CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)

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Project Number

31475

Project Title

From Concentrator to Tracker: An Innovative Solution for Maximizing Electric Power from Solar Photovoltaic Cells

Abstract

Objectives/Goals

With the awful BP oil spill in the back of my mind, I feel a sense of urgency to make green energy accessible to all. Solar trackers can increase power output by close to 40%, but even a simple tracker for doing science fair experiments costs $100. My goal is to build an affordable tracker with real-world applications at half the cost. After 10 prototypes, I created three trackers and my research question was which design would be the cheapest and most efficient. My hypothesis was that my focal-point tracker would be superior in both cost and power output performance, because it does not use expensive circuitry and it is the only one that receives concentrated light.

Methods/Materials

The three trackers that I built are: (1) a shaded solar-powered tracker, (2) a micro-controlled servo tracker, and (3) the novel focal-point tracker. The first two trackers use electric motor drives to follow the sun at a rate of 15 degrees per hour. My focal-point tracker consists of a circular solar concentrator and a tubular collector that moves inside it along a path determined through simulation by ray tracing software. The collector is moved by a clock at 20 degrees per hour. A flexible 80 mm x 150 mm solar cell and a load resistor are attached to each setup and the control. On a large table outdoors, I oriented all four configurations perpendicular to the rays of sun during solar noon. Then I let them track the sun and measured the voltage of each setup's resistor with a digital multi-meter every 15 to 30 minutes for 5 to 7 hours a day over 8 days.

Results

I calculated the current (mA) and power (W) and estimated the future cost ($) for each tracker and the control. Among the trackers, the focal-point tracker was the cheapest one which can be made for about $27 and it always had the highest power output with about 55% more than the control, while the other two trackers outperformed the control only by roughly half.

Conclusions/Discussion

My hypothesis was correct! My focal-point tracker was the winner by having the lowest cost and highest output. I know I can greatly improve the novel tracker's performance. My ray-tracing simulation suggests I can boost the power output by around 7 times. The plastic solar cell can only make about 100 mA without a load and melts in intense heat. I will look for a more powerful one that won't melt.

Summary Statement

I designed and built three solar trackers and found that my novel concentrating-type design performed the best in making electricity from sunlight.

Help Received

Mom helped me with my writing. Dad introduced me to Arduino microcontroller and servo motor and showed me how to do difficult math.