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Using Calling and Shading Materials for Increasing Photovoltaic Solar Module Efficiency for Pumping Irrigation Water in the New Valley

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Abstract

Solar energy is one of the main promising clean energy sources in future of the world. The technology of photovoltaic systems (PV) has continuous development with many applications. So, it is generate electricity without dangerous effects in the environment. Today, photovoltaic systems are largely used in rural electrification, and grid connected system water pumping irrigation and remote check point etc. Solar cell performance decreases with increasing temperature, fundamentally owing to increased internal carrier recombination rates, caused by increased carrier concentration. Results obtained showed that from 26.6 to 42.1 % reduction in power when temperature was 47 and 40^{o}C respectively

El–Kharga Oasis has hyper–arid climate which characterizes the western desert. El–Kharga oasis climate is continental with very hot summer and extreme daily temperature ranges. July is hottest month, with daily maximum and minimum temperature of about 40.9 and 24.7^{o}C, respectively. The maximum temperature occasionally approaches 50^{o}C ion summer; with January being the coldest month in January.

This work aimed to study and overcome the negative effects of climatic factors on the efficiency of solar panel quantities to increase the amount of pumped water to satisfy the growing crops needs. It was carried out at El-Kharga, New Valley Governorate, Egypt, which bounded by long 30 20 and 30 40 E and Lat 25 05 and 25 30 N.

To increase the efficiency of photovoltaic module two experiments were conducted:

1-Shading: Five shading treatments were tested including control, black screen sheath of 63% shading; grey screen sheath of 65% shading, black screen sheath of 73% shading and white screen sheath of 65% shading. The highest current and voltage output was from the control, and all other treatments were less than the control. The white 65% came the next after the control.

2- Cooling: In this part, five treatments were investigated namely, control, coaling by water, covering by glass 3 mm thick, Greenhouses effect as covering with glass at 2 cm over the panel and coating with as olive oil. The obtained results showed that was cooling with water was the best treatment may followed coating with olive oil and then the control.

The produced energy in will used for pumping irrigation water for growing crops in farms at north El-Kharga.

Keywords: *Irrigation Water, New Valley, photovoltaic systems.*

Introduction

Solar energy is one of the main promising clean energy sources in future of the world. The technology of photovoltaic (PV) is always on continuous developing in many applications. So it is generates electricity without dangerous effect on the environment. Photovoltaic (PV) systems are today largely used in rural electrification in a grid connected system, also in a water pumping for irrigation in remote points, etc.

Solar cell performance decreases with increasing temperature, fundamentally owing to increased internal carrier recombination rates, caused by increased carrier concentration. Results obtained showed that from 26.6 to 42.1 reduction in power when temperature was 47, 40 respectively

The power output delivered from a photovoltaic module highly depends on the amount of irradiance, which reaches the solar cell. Many factors determine the ideal output or the optimum yield in a photovoltaic module. However, the environment is one of the contributing parameters which directly affect the photovoltaic performance. Hasan and Mohamed, (2012) reported that the performance of PV module is influenced by several parameters such as the ambient temperature, humidity, rain, cloud and dust. In a desert environment the operational performance is impeded via the accumulation of sand particles on the surface and high ambient temperature.

Solar cells vary under temperature changes. The change in the temperature will affect the power output from the cells. The voltage is highly dependent on the temperature and an increase in the temperature will decrease the voltage. The efficiency decrease in the voltage with temperature increasing the temperature time, efficiency varies because of frequent variation of sun radiation. So efficiency varies with temperature and sun radiation (Fesharaki *et al*., 2011). Chatta *et al*.,(2018) reported that, the PV module temperature affected the output, open circuit voltage and module efficiency and developed the good correlations of temperature and power/efficiency.

The operating temperature of photovoltaic panels represents an important parameter that influences their conversion efficiency. High operating temperatures determine a decrease in the maximum output power under the same conditions of solar radiation, (Chereches *et al*., 2016).

Solar cell performance decreases with increasing temperature, fundamentally owing to increased internal carrier recombination rates, caused by increased carrier concentration. The operation temperature plays a key role in the photovoltaic conversion process. Both the electrical efficiency and the power output of the photovoltaic module linearly depend on the operating temperature, (Seshadri *et al*., 2013). Chereches *et al*., (2016) reported that the value of the current produced by PV cell has an insignificant rise when the temperature of the cell is greater, but the voltage has an important reduction, causing a drop of the maximum power generated. Majid *et al*.,(2014) showed that the efficiency of PV cell decrease 0.485% per 1°C, after the surface temperature increase above 25°C. The power outputs of photovoltaic (PV) modules that operating under real working conditions are influenced mainly by the solar irradiance,(Chattariya and Nipon, 2012, Ricardo *et al.,* 2002) and module temperature, (Sirisamphanwong, *et al.,* 2012). Hajighorbani *et al.* (2016) reported that, the PV output power is dependent on the solar irradiance and cell temperature. Low irradiance leads to low power, and high temperature causes a reduction in the output power. Furthermore, for each curve of the PV module, there is a point on the curve of the PV module, which delivers maximum power to the load. This point is known as maximum power point (MPP) (Hajighorbani *et al*., 2016, Xiao and Dunford, 2004)

Reaching the average ambient temperature in Egypt up to 34^{o}C in the summer, the cell temperature could reach up to 80^{o}C which decreases the output power by up to .56 % / K, fill factor to .2 % / K and conversion efficiency to .08% / K of the PV module, above the operating temperature, (Abdellatif *et al*., and Raziemska, 2003). Solar cells are semi–conductors; they are also very sensitive to temperature. The characteristic power curve is significantly affected by the module temperature. The open – circuit voltage significantly decreases with increasing the PV module temperature (values are up to -0.45% /K for crystalline silicon) whereas the short circuit current increases only slightly (values range between 0.04 and 0.09% / K), (Sonnenegie, 2010, Tetzlaff *et al*., 2013).

The solar cell efficiency is usually measured under the standard test condition (STC), with a PV cell temperature of 25^{o}C, irradiance of 1000 W\ m and air mass AM= 1.5. These conditions are rarely met at outdoor installations. The PV cell temperature, which can be assumed to be the same as the temperature of the PV module (Mattie *et al*., 2006, Tetzlaff *et al*., 2013) shows large variability under outdoor conditions. It has therefore an important impact on the solar cell efficiency and thus, on the energy yield. On a cloud free summer day in Central Europe, the cell temperature can easily reach 60^{o}C for free standing systems. This leads to a considerable reduced energy yield. King *et al.* (2002) three different PV technologies and found that the energy yield is lowered by 2 to 10 % at high module temperatures. Accurate cell temperature predictions are thus, a key factor to better assess the efficiency of PV installations (Tetzlaff *et al*., 2013). Seshadria *et al.* (2012) reported that, the performance ratio generally decreases with the latitude because of temperature. However, regions with high latitude have higher performance ratios due to low temperature, like, Southern Andes, Himalaya region, and Antarctica.

During summer days when the temperature is at its highest and the heat is built up quickly, the solar power output is reduced by 10% to 25% for the reason that, too much heat increases the conductivity of semiconductor making the charge balance and reducing the magnitude of the electric field. In addition, if the humidity penetrates into the solar panel frame, this can reduce the panel's performance producing less amount of power and can permanently deteriorate the performance of the modules.

El–Kharga oasis has a hyper – arid climate which is the same climatic characteristics of the western desert. El–Kharga oasis climate is continental with very hot summer and extreme daily temperature ranges. The hottest month is July, with daily maximum and minimum temperature of about 40.9 and 24.7°C, respectively. The maximum temperature occasionally approaches 50°C; with January being the coolest month. Wind speed increases progressively in November to January and reaches a peak in June and September. It records the lowest speed in July and august. From March to May, wind storms are common with sand storms causing dust storms famously known as EL-KMASIN.

The maen monthly relative humidity ranges from 28.5% during the summer to 48.3% during the winter. The pan evaporation on the bare soil ranges from about 5.79 mm day in December to 20.30 mm/day in June. Generally, the annual rainfall is extremely scarce and insignificant (less than 6 mm/year). The efficiency of the photovoltaic system depends on geographical location because solar radiation varies according to latitude. It depends also to position at which the PV panel set (tilted or horizontal), and the local meteorological condition (humidity, dust, temperature). So studying the behavior of solar cell with different climatic parameters is important because no electricity can be generated without solar radiation.

Therefore, the aims to eliminate the negative effect of the ambient high temperature of El-Kharga oasis on the photovoltaic cell used well water pumping.

Materials and Methods

Study area:

This study was carried out at El-Kharga, New Valley governorate, Egypt, which is bounded by longitude 30.20 and 30.40 E and Latitude 25.05 and 25.30 N. (Figure 1).

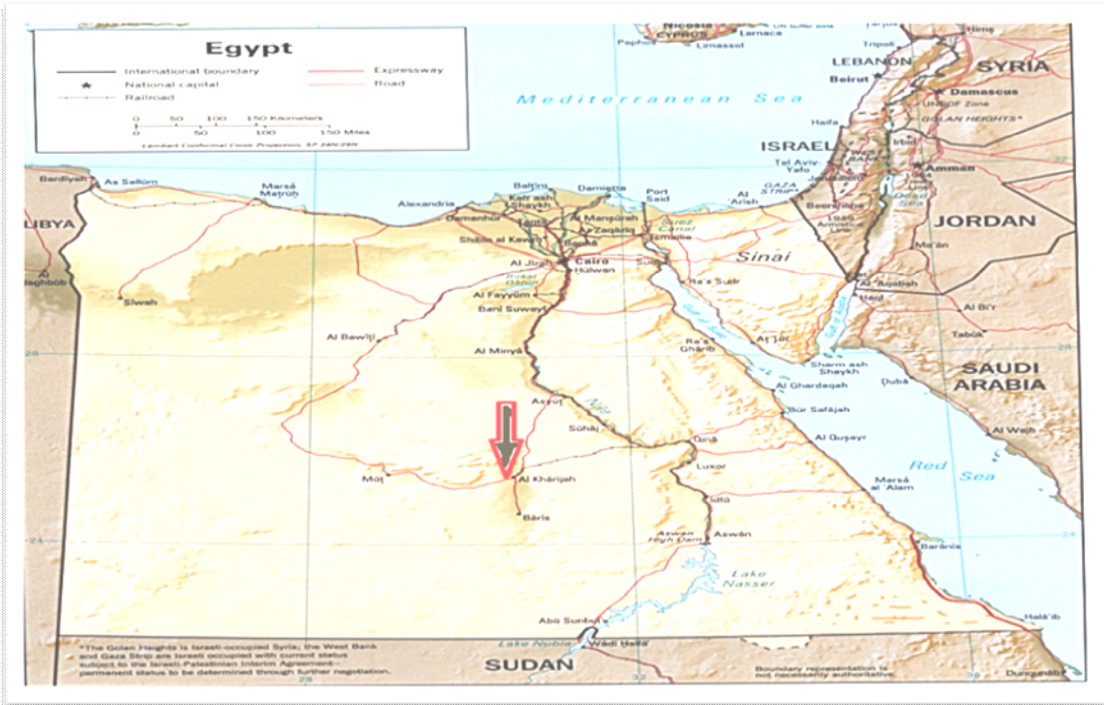

Figure 1. Egypt map shows the location of the Experiment at El-Kharga Oasis.

To achieve the previous objective tow method namely, shading and Cooling the PV were used.

System component:

Photovoltaic (PV) panels system was installed in the open field at El-Kharga Oasis using five PV Model PR50Wp, Proflex Solar trade mark PROFLEX polycrystalline Silicon PV Module with rated power 50W, rated Voltage17.8V (open circuit voltage 22.1V) and rated current 2.81A (Short circuit current 2.98A) with Photovoltaic module rated at 1000 W/ m^2 solar irradiant (AM 1.5) at 25^{o}C cell temperature. Maximum series fuse rating 10A and maximum system open circuit voltage 750 VDC; with standard code IEC 61215 and tracking No.: PRPV-P50WOTZX imported from BEIJING PROFLEX CO. China. With the diminutions of 50.5 cm W X 69.5 cm L X 2.5 cm H (Figure 2).

Figure 2.Photovoltaic (PV) panels with diminutions of 50.5 cm W X 69.5 cm L X 2.5 cm H, tilted at 30 degrees to ward south at El-Kharga to face the sun, with a thermometer of 0-100 ^{o}C scal.

The five PV module plates were fixed on a wooden frame as it is shown in Figure 3, which has a front height of 1 meter from the floor and a back height of 1.35 meter from floor, that was done to keep an angel of 30 degrees toward south to face the sun. The distance between panels was 10 cm. A 0-100 ^{o}C thermometer was fixed on each PV module using colorless silicon adhesive to measure the cell surface temperature, and one thermometer was hanged freely in the shade under the system to measure the ambient air temperature.

Figure 3. Five photovoltaic (PV) panels fixed at 30 degrees facing the sun southward at El-Kharga Oasis.

Shading experiment:

To improve the efficiency of photovoltaic (PV) panels by shading**,** five shading treatments were tested including 1-control, 2-black screen sheath of 63% shading, 3-grey screen sheath of 65% shading; 4-black screen sheath of 73% shading and 5-white screen sheath of 65% shading. The screen was fixed in a wooden frame with a thickness of 2.5 X 2.5 cm (Figure 4) that was used to cover the module. The temperature, current AM and voltage (V) of every module were measured five times daily during the sun shine lightening hours at 8,10,12 Am, 2 and 4 Pm starting from 15 February 2018 to 21st of July 2018**.**

2-Black63%	3-Gray 65 %	4-Black 73%	5-Whit 65%

Figure 4. Shading treatments with screen sheath of different colors and intensities.

Cooling experiment:

This part experiment to increase the solar panel efficiency by cooling using water and glass or coating with olive oil as reflecting liquid**.** To achieve this objective, five treatments were investigated as it follows:

1-Control without any treatment, 2 cooling the panel by running water, 3- cooling by water running over glass of 3mm thick, 4- green-houses effect by cooling with water running over glass at 3 cm over the panel; 5- coating by olive oil.

For each model T the temperature (°C) current (A) and voltage (V) were measured five times every day during the sun shine lightening hours at 8,10,12 Am, 2 and 4 Pm starting from 22nd of July 2018 to 28th of February 2019.

Results and Discussion

Daily Changes in Power Production from PV module:

To study the daily changes in power production by Photovoltaic module at El-Kharga Oasis, western desert of Egypt; the air and PV module surface temperature; open circuit voltage (Volt), current (Ampere); and power produced were recorded at six points daily from 19th of Feb to 1st of March 2018 in El-kharga Oasis the results were drown in Figure 5. The daily changes in the power produced by the PV module from the 19th Feb. to 1st of March 2018 at El-kharga city are present in Figure 5.

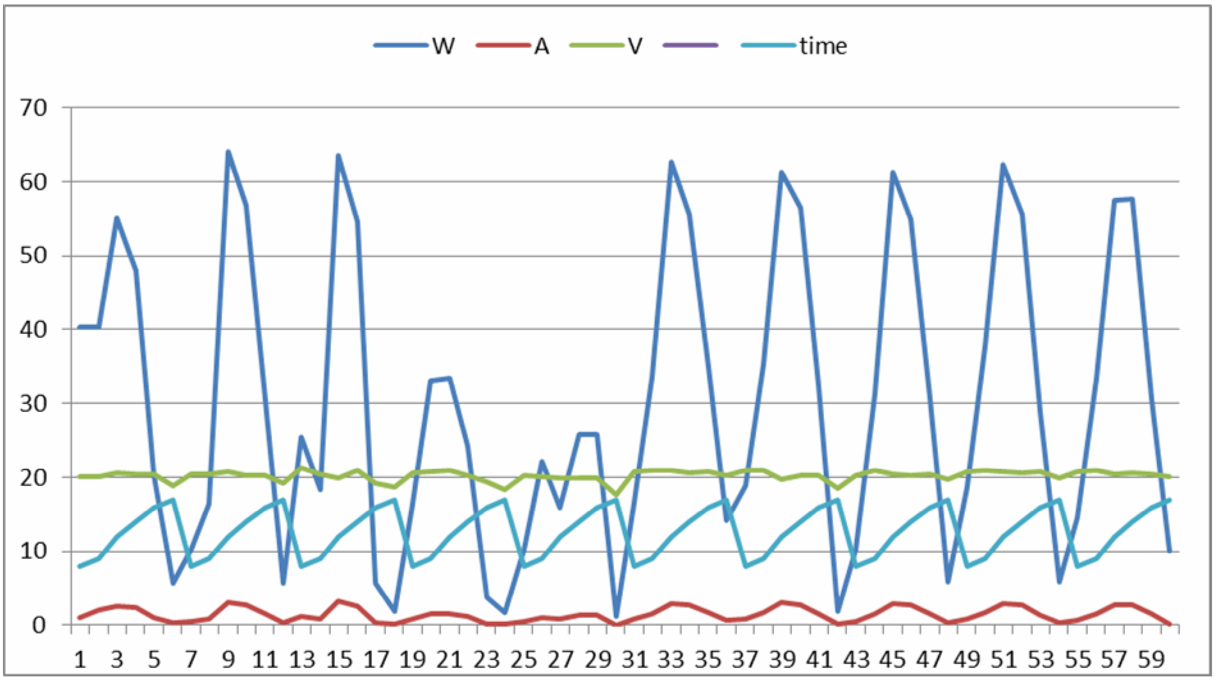

Figure 5. Daily changes in the open circuit voltage, ampere and power produced from 19th of Feb to 1st of March 2018 in El-kharga Oasis.

The daily wave shows that the increasing current gradually increased with sun raise starting from 8-9 am and reached the beak at 12-2 pm and then it decreased at 4-5 pm. The current maximum value was 3.2 A. However, the open circuit voltage did not change as much. It changed almost from 17 V to around 21.

The power started almost from zero to reach the maximum value of 64.1watts at 12-2 pm.

Considering the specification of the PV module with rated power of 50W, rated voltage 17.8V (open circuit voltage 22.1V) and rated current of 2.81A (Short circuit current 2.98A), the obtained power was high during the noon time between 12 to 2 pm. However, some peaks such as at points 21 and 28, the power was unusual either due to clouds or dusty storms.

Seasonal Changes in Power Production from PV Module:

Following the temperature of the air and the surface of the control PV module as well as the produced power from the 8th of March 2018 (Spring) to the 6th of July 2018 (Summer); it was found that the temperature of the module raised by 30 to 60% more than the air temperature on the 23 May 2018 it reached 70°C while the air temperature was 46 °C. The seasonal increase in the temperature reduced gradually the produced power with a liner equation of Power = 54.009 – 0.3334 x.

Sonnenegie (2010) and Tetzlaff (2013) reported that the open – circuit voltage significantly decreases with increasing the PV module temperature (values are up to -0.45% /K for crystalline silicon) whereas the short circuit current increased only slightly (values range between 0.04 and 0.09 % / K).

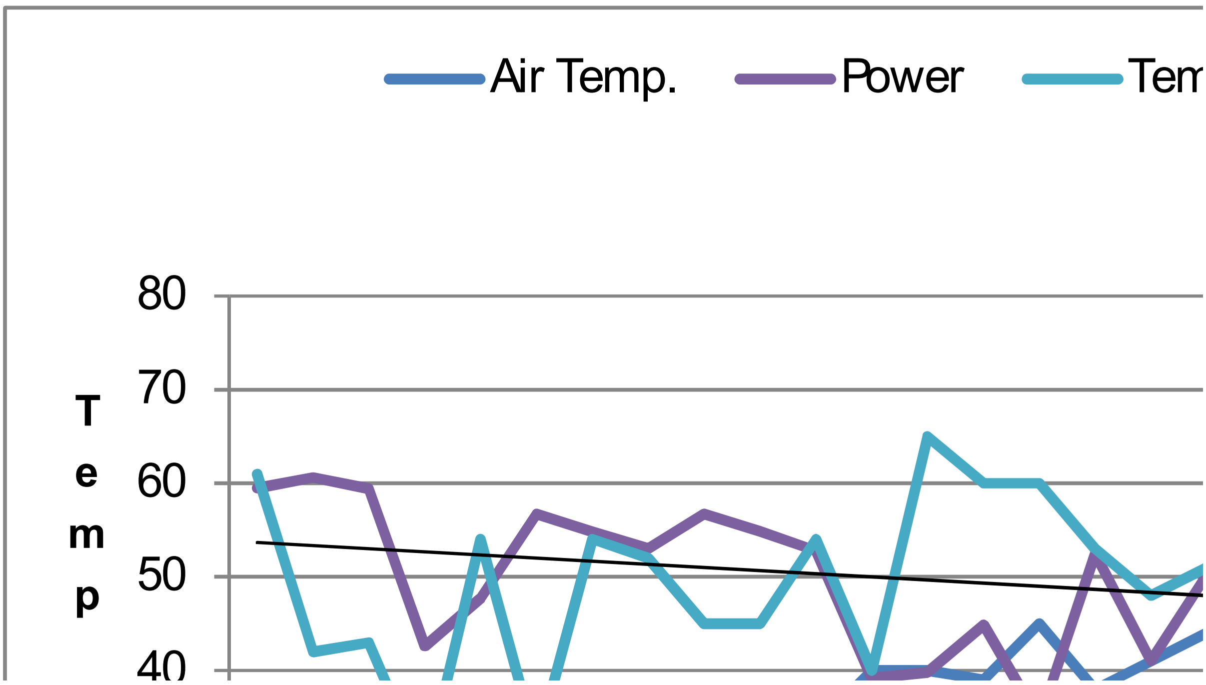

Figure 6: Air and PV module temperature and power produced by the control treatment from the 8th of March the 6th July 2018.

Table 1. Power (watts) changes affected by shading treatment from the 8th of March to 7th of July 2018.

Serial	Date	Power (W)				
		Control	Black 63	Black 76-3	Gray 65	Whit 65
1	8/3/2018	59.47	22.80	40.11	22.18	52.11
2	10/3/2018	60.60	29.80	36.60	3.42	53.30
3	17/3/2018	59.40	28.30	40.20	23.70	52.70
4	2/3/2018	26.60	21.10	22.70	6.44	10.40
5	28/3/2018	47.70	21.20	29.80	6.12	21.70
6	5/4/2018	56.70	28.60	37.90	24.50	43.09
7	12/4/2018	54.80	26.40	31.30	18.01	41.00
8	19/4/2018	53.00	10.70	32.30	23.30	18.12
9	25/4/2018	56.70	13.12	34.50	35.00	19.40
10	26/4/2018	54.86	4.08	32.80	16.16	45.32
11	27/4/2018	52.78	21.47	33.66	20.90	42.21
12	30/4/2018	14.89	5.39	5.86	3.60	12.87
13	1/5/2018	39.80	16.51	17.07	13.79	34.92
14	2/5/2018	44.85	18.61	16.91	14.14	34.47
15	4/5/2018	34.65	13.91	15.05	13.16	32.23
16	8/5/2018	52.50	23.64	31.80	18.15	40.20
17	11/5/2018	41.00	11.82	15.25	11.58	12.29
18	20/5/2018	50.25	22.50	19.60	28.90	38.00
19	23/5/2018	48.00	20.72	27.68	15.55	35.90
20	27/5/2018	51.25	22.67	21.60	17.33	41.61
21	1/6/2018	47.76	21.12	28.32	16.72	34.43
22	4/6/2018	46.33	19.99	10.53	10.92	33.13
23	7/6/2018	42.02	22.29	15.12	21.65	31.00
24	13/6/2018	46.92	20.88	27.66	15.52	29.40
25	18/6/2018	45.10	19.70	26.00	15.01	19.10
26	22/6/2018	43.56	19.29	25.09	14.58	32.90
27	29/6/2018	47.38	20.20	12.46	16.54	34.90
28	30/6/2018	47.90	20.60	18.40	16.40	15.15
29	1/7/2018	47.15	20.29	15.64	14.63	28.90
30	7/7/2018	51.00	19.10	9.80	12.50	31.44
Average		51.00	19.50	8.80	12.50	31.44

Shading e:

Shading the PV panels generally produced unexpected negative results. The highest values of current (A), voltage (V) and power (W) output was from the uncovered control PV module. However, the other treatments showed lower values were than the control. The white screen of 65% shading came the next to the control (Table 1).

On 24th of March, the temperature of the air and all other treatments showed lowest values because it was windy cloudy day.

Table 2. Temperature changes affected by shading treatment from the 8th of March to 7th of July 2018.

	Temperature °C					
Date	**Air**	**Control**	**Black 63**	**Black 76-3**	**Gray 65**	**Whit 65**
8/3/2018	38	61	58	61	59	64
10/3/2018	29	42	42	38	41	44
17/3/2018	31	43	43	51	51	51
2/3/2018	25	29	29	28	29	29
28/3/2018	30	54	54	48	49	55
5/4/2018	28	32	31	31	34	38
12/4/2018	38	54	48	47	48	52
19/4/2018	38	52	50	50	50	52
25/4/2018	30	45	44	48	44	47
26/4/2018	30	45	44	48	49	51
27/4/2018	34	54	56	60	60	60
30/4/2018	40	40	38	40	39	39
1/5/2018	40	65	52	60	62	60
2/5/2018	39	60	62	60	60	61
4/5/2018	45	60	60	57	60	57
8/5/2018	38	53	52	54	53	58
11/5/2018	41	48	41	50	51	53
20/5/2018	44	51	50	50	58	50
23/5/2018	46	70	69	64	70	67
27/5/2018	39	58	49	48	51	51
1/6/2018	40	58	58	61	61	52
4/6/2018	38	50	48	54	50	52
7/6/2018	39	39	48	53	51	50
13/6/2018	39	52	51	55	56	53
18/6/2018	40	49	48	50	50	52
22/6/2018	47	58	60	60	62	52
29/6/2018	38	48	48	50	50	51
30/6/2018	38	47	50	49	50	52
1/7/2018	39	50	50	52	52	39
7/7/2018	40	55	52	55	56	67
Average	37.4	50.7	49.5	51.1	51.9	52.0

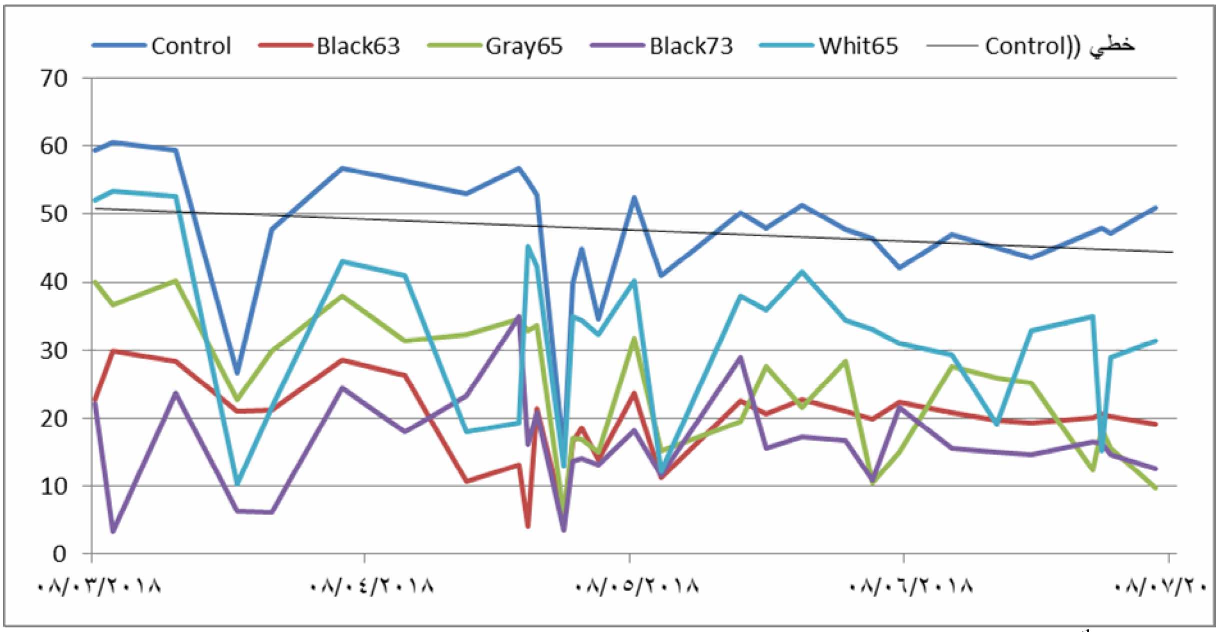

Figure 7. Power (watts) changes as affected by shading treatments from the 8th of March to the 7th of July 2018.

It is clear that the shading did not reduce the surface module temperature but it increased it and reduced the current and the power (Table 2). The order of the produced power was: Control > 65% white shading > 65% gray shading > 63% blck shading > 73% black shading (Table 2 and Figure 7). Also, it is clear that going from spring to summer the power declines.

The sudden drop in the power on the 24th of March and the 30th of April was associated with clouds while, the 11th of May was strong wind plowing day, which the temperature and visible light were reduced. As it well known that; the solar radiation composed of 45% visible light; 46% infrared radiation (thermal) and 9% ultraviolet radiation. Most of these radiations are blocked by clouds.

Cooling effect:

The temperature degree on the surface of the PV module including air ascended in the order of 33.1°C for direct water cooling < 33.2°C for air < 46.3 °C for control without cooling < 47.5°C for water cooling over glass < 59.7 °C for water cooling over glass chamber. However, coating the PV module with the olive oil gave the PV module surface temperature of 50.2°C (Table 3). Cooling the PV module with the water directly on the surface gave positive results. The next best treatment was coating the module by olive oil once every 16 days. Therefor, the best treatment was cooling with water followed by coating by olive oil.

Table 3. Temperature change of the photovoltaic module affected by water cooling or olive oil coating at El Kharga Oasis, from 7/22 /2018 to 2/28/2019.

Date	Temperature ^{o}C					
	Air	Control	Wat. col	Wat. Gi. Co	Wat. Gi.Ch.Col	Olive Cot.
22/7/2018	41	55	35	52	70	63
23/7/2018	40	50	39	50	61	52
26/7/2018	45	51	43	51	70	68
27/7/2018	43	54	36	50	70	56
28/7/2018	40	51	33	52	63	53
31/7/2018	42	61	38	68	72	73
1/8/2018	42	63	36	36	63	72
3/8/2018	40	51	33	52	66	55
4/8/2018	41	54	35	52	66	56
5/8/2018	42	56	37	46	52	57
6/8/2018	40	49	32	49	60	55
9/8/2018	36	49	35	51	68	42
11/8/2018	40	51	33	52	64	52
16/8/2018	39	50	36	53	73	70
24/8/2018	40	54	37	57	69	50
27/8/2018	38	45	33	48	60	53
6/9/2018	40	51	39	48	69	70
12/9/2018	37	48	37	50	69	55
18/9/2018	35	48	30	51	71	58
27/9/2018	33	48	34	53	50	51
3/10/2018	41	53	35	52	71	50
10/10/2018	34	43	30	47	56	54
18/10/2018	33	48	38	48	60	56
25/10/2018	44	33	36	49	50	52
1/11/2018	34	49	35	50	61	49
15/11/2018	20	40	25	42	50	40
29/11/2018	28	50	26	53	73	49
6/12/2018	23	35	25	24	45	34
13/12/2018	23	36	17	40	48	42
27/12/2018	20	32	14	38	45	40
3/1/2019	19	46	26	48	47	48
10/1/2019	20	35	25	42	47	32
15/1/2019	19	42	35	50	55	45
24/1/2019	25	49	33	50	55	50
31/1/2019	23	43	29	45	53	37
7/2/2019	22	35	28	40	47	34
14/2/2019	17	31	22	39	43	25
21/2/2019	36	36	26	42	50	34
28/2/2019	22	34	24	40	50	35
Average	33.2	46.3	31.3	47.5	59.7	50.2

Table 4. Open circuit voltage (Volt) of the photovoltaic module affected by water cooling or olive oil coating at El Kharga Oasis, from 7/22 /2018 to 2/28/2019.

Date	Voltage (V)				
	Control	**Wat. col**	**Wat. Gi. Co**	**Wat. Gi.Ch.Col**	**Olive Cot.**
22/7/2018	20.40	21.50	19.90	19.80	20.40
23/7/2018	20.30	21.40	20.00	19.80	20.30
27/7/2018	20.10	20.10	19.80	19.60	20.00
31/7/2018	19.70	21.00	19.20	19.00	19.80
1/8/2018	19.50	20.80	19.20	19.00	19.60
3/8/2018	20.40	21.30	19.80	19.60	20.30
5/8/2018	20.10	21.00	19.50	20.40	20.20
6/8/2018	20.60	21.00	20.00	19.90	20.50
9/8/2018	20.70	21.60	19.90	19.90	20.70
11/8/2018	20.40	21.40	19.70	19.70	20.30
16/8/2018	20.80	21.60	20.00	19.80	21.00
17/8/2018	20.40	21.00	19.80	19.60	20.30
24/8/2018	20.50	21.0	19.70	19.50	20.20
24/8/2018	20.40	21.30	19.70	19.70	20.40
27/8/2018	21.00	21.80	20.20	20.10	20.70
6/9/2018	20.30	21.10	19.60	19.60	20.20
12/9/2018	20.60	21.20	19.90	19.90	20.60
18/9/2018	20.60	21.30	19.90	19.80	20.50
27/9/2018	20.90	21.80	20.10	20.00	20.80
3/10/2018	20.40	21.60	19.80	19.90	20.50
10/10/2018	21.40	22.00	20.40	20.70	21.80
18/10/2018	20.80	21.30	20.00	19.90	20.70
25/10/2018	21.00	21.20	20.30	20.50	20.50
1/11/2018	20.60	21.10	19.80	19.70	20.60
8/11/2018	20.90	21.70	20.10	20.40	20.90
15/11/2018	21.40	21.60	20.70	20.70	19.80
22/11/2018	21.20	21.70	20.60	20.40	21.10
29/11/2018	20.60	21.50	19.80	19.70	20.50
6/12/2018	21.30	21.10	19.40	19.40	20.30
13/12/2018	21.60	22.20	20.80	20.80	21.50
20/12/2018	21.70	22.10	21.10	20.90	21.60
27/12/2018	21.90	22.30	21.10	20.90	21.70
3/1/2019	21.00	21.80	20.20	20.10	21.10
10/1/2019	21.80	22.20	20.90	20.80	21.50
15/1/2019	21.10	21.70	20.30	20.20	21.00
24/1/2019	20.50	21.60	19.90	20.00	20.80
31/1/2019	21.20	21.50	21.20	20.60	21.50
7/2/2019	21.60	22.10	20.90	20.80	21.40
14/2/2019	22.00	22.40	21.30	21.40	22.00
21/2/2019	21.60	22.10	20.80	20.70	21.40
28/2/2019	21.60	22.00	20.90	20.80	21.40
Average	20.60	21.50	20.10	20.10.	20.70

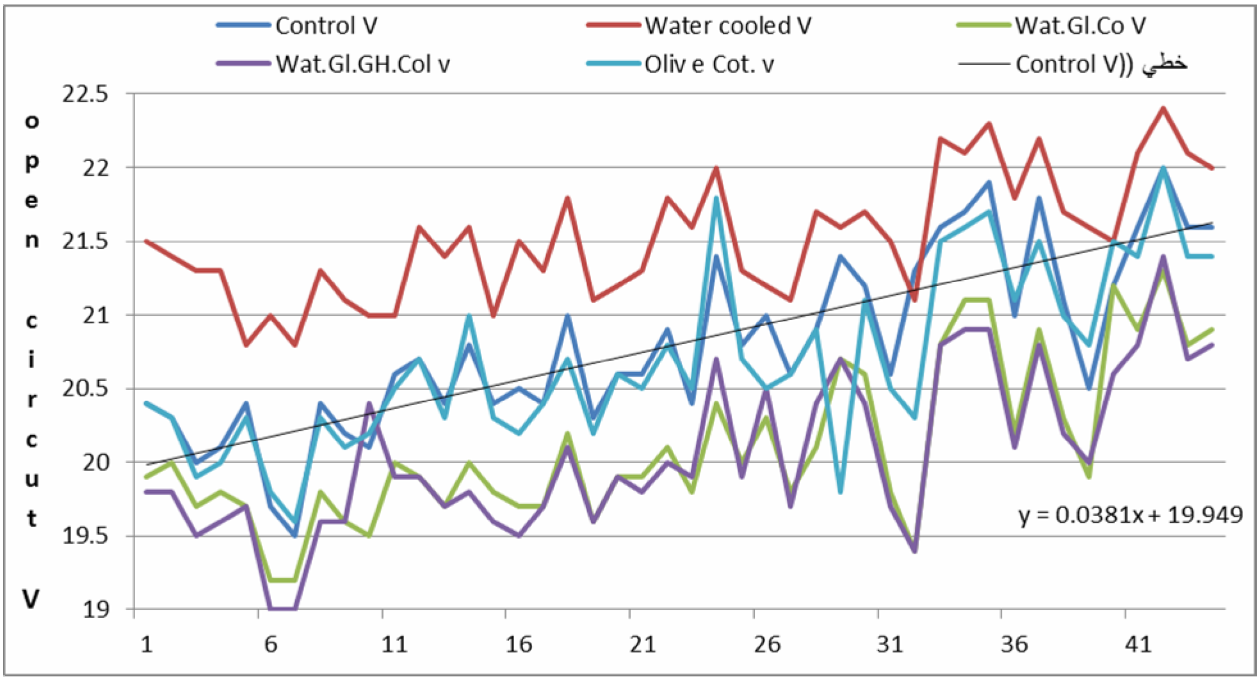

Figure 8. Open circuit voltage (V) of the photovoltaic module affected by water cooling or olive oil coating at El Kharga Oasis, from 7/22/2018 to 2/28/2019.

The open circuit voltage did not vary much between treatments. However the highest voltage was obtained from the direct water cooling with an average of 21.5 V. However, the control and olive oil coating gave 20.8 and 20.7 V, respectively, but cooling over glass or glass chamber gave an average volt of 20.1V (Figure 8; and Table 4).

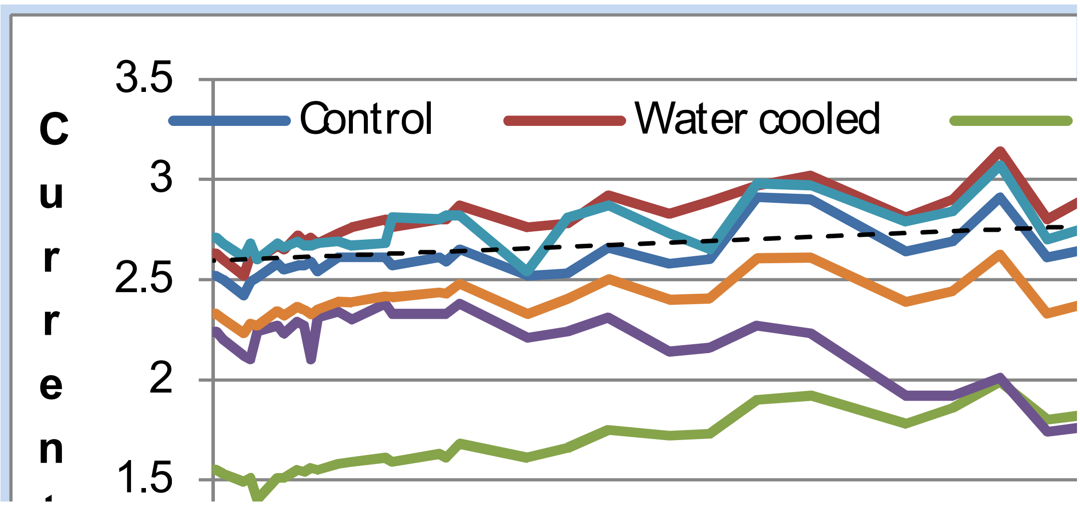

Figure 9. Current (Am) produced from the photovoltaic module affected by water cooling or olive oil coating at El Kharga Oasis, from 7/22 /2018 to 2/28/2019.

The current ampere of the short circuit was slowly increased with time from summer 2018 to spring with using the direct water cooling of the PV module. Also, there were slight differences between the ampere produced from the direct water cooling; the control and olive oil coating. Their produced current was over the average value while water cooling over glass or glass chamber produced lower current less than average one (Figure 9 and Table 5).

Table 5. Short circuit ampere (Am) of the photovoltaic module affected by water cooling or olive oil coating at El Kharga Oasis, from 7/22 /2018 to 2/28/2019.

Date	Ampere (Am)					
	Control	Wat. col	Wat. Gi. Co	Wat. Gi.Ch.Col	Olive Cot.	Average
22/7/2018	2.52	2.63	1.55	2.24	2.71	2.30
23/7/2018	2.50	2.60	1.53	2.20	2.68	2.30
27/7/2018	2.42	2.52	1.49	2.12	2.61	2.20
31/7/2018	2.49	2.62	1.51	1.22	2.68	2.10
1/8/2018	2.51	2.60	1.40	2.24	2.60	2.30
3/8/2018	2.58	2.67	1.51	2.27	2.68	2.30
5/8/2018	2.55	2.65	1.51	2.23	2.66	2.30
6/8/2018	2.57	2.72	1.55	2.29	2.69	2.40
9/8/2018	2.57	2.69	1.54	2.27	2.67	2.30
11/8/2018	2.59	2.71	1.56	1.12	2.67	2.10
16/8/2018	2.54	2.68	1.55	2.31	2.68	2.40
17/8/2018	2.61	2.73	1.58	2.34	2.69	2.40
24/8/2018	2.61	2.76	1.59	2.30	2.67	2.40
24/8/2018	2.61	2.80	1.61	2.38	2.68	2.40
27/8/2018	2.57	2.76	1.59	2.33	2.81	2.40
6/9/2018	2.61	2.80	1.63	2.33	2.80	2.40
12/9/2018	2.59	2.80	1.61	2.33	2.82	2.40
18/9/2018	2.65	2.87	1.68	2.38	2.82	2.50
27/9/2018	2.52	2.76	1.61	2.21	2.54	2.30
3/10/2018	2.53	2.78	1.66	2.24	2.81	2.40
10/10/2018	2.66	2.92	1.75	2.31	2.87	2.50
18/10/2018	2.58	2.83	1.72	2.14	2.73	2.40
25/10/2018	2.60	2.89	1.73	2.16	2.65	2.40
1/11/2018	2.91	2.97	1.90	2.27	2.98	2.60
8/11/2018	2.90	3.02	1.92	2.23	2.97	2.60
15/11/2018	2.64	2.81	1.78	1.92	2.79	2.40
22/11/2018	2.69	2.90	1.86	1.92	2.84	2.40
29/11/2018	2.91	3.14	1.99	2.01	3.07	2.60
6/12/2018	2.61	2.80	1.80	1.74	2.70	2.30
13/12/2018	2.66	2.93	1.83	1.77	2.77	2.40
20/12/2018	2.65	2.96	1.97	1.85	2.74	2.40
27/12/2018	2.57	2.88	1.97	1.78	2.69	2.40
3/1/2019	2.89	2.90	1.81	1.65	2.82	2.40
10/1/2019	2.89	2.88	1.87	1.68	2.78	2.40
15/1/2019	3.05	3.04	1.96	1.90	2.94	2.60
24/1/2019	2.99	3.06	1.96	1.58	2.92	2.50
31/1/2019	3.01	3.04	1.85	1.88	2.86	2.50
7/2/2019	3.01	3.09	1.83	1.81	2.73	2.50
14/2/2019	3.01	3.08	1.85	1.99	2.83	2.60
21/2/2019	3.10	3.10	1.84	2.01	2.80	2.60
28/2/2019	2.96	3.08	1.82	1.99	2.74	2.50

Table 6. Power produced (W)from the photovoltaic module affected by water cooling or olive oil coating at El Kharga Oasis, during 7/22 /2018 to 2/28/2019.

Date	Ampere (Am)					
	Control	Wat. col	Wat. Gi. Co	Wat. Gi.Ch.Col	Olive Cot.	Average
22/7/2018	51.40	56.60	30.80	44.30	55.28	47.70
23/7/2018	50.90	55.60	30.60	34.50	54.40	47.00
26/7/2018	48.40	53.60	29.30	41.30	51.70	44.90
27/7/2018	50.00	55.80	29.80	43.00	53.60	46.40
31/7/2018	50.80	56.00	28.90	43.13	53.00	46.40
1/8/2018	49.70	55.12	28.90	42.27	52.10	45.60
3/8/2018	52.40	57.90	30.69	44.88	54.60	48.10
4/8/2018	51.90	56.70	30.10	44.40	53.60	47.30
5/8/2018	52.00	56.90	30.40	43.00	54.00	47.30
6/8/2018	52.30	56.28	31.00	45.90	54.90	48.10
9/8/2018	54.00	58.90	31.40	46.50	55.60	49.30
11/8/2018	53.20	59.064	31.32	45.08	54.20	48.60
16/8/2018	54.20	60.48	32.20	47.12	56.28	50.10
17/8/2018	52.43	57.96	31.48	45.66	57.04	48.90
24/8/2018	53.50	60.20	32.11	45.44	56.56	49.60
25/8/2018	52.84	59.64	31.41	45.90	57.53	49.50
27/8/2018	55.65	62.57	33.94	47.84	58.37	51.70
6/9/2018	51.16	58.24	31.56	43.30	51.30	47.10
12/9/2018	52.12	58.97	33.03	44.576	57.88	49.30
18/9/2018	54.80	62.20	34.83	45.74	58.86	51.30
27/9/2018	53.90	61.69	34.57	42.80	56.784	49.90
3/10/2018	53.04	62.40	34.20	42.90	54.32	49.40
10/10/2018	62.27	65.34	38.76	46.90	64.90	55.60
18/10/2018	60.32	64.33	38.40	44.38	61.47	53.80
1/11/2018	54.30	59.20	35.20	37.80	57.40	48.80
8/11/2018	56.20	62.90	37.30	39.10	59.30	51.00
15/11/2018	62.27	67.80	41.10	41.60	60.70	54.70
22/11/2018	55.33	60.76	37.08	35.50	56.97	49.10
29/11/2018	54.70	62.99	36.20	34.80	56.70	49.10
13/12/2018	57.24	65.71	40.98	38.48	58.91	52.30
20/12/2018	55.70	63.60	41.50	37.20	58.10	51.20
27/12/2018	63.20	64.60	38.19	34.48	61.19	52.30
3/1/2019	60.69	62.78	37.77	33.76	58.60	50.70
10/1/2019	66.49	67.40	40.96	39.52	63.20	55.50
15/1/2019	63.00	66.40	39.70	31.90	61.30	52.50
31/1/2019	63.80	65.30	39.22	38.70	61.40	53.70
7/2/2019	65.01	68.20	38.03	37.60	58.40	53.40
14/2/2019	66.20	68.90	39.40	42.50	62.20	55.80
21/2/2019	64.80	68.50	38.20	41.60	59.90	54.60
28/2/2019	63.90	67.76	38.038	41.392	58.60	53.90
Average	56.00	61.20	34.50	41.90	57.20	50.20

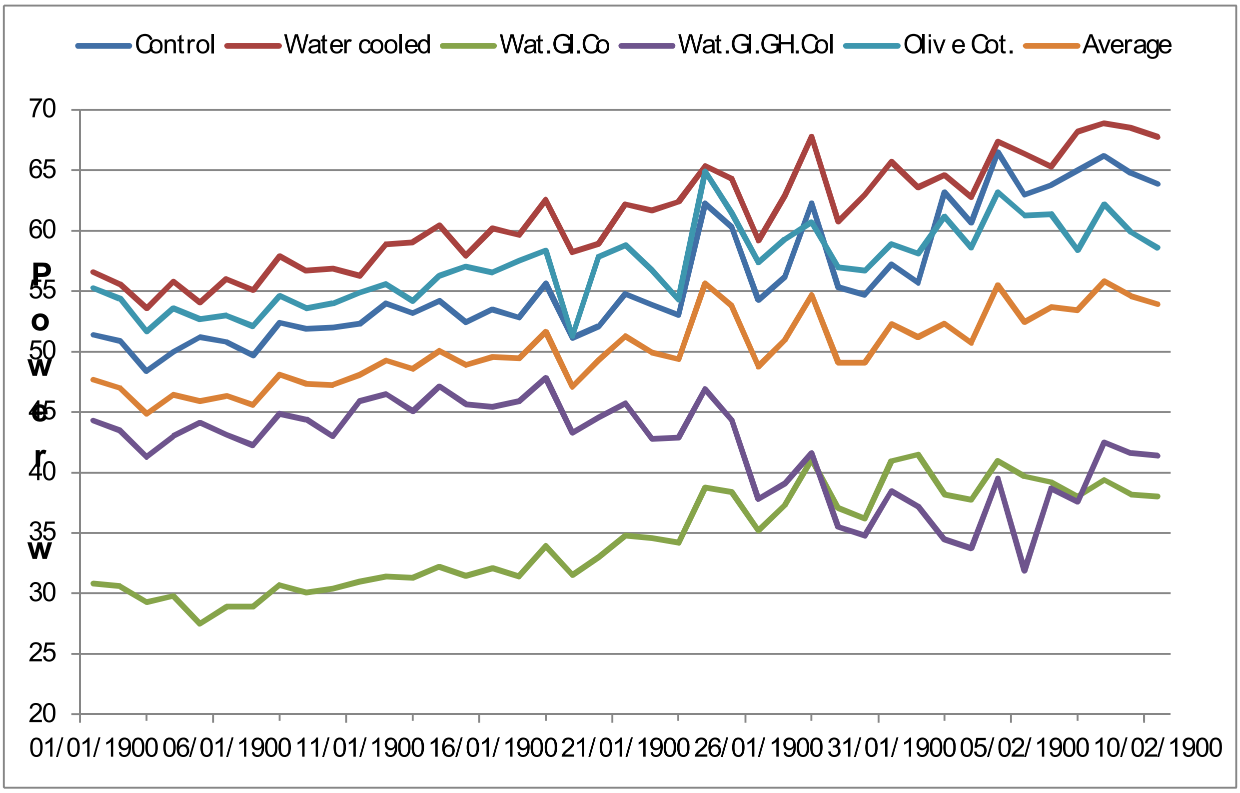

Figure 10. The power produced from photovoltaic module affected by water cooling or olive oil coating at El Kharga Oasis, during from 7/22 /2018 to 2/28/2019.

Water cooling is working on raising the voltage difference (open circuit voltage) by a large margin but, it increases the current by a low margin. However, water cooling treatment showed higher impact in reducing module temperature than that of the olive Oil coating. (Figure 10 and Table 6).

Olive oil started at 12 pm to show or cause a significant power rise but, it did not affect the voltage differences. However, olive oil coating showed its effect through 16 days. The power producing using olive oil was high but less than the direct water cooling but shortly there after at 4 and 5. The olive oil coated module produced a power value higher than that using water cooling while the surface temperature of the board treated with olive became higher. Also, olive oil treatment did not have any marked effect in the winter and its effect disappeared in December.

In the field experiment (Part II) the produced energy in turn increased the pumped water and were associated with increasing the plant growth in the tested farms at north El-Kharga

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إستخدام مواد للتبريد والتظليل لرفع كفاءة الوحدات الكهروضوئية الشمسية لضخ ماء الرى فى الوادى الجديد

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الملخص

الطاقة الشمسية هي واحدة من مصادر الطاقة النظيفة الواعدة في مستقبل العالم. وقد تطور استعمال تقنية الخلايا الفولتية الضوئية (PV) باستمرار في العديد من التطبيقات، فهي تولد الكهرباء بدون تأثير خطير على البيئة. حيث تستخدم أنظمة الخلايا الضوئية اليوم بشكل كبير في كهربة الريف ، في نظام متصل بالشبكة ، وأيضاً في الري وضخ المياه في المناطق النائية ، وفي السيارات المتحركة وانارة الطرق وتشغيل الاقمار الصناعية ..الخ. ويتناقص أداء الخلايا الشمسية الضوئية مع زيادة درجة الحرارة ، وأظهرت الابحاث حدوث حوالي ٢٦,٦ إلى ٤٢,١% انخفاض في الطاقة عندما وصلت درجة الحرارة ٤٠ و ٤٧ على التوالي.

تتميز واحة الخارجة بمناخ شديد الحراي يميزالصحراء الغربية. حيث ان مناخ الواحات قاري ذات صيف حار جداً ودرجات حرارة يومية شديدة. يعتبر شهر يوليو الأكثر سخونة، حيث يبلغ الحد الأقصى والحد الأقصى اليومي حوالي ٢٤,٧ و ٤٠,٩ م° على التوالي. درجة الحرارة القصوى تقترب أحياناً فين فصل الصيف من ال٥٠ م°؛ مع كون يناير هو اقل الشهور حرارة. يهدف هذا البحث إلى دراسة والتغلب على الآثار السلبية للعوامل المناخية على كفاءة كفائة الألواح الشمسية الضوئية لزيادة كمية الكهرباء الناتجة وبالتالي زيادة المياه التي يتم ضخها لتلبية احتياجات المحاصيل المتزايدة. أجريت هذه الدراسة في محافظة الخارجة ، محافظة الوادي الجديدة ، بمصر ، والتي تقع بين خطي طول ٢٠. ٣٠ و ٤٠. ٣٠ E ودائرة عرض ٢٥,٠٥ و N٢٥,٣٠.

لزيادة كفاءة الألواح الكهروضوئية تم إجراء تجربتين:

١ – التظليل: تم اختبار خمسة معاملات تظليل شاملة معاملة الكنترول، التغطية بشاش من السيران الاسود بنسبة تظليل ٦٣ ٪. التغطية بشاش من السيران الاسود بنسبة تظليل ٦٥ ٪. التغطية بشاش من السيران الاسود بنسبة تظليل ٧٣ ٪. التغطية بشاش من السيران الابيض بنسبة تظليل ٦٥ ٪.

كان أعلى خرج التيار والجهد من معاملة الكنترول ، وكانت جميع المعاملات الأخرى أقل من الكنترول وكان التغطية بالسيران الابيض بنسبة تظليل ٦٥ ٪ هي الاقرب لمعاملة الكنترول ولكن اقل منها.

٢– التبريد: في هذا الجزء ، تم اختبار خمس معاملات على النحو التالي ،

١- الكنترول لوح بدون اي تغيير
٢– التبريد عن طريق غشاء من الماء الجاري مباشرة علي لوح التوليد.
٣– التغطية بلوح من الزجاج سمك ٣ مم مع التبريد عن طريق غشاء من الماء الجاري.
٤– التغطية بلوح من الزجاج سمك ٣ مم وعلي ارتفاع ٣سم من لوح التوليد مع التبريد عن طريق غشاء من الماء الجاري
٥ – الطلاء بالسوائل مثل زيت الزيتون أو زيت الذرة أو الكيروسين.

وأظهرت النتائج التي تم الحصول عليها أن أفضل طريقة هي التبريد بالماء مباشرة ثم الطلاء بواسطة زيت الزيتون أو زيت الذرة أو الكيروسين.

زيت الزيتون يبدا تاثيره في الظهور الساعة ١٢ وزيت الزيتون يعمل علي رفع التيار بنسبة كبيرة لكن لا يوثر على علي فرق الجهد يستمد تاثيره ١٦ يوم زيت الزيتون تاثيره اقل

من التبريد بالماء بقليل الساعة ٤و٥ زيت الزيتون تاثيره اعلى من الماء درجة حـــرارة اللـــوح الموضوع عليه زيت الزيتون بتكون عالية زيت الزيتون ليس له تاثير في الـــشتاء بـــدا يختفـــى تاثيره شهر. الجاز يعمل على رفع التيار ولا يؤثر على فرق الجهد يحـــدث تطـــاير للجـــاز ولا يستطيع البقاء اكثر من يوم.

التبريد بالماء يعمل على رفع فرق الجهد (open circuits voltage) بنسبة كبيرة والتيار بنسبة قليلة تاثير الماء اعلي من تاثير زيت الزيتون التبريد بالماء يقلل من درجة حرارة اللوح

فى البحث الحقلي بتطبيق معاملات التبريد الايجابية زادت الطاقة المنتجة بـــدورها عنـــد تبريد الواح التوليد بالمياه الجارية علي سطح اللوح، وارتبطت بزيادة نمو النبات فـــي المـــزارع المختبرة في شمال الخارجة.