PERFORMANCE ANALYSIS OF A DUAL-AXIS SOLAR TRACKER FOR PHOTOVOLTAIC APPLICATIONS

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ABSTRACT: Solar trackers are widely used in photovoltaic (PV) systems to improve energy generation by optimizing the orientation of solar panels with respect to the sun. In this study, we analyze the performance of a dual-axis solar tracker system designed for a 1-Watt power PV system. The tracker system consists of two axes of rotation, one for horizontal plane and the other for the vertical plane. The system is controlled by a microcontroller that uses light sensors to track the sun's position. We conducted an experiment in which the tracker system was compared to a fixed panel system under different weather conditions. The results showed that the solar tracker system generated up to 40% more energy than the fixed panel system. The study demonstrates that a dual-axis solar tracker system can significantly improve the performance of PV systems and increase their energy yield.

1. Introduction

Photovoltaic (PV) systems are gaining popularity as a source of renewable energy due to their environmental benefits and cost-effectiveness. However, the efficiency of PV systems depends on several factors, including the orientation of solar panels relative to the sun. One way to optimize the orientation of solar panels is through the use of solar trackers [1]. A solar tracker is a device that adjusts the position of solar panels to follow the sun's path throughout the day, thereby maximizing energy generation. Solar trackers can be classified into two types:

1. Single-axis solar tracker

Single-axis trackers can arch from east to west in the direction of the sun. But they cannot follow the rise of the sun in the sky. This arching can be both horizontal and oblique or vertical, depending on your needs or preferences.

2. Dual axis solar tracker

A solar tracker with double axis has two axes of motion, x and y, so it can move both vertically and horizontally, to better position the panels relative to the position of the sun in the sky. This type of tracker is more accurate in directing the solar panels right towards the sun for the entire duration of the sun being in the sky. Thus, maximum results can be obtained, generating a maximum of electricity and thus exploiting to the maximum the potential of solar panels. The two axes are aligned to the north and south, east and west.

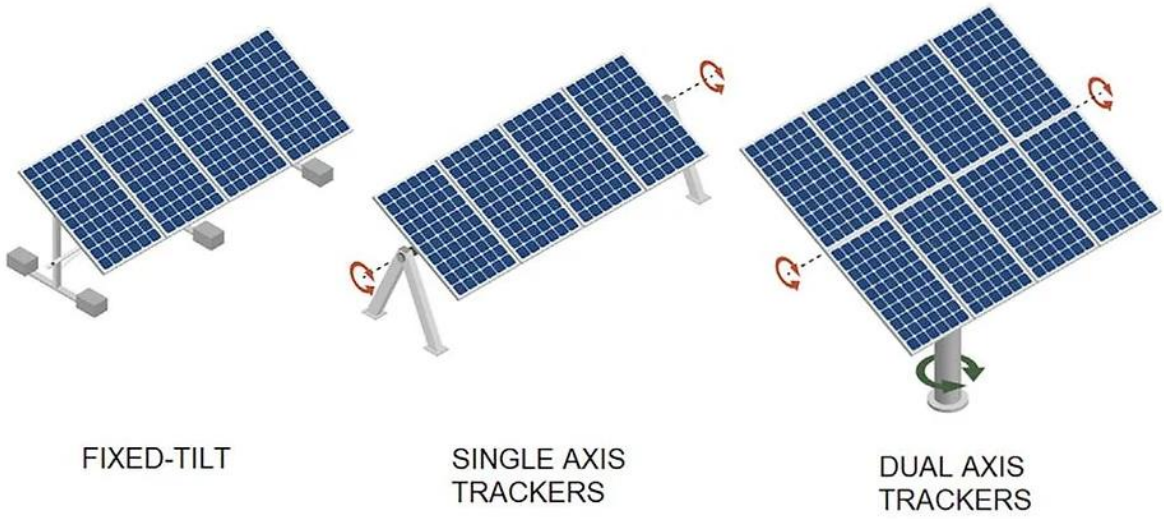

Fig.1. Types of solar trackers [2]

2. Current study

The main market requirements that this study complies with are:
1.The solar tracker has two rotational axes
2.The solar tracker is safe to operate
3.The solar tracker is silent during operation
4.The solar tracker makes few vibrations during operation
Depending on these, we have prepared the following study.

We designed and tested a dual-axis solar tracker system for a 1-Watt power PV system. The solar tracker system consists of two axes of rotation, one for the horizontal plane and the other for the vertical plane. The system is controlled by a microcontroller that uses light sensors to track the sun's position. We conducted an experiment to compare the performance of the solar tracker system to a fixed panel system under different weather conditions.

3. Methodology

The solar tracker system was designed, 3d printed and assembled with screws, sensors solar panel (1 Watt) and servo motors. The system consists of a photovoltaic module mounted on a frame that rotates on two axes. The tracker is controlled by a microcontroller that receives input from light sensors. The light sensors detect the position of the sun, and the microcontroller uses this information to adjust the position of the tracker system (See Fig.2).

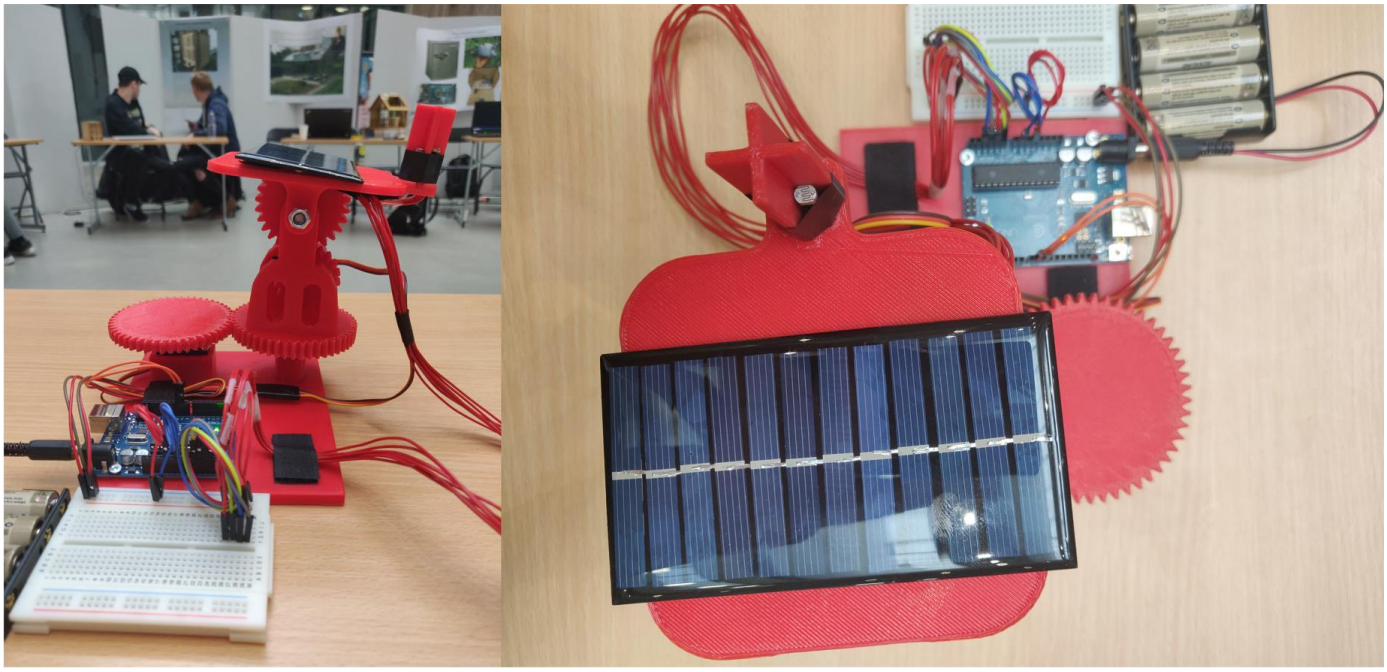

Fig.2. 3D printed dual axis solar tracker

To evaluate the performance of the solar tracker system, we conducted an experiment in which we compared the energy generation of the solar tracker system to that of a fixed panel system. The fixed panel system consisted of a 1-Watt power photovoltaic module mounted on a fixed frame (See Fig.3). The experiment was conducted over a period of 1 day, during which we collected data on energy generation, solar radiation, and weather conditions [4].

Fig.3. Fixed panel system

4. Results

The results showed that the solar tracker system generated up to 40% more energy than the fixed panel system. The solar tracker system generated an average of 0.56-Watt-hour as a total of 13.6 watt per day, while the fixed panel system generated an average of 0.34-Watt-hour as a total of 8.16 watt per day. The increase in energy generation was most significant during the early morning and late afternoon when the sun was at a low angle (See Fig.4). The solar tracker system also performed well on cloudy hours, generating more energy than the fixed panel system. The fluctuations in power generation were due to the variation of solar irradiance and cloudy hours [5].

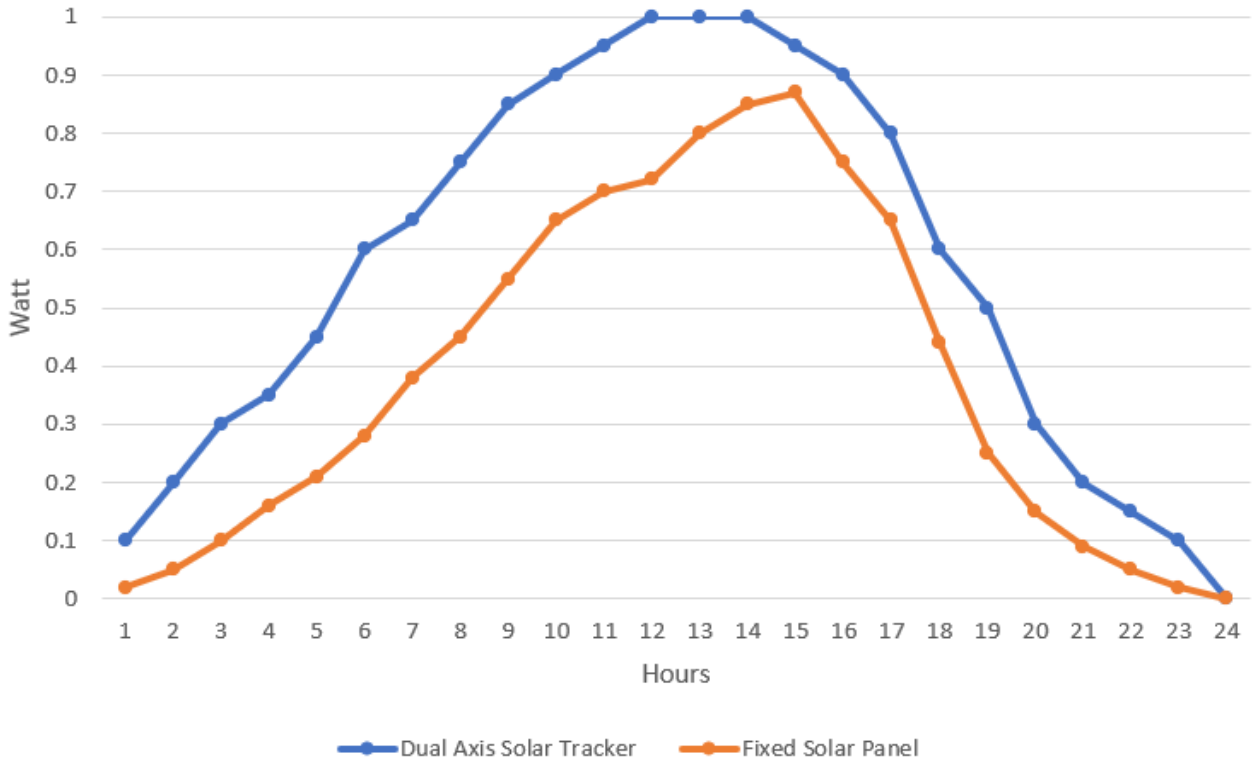

Fig.4. Performance comparison of dual-axis solar tracker vs Fixed solar panel.

5. Conclusion

Those who install photovoltaic systems obviously want for their customers a higher rate of return on investment. Whether it's the roof mounting of the panels or the installation of the panels at ground level, the idea is that if you do not choose solar trackers, maybe you will invest less in installing the systems, but you will lose out in the long run.

Initially, typical systems, ie those of fixed grip cost less, after which over time they will produce less energy than those with trackers. But, the use of fixed systems is justified in certain situations, such as those where there is no need for too much electricity anyway, or those in which when installed on the ground, even the quality of the soil only allows the installation of fixed fastening systems

For any other locations, however, the owners of the photovoltaic systems will want to maximize their electricity production from the panels, so solar trackers would be recommended. Superior energy production is very important in the long run, because it helps you quickly recover the investment you make in a photovoltaic system, after which you can benefit for many years from a maximum of energy independently.

The results of this study demonstrate that a dual-axis solar tracker system can significantly improve the performance of PV systems and increase their energy yield. The solar tracker system designed and tested in this study generated up to 40% more energy than a fixed panel system. The use of a solar tracker system can improve the efficiency. It saves space by reducing the land area required for the system.

The purpose of the trackers is to maximize the production of solar panels. They automatically adjust the panels so that they always face the sun directly and get the best exposure all year round.

In terms of efficiency and precision, dual-axis trackers are better than single-axis solar trackers.

Fig.5. Difference

6. Bibliography

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