CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

J0220

Project Title

To Characterize the Energy Loss for Different Types of Light Bulbs, and Ways to Recover & Reuse Some of the Energy Loss

Abstract

Objectives/Goals

The light emitted by lamps in the backward direction is not useful. The purpose of my project is to make an efficient device to collect the wasted light by studying optimal location of a solar cell for three different types of lamps (Incandescent, Fluorescent and LED). When applied in industrial or residential lighting this method can create energy that will help to conserve our planet#s resources in a small way. Also in space exploration when there is no sun light this method can be useful.

Methods/Materials

Solar cell current and voltage were measured (with a multimeter) by increasing the distance between the lamp and the cell (from 1-15 cm). Solar cell angular orientation was changed from 0°-170° and was compared amongst the three lamp types. Two solar cells were mounted on the lamp shade and are connected in series to show that the voltages can be added. The solar cell current/voltage dependence on the distance from the lamp helps to understand how much the cell output can be increased. From the angular distribution, the amount of light emitted in the backward direction was estimated.

Results

As distance increased cell current decreased as predicted by $1/r^2$ relationship. Incandescent lamp showed constant angular distribution (till 150°), while CFL and LED lamps showed their peeks at 50° and 100° respectively. Fraction of backward emission is 40% for CFL while it is 46% for Incandescent and LED. LED lamp was the brightest but incandescent lamp showed 5 times higher current. Two mounted Solar cells when connected in series showed that voltages were added.

Conclusions/Discussion

More than 40% of light is wasted for all three lamps. Incandescent lamp spectrum goes beyond the visible wavelength range (400-750nm). Silicon solar cell absorbs up to 1200nm. My method recovers from unused angular distribution and unused energy beyond visible range. For incandescent lamp, open circuit voltage of 3.65 V and closed circuit current of 9.68 mA were measured for a single cell. Two solar cells in series can generate 7.3V. Six pairs in parallel circuit can produce 58 mA. Twenty incandescent lamps connected in parallel can increase current to 1.16 A, enough to charge an iPhone in 50 hours. Incandescent lamps can generate 5 times more energy compared to LED or CFL. Output can be further increased by 35% by bringing the cells 1 cm closer to the lamp.

Summary Statement

My project shows that it is possible to recover a small amount of wasted energy by using solar cells in the back of a lamp shade.

Help Received

I made the angular measuring device and measured the cell current, voltage and distance dependence myself. I mounted the solar cells on the lamp shade. My dad helped me to analyze crystalline silicon solar cell response to spectra from the three types of lamps.