CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

S0917

Project Title

A Solar Thermoelectric Generator Utilizing a Phase Change Thermal Battery

Abstract

Objectives/Goals

Solar Thermoelectric Generators (STEGs) convert the heat generated by sunlight directly into an electrical current through the Seebeck Effect. Despite its excellent reliability as a solid-state heat converter and potential for exceeding efficiencies of 15%, scientists have not developed a functioning model for real-world applications. My engineering goal was to design and create a viable STEG by recycling the inefficient energy lost as heat and implementing a low-cost thermal battery for energy storage.

Methods/Materials

First, mirrors are angled to focus sunlight into the device. The sunlight is absorbed by a Black Body, and a container filled with Paraffin Wax is heated in the process. Heat is stored inside the wax as it enters a phase change, and is extracted by the Thermoelectric Generator during use to generate electricity. The energy lost as inefficiency is redirected by a heat sink to heat water for commercial water heating purposes. High heat retention of the device was achieved with 2" commercial polystyrene. Recorded temperatures (infrared thermometer) and known values such as R-value and specific heat were used to calculate the efficiency of the device as well as the heat retention of the battery. CAD Software (SolidWorks) was also used to model the device.

Results

Despite testing in suboptimal test environments, an efficiency of 10.58% and a cost per watt of $3.02 was determined. In addition, the phase change thermal battery was able to retain 83.35% of its energy over a 3-hour period.

Conclusions/Discussion

Because access to preferred materials was limited, the efficiency and heat retention of my final device is predicted to be much higher. Previously thought to be purely experimental and noncompetitive with other solar technologies, my device serves as a promising model for future Solar Thermoelectric Generators due to its reliability, high efficiency, and capacity for storing energy.

Summary Statement

I designed and built a viable Solar Thermoelectric Generator prototype by recycling wasted heat energy and integrating a phase change thermal battery.

Help Received

Mr. Charles Williams and Mr. Kenji Mitchell assessed the validity of my results. SolidWorks was given access by Mr. Charles Williams and was introduced by Chloe Liau, a fellow student.