Researching Possible Solar Power Alternatives With Mirrors

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Innovate: IA Project Showcase

Research Question: How does the addition of mirrors to focus sunlight into a concentrated point for the purpose of heating water into steam compare to the energy efficiency of photovoltaic solar panels?

Abstract

It is hypothesized that the addition of mirrors to focus sunlight onto a specific point will lead to a greater efficiency of solar energy when compared to traditional photovoltaics.

The design of this study involves the creation of a prototype in which mirrors are used to heat water using light from the sun. The prototype was left outside for the duration of the day and the amount of water turned into steam was measured.

At the end of the experiment, the evaporation rate of the water inside the prototype was turned into joules, then compared to the energy generation capacity and efficiency of traditional photovoltaics.

These findings may be used to possibly provide insight into further solar power technologies with the addition of mirrors. This technology may be used to close the energy deficit in many developing areas or drive down the MWh cost in developed areas.

Background

Photovoltaic solar panels are the traditional means of generating energy via solar power, using the photons of light to excite a silicon gel inside the panel and lead to the movement of electrons through a copper wire, generating electricity. These panels mainly target visible light, meaning that when the photons of light are degraded to a lower energy level, turning into heat, they are then unusable to generate power, causing efficiency issues. The more steps it takes to get from the sun to the electrical grid, the lower energy efficiency will be, as heat energy is lost at every step where energy is transformed.

Climate change is a major factor on the global stage, largely caused by the burning of fossil fuels, such as coal, oil, and natural gas. The burning of these fuels cause the release of carbon dioxide, which has been stored underground for millions of years, to be released back into the atmosphere, causing an imbalance of gasses and an increased average global temperature. This increased temperature can lead to biodiversity loss, crop failure, and extreme weather, which is why many people are focused on replacing fossil fuels with renewables, like solar.

Results

The results show that our prototype is more efficient in generating energy than traditional photovoltaics, as shown by a higher kWh generation and a higher percent energy generation of our prototype. The following data was calculated using our prototype:

Energy used: 97,793J

Energy generated: 9.032270138889 Wh

Energy efficiency: 33.25%

Methodology

In the design phase, we brainstormed various designs of alternatives to traditional photovoltaics which may be more efficient, which led us to variety of designs before we finally settled on the one which we would use for our experiment.

To begin the experiment, 118ml, or 4oz, of water was added to the chamber where the sunlight would be focused, and the prototype was set out at 10:00am. 3.5 hours later at 1:30pm, we returned, measuring the amount of water left in the chamber, taking note of the weather and temperature, and refilling the chamber with 118ml. Returning one more time after 2 more hours at 3:30pm, we checked the amount of water left in the chamber, taking note of the weather and temperature, and recording the data.

Once we had the data, we used the following formula to calculate the efficiency and the energy generation capacity of our prototype:

Q: Amount of energy it takes to heat the water.

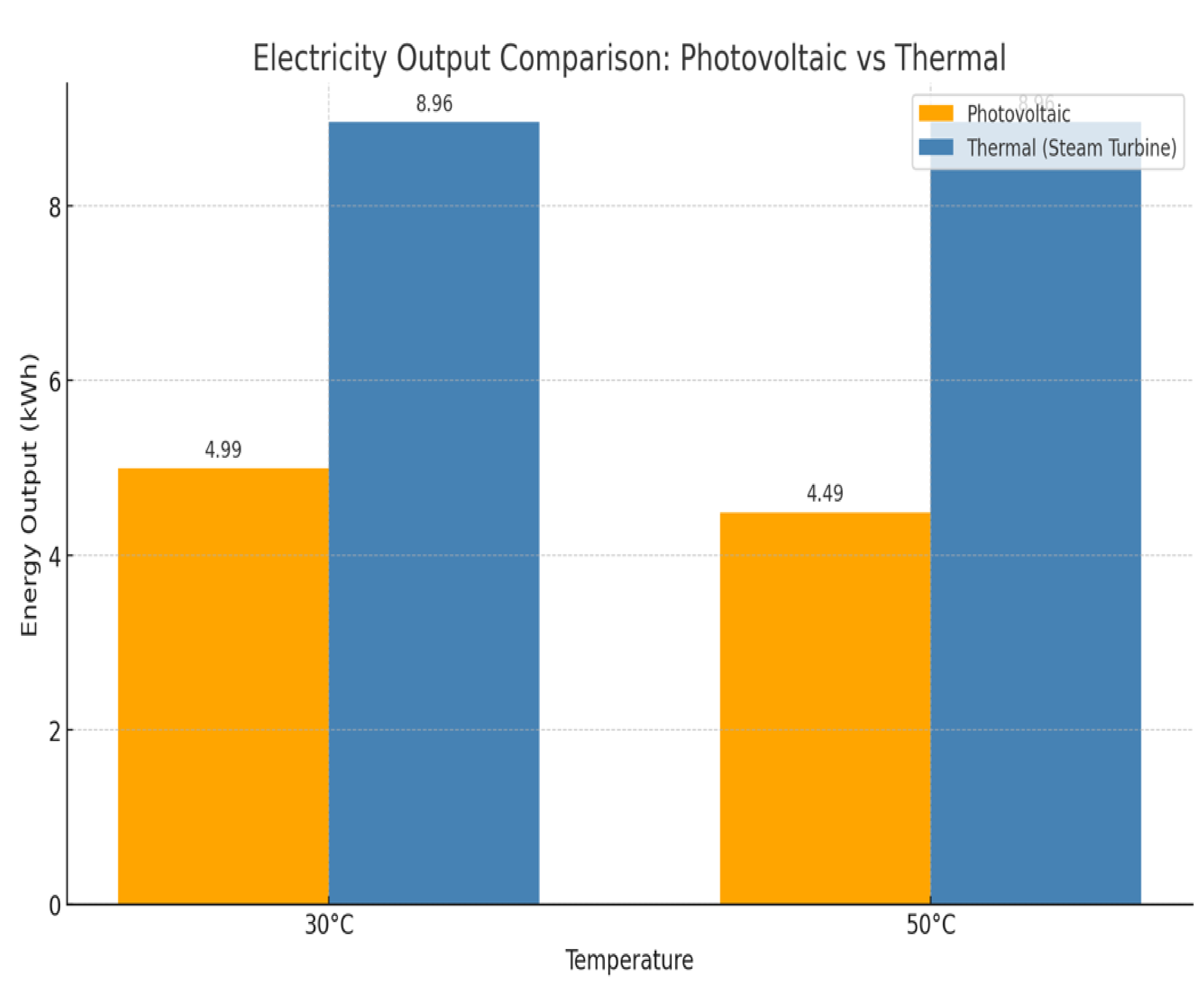
m: Mass of the water being heated.

c: Specific heat of water (4.18 J/g)

ΔT: Difference between the final temperature and starting temperature.

Formula for energy needed to get water to a certain temperature: $Q=mc\Delta T$

During comparison, we assumed a panel evaporated 38 Liters instead of 38 milliliters, and that the temperature was 30 degrees C or 50 degrees C.



Materials

Materials for this project include:

- Our prototype
- Water
- A graduated cylinder
- A thermometer

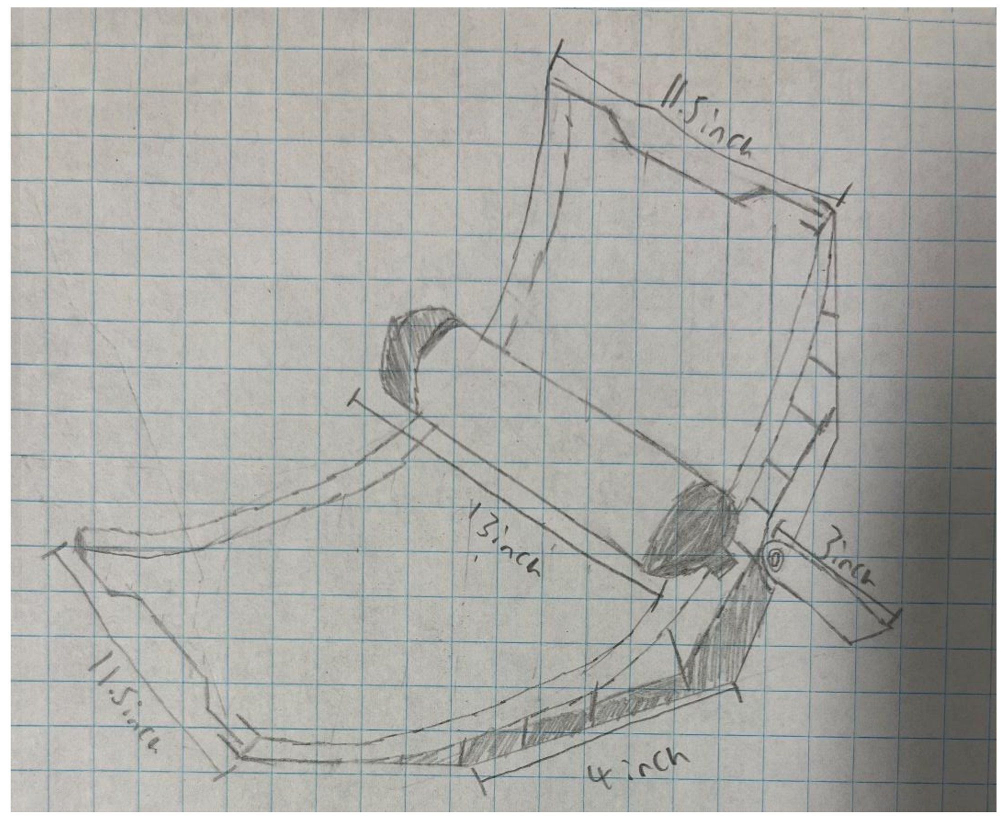
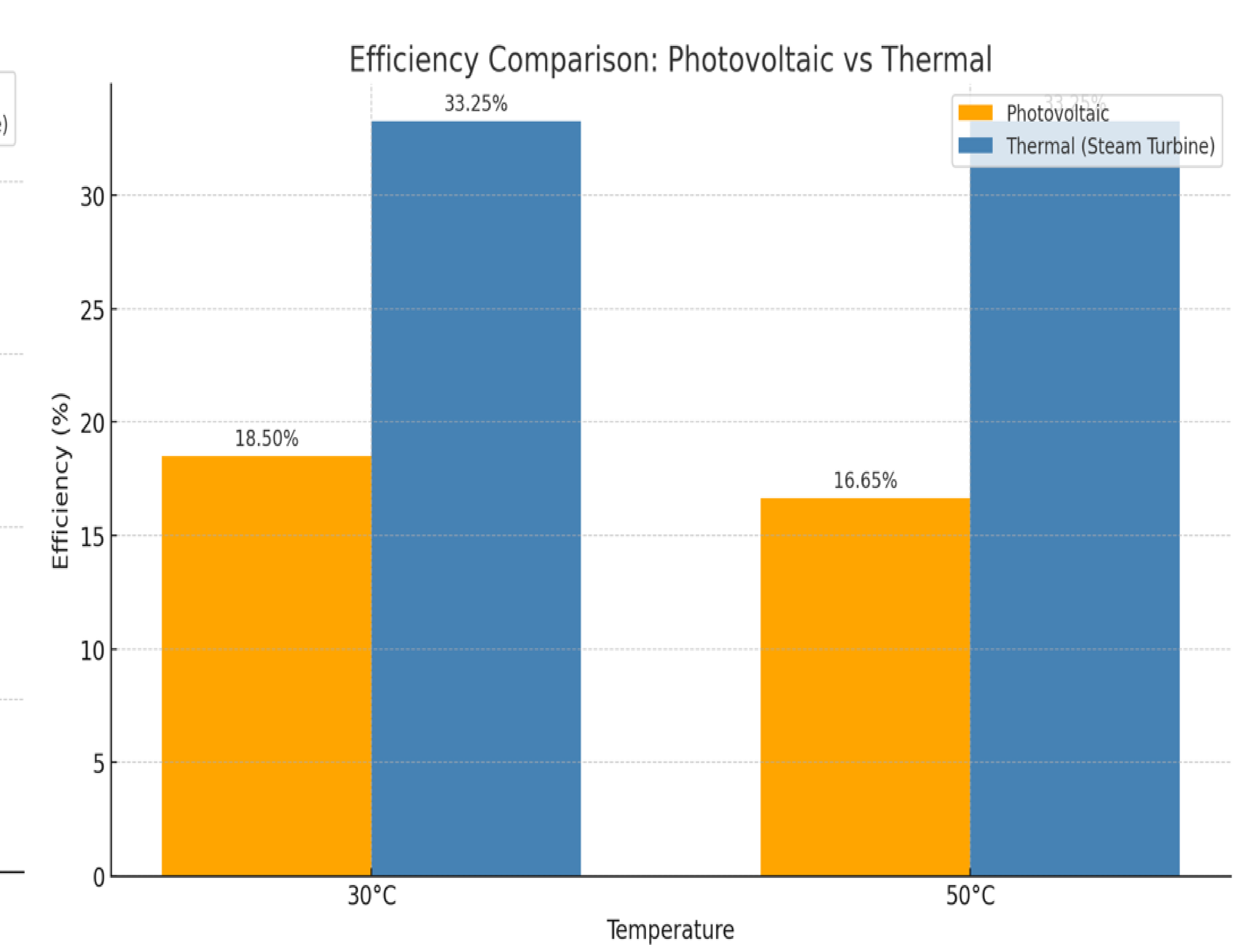


Figure 1: Our final prototype drawing. It contains an insulated, semi-transparent tube with a sleeve for holding the water, sat in the middle of a parabolic mirror to focus the light.



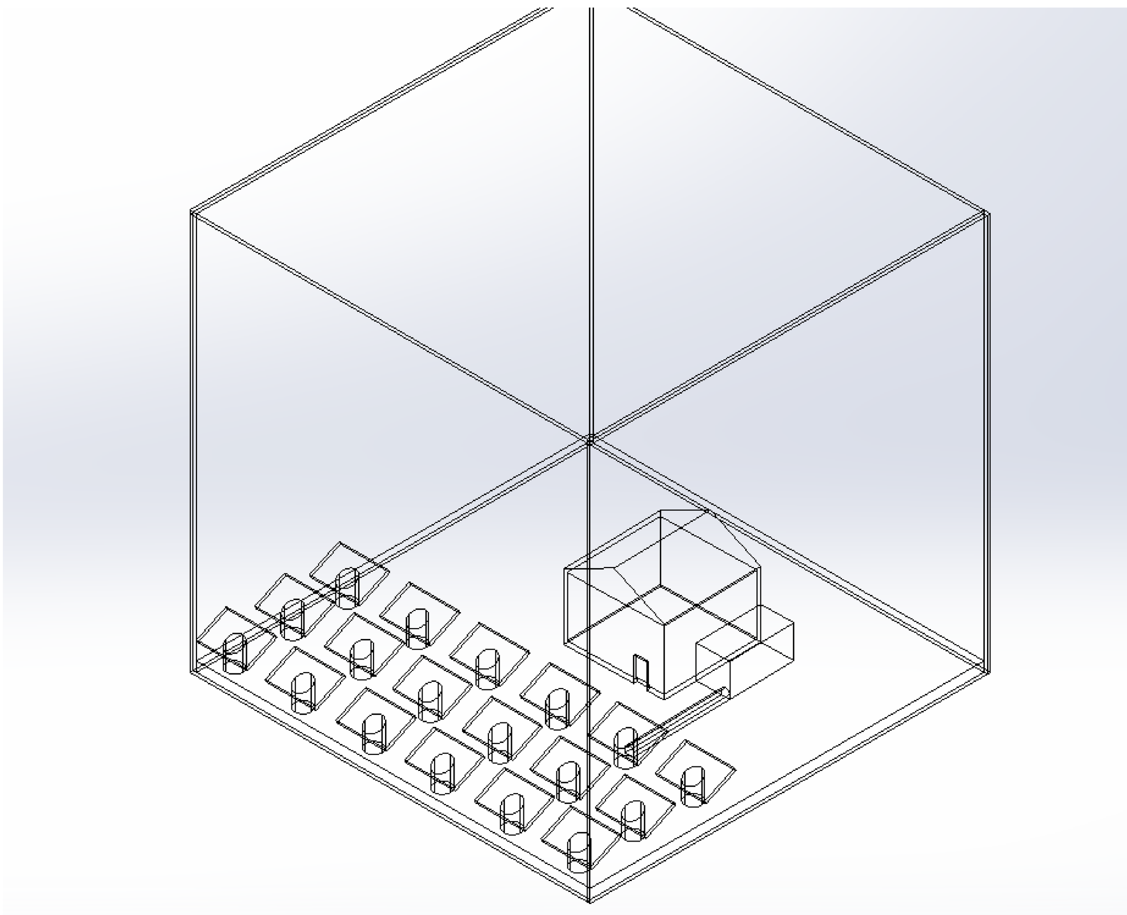


Figure 2: Our original prototype, which has an array of solar panels inside an acrylic box. We redesigned this prototype to be smaller, less expensive, and more practical.

Figure 3: The final prototype during the experiment. Water goes in the metal sleeve then slides in the tube. Light is focused onto the tube using the mirrors.

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