Solar Cell Simulation

Student Objective
The student:
- will be able to describe how energy moves from the Sun to the photovoltaic cell to the wire and to the load
- will be able to explain what happens when a photovoltaic cell is shaded.

Key Words:
current
electron
load
photon
photovoltaic
simulation

Materials:
- open area (field or playground)
- chalk or traffic tape to outline areas
- bell
- 40 ft string or rope, with 10 knots 2 feet apart (the rest is unknotted) Knot the two ends of rope together in a large circle

Time:
½ hour

Background Information

Photovoltaic refers to the process of turning the energy of the Sun directly into electrical current through the use of photovoltaic cells. These cells (commonly called solar cells) are manufactured in several different ways, however the most common method uses silicon that undergoes a chemical process to add electrons and increase its instability. The silicon mixture is allowed to form crystals from which the photovoltaic cells are made. Electricity is produced when a photon of light energy strikes the solar cell, exciting the electrons. This action causes the electrons to 'flow', starting an electric current. The conversion of sunlight to electricity happens silently and instantly with no moving parts to wear out, no emissions and without a depletion of resources.

Photovoltaic technology is relatively new; as a viable energy source, it is a little over 50 years old. However, it has great potential for the future. As a source of energy, sunlight is free, its supplies are unlimited and it is available in the majority of areas of the world. However, at this time the relatively higher cost of photovoltaic cells and systems is limiting its use. This is expected to change as our supplies of fossil fuels diminish, new methods of producing photovoltaic cells are discovered, and the increase in demand for the technology brings the price down.

Procedure

1. Explain to the students what 'simulation' means.
2. Outline an area on the ground approximately 10 feet by 10 feet to represent the photovoltaic (PV) cells.
3. Outline another area representing the Sun as a large circle 15 feet in diameter.
4. Half of the students spread out in the PV cell, holding onto the rope at a knot. They represent the electrons in the cells.
5. The other students stand in the Sun and represent the photons emerging from the Sun.
6. Place the bell outside the PV cell and have the student with the last knot on the rope before the unknotted part stand near the bell. The rope then circles back into the cell (without knots) simulating the electrical circuit.
7. Explain the following to the class.
    - One student who represents a photon will walk and join hands with the first student (electron) inside the PV cell. This gives the electron energy and it starts to move.
    - The photon and electron holding hands move together down the rope to the next electron and tag it. This student then moves down the rope to tag the next student. This movement and tagging continues until the energy reaches the last student on the knotted part of the rope.
    - This student activates the load on the circuit (rings the bell). The whole class yells out "Hurray for solar energy." The electron student circles around on the unknotted part until they come back to the first knot (now vacated), ready to be tagged.
    - Another photon leaves the Sun, and the movement continues in the same way (the photon pairs up with an electron, moves down the rope, tags the next electron, until the bell is rung, class chants, electron travels back on the circuit to the PV cell, etc.).
    - Continue this movement until all the photons are gone from the Sun.
8. Gather students together and lead a discussion about what happened. Make sure that students understand what real-world things the different groups represented. Ask students how they would change the simulation to represent a cloudy day.

Key Words and Definitions

- **current** - the flow of an electric charge
- **electron** - negatively charged particle of electricity
- **load** - a device on an electric circuit to which power is delivered
- **photon** - the small pieces of light
- **photovoltaic (PV)** - the effect of producing electric current using light
- **simulation -** the imitation of the way in which a system or process works

Further Activities

1. Simulate a cloudy day. On a partly cloudy day, the students could mimic the actual conditions by representing clouds when an actual cloud passes over, and sunshine when it

is clear.

2. Have the last electron call out the name of an appliance or electrical device that they are powering (instead of ringing the bell). Each device may only be named once.

Related Reading

- ***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.
- ***Sun Power: A Book about Renewable Energy*** by Esther Porter (Capstone Press, 2013)
  What makes our car go and our lights glow? Energy! Learn about clean, renewable power made by the sun, wind, water and the earth.

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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**		
Grade 1								
Earth in Space and Time	**Big Idea 5**	**SC.1.E.5**				**X**		
Grade 2								
Forms of Energy	**Big Idea 10**	**SC.2.P.10**	**X**					

Kindergarten Benchmarks
Science--Big Idea 1: The Practice of Science
- SC.K.N.1.4 - Observe and create a visual representation of an object which includes its major features.

First Grade Benchmarks
Science–Big Idea 5: Earth in Space and Time
- SC.1.E.5.4 - Identify the beneficial and harmful properties of the Sun.

Second Grade Benchmarks
Science–Big Idea 10: Forms of Energy
- SC.2.P.10 - Discuss that people use electricity or other forms of energy to cook their food, cool or warm their homes, and power their cars.