

A Study on The Effects of Energy Production Using a Solar Tracker Within The UK



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1) Abstract

To combat global warming and fossil fuel usage, the UK aims to reach its target of net zero emissions by 2050 [1]. This project aimed to assist with this by researching whether a solar photovoltaic panel can be used in conjunction with a single-axis solar tracker to increase its power output within the climate and weather conditions of the UK. This was done in two phases, the first being the development of the solar tracker in both a simulated and physical form. The second phase was experimentation with the developed tracker alongside a static photovoltaic panel. The outcome of this experiment is yes, using a solar tracker within the UK is viable. However, the results obtained from this test are not wholly valid, meaning further testing is required for a conclusive answer.

2) Aims

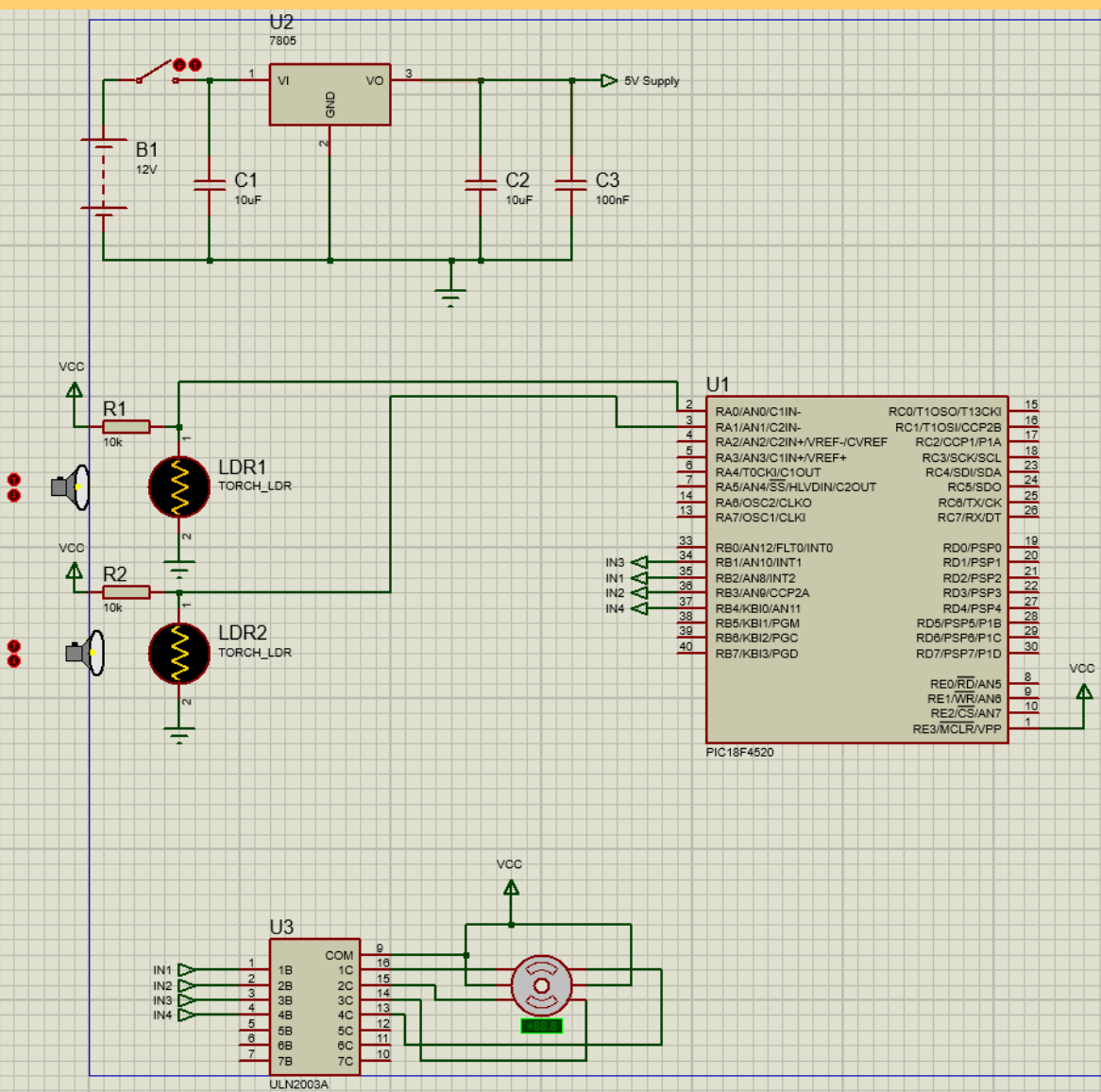
- 1. Design and create a microcontroller-based prototype of a solar tracking system.
- 2. Experiment by comparing the power output of the developed system to a static PV system.
- 3. Conclude on which system outperforms the other.

3) Objectives

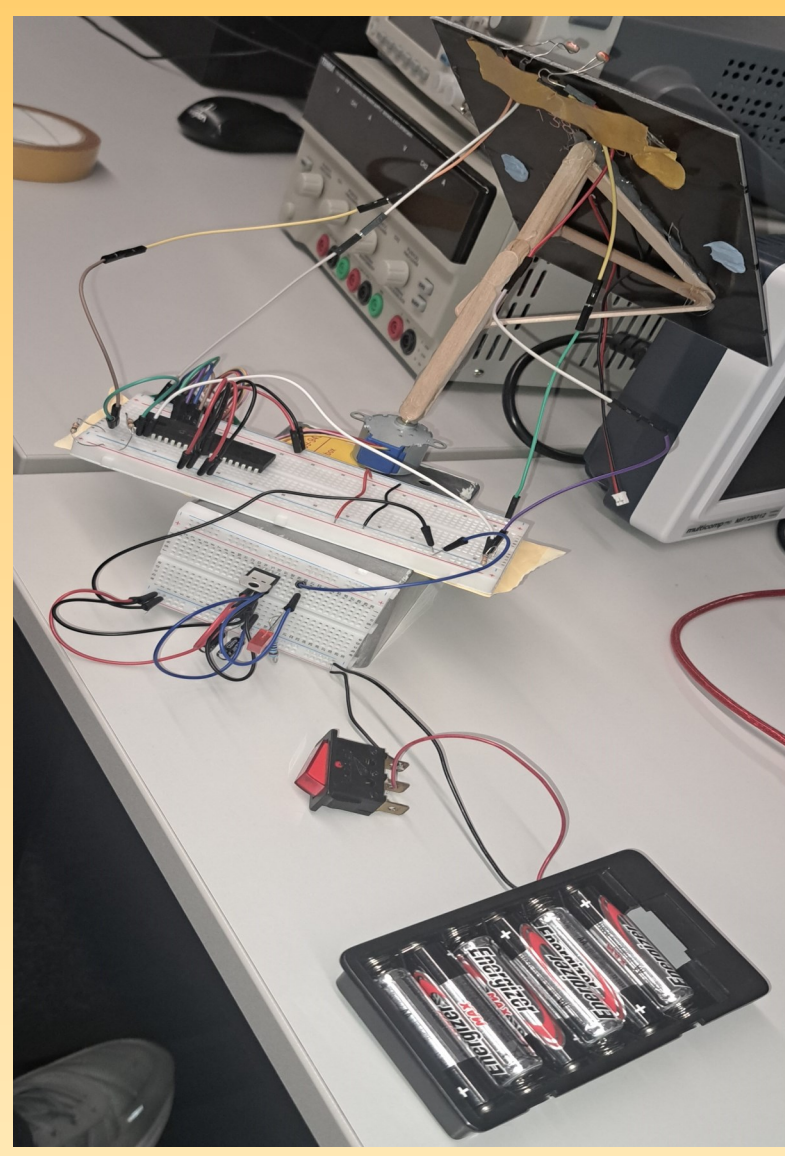
- 1. Review undertaken research.
- 2. Research into preexisting systems.
- 3. Design and code a simulated tracking system.
- 4. Build a physical prototype of the tracking system.
- 5. Build a static PV system to test the tracking system against.
- 6. Experiment to compare the power output of both systems over time and analyse collated data.
- 7. Decide using prior research and experiment results if the tracking system delivers a higher power output.

4) Simulation and Prototype

The tracker's movement is dictated by the LDRs placed above the PV panel. When sunlight is detected, the LDR which detects the greater amount of light will input a digital signal to the microcontroller. This makes the stepper motor turn in the direction of greater detected sunlight with assistance from its drive, the ULN2003 integrated circuit. Once the face of the panel is encompassed by sunlight and the sunlight detected by both LDRs is equal, the motor stops rotating which prevents further panel movement. The entire function of the system was achieved using code.



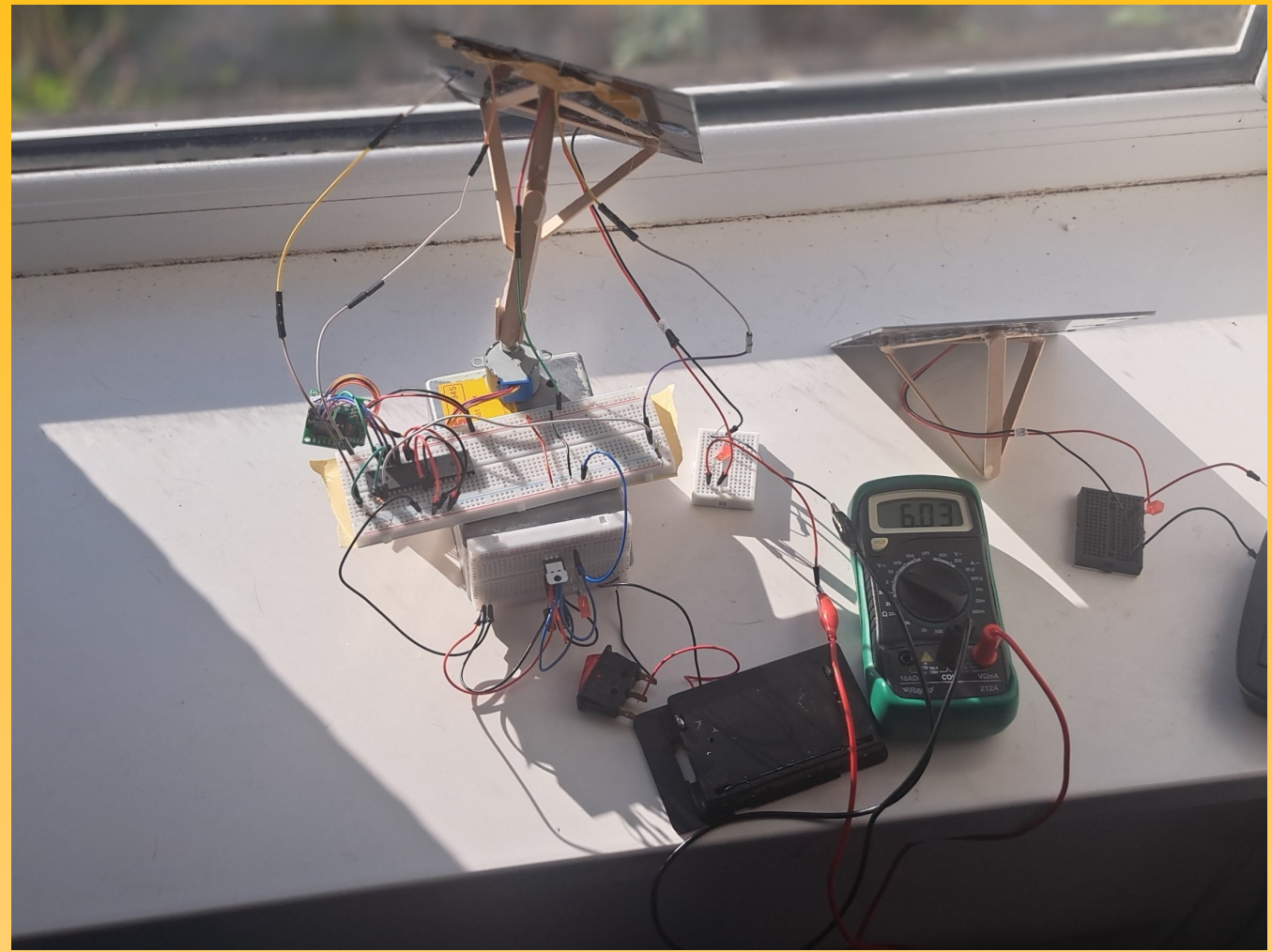
Proteus 8 simulation of the solar tracker



Solar tracker physical prototype

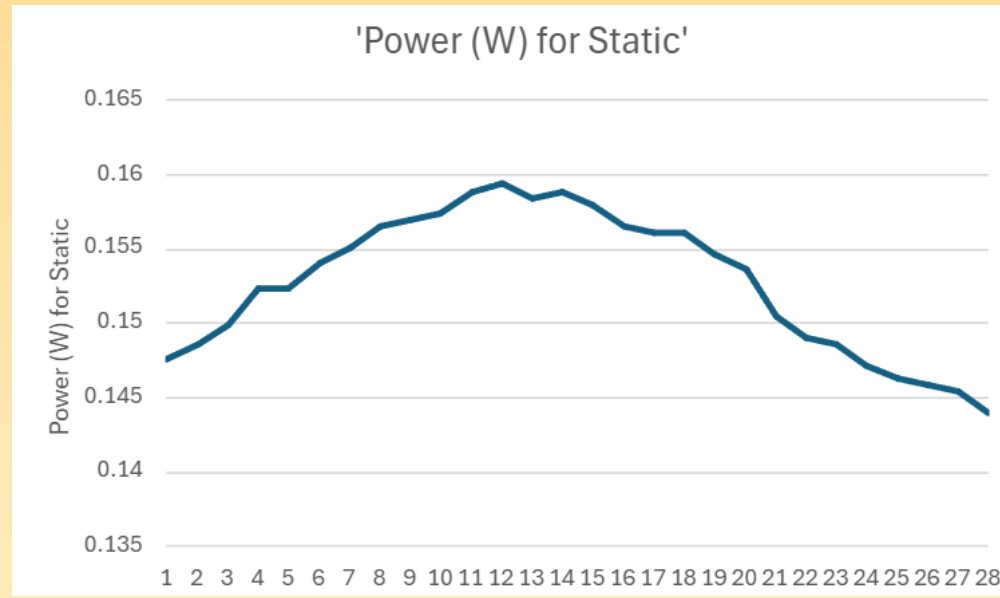
As shown in both images, the solar tracking system incorporates a PIC18F4520 microcontroller alongside a power rectification circuit that uses a 7805 connected to a 12V DC source. Additionally, two light dependent resistors (LDRs) are used for light detection. The stepper motor serves to allow for panel rotation and the PV panel itself to generate power for testing. The stand and tilt structure were constructed using glue and popsicle sticks.

5) Testing and Results

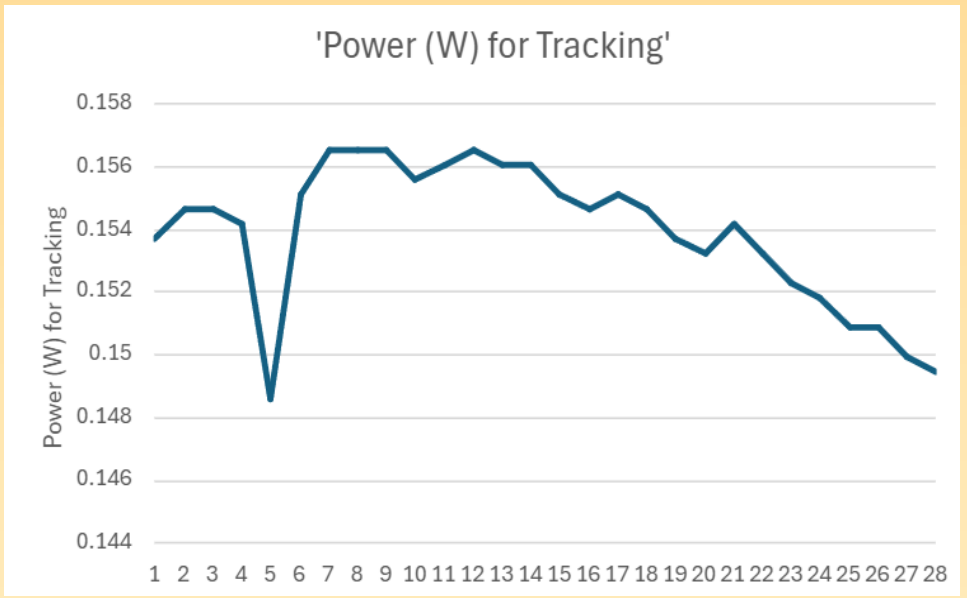


The image to the left shows the location and placements of both systems when tested during the experiment. It also shows how voltage measurements were gathered using a multi-meter.

Both graphs below show that the power output for the static PV panel was higher than the tracking PV panel. However, the power output for the tracking system was more consistent over a longer period. It also had an improved mean efficiency over the static system by 0.007%, lower than expected. The main reasons for this are due to the testing location and the positioning of the LDRs used by the tracking system.



Power output graph for static experiment results



Power output graph for tracker experiment results

6) Conclusion

All objectives except objective 7 were extensively met. The development of a simulated and physical prototype of a solar tracking system was successful. Experimentation of the tracking system was also successful as data was collected, compared and analysed. However, the experimental procedure was ultimately flawed and led to inconclusive results as to whether a solar tracker is suitable for use within a UK climate.

Reference [1] - National Grid, "How much of the UK's energy is renewable?," National Grid, 17 1 2024.