CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)

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Project Number

S0903

Project Title

Solar Panel Under Shadow: Increasing Efficiency via a New Configuration

Abstract

Objectives/Goals

It is known that shadows significantly reduce solar panels' output power in commercially available models. The objectives of this project are to investigate this phenomenon as well as develop a new configuration of solar cells so that the effect of shadows on output power is reduced, effectively increasing panel efficiency under shadow.

Methods/Materials

56 Electronic Goldmine Solar Cells (1.4" x 2.25" generating 0.5V and ~0.4A), wires, 8 resistors (2 Ohm), 2 LED modules as load, multimeter, soldering iron, construction light as indoor light source, wire cutters, solder, etc.

Most commercially available solar panels use series-parallel solar cell connections. I first measured solar cells' outputs (open circuit voltage and short circuit current) under different light intensities. I then connected two cells in series and parallel, measuring output powers when one cell of each pair is shadowed. This investigation allowed me to observe that under shadow, total output current is limited in a series connection and total output voltage is limited in a parallel connection, leading to low efficiency from traditional panels. To develop a new cell configuration, the series-parallel connection thus must be avoided. Guided by Kirchhoff's Laws and topological reasoning, I developed a new configuration. To compare an orthodox series-parallel configuration with the newly developed one, two 4 by 7 solar cell arrays were connected with both configurations. While total panel output powers under shadow were measured and compared quantitatively, two LED modules were used to demonstrate results qualitatively.

Results

Four shadow positions were used to evaluate the results. When the shadow was placed parallel to sides of the solar panel, the panels had similar, theoretically equivalent, outputs. However, when the shadow had a significant angle to the sides of solar panel, the new panel generated 56.3% and 71.1% more power than the other panel in two independent shadow positions.

Conclusions/Discussion

The new configuration indeed has a significant efficiency improvement over the conventional model under several shadow conditions. While only 4 by 7 solar cell arrays were used in this project, the methods and reasoning used here can be utilized to generate much bigger solar cell arrays that would have better efficiency than the simple series-parallel configuration. Such configurations have been proposed to be patented.

Summary Statement

Using a newly developed alternating-based solar cell configuration, as opposed to the traditional series-parallel based one, it is possible to reduce the effect of shadows upon a panel's current and voltage output.

Help Received

Ms. Cathy Prater (science teacher) helped review the project. Parents helped buy materials and provided a sufficiently resourced workplace.