

Experimental Study the Effect of Some Parameters to Improve Performance of Solar Cell

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ABSTRACT

The demands for electrical power are increasing. PV is one of the applications to produce electrical power, especially in areas have poor natural resource. In this study, an experimental investigation involves research on the optimum tilt angle for the power output and efficiency. The factors affecting the power output and efficiency of solar cell general are the ambient temperatures, tilt angle and natural particles polluting deposition outside the PV modules. In this study, five samples of solar cells are formed. The experiments were carried out in Kirkuk climate, Iraq, 2019. The experimental results showed that the best average power output of the ($\varphi=35^\circ$) at a rate of (45.4 W). The increment in the power output of ($\varphi=35^\circ$) is (81.5%) when compared with ($\varphi=0^\circ$).

KEYWORDS

Solar Cell, PV, Clean and Dirty cell.

INTRODUCTION

Clean energy results from natural sources such as the sun, ocean, sea, and wind; this technique guarantees that the energy stores are naturally replenished. Renewable energy is increasingly critical, mainly following the increase in environmental contaminant and the continuous alteration in petroleum oil cost. Photovoltaic power has been approved to stand in traditional power. Solar power has good potential and has several positive attributes as the immediate transformation technique built on solar photovoltaic, particularly in distant areas and deserts [1]. When photons of light fall on the cell, they transfer their energy to the charge carriers. The electric field across the junction separates photo-generated positive charge carriers (holes) from their negative counterpart (electrons) in the depletion zone and produce electromotive force [2, 3]. The basic substance feature of a semi-conductor may limit the system efficiency by about (15 – 20) % [4].

Various parameters, including environmental conditions, influence the efficiency of PV systems. Many studies in environmental conditions like (wind speed, temperature, and dirt accumulation). [5] investigated experimentally in the laboratory to define the influence of dirtiness on the output power of photovoltaic panels and performance. [6] revealed that the efficiency of photovoltaic cells reduction 0.485% by one $^\circ\text{C}$, after the temperature of photovoltaic panel surface rise from 25°C . M. Benghanem [7] discover that the loss in the amount of possessed solar radiation when using the yearly average fixed angle is around 8% compared with the monthly optimum slope angle. Ehsan F. [8] clears that the photovoltaic panel efficiency and fill factor influenced inversely with increases in the temperature. He shows that the voltage generated across the photovoltaic panel increase when cooled the panel by 11.8%. On the other hand, the output power is decreasing by the unclean panel. As a result, it deposits natural contamination on the surface of the photovoltaic panel.

Bhattacharya T. et al. [9] displayed a statistical study approach to defining the influence of wind velocity and air temperature on the efficiency of the solar cell panel. Finally, Dincer F. et al. [10] considered many factors that influence solar cell efficiencies, such as different cell temperatures and orientation with solar radiation. Tans et

al. [11] introduced an advanced technique in order to augment the photovoltaic model's minimize costs and transformation efficiency. [12 and 13] enhanced the performance of photovoltaic panels by sprinkling water on the top surface of the PV panels. [14] examined the impact of environmental contamination on the output generated by photovoltaic empirical, and they concluded that the output generation decreased about 92%. Qais M. [15] shows that the power output drops as the temperature rises. Compare to the experiential tests, in regard to output decrease percentage per temperature vary from one module to another, which are for Monocrystalline mode > Polycrystalline mode > Copper indium gallium mode. This search aims to discover the optimum tilt angles and the influence of ambient weather on the output electricity of photovoltaic panels empirically in Kirkuk city, Iraq. The experimental consideration was achieved using five same photovoltaic panels. One of these models is considered as a reference model to others. Furthermore, its performance has been compared with the other modules, which expand deposits, natural contamination on the top face of the photovoltaic panels.

EXPERIMENTAL WORK

The experimental tests are conducted using five cells with a maximum power output of 80 W. This mechanism consists of a moving pedestal that relocates at varied angles on a fixed stand and consists of orthogonal four pieces of Aluminum rods connected in a rectangular shape with fast screws that take long (0.94 m) and width (0.64 m). The orthogonal Aluminum pieces are connected in a rectangle with the exact dimensions as the fixed armrest and the PV units related to the test board, as shown in Figure (1). The board test consists of voltmeter, ammeter, and the lamp has a capacity of 10 watts (DC electric lamp) as shown in Figure (2).



Figure 1. Front view of test rig.



Figure 2. Back view of test rig.

The maximum power can be estimated by the following:

$$P_{\max} = I_{pm} * V_{pm} \quad (1)$$

And the estimation of ultimate output can be related to the open circuit voltage and short circuit current (I_{sc}) [18, 19].

$$P_{\max} = F_F (V_{oc} * I_{sc}) \quad (2)$$

Where, I_{sc} is short circuit current, F_F is fill factor, V_{oc} is open-circuit voltage.

The subscript m means the maximum power point in the modules I-V curve. Both the open-circuit voltage and the fill factor reduce substantially with temperature (as the thermally excited electrons begin to dominate the electrical properties of the semiconductor). At the same time, short-circuit current raises, but only slightly [20]. Where F_F Fill factor of the photovoltaic panel. It is a measure of the photovoltaic panel quality, can be calculated graphically as the ratio of the rectangular areas clear in Figure (3).

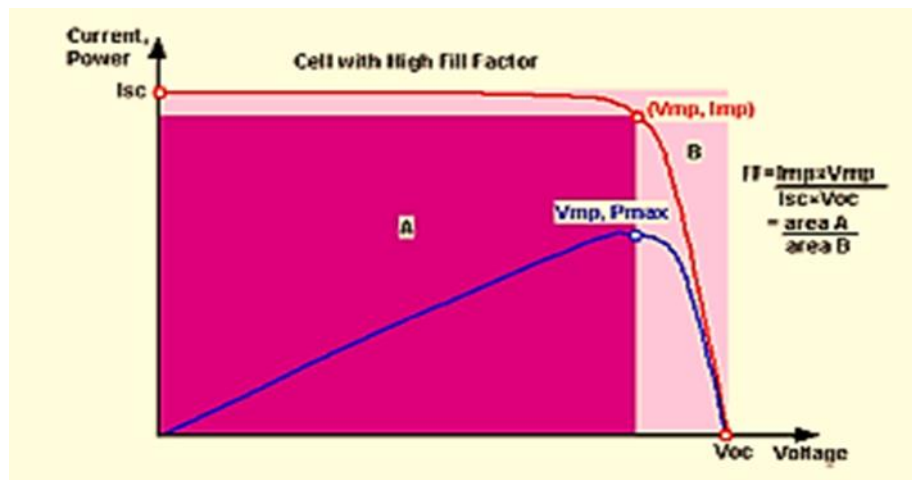


Figure 3. A typical current-voltage and maximum power curve.

According to the earlier description and Figure (4), the F_F can be formulated as:

$$FF = \frac{\text{area A}}{\text{area B}} = \frac{I_{mp} \times V_{mp}}{I_{sc} \times V_{oc}} \quad (3)$$

the solar radiation fall and photovoltaic panel area. The estimation of mode efficiency can be calculate by:

$$\eta = \frac{P_{\max}}{G \times A_c} \quad (4)$$

During three months (July, August, and September), the authors studied the effect of air temperature and solar radiation intensity. The execution of the experiment was by using five cells. The readings were taken at three different angles (20, 35, and 50) to obtain the best output power and solar cell efficiency. In addition, some of the solar cells were cleaned periodically. In contrast, another cell was left without cleaning during experiments to find out the effect of dust on the efficiency of the solar cell.

RESULTS AND DISCUSSION

Different experimental tests were performed to investigate the different effects on the output power and efficiency of the solar collector cell. These experiments can be summarized as follows:

- 1- Testing the output power of solar collector cell with different tilt angles.
- 2- Testing the impact of ambient weathers on the power output of photovoltaic panels empirical.
- 3- Testing the performance between cleaning solar collector cell and dirty.

Figure (4) shows the variation of the monthly ambient temperature during the three months of the year in Kirkuk city, 2019. As is known, the meteorological parameters, in particular, the array temperature, do not remain steady throughout the day but change dramatically. Hence it is worth investigating the effect the daily average temperature change depends on the optimum system performance. It shows several the temperature data between 42 and 46.8 °C in July and 39.1 and 53.7 °C in August, and 34.1 and 44.5 °C in September. Figure (5) shows the variation of solar radiation intensity during the three months of the year, Kirkuk city, 2019. It is presenting that the total hourly solar radiation intensity decreases from July up to September. The peaks for all months are between 10:30 AM and 1:30 PM. The main influences that change cell efficiency are ambient temperature, solar radiation intensity. The variety of power output for the photovoltaic cell for different tilt angle operations (five angles) is illustrated in Figure (6). It observed that the best average power output of the ($\phi=35^\circ$) at a rate of (45.4 W) due to oriented perpendicular to the sun's rays.

The orientation of a PV module can be specified by two angles: the tilt angle ($\phi=35^\circ$) and the azimuth angle ($\gamma=0^\circ$) and thus maximize the incident beam radiation. The second angle ($\phi=50^\circ$) generates average power output at a rate of (37.4 W). The third angle ($\phi=20^\circ$) generates average power output at a rate of (26.7 W). The fourth angle ($\phi=7^\circ$) generates average power output at a rate of (37.7 W). The lower average power output of the ($\phi=0^\circ$) at a rate of (23.5 W). Figure (7) shows the increment in the power output of ($\phi=35^\circ$) is (81.5%) when compared with ($\phi=0^\circ$). When comparison the ($\phi=35^\circ$) with ($\phi=20^\circ$) the increase is (71%), with ($\phi=75^\circ$) is (51.2%) and with ($\phi=50^\circ$) is (39.4%). These all compare with the ($\phi=0^\circ$). In the present work, a tilt solar cell that ($\phi=35^\circ$) is chosen as the best tilt angle because it gives (81.5%) increase when compared with ($\phi=0^\circ$). Apply the experimental procedure presented in Figures (8, 9, and 10). A systematic series of measurements were performed for several Periods corresponding to different dust deposition densities. During the three months (July, August, and September), the experimental analysis was performed. In particular, performing a clean matrimonial painting contaminated plate was compared with different amounts of accumulated natural air pollution on PV roofs during three months.

The experiment was always taking place under a clear sky. Usually around noon (solar irradiance between 700 and 900 W/m², under different weather conditions (such as the surrounding environment Temperature, humidity, wind speed, etc.) every time. The measurements recorded the photovoltaic panels and the environmental values Temperature, solar radiation, and solar irradiance. Figure (8) represents the change in the efficiency of the clean and dirty cell to the time. Results noted that the efficiency rate for the clean cell was up to 8.9% in July, while the dirty cell was up to 7.8%. The low efficiency of the dirty cell system is due to natural air pollution during the month. The efficiency difference between the two modes of the solar cell from clean and dirty ranged 1.1%. Figure (9) represents the change in the efficiency of the clean and dirty cell to the time. Results remarked that the efficiency rate for the clean cell in August is up to 8.1%, while a dirty cell is up to 6%. The low efficiency of the dirty cell system is due to natural air pollution during the month. The efficiency difference between the two modes of the solar cell from clean and dirty ranged 2.1%.

Figure (10) represents the change in the efficiency of the clean and dirty cell to the time. Results showed that the efficiency rate in September for the clean cell is up to 8.9%, while a dirty cell is up to 7.6%. The low efficiency of the dirty cell system is due to natural air pollution during the month. The efficiency difference between the two modes of the solar cell from clean and dirty ranged 1.3%. The variations in power output for different months (7, 8, and 9) increase with increasing solar radiation, as seen in Figures (11 and 12). The results also show that clean cell is higher than dirty cell for all other months (7, 8, and 9) and reason, as mentioned earlier. At the clean cell, the average power output in July, August, and September have been obtained as 43.8 W, 37.4 W, and 37.3 W, respectively. On the other hand, at the dirty cell, the average power output in July, August, and September has been obtained as 38.2 W, 29.7 W, and 31.7 W, respectively. Figures (13, 14, and 15) are clear that the hourly efficiency of the clean solar cell will decrease between 8:00 AM and 2:00 PM. This is because the ambient temperature will increase with the increasing solar radiation, affecting solar cell efficiency. The optimum efficiency is in September month due to cold ambient temperature compared to other months.

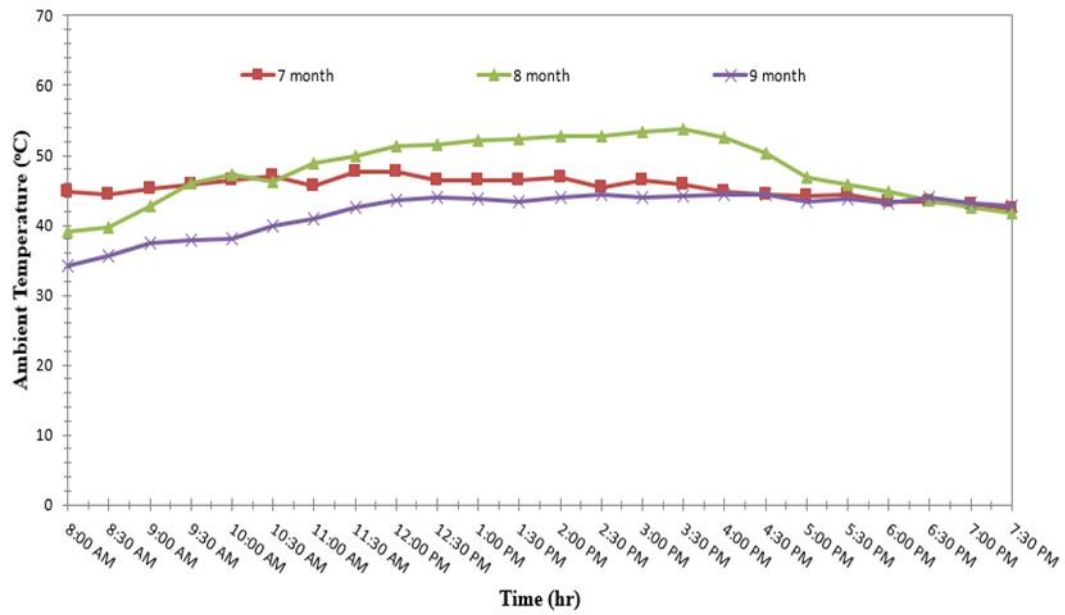


Figure 4. The variation of the monthly ambient temperature.

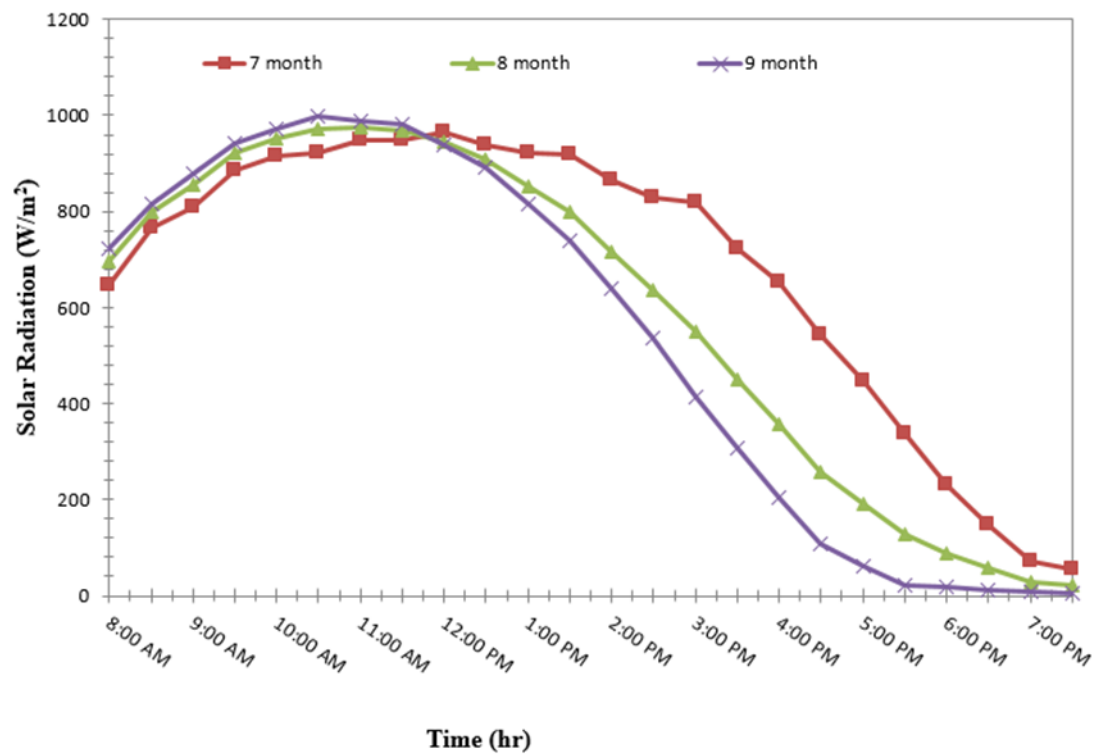


Figure 5. Shows the variation of solar radiation intensity.

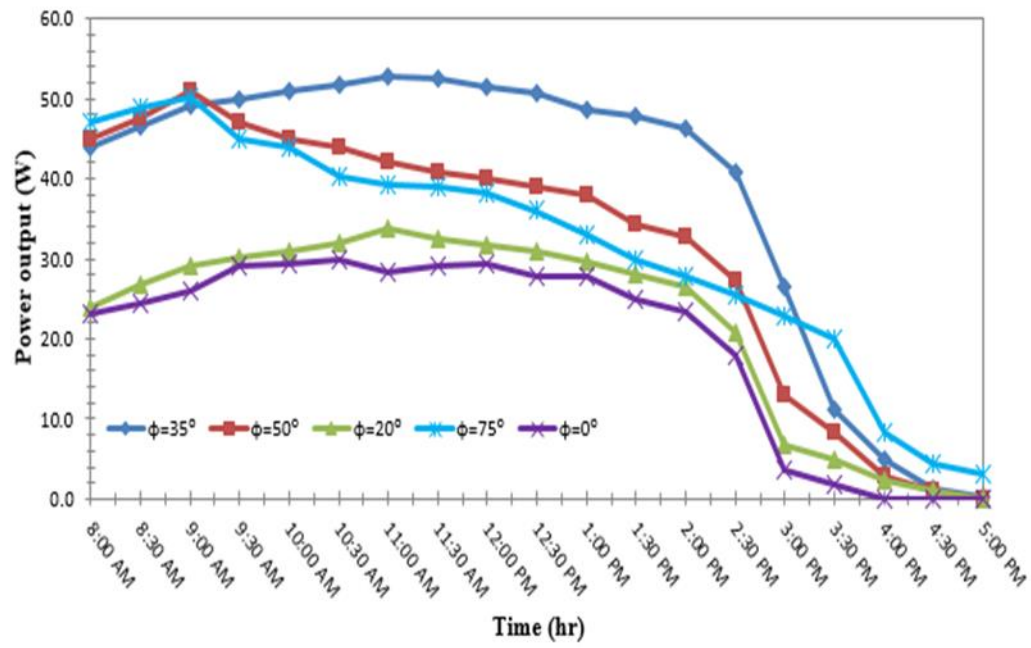


Figure 6. Relation between power output and variety of the tilt angle.

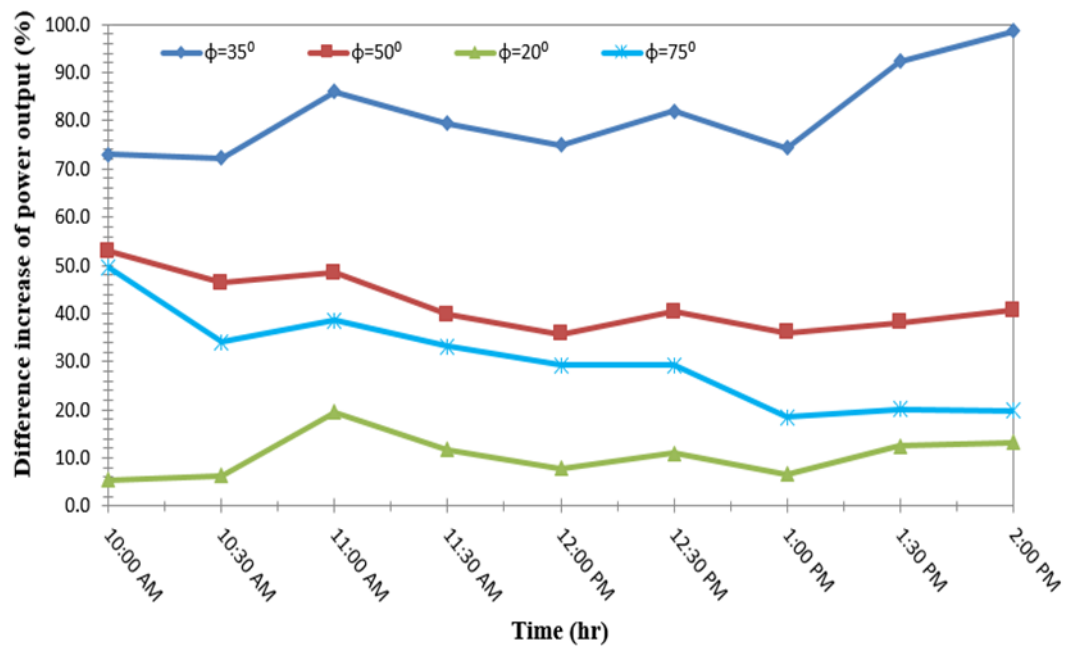


Figure 7. The relation between the power output and tilt angles

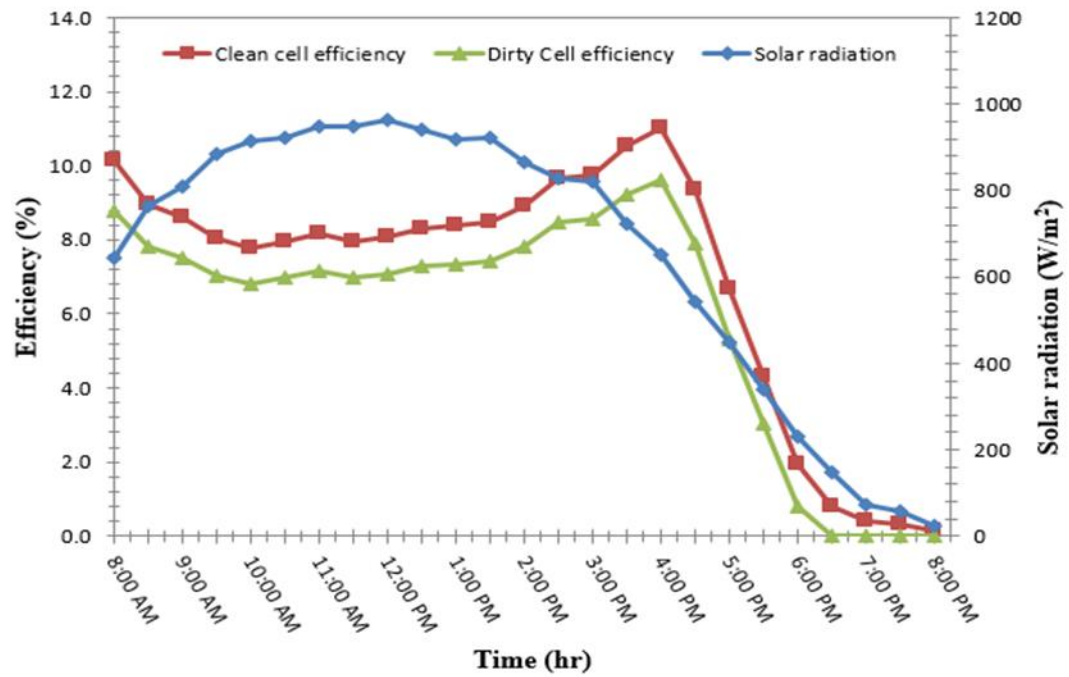


Figure 8. Variation of solar radiation and PV efficiency for the clean and dirty solar cell on Jul. 17, 2019.

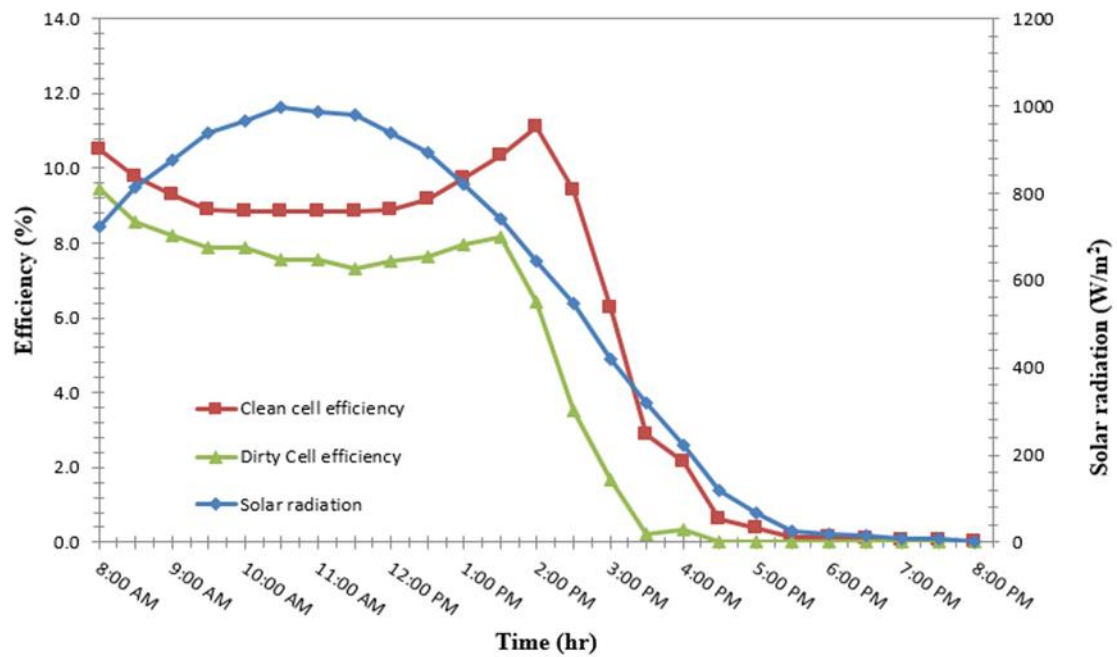


Figure 9. Variation of solar radiation and PV efficiency for the clean and dirty solar cell on Aug. 16, 2019.

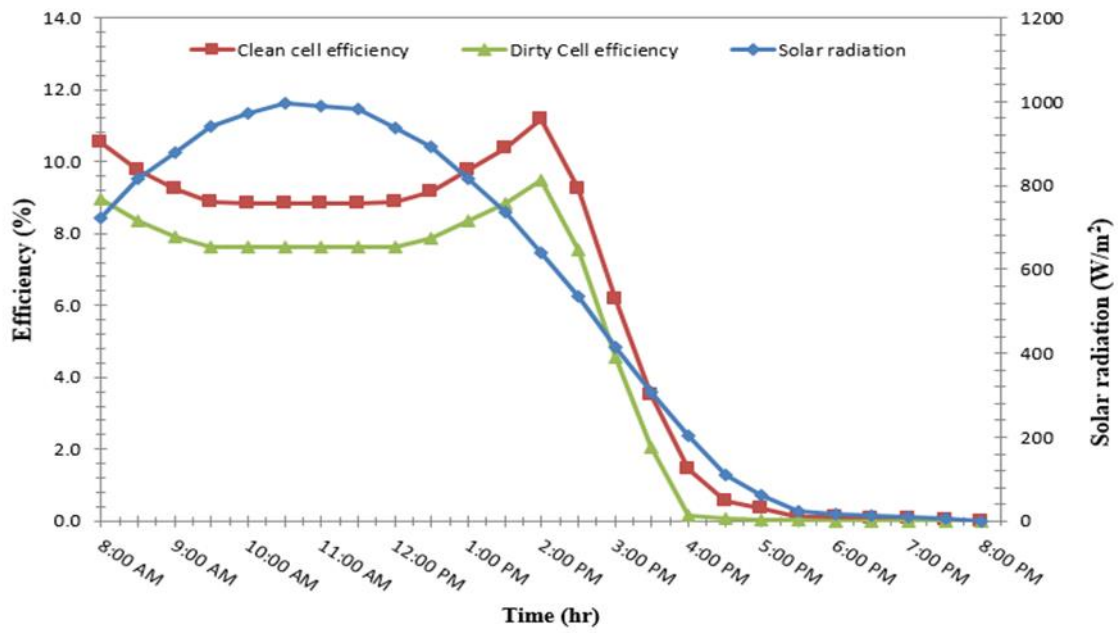


Figure 10. Variation of solar radiation and PV efficiency for the clean and dirty solar cell on Sep. 15, 2019.

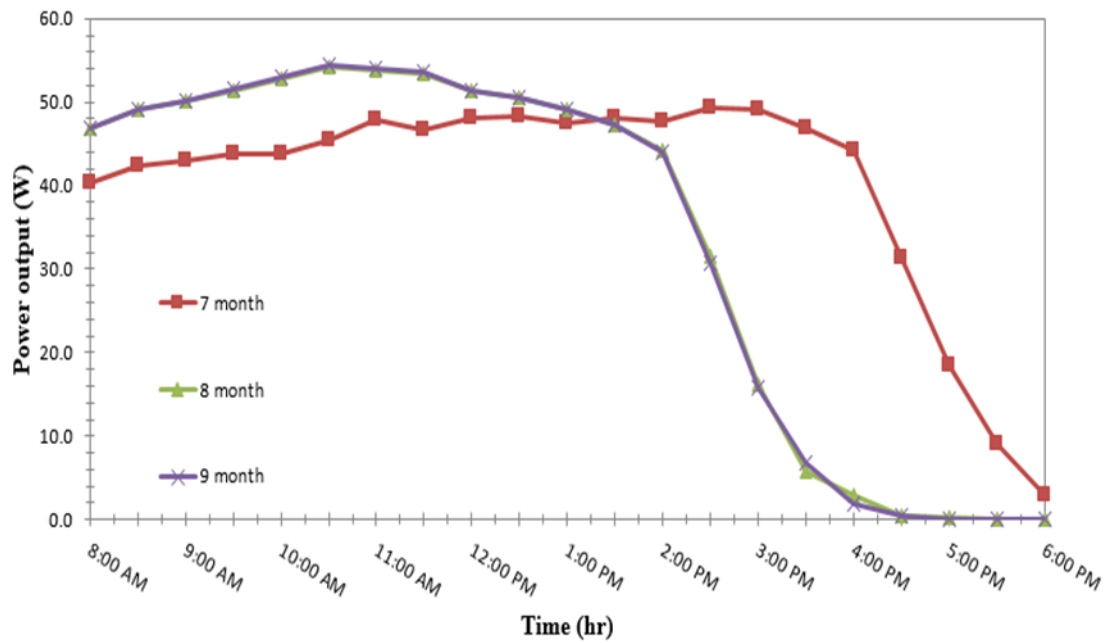


Figure 11. The variations in power output for different months for the clean solar cell.

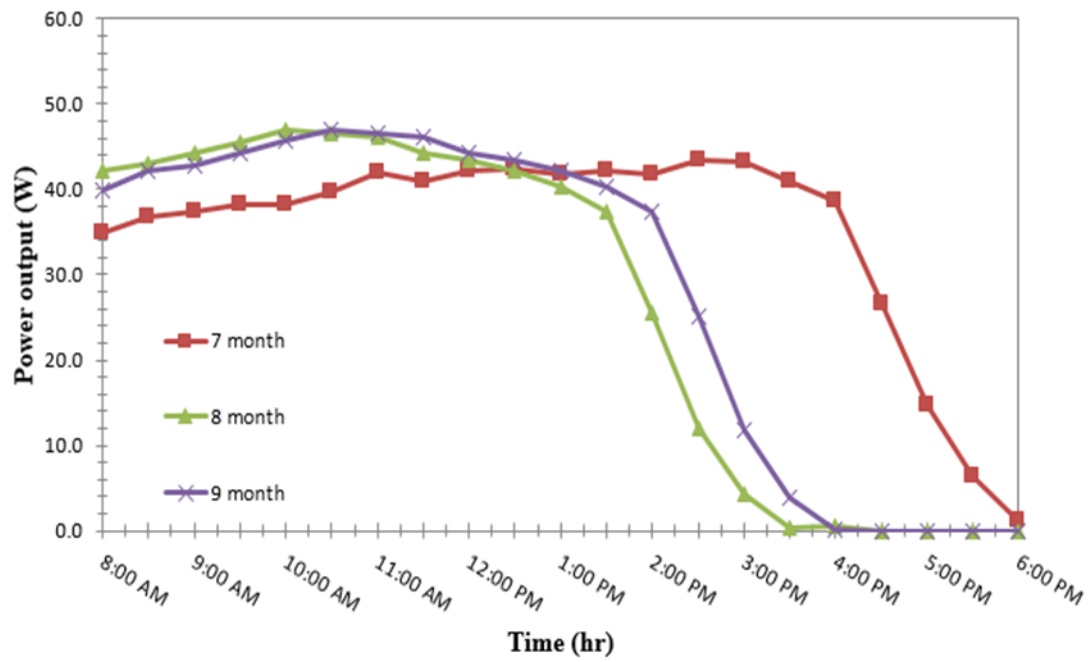


Figure 12. The variations in power output for different months for the dirty solar cell.

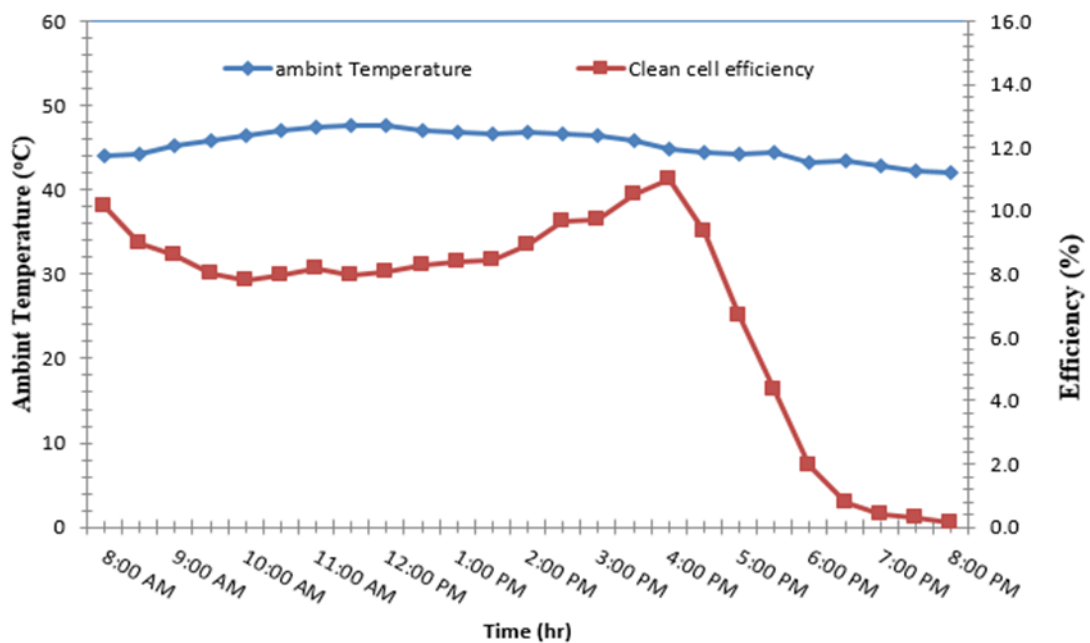


Figure 13. Variation of ambient temperature and PV efficiency for the clean solar cell on July. 17. 2019.

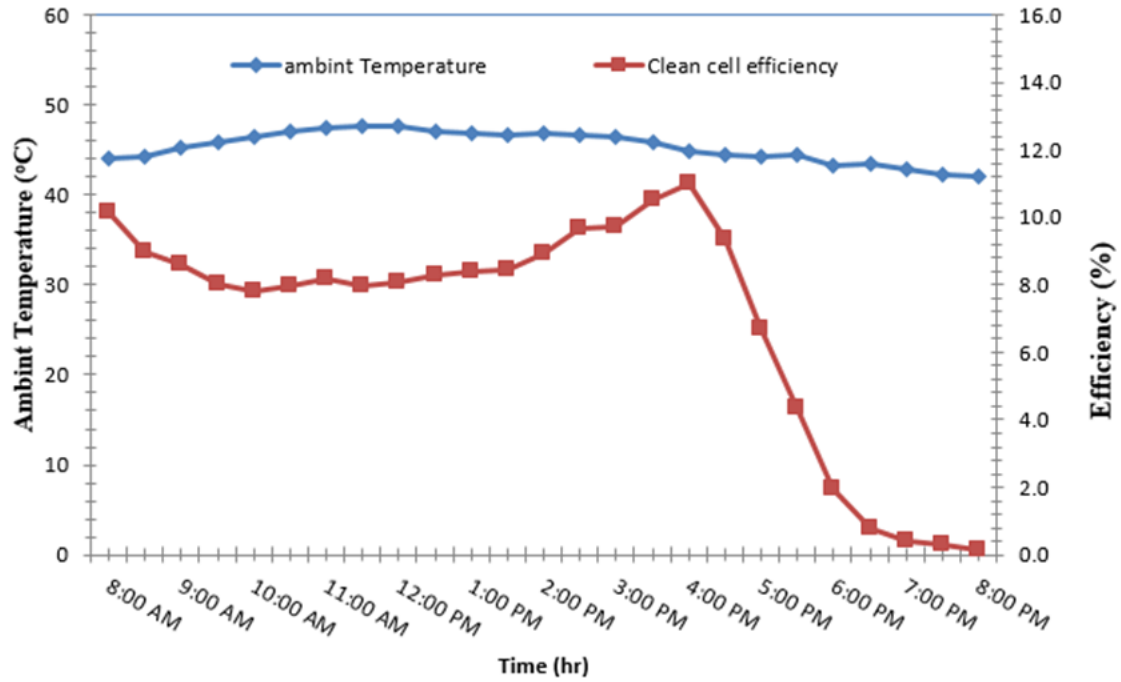


Figure 14. Variation of ambient temperature and PV efficiency for the clean solar cell on Aug. 16, 2019.

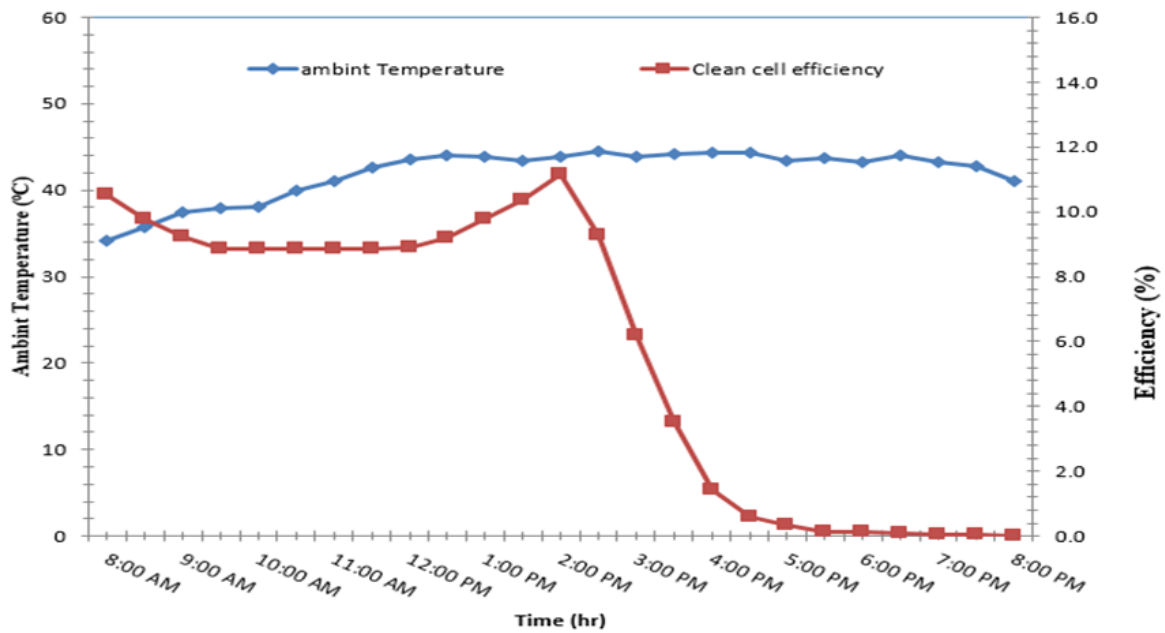


Figure 15. Variation of ambient temperature and PV efficiency for the clean solar cell on Sep. 15, 2019.

CONCLUSION

The sun as an energy source is recognized as very interesting renewable. Photovoltaic power has been allowed to stand in traditional power. Solar power has good potential and has many positive characteristics as the immediate transformation system established on solar photovoltaic, particularly in distant areas and deserts. The experimental tests are conducted using five cells to investigate the influence tilt angles and the ambient weather on the performance of photovoltaic panels. The results concluded the following:

1. The best average power output of the ($\varphi=35^\circ$) at a rate of (45.4 W).
2. The increment in the power output of ($\varphi=35^\circ$) is (81.5%) when compared with ($\varphi=0^\circ$).
3. The average efficiency difference between the two modes of the solar cell from clean and dirty ranged 1.5%.
4. . The optimum efficiency is on September month.

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