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
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)
- Science Discovery Sheet

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 excited 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. Photovoltaic systems are quiet, clean, and non-polluting.

For further information on how photovoltaics work and to view an animation of the process, visit the Department of Energy photovoltaics page at:
energy.gov/eere/videos/energy-101-solar-pv

Procedure
1. Discuss with the class what a photovoltaic (PV – "solar") cell does (turns the Sun's energy directly into electricity).
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. Divide the class into groups of 2 - 3 students per group.
4. Give each group of students a photovoltaic cell, motor and propeller.
5. Demonstrate how to attach the propeller to the motor. Have the students attach theirs.
6. Demonstrate how to attach the cell wires to the motor wires--red to red, black to black.

Have the students attach their wires.

7. 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.
8. Take the "solar powered systems" outside and activate them in the sunlight.
9. 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?
9. After returning to the classroom, discuss variables that can affect the output of the photovoltaic cell such as:
    - time of day
    - weather conditions
10. Students should then draw a solar powered system on their Science Discovery Sheet. Encourage them to be creative about what device their system powers.

Key Words and Definitions

- **load** – a device to which power is delivered, such as a motor, a light, or a household appliance
- **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 complex or unified whole

Further Activities

1. Show the class pictures of other solar powered systems and houses with photovoltaics. A Google photo search for "photovoltaics", "solar house", and "solar gadget" will yield many up-to-date photos.
2. Lead a discussion of photovoltaic systems in your community. Some examples could be remote signs, roadside call boxes, signal buoys, weather stations, electric fencing, or emergency shelters.

Further Reading

- ***Little Factory*** by Sarah Weeks and Byron Barton (Laura Geringer, 1998)
  This book and accompanying CD, tell the story (and sing the song) of a little man who builds a little factory and the little workers who come to run the machinery and work on the conveyor lines. When the factory expands and becomes crowded and full of smoke which chokes the employees, they leave. The owner then cuts back, switches to solar

energy and everyone returns. The frequently recurring refrain of 'la-dee-dah, la-dee-dah' makes this story also great for sing-alongs.

- ***Solar Power Comes to My Home*** by Susie Flann (BookSurge Publishing, 2008)
  This book not only explains photovoltaics, but shows the excitement of welcoming this new technology into your home.

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Florida NGSS Standards & Related Subject Common Core

			.1	.2	.3	.4	.5	.6
Grade K								
The Practice of Science	**Big Idea 1**	**SC.K.N.1**	**X**				**X**	
Grade 1								
The Practice of Science	**Big Idea 1**	**SC.1.N.1**	**X**					
Earth in Space and Time	**Big Idea 5**	**SC.1.E.5**				**X**		
Grade 2								
The Practice of Science	**Big Idea 1**	**SC.2.N.1**	**X**					
Forms of Energy	**Big Idea 10**	**SC.2.P.10**	**X**					
Language Arts	**Kindergarten:** LAFS.K.SL.1.1, LAFS.K.SL.2.5 **First Grade:** LAFS.1.SL.1.1 **Second Grade:** LAFS.2.SL.1.1							
Visual Arts	**Kindergarten:** VA.K.O.3.1, VA.K.H.3.1							

Kindergarten Benchmarks

Science--Big Idea 1: The Practice of Science

- SC.K.N.1.1 - Collaborate with a partner to collect information.
- SC.K.N.1.5 - Recognize that learning can come from careful observation.

Language Arts–Standards for Speaking and Listening

- LAFS.K.SL.1.1 - Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and larger groups.
- LAFS.K.SL.2.5 - Add drawings or other visual displays to descriptions as desired to provide additional detail.

Visual Arts–Organizational Structure

- VA.K.O.3.1 - Create works of art to document experiences of self and community.

Visual Arts–Historical and Global Connections

- VA.K.K.3.1 - Express ideas related to non-art content areas through personal artworks.

First Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- SC.1.N.1.1 - Raise questions about the natural world, investigate them in teams through free exploration, and generate appropriate explanations based on those explorations.

Science–Big Idea 5: Earth in Space and Time

- SC.1.E.5.4 - Identify the beneficial and harmful properties of the Sun.

Language Arts–Standards for Speaking and Listening

- LAFS.1.SL.1.1 - Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups.

Second Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- SC.2.N.1.1 - Raise questions about the natural world, investigate them in teams through free exploration and systematic observations, and generate appropriate explanations based on those explorations.

Science–Big Idea 10: Forms of Energy

- SC.2.P.10.1 - Discuss that people use electricity or other forms of energy to cook their food, cool or warm their homes, and power their cars.

Language Arts–Standards for Speaking and Listening

- LAFS.2.SL.1.1 - Participate in collaborative conversations with diverse partners about grade 2 topics and texts with peers and adults in small and larger groups.

National Next Generation Science & Common Core Visual Arts Standards

Kindergarten Standards

Science–Earth and Human Activity

- K-ESS3-3 - Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

Science–Energy

- K-PS3-1 - Make observations to determine the effect of sunlight on Earth's surface.

Science–Engineering Design

- K-ETS1-1 - Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Visual Arts–Creating

- CR. 2.3.Ka - Create art that represents natural and constructed environments.

Note: Related Common Core Language Arts Standards are listed in the Florida section above.

First Grade Standards

Science–Engineering Design

- 1-ETS1-1 - Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Visual Arts–Creating

- CR.1.2.1a - Use observation and investigation in preparation for making a work of art.

Note: Related Common Core Language Arts Standards are listed in the Florida section above.

Second Grade Standards

Science–Engineering Design

- 1-ETS1-1 - Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Note: Related Common Core Language Arts Standards are listed in the Florida section above.

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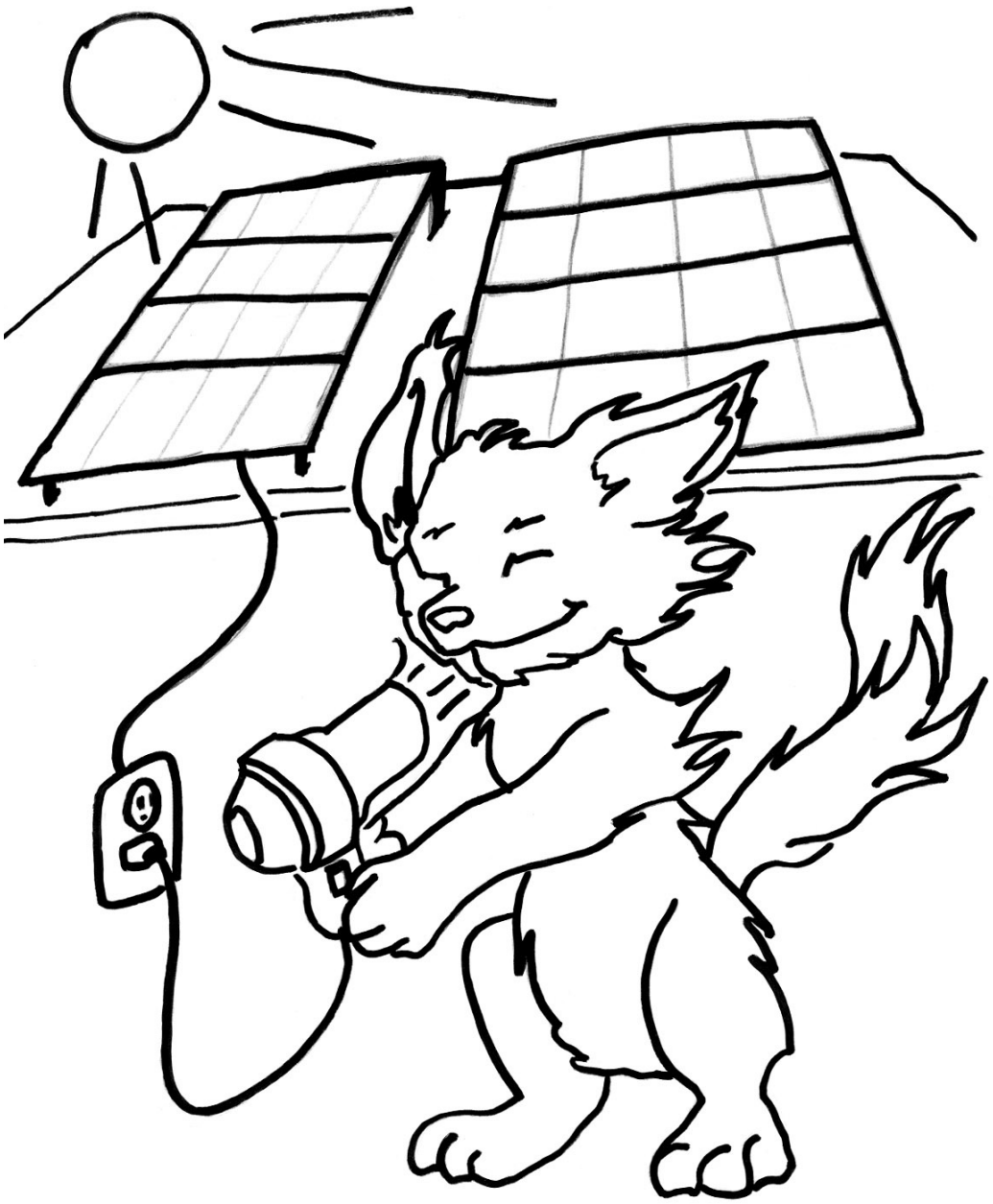
Color this solar powered system.



Draw a solar powered system below.