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An experimental study of PV/T system using parabolic reflectors and heat exchanger

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ABSTRACT

Photovoltaic (PV) systems can be made more efficient by forcing the PV panel to operate at its maximum point power due to the electrical properties of photovoltaic generators, which are substantially non-linear (MPP). This study examines the effectiveness of using a combination of parabolic concentrator Bi-reflector and heat exchanger as a cooling system on the performance of photovoltaic generators to get a photovoltaic/thermal (PV/T) system, and their effect on the direct current (DCDC) converter using matrix laboratory (MATLAB) simulink. The experimental tests were carried out under various temperature values and sun irradiation. The results demonstrated that the use of parabolic Bi-reflectors, to further illumine te the panels, and the use of the cooling system to absorb excess heat to get heat water, could increase and enhances performances of the photovoltaic generator.

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1. INTRODUCTION

Utilization of fossil fuels in excess during this period and renewable energy sources will take their place because of its enviromentally and renewable qualities [1]. As a kind of clean energy, solar energy plays a critical role in a country's or the world's energy needs [2], and the use of solar energy (photovoltaic (PV) system) is rapidly expanding in the sustainable renewable energy market and it is very expected to take a very important role in the mix of renewable energies in the future [1], [3]. The use of energy solar has a great promise and wide range of applications that may be used to meet the rise in demand for energy [4], this is one of the most essential kind of sustainable sources energy that have attracted the interest of a big number of scientists around the world to work on it. Indeed, in one hour, the amount of solar energy intercepted by earth throughout the year, is much greater than the world's energy consumption [5], to make this energy competitive, it is very important to recover as much energy use as possible from the solar energy system. But solar energy remains more expensive than traditional electrical fossil-fueled [6], the solar radiation lost that is not used to generate electricity is almost entirely transformed into heat [7], to produce more electric power with the same PV module, various methods are still being used in order to achieve the maximum output power [8], as the quantity of electricity generated by PV systems is proportional to the radiation, so concentrator system may be a viable option for increasing efficiency. This would lower the cost of electricity generation by PV system [9], we are studied the effect of employing a bi-reflector on the temperature of a solar PV.

On the other hand, the increase in temperature of solar cells results in a decrease of both efficiency and power when the PV panel is irradiated with the layers of the solar cell and lead to a shorter life of the system [10], where the average reduction in efficiency of solar panel is about 0.45 % for each degree over the 25 °C [11]. Both solar cell uniformity and their temperature should be regulated by using the appropriate of cooling system, the both technologies used may provide the opportunity to rise or increase the exploit of solar energy and enhance efficiency [12]. Photovoltaic thermel regulation techniques can be divided into passive or active cooling technique, or a combination of both, where passive heat sink cooling is suitable for cooling photovoltaic cells without or with capacitors [13], [14]. Passive system technique does not require any input power while active thechnique demand input power [15]. It has been discovered that efficiency of Panels decreases by 0.5 percent when the panel temperature rises 1 °C degree [16], The use of a combination of active and passive cooling technologies to improve the cooling and regulation of high-power concentrated PV systems has recently been proposed [17], for that we are going to use two cooling systems in ower research to improve performances of the PV panel, previous Several studies have reported that solar irradiation intensity may be increased by using planar reflector [18], according to researchs, the cells amorphous silicon performance decreases by 0.05% with every 1 °C increase and in the case of silicon cells of crystalline, the range decrease between 0.4% and 0.5% [19]. To correct this rise in temperature must be add a cooling system to decrease it.

Real-time experiments and comparison analysis were carried out in this work between three PV panels carried conducted at various solar radiation levels and temperature values, and its impact on power in the output of PV system were check out, the first PV panel without reflectors and without a cooling system, the second panel with two parabolic-reflectors, and the third panel with two parabolic-reflectors and two cooling methods. In addition, the aim of this research was to assess an optimal way to operate the solar panels with the proposed parabolic bi-reflectors and cooling technique, aluminum foil is economical and inexpensive reflective material that was addressed for economical and high output power solar panel, which is a sheet of aluminum very thin, range from 0.006 mm to defined limit of upper International Organization for Standardization (ISO) witch is 0.2 mm [20].

2. PROPOSED COOLING TECHNIQUES

Solar panels are thermally sensitive, when temperature increases will reduce the semi-conductor bandgap [21], increasing in PV panel temperature make the intrinsic semiconductor band gap shrink, as a result of this, panel Vopen-circuit voltage decreases. As the temperature is raised, the panel $I_{current}$ output increase for a level surface panel temperature rise, is proportionally lower than the voltage decrease, for this reason the panel cells efficiency is reduced [21]. To reduce the temperature and boost efficiency of solar PV, cooling systems are required, the following two cooling techniques were added to the solar panel to create a functional cooling technique for a solar PV panel.

3. EXPERIMENTAL SETUP

Various cooling strategies have been used to enhance the performances of PV panel [22]. The tube heat exchanger with optimal design is the most commonly used form of heat exchanger for heat transmission [23], [24], In this experiment; heat sinks were integrated on the solar panel rear side to transfer exces heat energy from the higher temperature the lower temperature. In addition to this, and because the energy efficiency of the solar panel can be boosted if an incompressible fluid (oil, water.. for example) is used in this PV-T system [25], we integrate a copper pipe that contains cooled water in a closed circuit. The copper pipe was attached with heat sinks, and a pump circulate cooled water in this circuit from a storage tank to the pipe. Cooled water in the copper pipe captures thermal energy from the solar panel and from heat sinks to produce hot water. This gives us a PV/T system as shown in Figure 1.

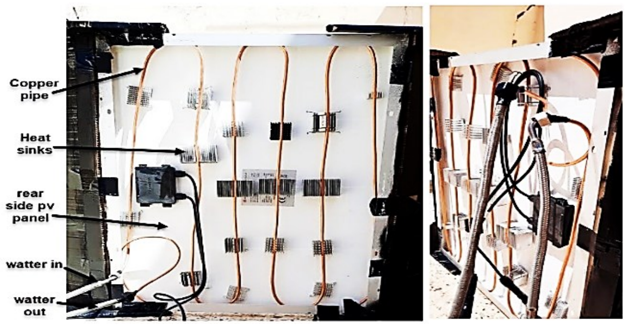

Figure 1. Solar panel with copper pipe and heat sinks on rear side

The experiment was carried out in March 2020 at the Tahiri Mohammed University of Technology's smart grid laboratory in Bechar, Algeria, at latitude 31.38° and longitude -2.15°. A photovoltaic module of 150 w was used to observe the effect of the parabolic bi-reflectors and the cooling systems on the panel performances. The PV module specifications are given in Table 1 (at $S_{tandard}$ T_{est} $C_{onditions}$ 1.5 25 °C , 1000 W/m²).

Table 1. PV module specification

S_{hort} C_{ircuit} c_{urrent} Ish	8.98 A
$V_{oltage}O_{pen}C_{ircuit}$ Voc	22.54 V
$M_{aximum}V_{oltage}$	18 V
$M_{aximum}C_{urrent}$	8.34 A
$M_{aximum}P_{ower}$	150 W
T_{est} $C_{onditions}$	AM 1.5 25°C 1000 W/m²

The output voltage and current were measured with a millimeter under various irradiance and temperature conditions. According to the solar panel specifications that we use, by the equation, the Fill factor can be calculated [26],

$$FF = \frac{V_{MPP} \times I_{MPP}}{V_{OC} \times I_{SC}}$$
$$FF = \frac{18 \times 8.34}{22.54 \times 8.98}$$
$$FF = 0.74$$

with the equation we can calculate the output power of solar panel that is,

$$P_{OUT} = V_{OC} \times I_{SC} \times FF$$
$$P_{OUT} = 22.54 \times 8.98 \times 0.74$$
$$P_{OUT} = 149.78W$$

we can calculate the solar panel's maximum efficiency output, is defined by the percentage of optimum output power [27],

$$\eta = \frac{P_{OUT}}{P_{IN}} \times 100\%$$

the dimensions of the solar panel are 1480 * 680 mm². The solar panel was mounted on metal support consists of a lower part fixed, and moving upper part to permit the inclination of reflectors in terms of the horizontal plane, and a parabolic Bi-reflectors aluminized foil that reflects diffuse solar light, whose length and width are 1480 mm and 600 mm, respectively, were installed in a moving position. The working principle of solar panel with optical reflectors is to obtain the maximum amount of sun radiation as shown in Figure 2.

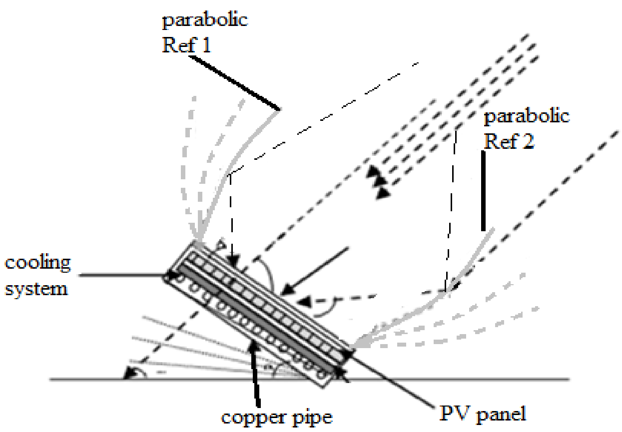

Figure 2. PV-T panel and parabolic Bi-reflectors diagram

The large input in current which goes through the inductor is the problem for this converter, that make this a disadvantage topology that we should find another, that can increase current in output of PV panel. for that We've proposed a completely self-contained optimal dimensioning solution [28], [29]. In order to provide a stable inclination and is estimated to reflect the sun's rays radiation onto the solar pv panel. Table 2 illustrate the results measurement of voltage, currant and power of the pv panel with bi-reflectors and the cooling system,the measurement was taken between 11:00 AM to 04:00 PM. Our experience is represented in Figure 3.

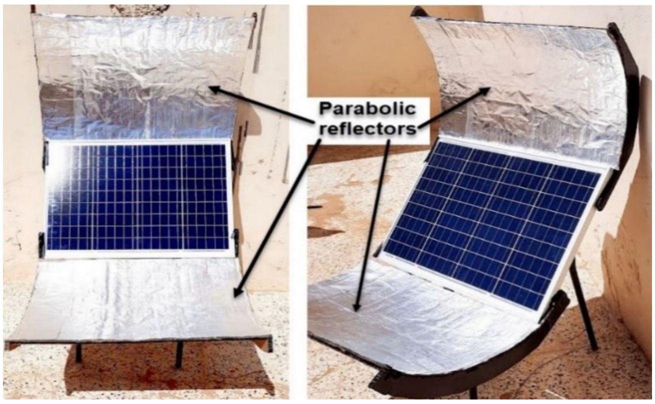

Figure 3. Experimental setup of PV module with parabolic reflectors

Table 2. Measurement results of the solar panel output with reflectors and cooling system (10/03/2020)

Time	Voltage (V)	Curent (A)	Power (W)	Cyclical Repert
11:00	11	1.4	140	0.5
12:00	12.5	2.2	147	0.49
13:00	13.6	3.4	148	0.47
14:00	14.5	4.4	148.5	0.45
14:30	15.7	5.4	150	0.41
15:00	16.8	6.4	151	0.39
15:30	17.4	7.4	151	0.37
16:00	18	8.3	150	0.34

4. RESULTS AND DISCUSSION

We compared the experimental results for: Ishc short circuit current, Voc open-circuit voltage, output power and surface temperature of the PV module with, and without reflectors and cooling systems, and the test results are shown in the figures. In this case of tempreture mesearement, we take the results of mesearement between 08:00 AM to 04:00 PM, to observe the effect of tempreture on pv panel all day long.

By using the bi-reflectors without cooling systems, the temperature on the surface of the PV module was steadily rising, up from 30 °C at 9:00 am to 52 °C at 13:00 pm. However, the PV module's surface temperature was reduced to 38 °C at 13:00pm in the case of using cooling systems. By adding cooling systems, The PV module's surface temperature was stabilized between 25 and 39 °C. even though solar irradiation was high because of reflectors as shown in Figure 4.

Figure 5 showed the graph of PV module current measurement compared between panel without reflectors, the PV panel with reflectors and PV panel with the mounted reflectors and cooling system. From the result of the study, showed that the current PV panel without reflectors kept in the range of 0.5A to 5.5A, while the current panel kept in the range of 1.5A to 8A. In the case of using PV panel with reflectors and this is due to the increase in irradiation due to reflectors. Figure 6 shows that The PV module's open-circuit voltage is kept between 10 and 13 volts. By using reflectors and this is because the rise in PV module's temperature, while the open-circuit voltage is kept in the range of 11 v to 18 v by using cooling systems with reflectors and this is due to the decrease in temperature by using cooling systems. The study's findings revealed that solar panels with cooling systems had a more stable surface temperature than solar panels without cooling systems. Owing to the cooling system attached to the rear side of the solar panel absorbing exces heat and channeling it through the copper pipe, and the cold water assisting in heat dissipation. A higher Voc voltage is generated by a photovoltaic panel because this was a demonstration of the solar panel's technical characteristics.

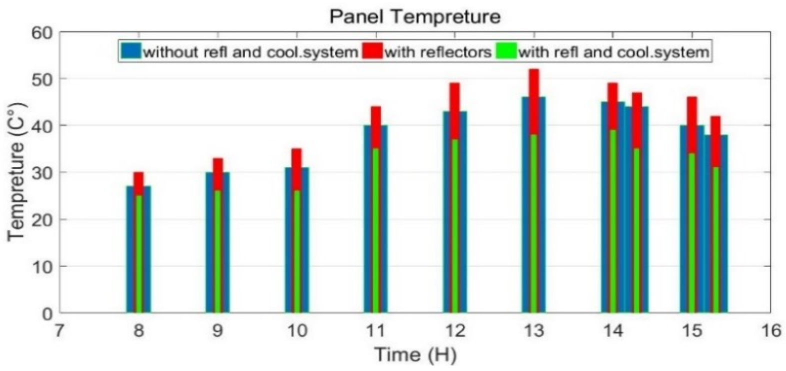

Figure 4. Solar panels temperature

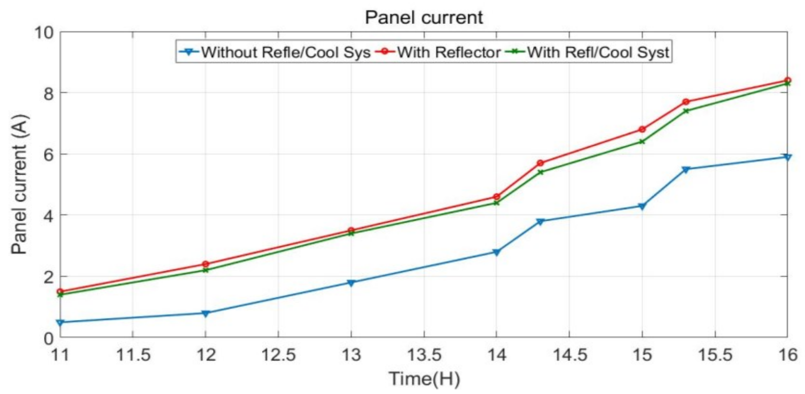

Figure 5. Panel output current

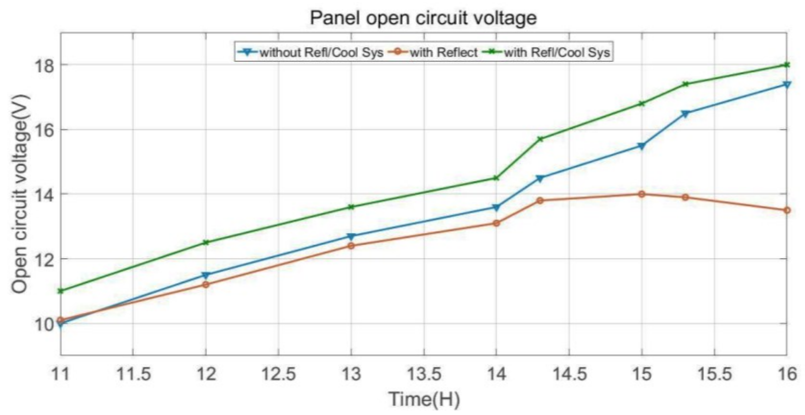

Figure 6. Panel Voc open circuit voltage

Figure 7 depicted a graph of PV panel output power measurement compared between panels without reflectors, PV panel with mounted reflectors and PV panel with reflectors and cooling system. From the results, the study findings revealed that the output power of PV panel without reflectors kept in the range of 105 to 117 w, while the output power of PV panel in the case of using PV panel with reflectors kept in the range of 125 to 139 w and this is due to the increase in the current panel due to reflectors, while in the case of using a PV panel with reflectors and cooling system, the output power is kept in the range of 139 to 150 w, which is due to the increase in the current panel due to reflectors, and increase in voltage PV panel due to the decrease in temperature because of the existence of the cooling system. Table 3 showed the result of comparison between the structures of the PV panel, and the using reflectors and cooling system on panel performance, the temperature of the surface of the PV panel, voltage and the output power of the PV panel.

We used MATLAB Simulink program, to show the effect of parabolic reflectors and cooling system on the DCDC boost inverter, as well as the comparison between two chains of conversion with and without parabolic reflectors and cooling system using the results of the experiment Table 2. Chains conversion with and without parabolic reflectors and cooling system under matlab simulik program as shown in Figure 8.

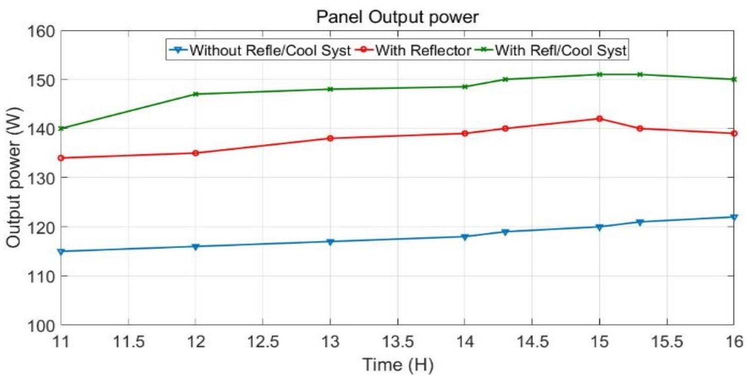

Figure 7. Panel output power

Table 3. Efficiency of PV module with reflectors and cooling systems
(Panel temperature, Voc and output power)

	PV panel			PV+refl +coolsys			Delta(°)			Efficiency %		
	Temp (C°)	Voc (V)	Power (W)	Temp (C°)	Voc (V)	Power (W)	Temp (C°)	Voc (V)	Power (W)	Temp (C°)	Voc (V)	Power (W)
Average	38.4	12.8	113.5	33.1	14.5	149	5.3	1.7	35.5	13.8	11.7	23.8
The highest	46	16.5	117	38	18	150	8	1.5	33	17.4	8.3	22

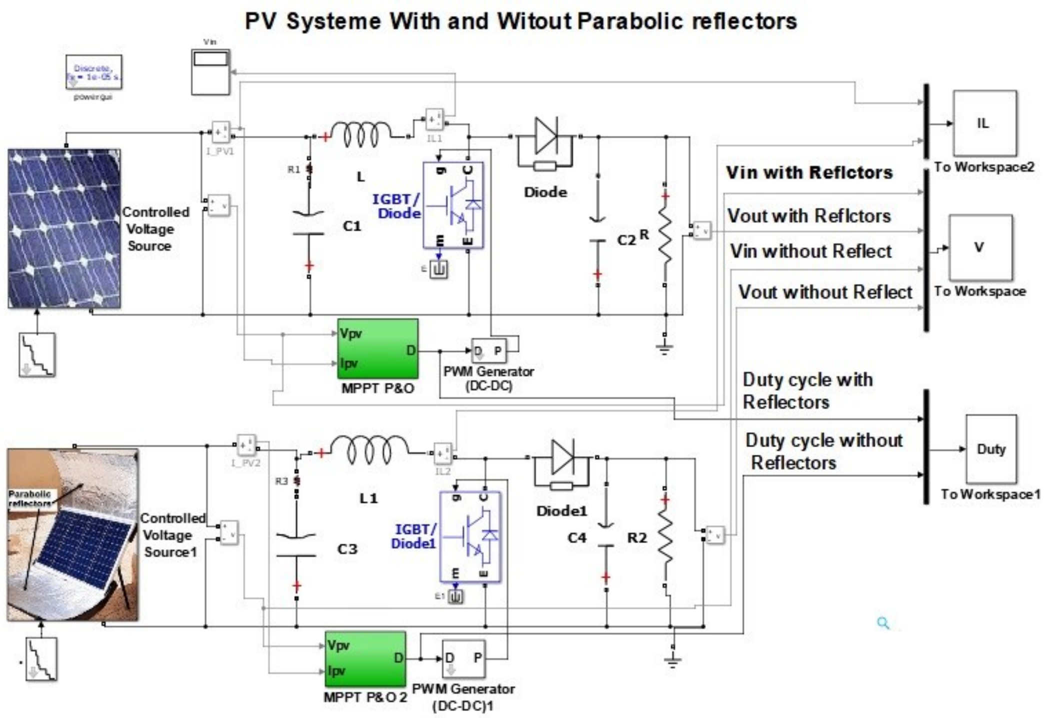

Figure 8. Chains conversion with and without parabolic reflectors and cooling system under matlab simulik program

The results of simulation are given in Figures 9-13. These figures show us the output voltage, output current, output power, the values of duty cycle and the the PV panel's efficiency. Figure 9 show that the output voltage in the case of using parabolic concentrators with cooling system is greater than the output voltage without using concentrators and up to 18v, and the output current at the output of chain conversation with the use of concentrators and cooling systeme is greater than the the output current intensity without using concentrators and up to 8A Figure 10, and the Boost chopper coil consumes a lot of power or which absorbed through the inductor. On the other hand, Figure 12 show that the values of DC duty cycle when using concentrators and cooling systeme is less than the DC duty cycle values in the case when concentrators absence, and as a result, Figures 12 and 13 show that the use of reflectors and cooling system increase the output power and enhance performances and efficiency of the pv panel.

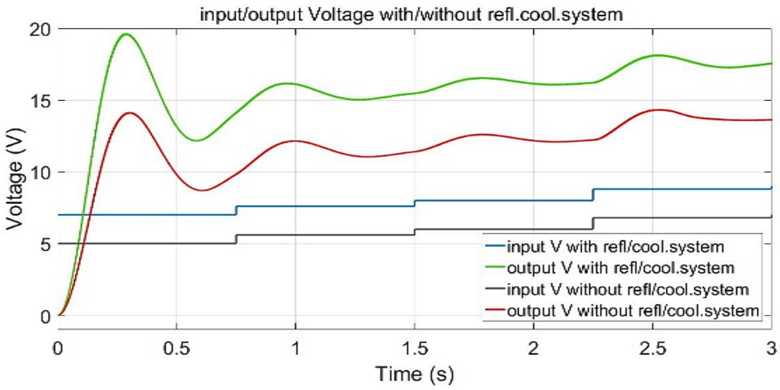

Figure 9. Input and output voltage with and without concentrator system

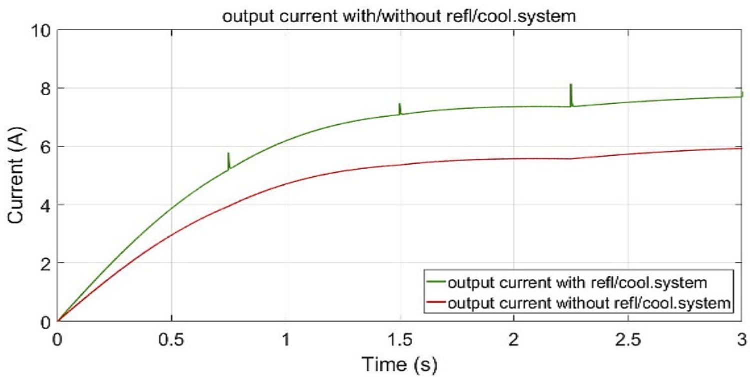

Figure 10. Output current with and without concentrator system

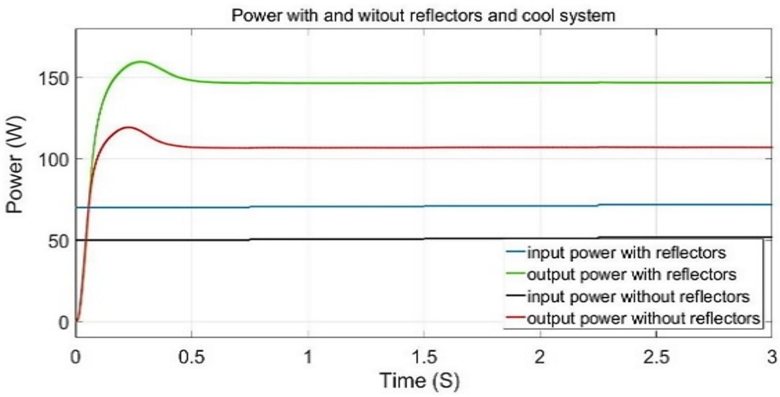

Figure 11. Input and output power with and without concentrator system

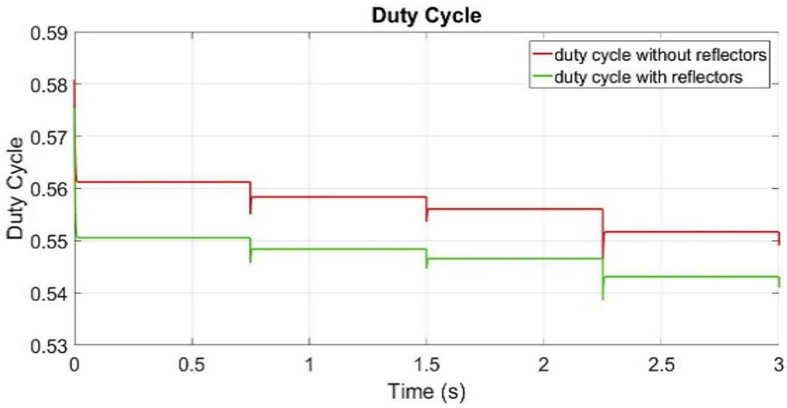

Figure 12. Cyclic report of the boost inverter

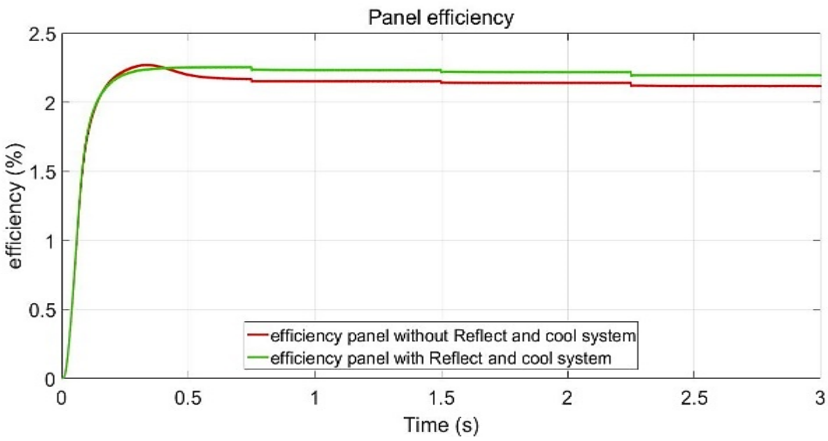

Figure 13. Panel efficiency with and without Reflectors and cooling system

5. CONCLUSION

The aim of the present study is to demonstrate the impact and the importance of increasing solar irradiation by adding parabolic reflectors and the decrease in the surface solar pv panel temperature by adding cooling systems, on the pv panel performances and energy efficiency. From the results obtained, we were able to conclude that: By adding a parabolic reflector, the output current of the PV panel can be rised by increasing solar irradiation, but this technique increases the temperature in the surface of pv panel up to 60 °C, to adjust the temperature in the surface of solar pv panel, two cooling techniques systems have been added, a Heat sinks were integrated on the rear side of the PV panel attached with a copper pipe that contains cooled water in a closed circuit. The temperature in the surface of PV panel decreased by 13.4% when the PV panel was cooled, it can be concluded to be very effectual in reducing the pv panel surface temperature when using the same solar panel without the cooling system as a comparison. By using parabolic reflectors with coolig system, the duty cycle decreases from 0.55 to 0.51, which means a great advantage to avoid current consumption at the coil. A high enhanced in performances as output power solar system is discussed in this research, cost-effective, and can be easily used and adopted as a future green energy system, particularly in countries with hot weather.

REFERENCES

[1] J. M. Pearce, "Photovoltaics-A path to sustainable futures," *Futures*, vol. 34, 663-674, 2002, doi: 10.1016/S0016-3287(02)00008-3.
[2] S. E. Hosseini, "Development of solar energy towards solar city Utopia," *Energy Sources, Part A Recover. Util. Environ. Eff.*, vol. 41, no. 23, pp. 2868–2881, 2019, doi: 10.1080/15567036.2019.1576803.
[3] K. Branker, M. J. M. Pathak and J. M. Pearce, "A 'review of solar photovoltaic levelized cost of electricity," *Renew. Sustain. Energy Rev.*, vol. 15, no. 9, pp. 4470-4482, 2011, doi: 10.1016/j.rser.2011.07.104.

[4] A. Fudholi, M. Mustapha, I. Taslim, F. Aliyah, A. Gani Koto and K. Sopian, “Photovoltaic thermal (PVT) air collector with monofacial and bifacial solar cells: a review,” *International Journal of Power Electronics and Drive Systems (IJPEDS)*, vol. 10, no. 4, p. 2021, 2019, doi: 10.11591/ijpeds.v10.i4.pp2021-2028.

[5] D. Arvizu *et al., Direct solar energy. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation*. O. Edenhofer *et al*. Eds., Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Available Web-link: http://srren.ipccwg3.de/report/IPCC_SRREN_Ch03.

[6] V. Jiménez, “*World Sales of Solar Cells Jump 32 Percent*,” Earth Policy Institute. [Online]. Available: http://www.geni.org/globalenergy/library/media_coverage/earth-policy-institute/world-sales-of-solar-cells-jump-32-percent/index.shtml (accessed: Aug 7, 2000).

[7] G. Popovici, S. Valeriu, T. Dorin and N.-C. Chereche, “Efficiency improvement of photovoltaic panels by using air cooled heat sinks,” vol. 85, no. November 2015, pp. 425-432, 2016, doi: 10.1016/j.egypro.2015.12.223.

[8] Y. Siahaan and H. Siswono, “Analysis the effect of reflector (flat mirror, convex mirror, and concave mirror) on solar panel,” *International Journal of Power Electronics and Drive Systems (IJPEDS)*, vol. 10, no. 2, p. 943, 2019, doi: 10.11591/ijpeds.v10.i2.pp943-952.

[9] Ö. D. Başak and B. S. Sazak, “Effect of components on a solar panel system Efficiency,” *IJRET*, vol. 3, special no. 17, IACEIT-2014 Dec-2014.

[10] A. Fudholi, M. Fazleena Musthafa, I. Taslim, M. Ayu Indrianti, I. Noviantari Manyoe and M. Yusof Othman, “Efficiency and energy modelling for PVT air collector with extended heat transfer area: a review,” *International Journal of Power Electronics and Drive Systems (IJPEDS)*, vol. 10, no. 4, p. 2029, 2019, doi: 10.11591/ijpeds.v10.i4.pp2029-2036.

[11] P. Modules, S. E. Centre, C. G. O. Complex and N. Delhi, “Effect of Temperature on Power Output from Different Commercially available Effect of Temperature on Power Output from Different Commercially available Photovoltaic Modules,” *Int. Journal of Engineering Research and Applications*, vol. 5, no. 1, July, 2015.

[12] H. Boulaich, A. Benkaddour, O. Hamdoun and E. Aroudam, “Analysis of thermal-electrical performance of PVT collector with reflectors,” vol. 12, no. 2, pp. 1045-1054, 2021, doi: 10.11591/ijpeds.v12.i2.pp1045-1054.

[13] A. Royne, C. J. Dey and D. R. Mills, “Cooling of photovoltaic cells under concentrated illumination: a critical review,” *Sol Energy Mater Sol Cells*, vol. 86, no. 4, pp. 451-83, 2005, doi: 10.1016/j.solmat.2004.09.003.

[14] A. M. A. Soliman, H. Hassan, M. Ahmed and S. Ookawara, “A 3d model of the effect of using heat spreader on the performance of photovoltaic panel (PV),” *Math Comput Simul 2018*, vol. 167, pp. 78-91, Jan. 2020, doi: 10.1016/j.matcom.2018.05.011.

[15] H. Peng, G. Ding, H. Hu and W. Jiang, “Effect of nanoparticle size on nucleate pool boiling heat transfer of refrigerant/oil mixture with nanoparticles,” *International Journal of Heat and Mass Transfer*, vol. 54, no. 9-10, pp. 1839-1850, Apr. 2011, doi: 10.1016/j.ijheatmasstransfer.2010.12.035.

[16] S. P. Philipps, A. W. Bett, K. Horowitz and S. Kurtz, “Current Status of Concentrator Photovoltaic (CPV) Technology,” *Natl. Renew. Energy Lab*., 2015-1–25, doi: 10.2172/1351597.

[17] H. A. Nasef, S. A. Nada and H. Hassan, “Integrative passive and active cooling system using PCM and nano fl uid for thermal regulation of concentrated photovoltaic solar cells,” *Energy Convers. Manag.*, vol. 199, no. September, p. 112065, 2019, doi: 10.1016/j.enconman.2019.112065.

[18] C. Deline, A. Dobos, S. Janzou, J. Meydbray and M. Donovan, “A simplified model of uniform shading in large Photovoltaic arrays,” *Sol. Energy*, vol. 96, pp. 274-282, 2013, doi: 10.1016/j.solener.2013.07.008.

[19] S. Dubey and G. N. Tiwari, “Thermal modeling of a combined system of photovoltaic thermal (PV/T) solar water Heater,” *Sol. Energy*, vol. 82, no. 7, pp. 602-612, 2008, doi: 10.1016/j.solener.2008.02.005.

[20] M. A. Khan, B. Ko, E. Alois Nyari, S. E. Park and H.-J. Kim, “Performance Evaluation of Photovoltaic Solar System with Different Cooling Methods and a Bi-Reflector PV System (BRPVS): An Experimental Study and Comparative Analysis,” *Energies*, vol. 10, no. 6, p. 826, 19 June 2017, doi: 10.3390/en10060826.

[21] C. B. Honsberg and S. G. Bowden, “Photovoltaics Education Website,” 2019. [Online]. Available: https://www.pveducation.org

[22] M. Emam, M. Ahmed and Shinichi Ookawara, “Performance analysis of a new concentrator photovoltaic system integrated with phase change material and Water jacket,” *Sol. Energy,* vol. 173, pp. 1158-1172, 2018, doi: 10.1115/ES2016-59641.

[23] C. Somasundar Reddy and K. Balaji, “A fuzzy-PID controller in shell and tube heat exchanger simulation modeled for temperature control,” *Indonesian Journal of Electrical Engineering and Computer Science* (*IJEECS)*, vol. 21, no. 3, p. 1364, 2021, doi: 10.11591/ijeecs.v21.i3.pp1364-1371.

[24] L. Costiuc and V. Popa, “Simulink Model for a Heat-Exchanger,” 2009. [Onlline]. Available: http://aspeckt.unitbv.ro/jspui/bitstream/123456789/1209/1/859.pdf

[25] N. Shahirah, B. Rukman, A. Fudholi, I. Taslim, M. A. Indrianti and A. Fudholi, “Electrical and thermal efficiency of air-based photovoltaic thermal (PVT) systems : an overview,” *Indonesian Journal of Electrical Engineering and Computer Science* (*IJEECS)*, vol. 14, no. 3, pp. 1134-1140, 2019, doi: 10.11591/ijeecs.v14.i3.pp1134-1140.

[26] Ankit Khanna, Thomas Mueller, Rolf A. Stangl, Bram Hoex, Prabir K. Basu and Armin G. Aberle, “A Fill Factor Loss Analysis Method for Silicon Wafer Solar Cells," *IEEE Journal of Photovoltaics*, vol 3, no. 4, pp. 1170-1177, Oct 2013, doi: 10.1109/JPHOTOV.2013.2270348.

[27] S. M. Wong, H. Y. Yu, J. S. Li, G. Zhang, Patrick G. Q. Lo and D. L. Kwong, "Design High-Efficiency Si Nanopillar-Array-Textured Thin-Film Solar Cell," *IEEE Electron Device Letters*, vol. 31, pp. 335-337, April 2010, doi: 10.1109/LED.2010.2040062.

[28] Weidong Xiao and W. G. Dunford, "A Modifed Adaptative Hill Climbing Maximum Power Point Tracking (MPPT) Control Method for Photovoltaic Power Systems," *2004 IEEE 35th Annual Power Electronics Specialists Conference*, université de Columbia, 2003, doi: 10.1109/PESC.2004.1355417.
[29] B. Mohammed, B. Kadri, N. Abdelfatah and B. Ismail, "Design and modeling of optical reflectors for a PV panel adapted by MPPT control," *Indonesian Journal of Electrical Engineering and Computer Science* (*IJEECS)*, vol. 16, no. 2, pp. 653-660, 2019, doi: 10.11591/ijeecs.v16.i2.pp653-660.

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