SCHOOL OF ENGINEERING

Portable Solar Energy Concentrator

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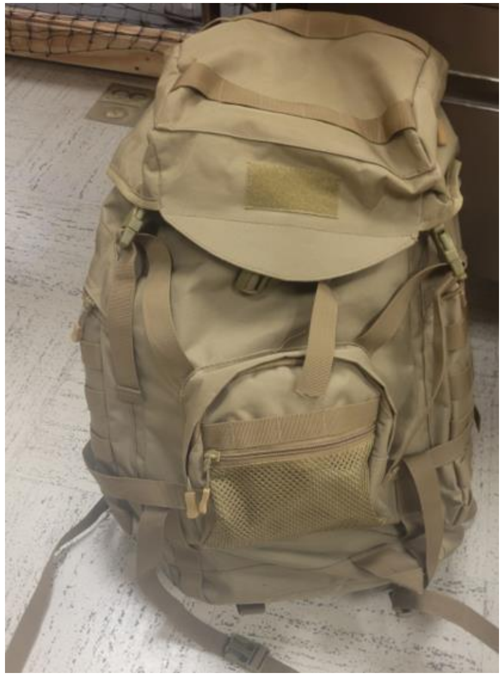
Global Problem

WET-Kit



Water Access

Electricity Access

Telecommunication Access

Objective

- Utilizes solar panels to provide portable electricity
- Electronic devices and basic medical equipment will be able for charge
- Average conversion rates range from 15%-20%
- We aim to increase the efficiency of solar cells by using lenses to concentrate solar energy.
- These solar panels will not be hindered by weather conditions and latitude.

Phase I: Lens Concentration and Reflective Material

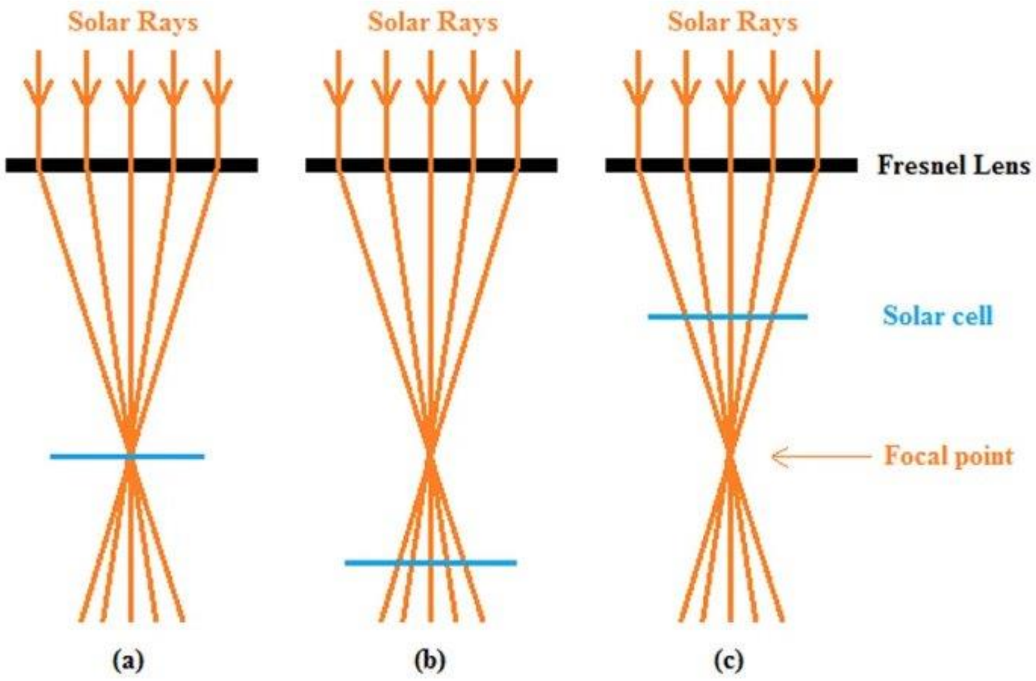


Figure 1. Diagram of light concentration through a Fresnel Lens

How do we improve solar panels?

- Fresnel Lens to concentrate solar energy onto solar panel
- Reflective material to encapsulate and position the solar energy

Light Concentration Experiment

Can a Fresnel lens concentrate light for better voltage output on solar panels?

Figure 2. How we tested the viability of a Fresnel lens

Initial Experiment

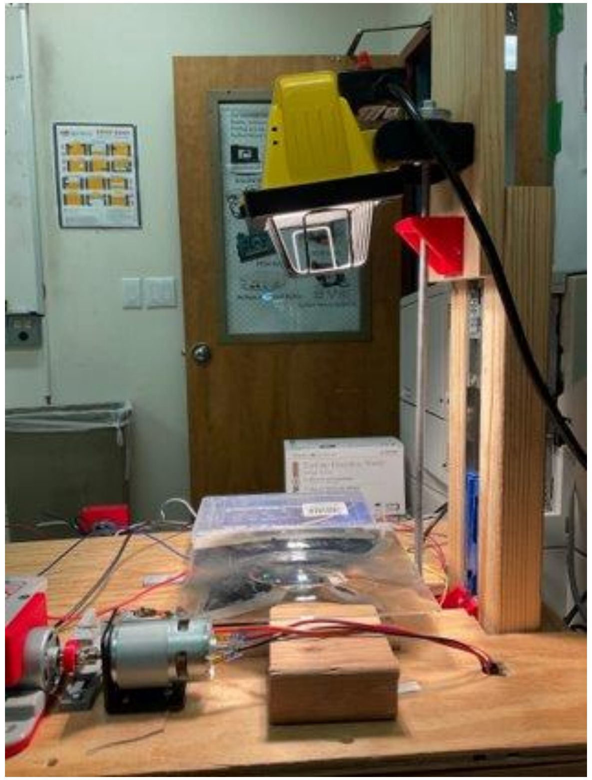


Figure 3 First concept of Fresnel Lens experiment

Reference Solar Panel

Figure 4. Solar panel in normal conditions, 13.5 inches from the lamp

Experiment Variations

Figure 5. Here we have the Lens 9 inches away from the PV

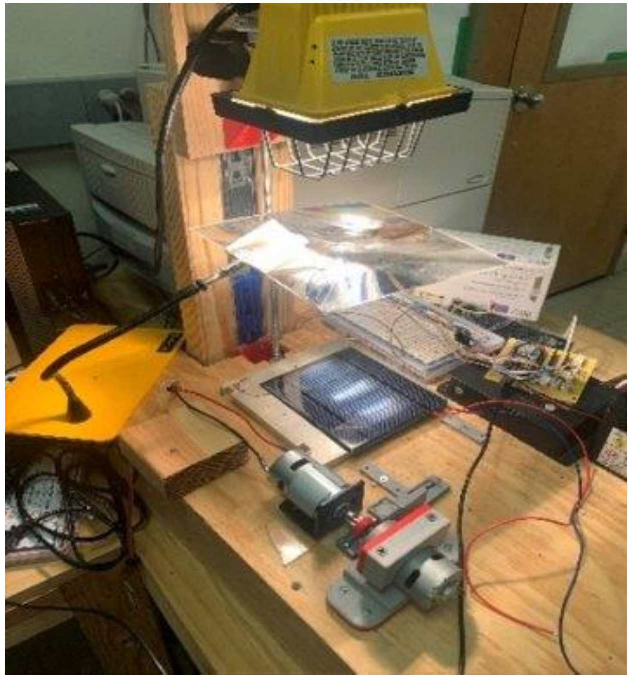


Figure 6. We moved the lens closer by 4 inches

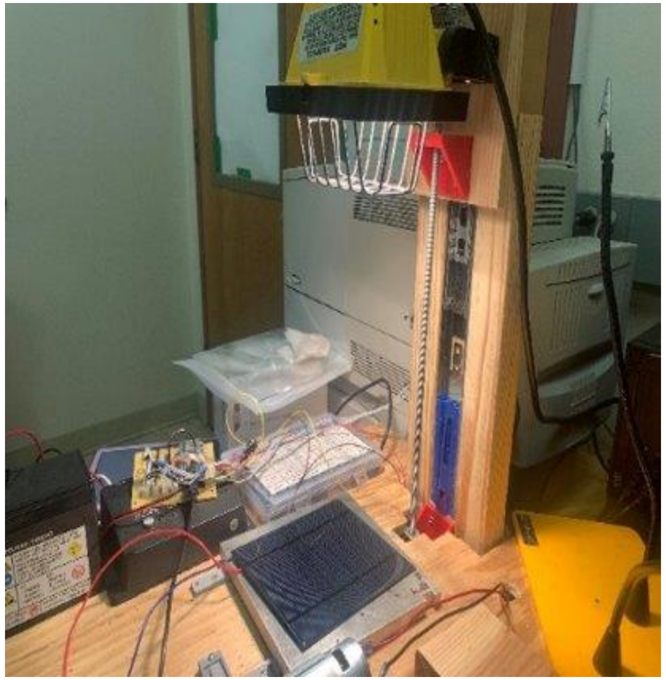


Figure 7. Using a heat sink to increase voltage

Light Concentration Results

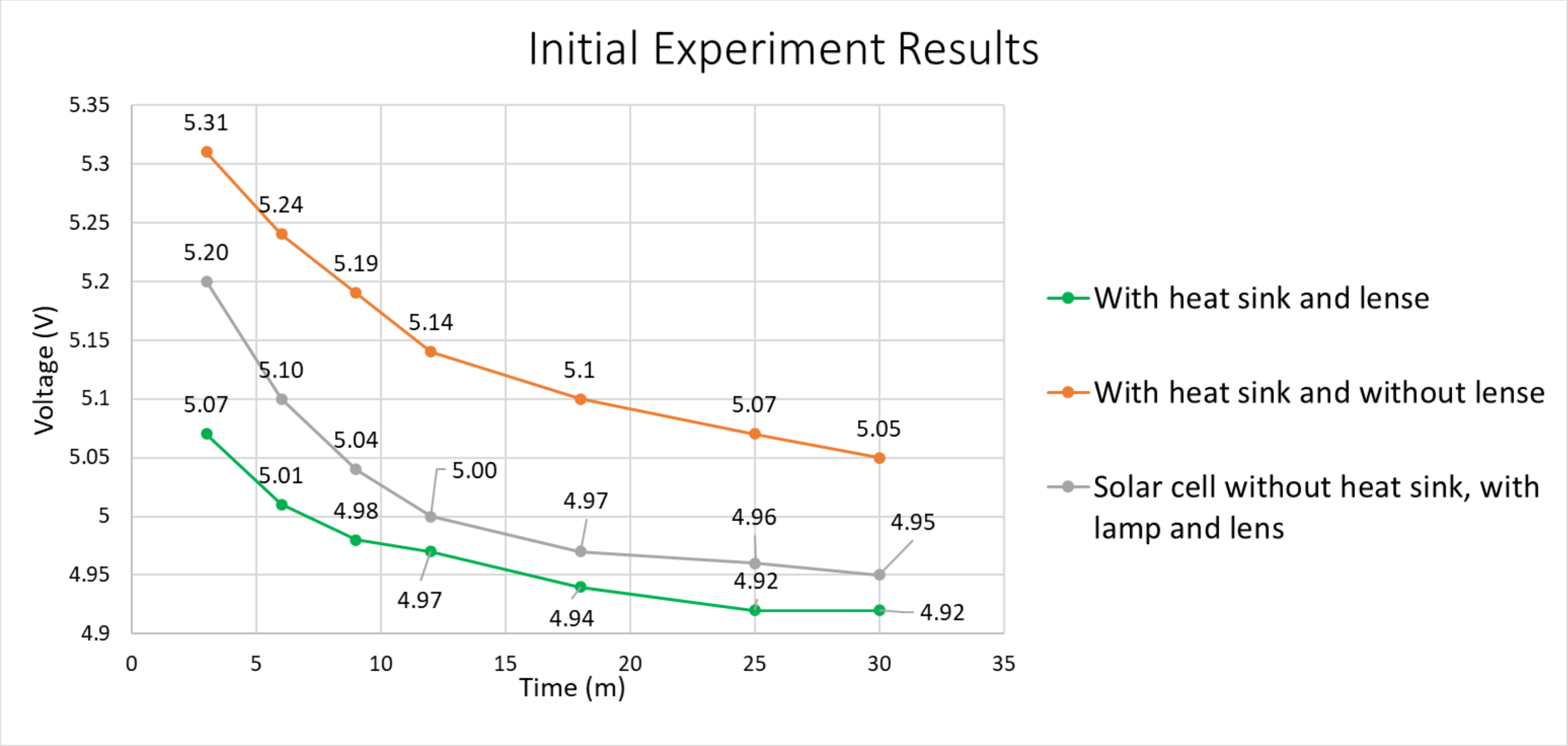


Figure 8 Our first experiment with the Fresnel lens

Light Concentration Results

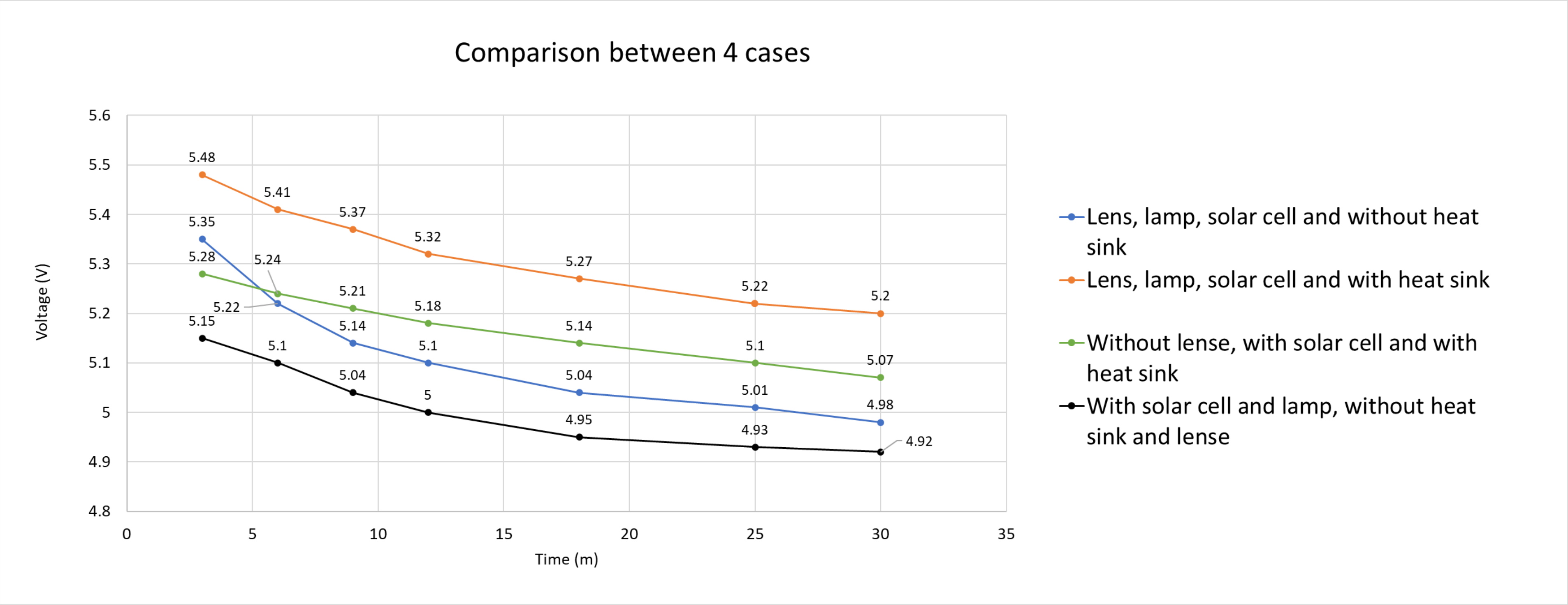


Figure 9. Our second experiment with the Fresnel lens that yielded proper results

Lens Distance Experiment

Tested the **best distance for the lens** to be at, so the distance could remain constant

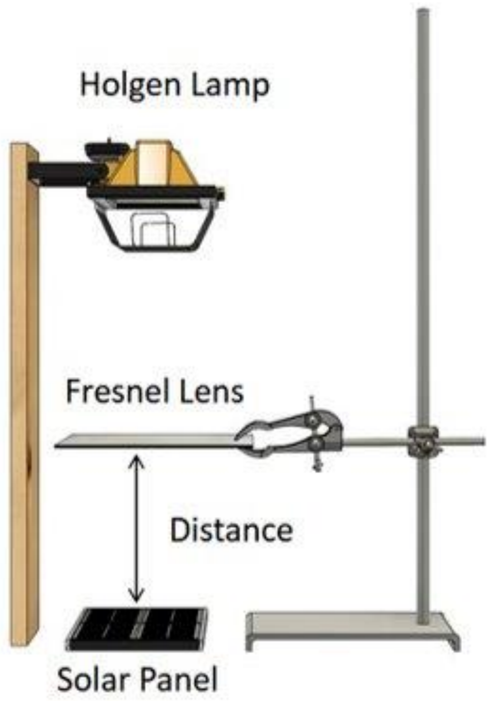


Figure 10. Graphic for lens distance experiment

Experiment Variations

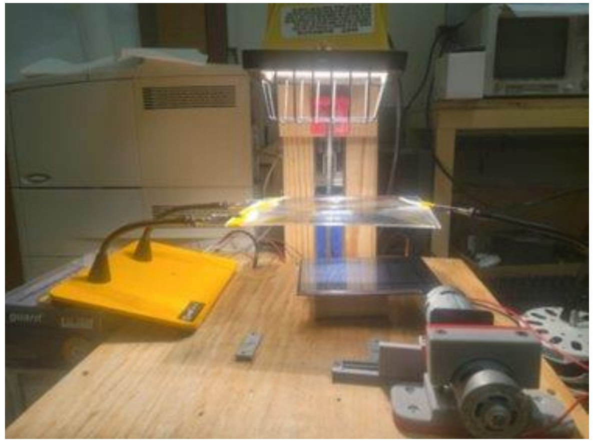


Figure 11. Fresnel Lens at 3 inches with respect solar cell

Figure 12. Fresnel Lens at 6 inches with respect solar cell

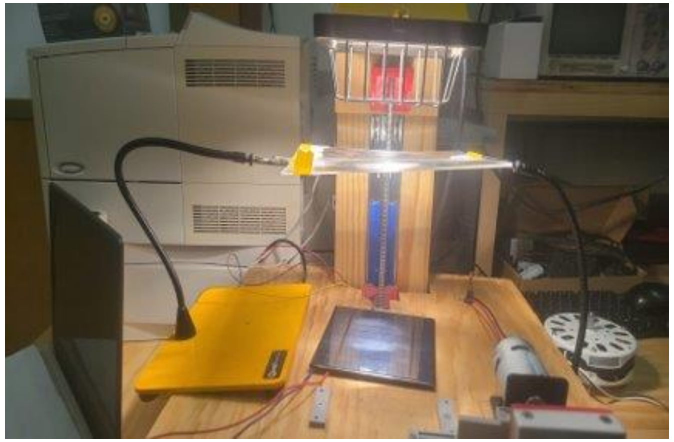


Figure 13. Fresnel Lens at 7 inches with respect solar cell

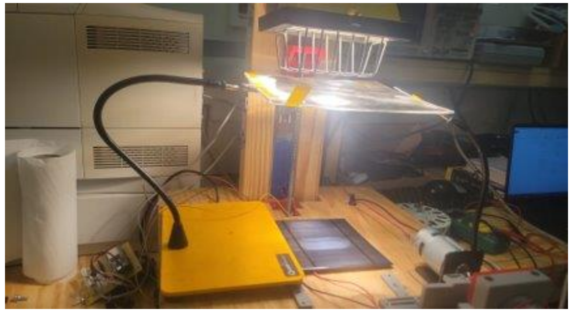


Figure 14 Fresnel Lens at 6 inches with respect solar cell

Lens Distance Results

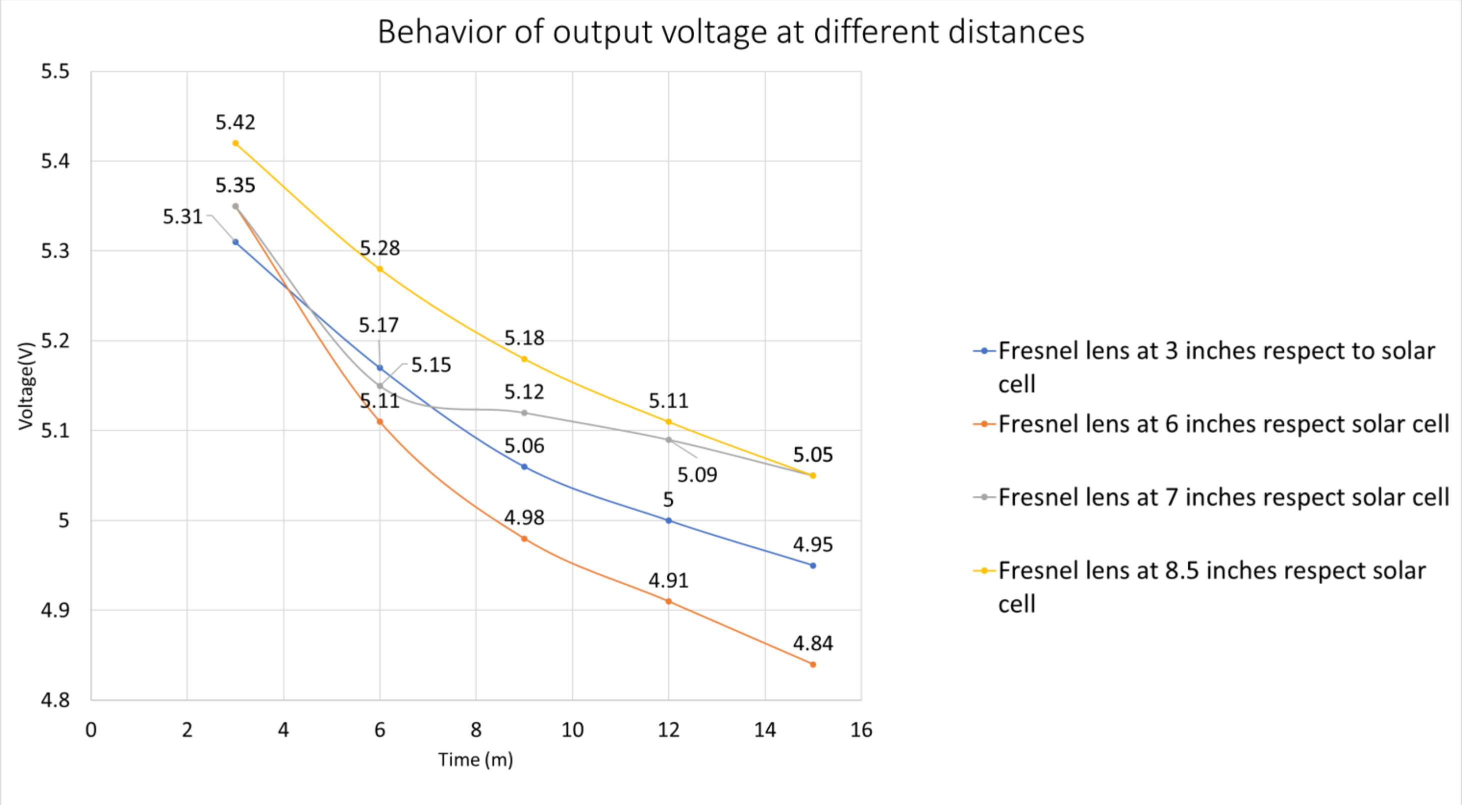


Figure 15 Finding the best distance for the lens

Reflective Materials

Mylar

- Durable
- Lower temperatures
- Cost efficient
- Lower voltage output
- Non-Biodegradable

Foil

- Higher voltage output
- Cost efficient
- Malleable
- Biodegradable
- Higher temperatures
- Less durable

Reflectivity Experiment

Tested if the solar panel could capture more solar energy if we used different reflective materials

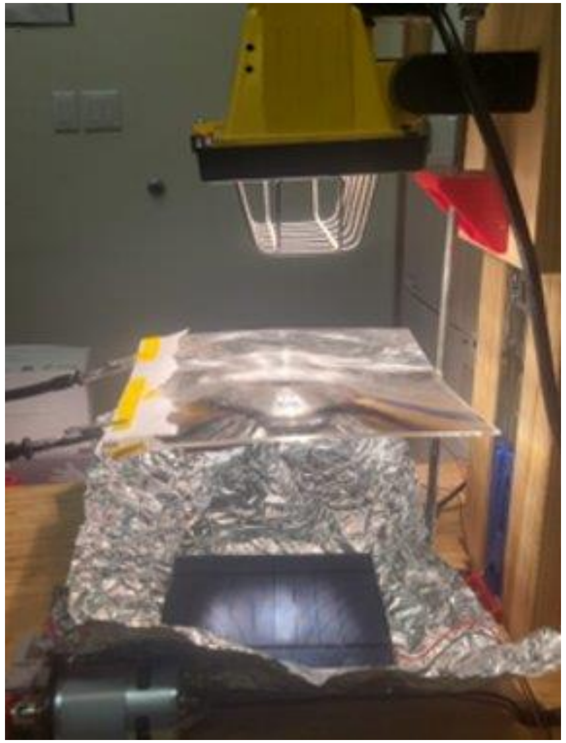


Figure 16. Experiment with Aluminum Foil

Figure 17. Experiment with Mylar bags

Reflectivity Experiment Results

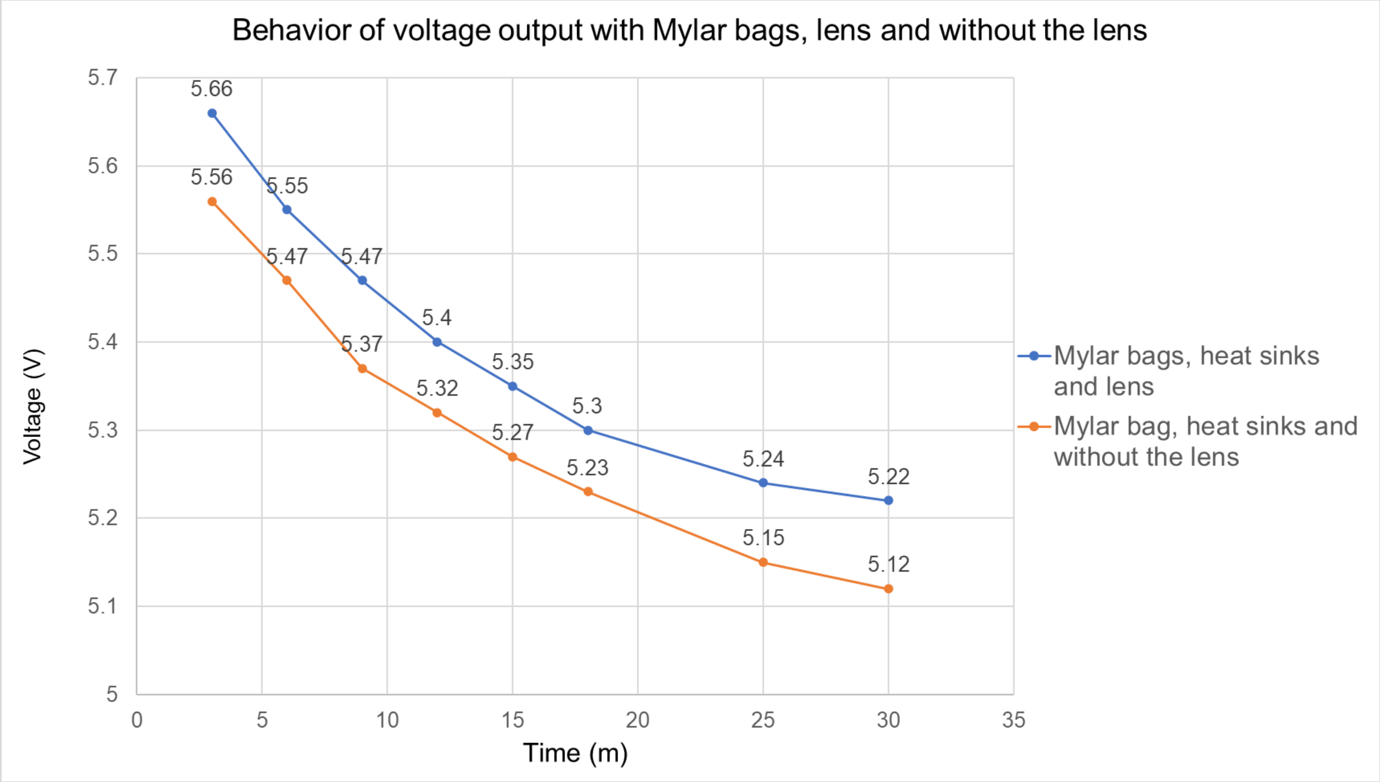


Figure 18 voltage difference with and without lens while mylar surrounds solar panel

Data

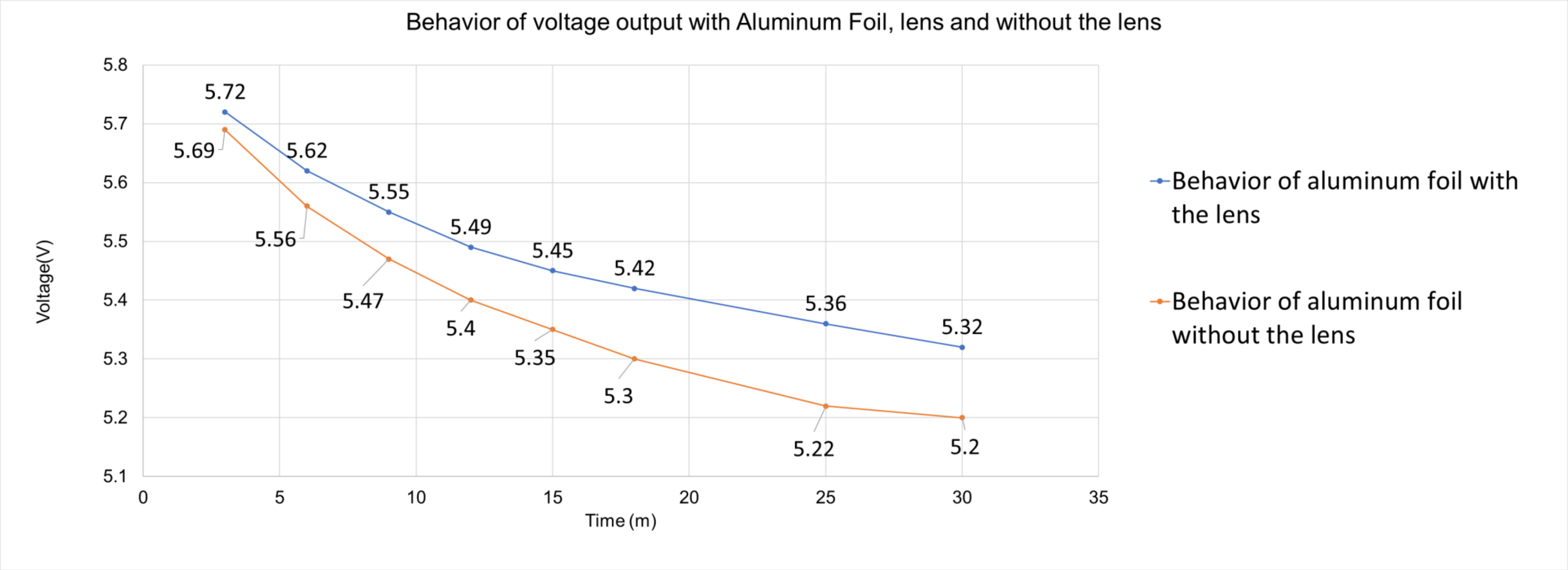


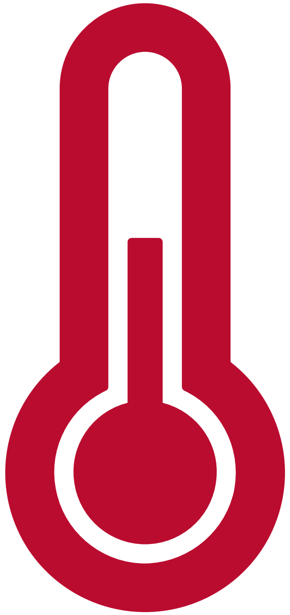
Figure 19. Using foil with and without a lens

Phase II: Cooling

- Increases economic viability
- Increases lifespan
- Decreased temperatures increases efficiency

Types of cooling

- Passive-Utilizes materials for heat transfer
- Active-Utilizes external devices for heat transfer



Heat Sink Experiment

- A large aluminum heat sink in our first experiment did not transfer heat very well
- We decided to utilize a smaller aluminum heat sinks in different variations to target focal points on the solar panel with the highest temperatures

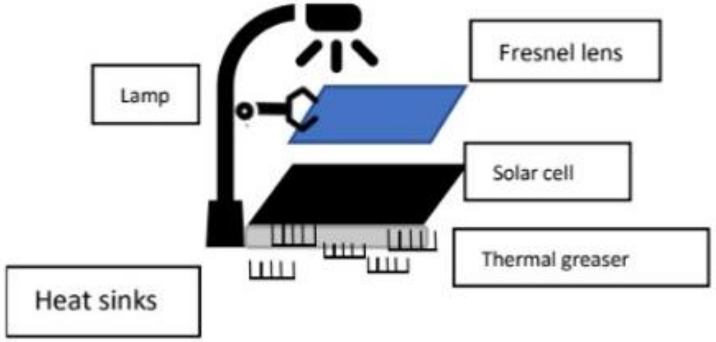


Figure 20. 5 heat sinks distribution

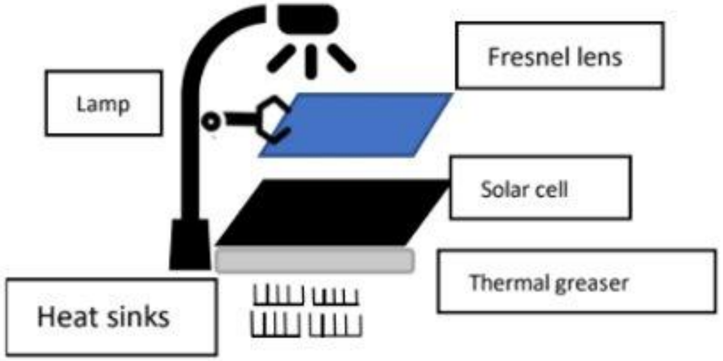


Figure 21. 4 heat sinks distribution

Experiment Variations

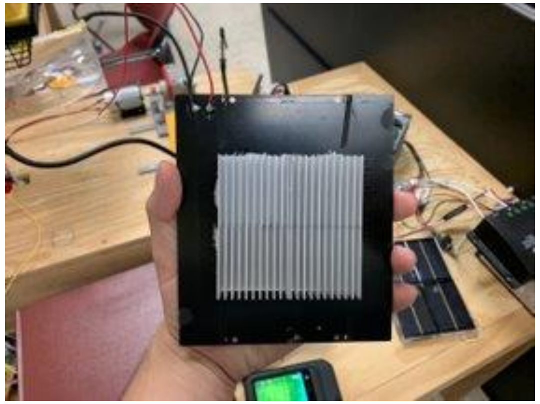


Figure 22. Solar cell with 4 heat sinks distribution

1. Concentrated the heat sinks where most of the heat was focused on the solar panel

Figure 23. Solar cell with 4 heat sinks distribution

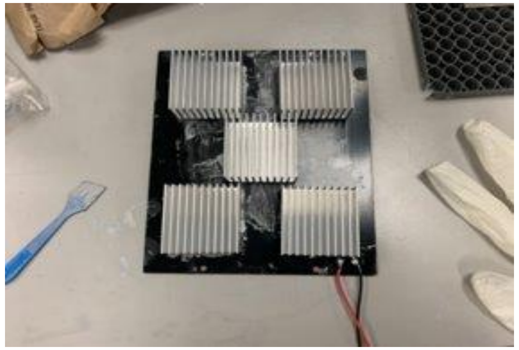


Figure 24. Solar cell with 5 heat sinks distribution

2. Try and disperse the heat sinks to have more coverage on the solar panel.

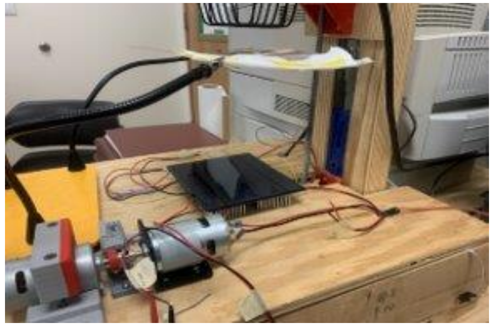


Figure 25. Solar cell with 5 heat sinks distribution

Data

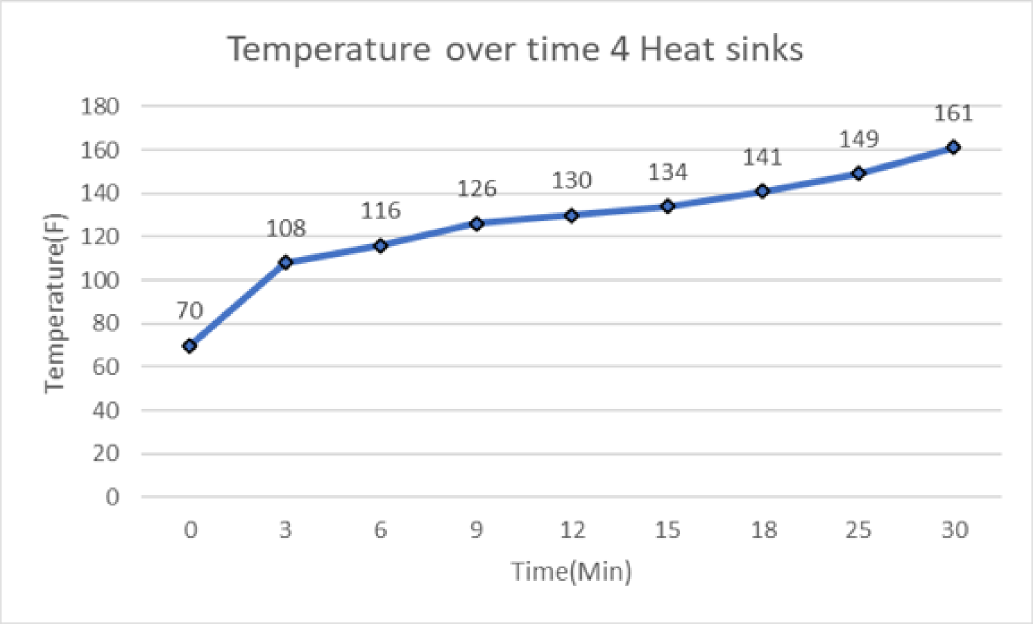


Figure 26. Temperature with 4 heat sinks

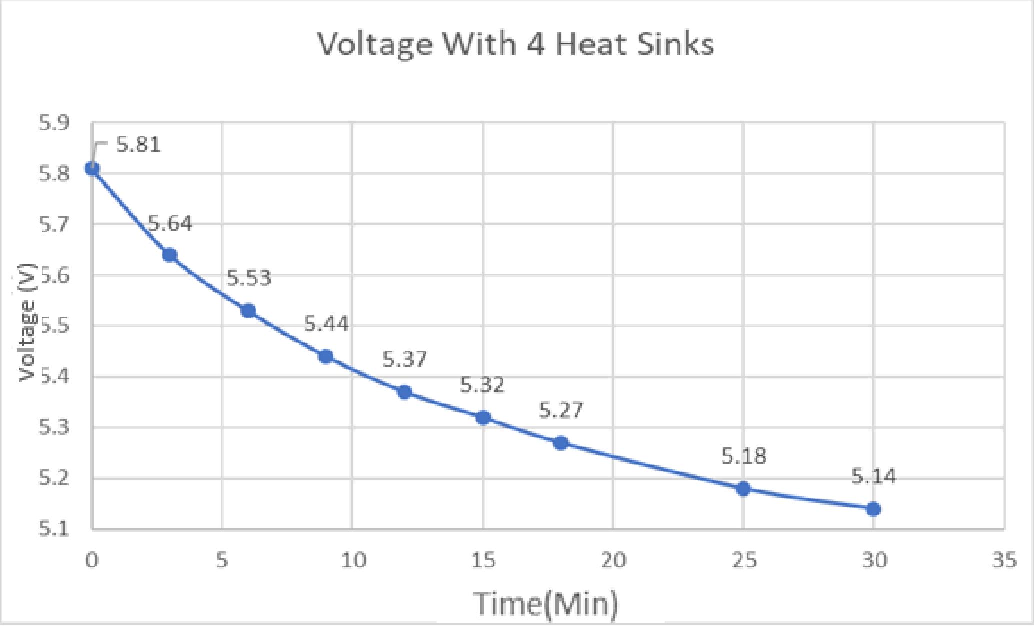


Figure 27.Temperature with 4 heat sinks

Data

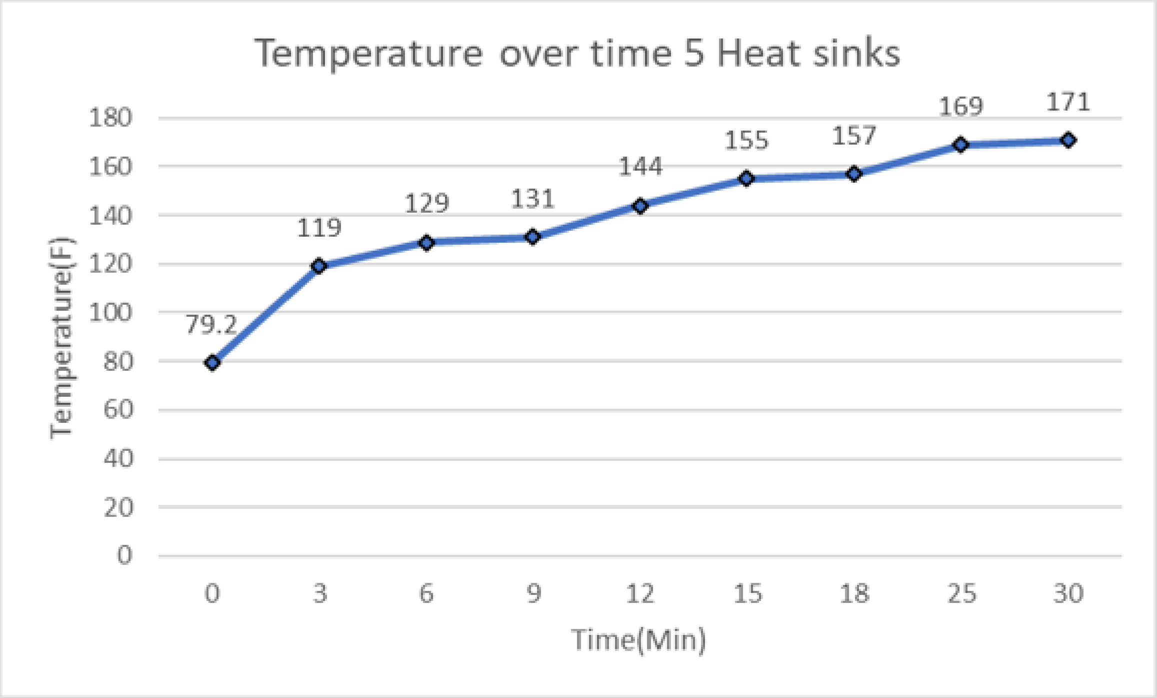


Figure 28. Voltage with 5 heat sinks

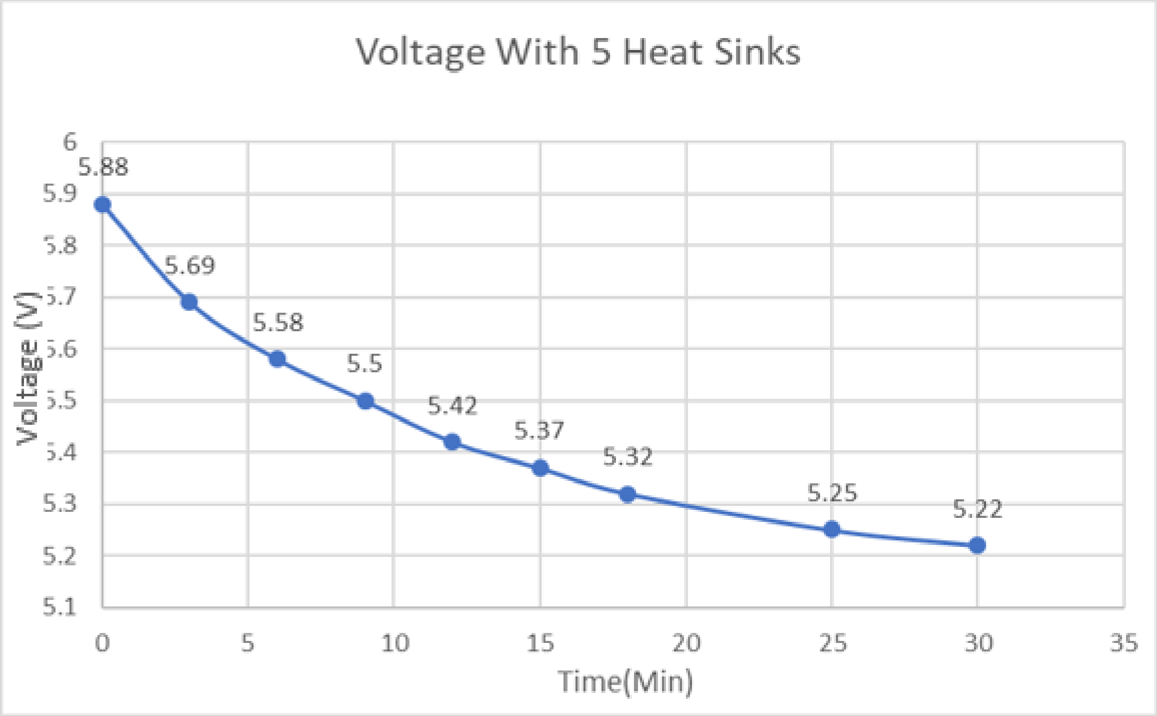


Figure 29. Voltage with 5 heat sinks

Voltage Depreciation Results

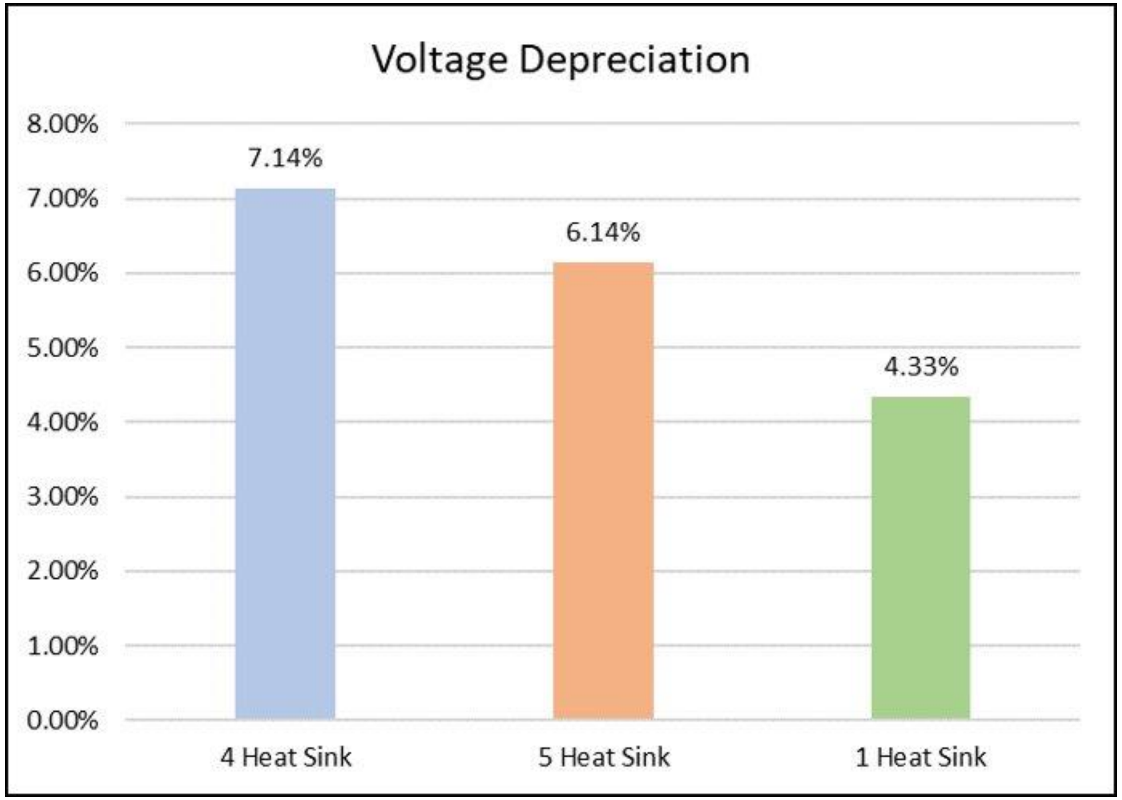


Figure 30. The rate that voltage depreciates for each iteration

Future Cooling Techniques

Phase Changing Materials(PCMs)

Inorganic PCMs

- Sodium carbonate decahydrate & magnesium sulfate heptahydrate eutectic mixture
- Calcium chloride heptahydrate(Pure Salt Hydrate)

Organic PCMs

- Paraffin wax

Burlap Fabric

Water Syphon

Utilizes gravity for water distribution

Liquid container

High heat transfer for low cost.

Portability

How do we make these concepts portable?

- A lightweight lens holder
- Angled solar stand lined with mylar and passive cooling system.

Portable Lens Holder

- Angle adjustment
- Leg height adjustment
- Compact
- Light Weight
- Portable

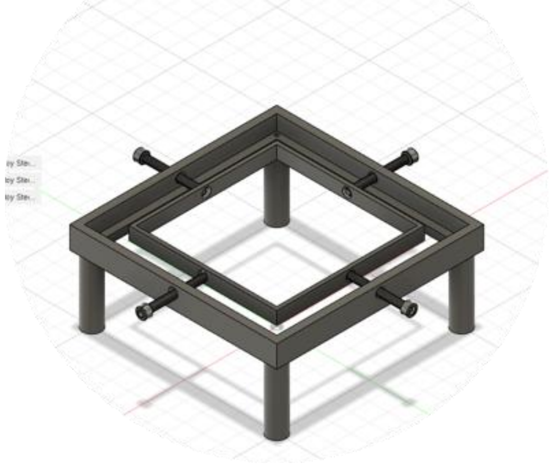


Figure 31. Lens holder

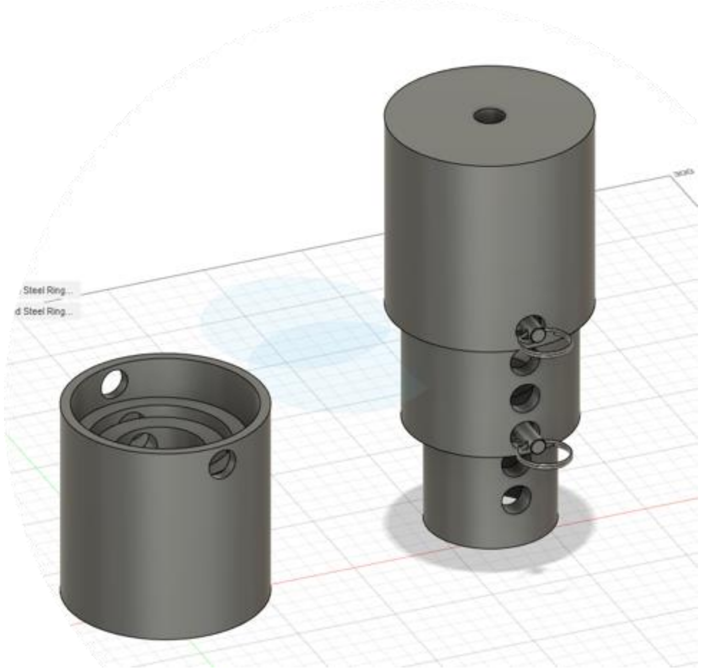


Figure 32. Adjustable legs for the lens holder

Foldable Solar Cell

- This array of collapsible solar cells will be attached to the backpack with Velcro on top of this
- On-the-move electricity

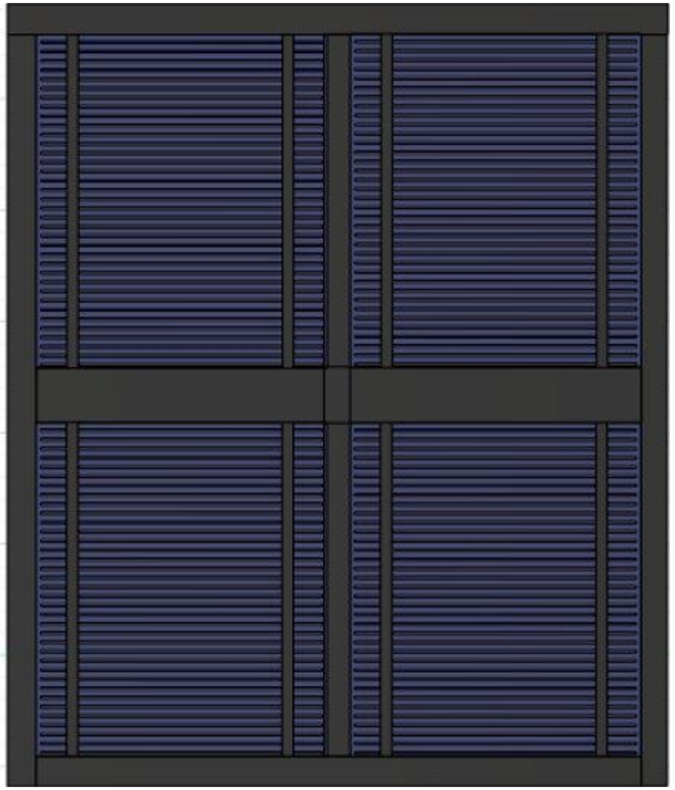


Figure 33. Foldable solar panels

Cooling System and Reflective Material

Heat sinks- will always be attached to the solar panel

PCMs- encapsulation has yet to be determined

Burlap fabric- attached with Velcro strips

Mylar- will be laid around solar panels to increase sun coverage

Conclusion

- Concentrating solar energy
- Increasing the efficiency of the solar panel
- Increase viability with passive cooling system
- Utilize reflective material to manipulate sunlight
- Make solar panels more adaptive to weather conditions
- Contribute to the global initiative of the WET Kit

Figure 34. WET kit with our solar panel that will be used in the foldable solar cell

Sources

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