Enhancing Electrical Performance of PV Panels using a Single-Axis Polar Solar Tracker in Southern Algeria

Mohamed Yacine Rachedi[1,2*], Djamel Bechki[2], Yacine Marif[2], Hamza Bouguettaia[2]

[1]Department of Electronics & Telecommunications, University of Ouargla, Ouargla, Algeria
[2]LENREZA Laboratory, University of Ouargla, Ouargla, Algeria
*Corresponding author's e-mail: rachedi.yacine@univ-ouargla.dz

ABSTRACT

The reduced efficiency of photovoltaic (PV) solar panels in converting sunlight into electricity always necessitates economic supplements to enhance their performance. Therefore, the work presented inthis paper focuses on enhancing the electrical performance of PV panels in Ouargla city, southern Algeria, by employing a single-axis polar solar tracker through a practical approach. For this purpose,a mono-axial polar solar tracker has been constructed using an Arduino Uno microcontroller. Furthermore, the PV solar panel will be positioned facing the sun using an electrical motor with a maximum power of 70 W controlled by two light sensors placed on the top of the single-axis tracker. Its axis of rotation is tilted at the latitude angle of Ouargla (32 °) and faces south. According to the findings, the partial sun tracking mode led to an increase in short-circuit current that was an averagegain of 88%, despite a loss in open-circuit voltage of 2% compared to the conventional one. In addition,the daily average amount of captured solar irradiation by the surface of the tracking PV panel was 41.4%, compared to the fixed one. These percentages confirm that there will be an extremely high rate of improvement in the total amount of electrical power produced.

Keywords: PV panel electrical performance, Single-axis polar tracker, Southern Algeria

1 Introduction

Algeria is known for having one of the highest mean annual sun radiation values in the world, especially in the city of Ouargla (south-east of Algeria), which has considerable sunshine throughout the year (138 clear-sky days / year) [1], [2]. The optimal performance of photovoltaic (PV) systems can be attained by maintaining the panels in a position that is perpendicular to the sun's radiation path. As a consequence of this, utilizinga solar tracker system is the most effective method for ensuring that the PV panels are kept in the optimalposition. Several research papers have investigated the partial tracking mode and its impact on the performance of PV panels [3], among which are Artanto *et al.* [4], Gutiérrez and Rodrigo [5]. So, in this study, the impact of a polar axis solar tracker on the electrical performance of a PV module in the Ouargla region will be exposed.

2 Methodology

The experiment was carried out in Ouargla city (south-east of Algeria) (see Figure 1(a)), on the day of May 23, 2022 (very sunny with a clear sky), using the installation described in Figure 2(b) (a fixed PV panel tiltedat 32° and facing the south; the other one is attached to a polar axis solar tracker). Open-circuit voltage(V_{oc}) and short-circuit current (I_{sc}) have been hourly evaluated and recorded experimentally.

3 Results and Discussion

The tracking solar panel heats up faster than the fixed one since it is always facing the sun. This increasehas undesirable effects on the V_{oc} (see Figure 2(a)). Again, from Figure 2(b), the current I_{sc} in the mobile case is greater than that in the fixed one, which is due to the superiority of the solar radiation captured bythe moving structure compared to the fixed one in the totality of the hours of measurement.

DOI: 10.21467/abstracts.163 ISBN: 978-81-965621-5-1 (eBook)

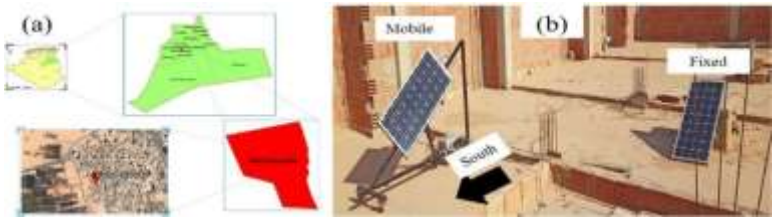

Figure 1: *(a) location of the test region, and (b) structure used in the experiments.*

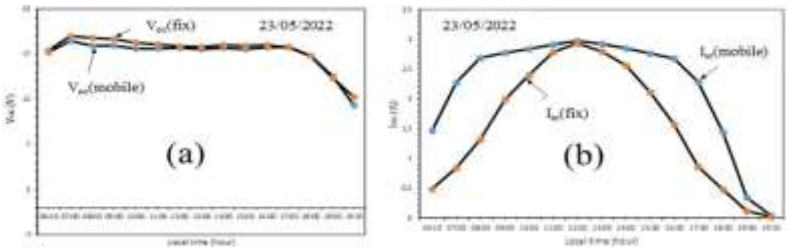

Figure 2: *(a) open-circuit voltage, and (b) short-circuit current in static and mobile cases.*

4 Conclusion

Improving PV panel electrical performance in the south-east of Algeria using a partial tracking technique was experimentally investigated in this paper. This steady concluded that the daily average amount of received sunlight on the moving system surface is 41.4%, compared to the conventional one. Additionally, in the tracking mode, the short-circuit current is increased by an average of 88% with a decrease in theopen-circuit voltage of 2%. Finally, the results obtained encourage us to use solar trackers, in particular the polar axis one, in industrial applications despite the fact that they dissipate energy and require more maintenance and human intervention.

5 Competing Interests

The authors declared that no conflict of interest exists in this work.

How to Cite

M. Y. Rachedi, D. Bechki, Y. Marif, H. Bouguettaia, “Enhancing Electrical Performance of PV Panels using a Single-Axis Polar Solar Tracker in Southern Algeria”, *AIJR Abstracts*, pp. 94–95, Feb. 2024.

References

[1] M. Y. Rachedi, D. Bechki, Y. Marif, S. Boughali and H. Bouguettaia, "A novel model for optimizing tilts of four reflectors on a flat plate thermal collector: Case study in Ouargla region", Case Studies in Thermal Engineering, vol. 32, pp. 101872, 2022.

[2] M. Y. Rachedi, D. Bechki, Y. Marif and H. Bouguettaia, "Solar flat plate collector enhanced by two reflectors: optimum tilts of reflectors", Electrical Engineering & Electromechanics, no. 5, pp. 67-70, 2022.

[3] A.R. Amelia, Y.M. Irwan, I. Safwati, W.Z. Leow, M.H. Mat, M. S. A. Rahim and S. Md. Esa, "Technologies of solar tracking systems: A review", IOP Conference Series: Materials Science and Engineering, Volume 767, pp. 012052, 2020.

[4] D. Artanto, A. Prasetyadi, D. Purwadianta and R. Sambada, Design of a GPS-based solar tracker system for a vertical solar still, 2016 International Conference on Smart Green Technology in Electrical and Information Systems (ICGTEIS), pp 140-143, 2016.

[5] S.Gutiérrez and P. M. Rodrigo, "Energetic analysis of simplified 2-position and 3-position North-South horizontal single-axis sun tracking concepts, Solar Energy, Volume 157, pp 244-250, 2017.

ISBN: 978-81-965621-5-1

Series: AIJR Abstracts

DOI: 10.21467/abstracts.163