SOLAR ENERGY

SOLAR POWERED CARS

Time Frame:	Standards:
75 Minutes Spread out over a longer period of time	Idaho Standard 2.3.1

Objectives:

Students will learn to use solar power in a basic model application. Different styles and designs will be used to explore the scientific process.

Material Needed:

Each person will need the following to make a simple and operational car.

1. A motor
2. Two axles
3. Two front wheels (thin)
4. Two rear wheels (thick)
5. Package of gears
6. Alligator clips
7. A laminated axle tube, or a straw
8. THE ABILITY TO THINK CREATIVELY!!!

For those who want to think far outside of the box, instructors may want to buy a few extra motors and some propellers.

What You Will Build:

Image from www.pitsco.com

Class Cost:

Costs are from the Pitsco Company catalog, and are subject to cancelation or change without notice.

Motors, type 280 ~ W54428. $1.75 each
Propeller ~ W13241. $0.50 each
Laminate Axel Tube ~ 53663. $0.25 each
Long Steel Axle ~ no cost quoted, very inexpensive
Rear Wheels ~ W13327. $0.14 each
Front Wheels ~ W13330. $0.11 each
Foam Board Blanks ~ Cut by teacher. 2' x 4' panels are about $3.00
Alligator clips/wires ~ no cost quoted, very inexpensive
"AA" cell batteries and holders for testing ~ Local hardware stores, $0.50
Solar Panel ~ W21112. $45.00 each

Cost per car (without panel) is about $5.00. The Solar Panel may be moved from car to car.

Construction Procedure:

The associated slide show presentation should be watched prior to the start of Solar Car production. It shows the steps to construction and it may make construction easier and faster by eliminating common errors and by showing some construction tips.

The students will probably be excited about building the solar powered cars and it is tempting for the instructor to allow for a day or two of uninterrupted building time for their completion. This may be an error.

The students will do a better job at solar car construction if they are given adequate time for reflection during the process. Many people have found that the students get the most out of this lab if the construction process is broken down into four or five distinct building periods of 15 to 20 minutes each. If students are given ample time between construction periods they are also far more likely to have completed an evaluation of their construction scheme. Additional material will also appear from home and outside the classroom. This will lead to more creative and successful designs.

Background Content:

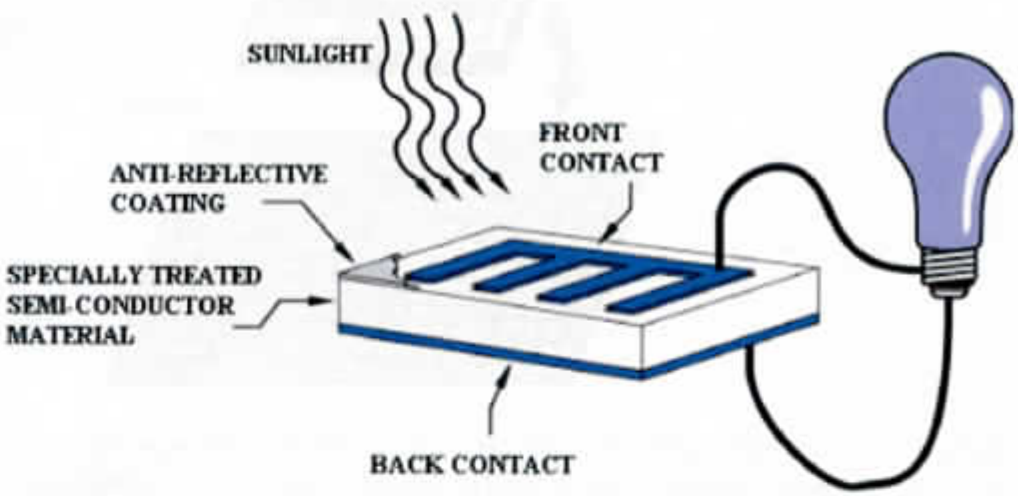
How do Photovoltaics Work?

by Gil Knier

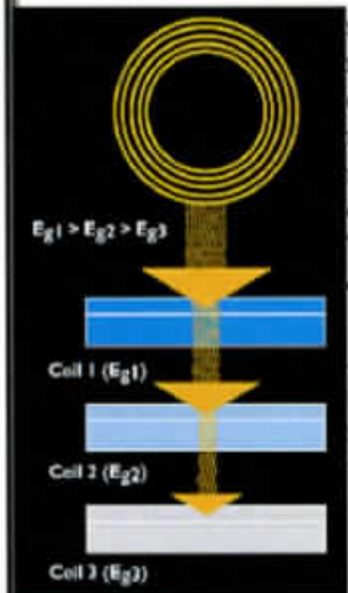
back to the Science@NASA story "The Edge of Sunshine"

Photovoltaics is the direct conversion of light into electricity at the atomic level. Some materials exhibit a property known as the photoelectric effect that causes them to absorb photons of light and release electrons. When these free electrons are captured, an electric current results that can be used as electricity.

The photoelectric effect was first noted by a French physicist, Edmund Bequerel, in 1839, who found that certain materials would produce small amounts of electric current when exposed to light. In 1905, Albert Einstein described the nature of light and the photoelectric effect on which photovoltaic technology is based, for which he later won a Nobel prize in physics. The first photovoltaic module was built by Bell Laboratories in 1954. It was billed as a solar battery and was mostly just a curiosity as it was too expensive to gain widespread use. In the 1960s, the space industry began to make the first serious use of the technology to provide power aboard spacecraft. Through the space programs, the technology advanced, its reliability was established, and the cost began to decline. During the energy crisis in the 1970s, photovoltaic technology gained recognition as a source of power for non-space applications.

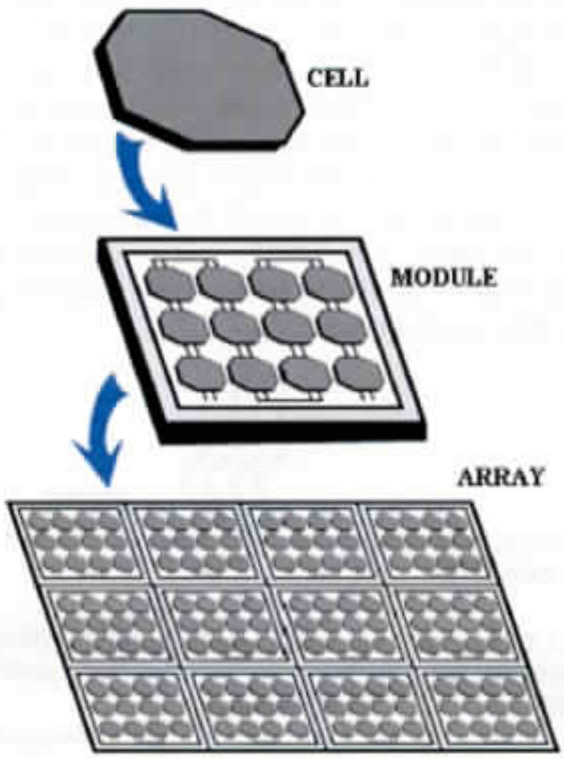


The diagram above illustrates the operation of a basic photovoltaic cell, also called a solar cell. Solar cells are made of the same kinds of semiconductor materials, such as silicon, used in the microelectronics industry. For solar cells, a thin semiconductor wafer is



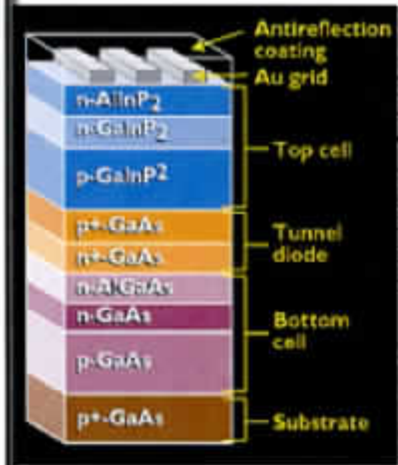
specially treated to form an electric field, positive on one side and negative on the other. When light energy strikes the solar cell, electrons are knocked loose from the atoms in the semiconductor material. If electrical conductors are attached to the positive and negative sides, forming an electrical circuit, the electrons can be captured in the form of an electric current -- that is, electricity. This electricity can then be used to power a load, such as a light or a tool.

A number of solar cells electrically connected to each other and mounted in a support structure or frame is called a photovoltaic module. Modules are designed to supply electricity at a certain voltage, such as a common 12 volts system. The current produced is directly dependent on how much light strikes the module.



Multiple modules can be wired together to form an array. In general, the larger the area of a module or array, the more electricity that will be produced. Photovoltaic modules and arrays produce direct-current (dc) electricity. They can be connected in both series and parallel electrical arrangements to produce any required voltage and current combination.

Today's most common PV devices use a single junction, or interface, to create an electric



field within a semiconductor such as a PV cell. In a single-junction PV cell, only photons whose energy is equal to or greater than the band gap of the cell material can free an electron for an electric circuit. In other words, the photovoltaic response of single-junction cells is limited to the portion of the sun's spectrum whose energy is above the band gap of the absorbing material, and lower-energy photons are not used.

One way to get around this limitation is to use two (or more) different cells, with more than one band gap and more than one junction, to generate a voltage. These are referred to as "multijunction" cells (also called "cascade" or "tandem" cells). Multijunction devices can achieve a higher total conversion efficiency because they can convert more of the energy spectrum of light to electricity.

As shown below, a multijunction device is a stack of individual single-junction cells in descending order of band gap (Eg). The top cell captures the high-energy photons and passes the rest of the photons on to be absorbed by lower-band-gap cells.

Much of today's research in multijunction cells focuses on gallium arsenide as one (or all) of the component cells. Such cells have reached efficiencies of around 35% under concentrated sunlight. Other materials studied for multijunction devices have been amorphous silicon and copper indium diselenide.

As an example, the multijunction device below uses a top cell of gallium indium phosphide, "a tunnel junction," to aid the flow of electrons between the cells, and a bottom cell of gallium arsenide.

References:

1. www.pitsco.com
2. www.science.gov
3.