Solar Powered System

Student Objective
The student
- understands that light energy from the sun can be turned into electricity with a photovoltaic (solar) cell.
- knows variables such as clouds, shading and direction of panel tilt, that can affect the amount of power that the photovoltaic cell produces.

Key Words:
load
orientation
photovoltaic (PV) system

Time:
1 class period

Materials
- small photovoltaic cell with wires attached (1 per group)
- motor (1 per group)
- propeller (1 per group)
- milliamp meter (1 per group)
- Science Journal

Internet Sites

http://www.eren.doe.gov/pv/howworks.html
Department of Energy photovoltaics page explains how photovoltaics work and includes a brief animation

http://solstice.crest.org/renewables/re-kiosk/index.html
Solar Energy page includes solar thermal, solar physics and photovoltaics.

http://webphysics.ph.msstate.edu/ccp/27-5
Animation shows the photoelectric effect while manipulating several parameters.

http://www.solardome.com
Energy education resources including solar, alternative fuel vehicles, wind energy and environmental education.

http://www.fsec.ucf.edu/PVT/pvbasics/index.htp
Florida Solar Energy Center (FSEC) basics of photovoltaic page.

Related Reading
Dr. Art's Guide to Planet Earth, p. 48 - 53; Energy from the Sun, Greenhouse Effect

Background Information
- Photovoltaic cells (called PV or solar cells) are made of silicon (sand). The silicon is heated to extreme temperatures. It is doped (coated/mixed) with chemicals, usually

boron and phosphorous. This sets up an unstable environment within the photovoltaic cell. When light strikes the cell, electrons are dislodged and travel along wires placed within the cell. The electrons follow the wire and power whatever load is attached, in this case a motor. This flow of electrons is called electricity.

- PV cells use light to produce electricity. Photovoltaic systems are quiet, clean, and non-polluting.

Procedure

1. Discuss what a photovoltaic (PV – 'solar') cell is made of and how it works.
2. Give each team of students a photovoltaic cell, motor and propeller.
3. Demonstrate how to attach the propeller to the motor. Have the students attach their propeller.
4. Demonstrate how to attach the cell wires to the motor wires – red to red, black to black. Have the students attach their wires.
5. Demonstrate the holding position of the system (i.e. face up, directed towards the sun), making sure that the wire connections do not touch each other.
6. Demonstrate how they will remove the motor and attach the milliamp meter. Point out that one of the terminals on the back of the milliamp meter has a '+' sign by it and should be connected to the positive (red) wire.
7. Take the "solar powered systems" outside and activate them in the sunlight.
8. While outside, discuss results and suggest things for the teams to try. Points to cover could include:
    - What happens when the panel is turned over away from the light?
    - What happens when part of the panel is shaded with your hand? How much of the panel can you shade before the motor stops?
    - Observe the rotation of the propeller blades, which way are they turning? What happens when the wires are attached the opposite way (red to black)?
    - Does the angle of the cell in relation to the sun make a difference in how fast the propeller turns?
    - What happens when the two alligator clips touch?
9. Have the students attach the milliamp meter and see how much amperage their cell is producing.
10. Challenge the students to see who can get their milliamp meter to read 500ma. *(Don't tell them right away, but to do this they will need to pair up and hook up more than one panel to their milliamp meter)*
11. After returning to the classroom, discuss variables that can affect the output of the photovoltaic cell such as:
    - time of day
    - weather conditions
    - time of year
    - location (latitude) on earth
12. Questions for further discussion:
    - What can we do to produce more electricity? *(Use more panels)*
    - How could you use a solar powered system for a flashlight which you want to use

at night when the sun isn't shining where you are?
Hint: You need a device to store the electricity. *(A battery)*

- What could we do to produce more electricity on a cloudy day? *(Use more cells in the system)*

13. Have students complete the Student Journal.

Energy Whiz

See if you can 'ace' a photovoltaic crossword puzzle at **http://energywhiz.com/**

Related Research

1. How are photovoltaics used in the space program? In telecommunications? Use the internet to collect data and pictures of these applications. Are the photovoltaic cells different or the same as those used in terrestrial applications?
2. How are photovoltaic cells made? Research the difference between single crystal, poly crystal and thin film cells. Which is the cheapest to produce? Which has the highest efficiency?
3. At the present time there are more photovoltaics in use on the continent of Africa than the North American continent. Why is this so? (Hint: It has nothing to do with climate, weather or latitude)

Solar Powered System

			.1	.2	.3	.4	.5	.6	.7
Nature of Matter	**Standard 1**	**SC.A.1.3-**							
	Standard 2	**SC.A.2.3-**			**X**				
Energy	**Standard 1**	**SC.B.1.3-**	**X**	**X**	**X**				
	Standard 2	**SC.B.2.3-**							
How Living Things Interact With Their Environment	**Standard 1**	**SC.G.1.3-**							
	Standard 2	**SC.G.2.3-**	**X**						

Benchmark SC.A.2.3.3 -The student knows that radiation, light, and heat are forms of energy used to cook food, treat diseases, and provide energy.

Grade Level Expectations

The student:

Sixth

- knows forms of radiant energy and their applications to everyday life.

Seventh

- knows uses of radiation, light, and thermal energy to improve the quality of life for human beings.

Eighth

- extends and refines knowledge of uses and forms of energy to improve the quality of life.

Benchmark SC.B.1.3.1 - The student identifies forms of energy and explains that they can be measured and compared.

Grade Level Expectations

The student:

Sixth

- understands that energy can be converted from one form to another (for example, solar energy to electricity).

Eighth

- knows examples of natural and man-made systems in which energy is transferred from one form to another.

Benchmark SC.B.1.3.2 - The student knows that energy cannot be created or destroyed, but only changed from one form to another.

Grade Level Expectations

The student:

Sixth

- understands that energy can be changed in form.

Benchmark SC.B.1.3.3 - The student knows the various forms in which energy comes to Earth from the Sun.

Grade Level Expectations

The student:

Sixth

- knows types of radiant energy that come to Earth from the Sun.

Seventh

- knows the characteristics, effects, and common uses of ultraviolet, visible and infrared light.

Eighth

- knows ways to measure the various forms of energy that come from the Sun.

Benchmark SC.G.2.3.1 - The student knows that some resources are renewable and others are nonrenewable.

Grade Level Expectations

The student:

Sixth

- knows renewable and nonrenewable energy sources.

Seventh

- understands the importance of informed use of natural resources.

Eighth

- knows that some resources are renewable and others are nonrenewable.

Solar Powered System

load - a device to which power is delivered, such as a motor, a light, or a household appliance

orientation - set in a definite position with reference to the points of the compass

photovoltaic (PV) - the effect of producing electric current using light
'photo': light
'voltaic': relating to electricity (volt)

system - a group or combination of things or parts forming a compex or unified whole

Solar Powered System

1. In the space below, draw a diagram of a solar powered system that lights a lamp and label its parts.

2. Make a list of things in your home and classroom that could be powered with photovoltaic energy (solar electricity). Circle any of the items in your list that you already power with photovoltaics.