



The City Tour for Solar Learning About Solar Power Student Guide Grades 6-8

Photovoltaic Energy Systems: Hands-on Exploration of Energy Conversion and Conservation

Solar Energy Student Guide - Grades 6-8 - Best for Science Classes

The questions...do you know the answers? If not, you will!

- Do you know the difference between a renewable and non-renewable energy resource, and why this difference matters?
- Have you ever seen a solar panel on top of a house or building and wondered how it works?
- Do you know how to generate and convert energy yourself, using solar cells?

Background:

You have probably heard a lot of talk lately about energy – the rising price of fuel, shortages in oil supply, and some of the impacts this is having locally and globally. In your own home, a parent may encourage you regularly to turn off the lights or the TV so you're not wasting electricity and the utility bill isn't too high. Perhaps you have also heard about the connection between energy generation and the health of our environment - and about the important issue of climate change.

Energy is at the center of everything we do today. Fossil fuels such as coal, oil and natural gas currently supply the fuel to run our motor vehicles and most of the electricity we depend on to power our country's homes and buildings. However, there are increasing concerns about the negative environmental and public health consequences of digging up and burning fossil fuels to supply our energy needs. Scientists, businesses and others across the world have been exploring renewable energy sources that could provide cleaner, more widely available, local alternatives, and there are a growing number of renewable energy applications in place today.

One renewable energy solution involves using electricity from the sun, in the form of photovoltaic (PV) technology. The following activities will help you better understand PV technology in a hands-on way. Perhaps you will be part of the solution someday, as a scientist, engineer, building system designer, architect, or policymaker.

About solar energy:

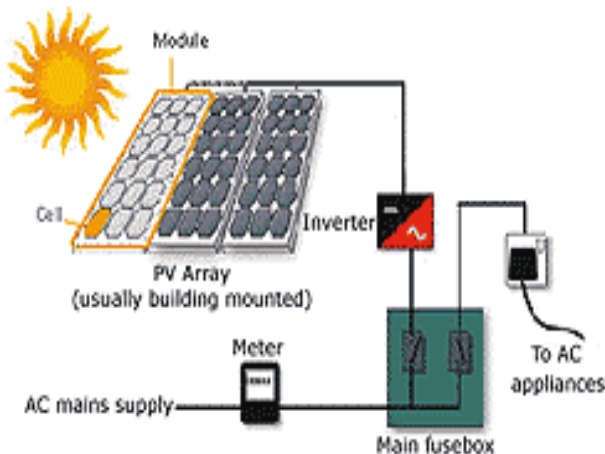
Solar energy from the ancient past is stored in fossil fuels, such as coal and petroleum. These sources of energy take very long periods of time to form – *millions of years* – and once depleted are nonrenewable within our lifetime. In other words, when we use a gallon of oil or a ton of coal it's gone forever. However, many of the Earth's energy resources are available on a continual basis. These include solar, wind, water, and geothermal energy (energy using heat from inside the earth). Other energy sources can be replenished over relatively short periods of time. These include wood and other biomass ("bio" means "life" or "living," so biomass energy is energy from living sources

such as corn or switch grass). All of these are considered renewable because their source of energy is replaced as soon as we use it, or not long after.

Solar power is a synonym of solar energy and refers specifically to the *conversion of sunlight into electricity*. Solar energy technologies take advantage of the sun's power as an energy resource for homes and buildings, and more applications are being researched.

Solar cells or photovoltaic (PV) cells convert solar energy into electricity using the photovoltaic, or "*light energy*," effect. When light strikes the cell, electrons are dislodged and travel along wires placed within the cell. This flow of electrons is electricity. The PV cell is the building block of solar modules that can be linked together in photovoltaic arrays to supply enough electricity to power whatever load is attached, such as a motor, light, or home appliance.

Major parts of a PV energy system include:



1. Sun – energy source
2. Photovoltaic Modules (series of connected PV cells) — these convert sunlight directly into electric current. Like batteries, the current they produce is direct current, or DC.
3. Inverter — the inverter changes the DC electricity produced by the modules into alternating current, or AC, electricity for use in a home or building.
4. Transformer (not pictured) — the transformer changes the voltage of the electricity coming from the inverter to match the voltage of electricity that is used in the building.

5. Electrical Distribution Panel (see Main Fusebox) — the electrical energy produced by the solar electric system is connected with the home or building's electric system at the distribution panel. This allows solar energy to be used for lighting, computers, and other electric loads.
6. Electric meter – the electric meter keeps track of the amount of electrical energy produced by the solar photovoltaic system. Electrical energy is measured in *kilowatt-hours*. If more electricity is produced than is needed by the home or building, and the system is connected to the grid, then the electricity can be sold back to the electric utility!

Activity 1: Create a physical representation of a photovoltaic energy system

Your task will be to take what you have learned about a PV energy system and its major parts and create, together with a team, a physical representation of one of these systems. You will then share your model with the class and explain the role that each component plays within the system.

Directions:

1. Review the major parts of a photovoltaic system above.
2. Your teacher will break the class into groups.

3. Work together for 15-20 minutes to create a physical representation of how a PV energy system works. Depending on the materials available to you, this could be done as a physical role play with props, a drawing or computer graphics representation, or 3-D model that you construct.
4. Take turns presenting your system to your class, giving an opportunity for everyone on your team to participate.

Materials that could be used to create a diagram of a photovoltaic energy system:

Your teacher will provide some or all of the materials below.

- Writing surface such as poster board, white board
 - Writing utensils such as markers for paper and/or white board
 - Colored paper for any cut-outs for diagram
 - Scissors and glue sticks
 - Computer with graphics-capable software
 - Cardboard paper / boxes
 - String or other electrical wire representation
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Activity 2: Build a photovoltaic energy system and see the science in action

You will have the opportunity to assemble your own PV energy system and power a small energy load, such as a fan or music unit. You will then test your device in the sunshine under several different conditions. Questions for your scientific investigation are listed below.

Materials

- Photovoltaic cells (PV cells)
- Propellers
- Data sheets
- Motors

Method

1. Attach propeller to motor. Some kits contain additional items that may be attached to and powered by the motor.
2. Attach red wire from motor to red wire on PV cell.
3. Attach black wire from motor to black wire on PV cell.
4. Place solar energy system in sunlight.

Questions for your scientific investigation:

1. What happens when the solar panel is turned over away from the light?
2. Observe the rotation of the propeller blades. Which way are they turning?
3. What happens to the propeller when the wires are attached red to black?
4. Does the angle of the cell in relation to the sun make a difference in how fast the propeller turns?
5. What would happen if several cells were hooked together?

Sources for more information:

About photovoltaic energy systems:

- www.fsec.ucf.edu/en/consumer/solar_electricity/basics/types_of_pv.htm
- www.fsec.ucf.edu/en/consumer/solar_electricity/basics/how_pv_system_works.htm
- www.wattsonschoools.com/systems.htm
- www.cogeneration.net/illust_pv_blockdiagram.gif
- <http://gsanara.rem-systems.com/>

General background:

- Solar: <http://www.eia.doe.gov/kids/energyfacts/sources/renewable/solar.html>
- Solar cells: http://www1.eere.energy.gov/solar/solar_cell_materials.html
- Photovoltaics: http://www1.eere.energy.gov/solar/pv_basics.html
- Ancient solar history:
<http://www.azsolarcenter.com/education/renewable011199.html>