving on Solar PV system.

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Abstract

In this paper reviews the researches into the impact weather condition on solar Photovoltaic output , which are have direct influence to reduce of electric power which produced by PV cells . And there are many reasons impact on PV output such of dust deposition, temperature and clouds, furthermore, display influence of solar radiation variation on solar PV system. It was used a Matlab/SIMULINK to find the results achieved.

الملخص

نظرا للأهمية الكبيرة للخلايا الشمسية كمصدر للطاقة المتجدد والنظيف وللاهتمام المتزايد علي هذا المصدر تتناول هذه الورقة الخلايا الشمسية في شرح مبسط علي تركيبها ومكوناتها ثم التركز علي تأثير العوامل الجوية علي الخلايا الشمسية من شدة الإشعاع الساقط علي الخلايا كذلك علي تأثير حركة السحب وتأثير ظلالها علي المسطح الشمسي وكيفية التغلب علي هذه المشاكل, وتوضيح ذلك بالتجربة العملية وباستخدام برنامج الماتلاب.

1. INTRODUCTION

One of the most desirable outcomes from modern science and engineering is developing a clean and renewable energy.

Photovoltaic energy is a promising upcoming energy resources, one of the main important reasons behind its popularity is pollution free. add to that the solar energy is one of the most promising energy resources in the word now. However, there are many problems can be facing these renewable-energy sources (solar PV) which are from the weather such as cloud moving, temperature and effects of solar radiation variation and other problems.

2. Solar Panels (PV)

Solar panels contain an array of closely interconnected solar cells. Solar cells are typically semiconductor devices. solar panels (PV) is compound from [1]

- PV cell – thin, semiconductor wafer that converts sunlight to DC current.
- PV module – series and parallel cell circuits sealed in a protective laminate.
- PV panel – two or more modules assembled as a pre-wired, field-installable unit.
- PV array – complete it power-generating unit that consists of the required number of modules/panels.

Components of Solar PV Systems

1. PV Array
2. Battery charge controller
3. Combination of charger and inverter
4. Back-up generator
5. DC and AC load

Figure (1) explains Installation method of work solar PV systems. [1].

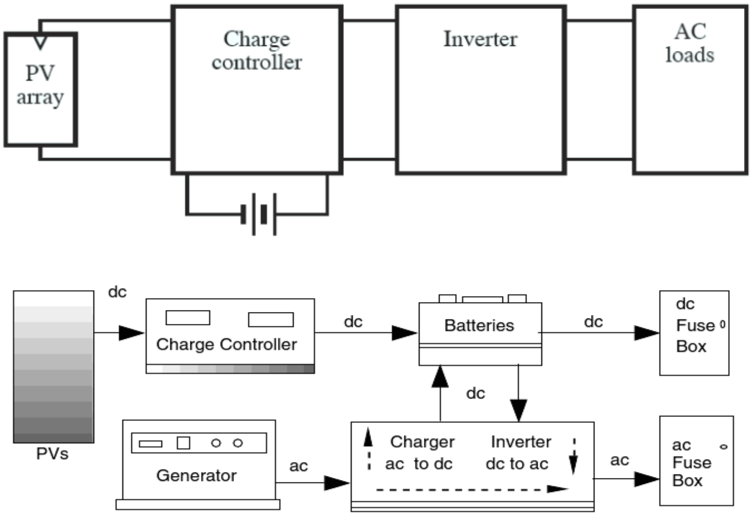

Figure (1) method of work solar PV systems.

3. cloud moving on Solar PV Output:

The functioning of solar PV is impacted by temperature, solar irradiance, shading and array configuration. Wholly or partially Shade can be caused by obstructions such as moving clouds, chimneys, trees, or nearby buildings. The situation is of special interest in case of big PV installations such as those used in distributed power generation systems. Under partly shaded conditions, the photovoltaic characteristics get more complex with more than one peak. Yet, it is very crucial to understand and predict them in order to draw out the maximum possible power. [2]

To understand affect the shading of PV system should be know the equivalent circuit model for a PV cell without shading which is consists of a real diode in parallel with an ideal current source and for a more realistic representation to the equivalent circuit we can add resistance in parallel to give effect of leakage current (RP) and resistance at the series to give effect of internal ohm's resistance

(RS) and as with any diode, there is an associated capacitance [3], so the equivalent circuit of PV system is as in the figure (2) below.

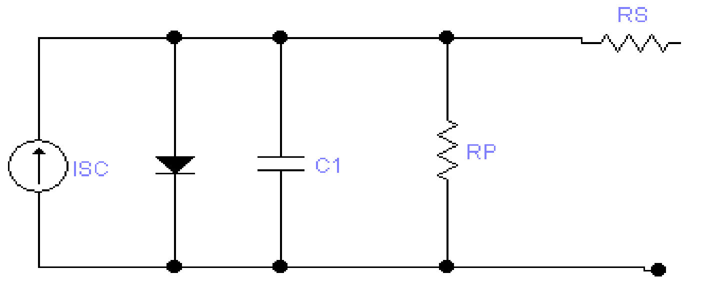

Figure (2) equivalent circuit of PV system

However, this capacitance is relatively small, so the effects on the output can often be neglected. So the equivalent equation [4] and circuit of PV system current is as the following in the figure (3):

$$\text{Ipv} = \text{Isc} - \text{Io}\left[\frac{q\left(v + \text{IRs}\right)}{\text{KT}} - 1\right] - \frac{V + \text{IRS}}{\text{RP}} \rightarrow 1$$

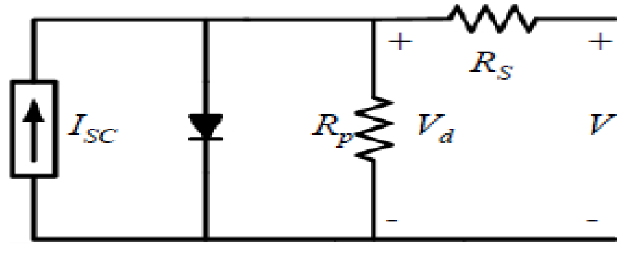

Figure (3) equivalent circuit of PV system current

With a shadowed module degrades the performance of the entire array and drops the voltage from Voltage (V) to different voltage (DV)، The equations explain that. [4,5]

$$V\ remaining \ = \ Vn-1 \ - \ I\left(RP+RS\right)\rightarrow 2$$

$$where.\ Vn-1 \ = \ V\left(n-1\right)/\,n$$

$$\Delta V = \ V \ - \ V\ remaining$$

$$= \ V - \ V\left(n-\ 1\right)/\,n+ \ I\left(\ Rp \ + Rs \ \right)\rightarrow 3$$

$$= \ V\,/\,n \ + \ I\left(RP+RS\right)$$

$$dV \approx \ V\,/\,n \ + \ IRP\rightarrow 4 \qquad Since\ RR»RS$$

The voltage drop problem in shaded cells could be corrected by adding a bypass diode across each cell. So a shaded cell experiences a drop as current is diverted through the parallel and series resistances.

A bypass diodes can mitigate the effects of shadows but they do not solve the issue completely. The following curve Figure (4) explain the effect of shading one cell in an n-cell module, no shading and affect bypass diode at shaded [4,5,6].

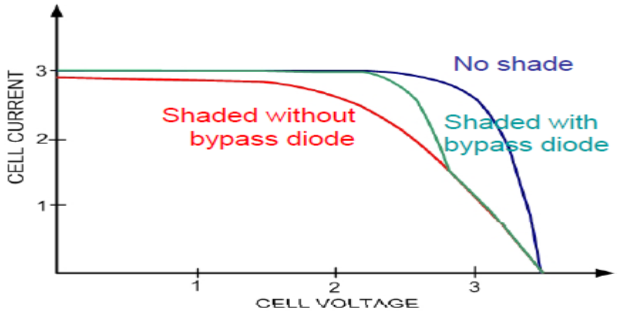

Figure (4) explain the effect of shading one cell

4. Solar Radiation Variation on solar PV system:

With no pollutant emission, Photovoltaic cells convert sunlight directly to electricity. In fact, when sunlight hits the cell, the photons are absorbed by the semiconductor atoms, freeing electrons from the negative layer. This free electron finds its path through an external circuit toward the positive layer resulting in an electric current from the positive layer to the negative one.

For calculates the PV cell photocurrent which depends on the radiation as in Equation number (2) below and By using the MATLAB/SIMULINK model of the this equation. [7,8,9] as in the figure (5) below:

$$Iph = \left[Isc + Ki\left(T - 298\right)\right]\frac{ß}{1000} \rightarrow 5$$

Ki=0.0017 A/.C is the cell's short circuit current temperature coefficient.

ß are the solar radiation (W/m2)

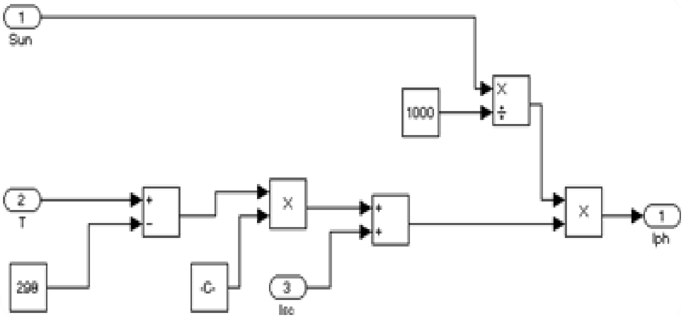

Figure (5) Iph Matlab/SIMULINK, subsystem for varying solar radiation.

5. Impacts of cloud moving and Solar Radiation Variation on Solar PV Output

To know the effect of radiation and clouds on solar PV system, it is used the following equipment, which consists of system for solar PV, a bypass diodes with daystar-meter of measurement radiation. It consists of a rheostat ,two digital multi-meters of measurement Current and Voltage, Watt-meter of Measurement Power and measurement cloud motion by (Develop a program that simulates the passage of clouds) as in the following figure (6) explain that and from the following table (1) shows the results obtained from previous experience.

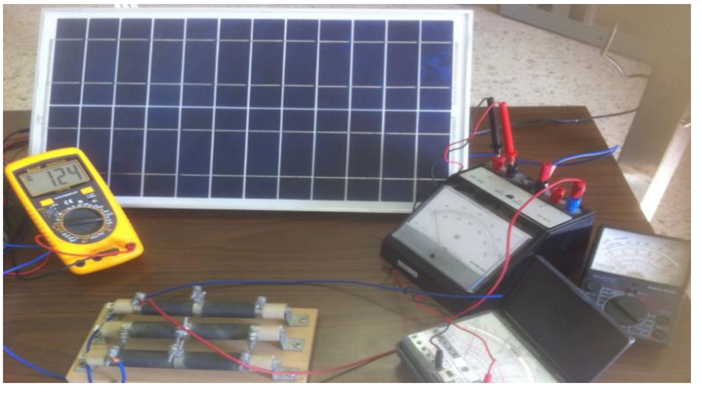

Figure (6) Practical circuit components

Table (1) the results obtained from previous experience.

solar radiation(mW/sq.cm)	Max Voltage (V)	Max Current (A)	Max Power (W)
100 (1 sun)	16.9	3.3	55.77
80	16.6	2.5	41.5
60	15.4	2.1	32.34
40	15	1.24	18.6
20	16.4	0.6	9.84

Here the MATLAB-based modeling and simulation scheme are used to estimate the I-V, P-I and P–V characteristics of a photovoltaic array under different cases due to partial shading. It can also be used for acquiring and assessing new maximum power point tracking methods, especially for partially shaded conditions. Moreover, it can be used as a means to study the effects of shading patterns on PV panel shaving dissimilar forms. It is followed that, for a set number of PV modules, the array configuration (refers to the number of series and parallel connections) importantly bears on the maximum usable power under partially shaded conditions.

We assume that solar PV with number of cell in one case is under full sun and get shadowed partially in the other cases S= (100, 80, 60, 40, 20) mW/sq.cm.

Figures (7), (8), (9) shows the simulation results which will be discussed in the next section

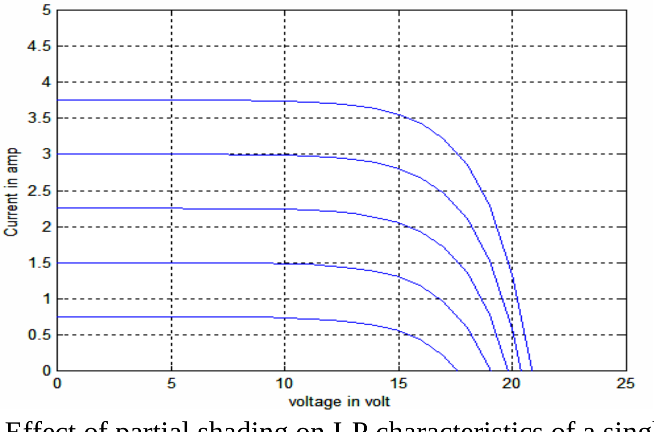

fig 7: Effect of partial shading on I-P characteristics of a single PV module

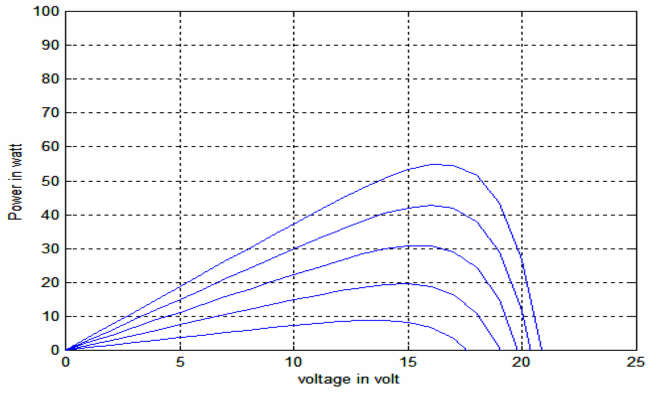

Fig8: Effect of partial shading on PV characteristics of a single PV module.

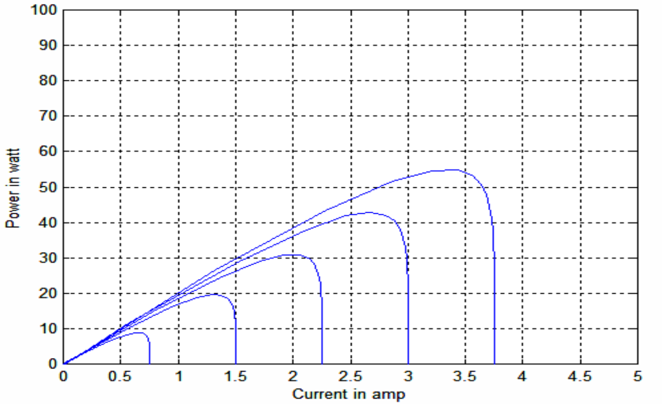

Fig 9: Effect of partial shading on I-V characteristics of a single PV module and different solar radiations.

6. Result discussion

From experience and curved, can be finding following:

- In the table shown the solar radiation was

S = (100, 80, 60, 40, 20) mW/sq.cm respectively

- From the figures above can be clearly seen the relationship between V-I , V-P & I-P curves.

- Figure (7) shows that the short circuit current (i.e. maximum current) generated by a solar cell or module is directly proportional to the solar irradiance with short circuit current level increasing as irradiance increases.
- The output voltage is also dependent on irradiance and increases slightly as irradiance increases which can be seen in figure (8).
- We can get the maximum power in each case by multiplying the maximum voltage in the fig (7) with maximum current in fig (8): $P\ max = V\ max * I\ max \rightarrow 6$

  $P\ max = 16.9 * 3.3 = 55.77w$
- From table (1) it can be see the results obtained with this model for different amounts of radiation, the Max Current has decrease from 0.6A to 3.3A when the solar radiation increased from 20mW/sq.cm to100mW/sq.cm and power increase from 9.84W to about 55.77W.

7. Conclusions and comment:

1) The measurements find that rapid cloud movement on solar PV system decrease their maximum power output from full power to about one-third of full power in approximately five seconds, which cause the problem of voltage flicker on distribution feeders.

2) The most severe condition in PV generation is encountered when sudden passage of a cloud bank sweeps the entire PV generator, resulting in large power. This condition can be further deteriorated if complete covering of PV arrays is associated with a sudden sharp change to load demand.

3) Cloud movement on solar PV system Lead to a change in the value and direction of the power on sub transmission and transmission may result in overloaded or under loaded lines. This lines and equipment may cause physical damage, and shorten equipment life. Because the Power relaying devices intended to allow one directional power flow may be falsely triggered. Under loaded lines may give cause for unacceptable voltage flickering or loss of service to the load. If the changes are rapid and significant, the utility may have difficulty adjusting to the changes in a timely fashion. These results are accompanied by high operating and productive costs for the utility to maintain its regulatory capacity.

4) To solve the effects of the shadows problem, we can use bypass diodes that increase the value of the electric current by using alternating current paths but do not completely solve the problem. so we can used small motors to control the direction of the solar panels.

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