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)
- magnifying glass (1 per group)
- color paddles (1 set per group)
- acrylic mirror (1 per group)
- milliamp meter (1 per group)
- Science Journal

Background Information
- Photovoltaic cells (called PV or solar cells) are made of silicon (sand). The silicon is heated to extreme temperatures, then 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 and how it works.
2. If you have played the Solar Cell Simulation game in *Solar Matters*, remind the students of the 'flow' of electrons in the system.
3. Give each team of students a photovoltaic cell, motor and propeller.
4. Demonstrate how to attach the propeller to the motor. Have the students attach their

propeller.

5. Demonstrate how to attach the cell wires to the motor wires – red to red, black to black. Have the students attach their wires.
6. 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.
7. Take the "solar powered systems" outside and activate them in the sunlight. Carry the rest of the experimental equipment outside with you.
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 to the motor 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 direction should the panel be facing to make the motor spin the fastest?
9. Gather the students together. Show the group a milliamp meter and explain that it is a device that can be used to measure how much electricity is produced by the photovoltaic panel.
10. Demonstrate how to attach the milliamp meter to a solar cell (the red wire attaches to the positive prong in the back--the one with the plus sign--and the other wire attaches to the other prong).
11. Explain to the students that they are to measure how much electricity their solar cell is producing. Then, they are to try and get their milliamp reading up to 500 mA (the top of the dial) using any of the materials available. Place the mirrors, color paddles, magnifying glasses and extra solar cells in a central place.
12. Pass out a milliamp meter to each group. Give them time to try out their ideas. (Hint: unless a group uses several mirrors, the only way they will be able to get their meters to 500 mA is to work together and wire several cells to one meter.)
13. If some time elapses and the students seem unable to figure out how to get their meters to read that high, give a hint, such as, "I have a solar panel on my roof and it is big enough to power my stereo, but I also want to power my television, and it isn't big enough. What can I do?"

14 After returning to the classroom lead a discussion about their observations. Questions you may wish to ask are:
   - Which devices increased the power output of the cell? *(mirror, magnifying glass)*
   - Why? *(They increased or focused the amount of sunlight hitting the solar cell.)*
   - What other variables affect the output of the photovoltaic cell? *(direction the cell is pointed, weather, time of day, time of year, latitude/position on the earth)*

15. Discussion questions for older students:
   - 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)

16. Have students complete the Student Journal.

Further Research

1. Use the internet to help you find schools that have some of their power coming from photovoltaics.
2. Can photovoltaics be used to power a vehicle? Research ways this can be done .
3. How are photovoltaics used in the space program?

Related Reading

- ***Energy and Power*** by Rosie Harlow and Sally Morgan (Kingfisher, 2002)
  Energy and Power explains what energy is and how we use it. It covers our use of both renewable and non-renewable resources, as well as various forms of alternative energy.
- ***Solar Power (Energy Forever Series)*** by Ian Graham (Raintree, 1999)
  This book examines solar energy, its history, uses, advantages and disadvantages, and new developments in the field.
- ***Solar Power (True Books)*** by Christine Petersen (Children's Press, 2004)
  This book provides readers with a lucid picture of the sun and wind as natural forces before introducing some of the technology (windmills, turbines, solar panels) used to harness energy on a large scale. The captioned photos are well chosen, and the science and the explanations of the technology are eminently clear. Peterson ends the book with a forecast of the future that informs kids about the advantages and disadvantages of such renewable resources and speculates on their use in years to come.
- ***Solar Power of the Future: New Ways of Turning Sunlight into Energy*** by Susan Jones (Rosen Publishing Group, 2003)
  Discusses various kinds of solar energy, the history and development of their use, economic aspects of solar energy, and future possibilities.
- ***Teaching Electricity: Yes, You Can: Grades 3 - 6*** by Steve Tomecek (Scholastic, 1999)
  Use balloons, paper clips and other easy-to-get stuff for super easy, super-cool activities that light up kids' science learning. Each lesson includes background information along with simple activities.

Internet Sites

http://www1.eere.energy.gov/kids/roofus/

Department of Energy, Energy Efficiency and Renewable Energy Network. Roofus' solar roof and neighborhood explains solar technology and shows students how to be energy smart in their own homes.

http://www1.eere.energy.gov/solar/animations.html

Department of Energy, Energy Efficiency and Renewable Energy Network**.** Video: *Photovoltaics: Turning Sunlight into Electricity*

EnergyWhiz

Draw a diagram of a solar powered system and submit it to the EnergyWhiz website at **http://energywhiz.com/ ,** along with your school name and grade**.** If we publish your diagram we will send you an EnergyWhiz t-shirt.

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			.1	.2	.3	.4	.5	.6
Nature of Matter	Standard 1	SC.A.1.2-	X	X		X		
	Standard 2	SC.A.2.2-						
Energy	Standard 1	SC.B.1.2-						
	Standard 2	SC.B.2.2-			X			
Earth and Space	Standard 1	SC.E.1.2-	X		X			
	Standard 2	SC.E.2.2-						

Benchmark SC.B.1.2.1 -The student knows how to trace the flow of energy in a system.
Grade Level Expectations
The student:
Fourth
• knows how to trace the flow of energy in a system
Fifth
• knows how to trace the flow of energy in a system (for example, electricity in a circuit).

Benchmark SC.B.1.2.2 - The student recognizes various forms of energy.
Grade Level Expectations
The student:
Third
• knows that the Sun provides energy for the Earth in the form of heat and light.

Benchmark SC.B.1.2.4 - The student knows the many ways in which energy can be transformed from one type to another.
Grade Level Expectations
The student:
Fourth
• knows ways that energy can be transformed (for example, electricity to light, light to electricity).

Benchmark SC.B.2.2.3 - The student knows that the limited supply of usable energy sources places great significance on the development of renewable energy sources.
Grade Level Expectations
The student:
Third

- knows that alternative energy sources are being explored using natural and mechanical processes.

Benchmark SC.E.1.2.1 - The student knows that the tilt of the Earth on its own axis as it rotates and revolves around the Sun causes changes in season, length of day, and energy available.
Grade Level Expectations
The student:
Fourth
- knows that the tilt of the Earth causes the change of seasons, length of day, and the amount of energy available.

Benchmark SC.E.1.2.3 - The student knows that the Sun is a star and that its energy can be captured or concentrated to generate heat and light for work on Earth.
Grade Level Expectations
The student:
Fourth
- knows how the energy of the Sun can be captured as a source of heat and light on Earth.

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 electricity using light.
'photo': light
'voltaic': relating to electricity (volt)

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

Solar Powered System

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

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.