# SOLAR ENERGY

JILL WILLIAMS

## WHAT IS IT? HOW CAN IT BE USED?

| Time Frame: | Standards: |
| --- | --- |
| 30-45 minutes | 8-9.PS.2.3.2 Classify energy as potential and/or kinetic and as energy contained in a field<br>7.S.1.2.2 Use observations to make defendable inferences<br>7.S.1.6.3 Evaluate data in order to form conclusions |

**Objectives:**

- To be introduced to solar energy by classroom discussion, reading the background information and finding answers to their questions in the reading and classroom discussion.

**Background Information:**

**What is energy?**

Energy is the ability to do work, the ability to make a change. Everything that happens in the world involves a change of some kind, the exchange of energy in some way. The total amount of energy in the universe remains the same. When we use energy, we do not "use it up"; we convert one form of energy into other forms. Usually the conversion of energy produces some heat, which is considered the lowest form of energy, since it dissipates into the surroundings and is difficult to capture and use again. Energy is categorized in many ways: the forms it takes and what it does: the changes it makes, the effects we can see, feel or measure.

**What Energy Does: Energy is recognized in the following ways:**

- **Energy is light**-energy produces light: the movement of energy in transverse electromagnetic waves-**radiant energy**.
- **Energy is heat**-energy produces heat: the movement of atoms and molecules within substances-**thermal energy**.
- **Energy is sound**-energy produces sound: the back-and-forth vibration of substances in longitudinal waves.
- **Energy is motion**-energy produces motion-**kinetic energy**.
- **Energy is growth**-energy is required for cells to reproduce: chemical energy stored in the bonds of nutrients-**chemical energy**.
- **Energy is electricity** to run technology: the movement of electrons from atom to atom.

**Forms of Energy: Energy is recognized in many forms, all of which are potential or kinetic:**

- Thermal Energy (Heat)- potential energy
- Mechanical Energy (Motion)- kinetic energy
- Chemical Energy (Energy in Wood, Fossil Fuels)- potential energy
- Electrical Energy (Electricity, Lightning)- kinetic energy

- Nuclear Energy (Fission, Fusion)- potential energy
- Radiant Energy (Visible light, X-rays, Microwaves)- kinetic energy
- Sound (Motion)- kinetic energy

**Background Information: Continued**

**Solar Energy**

Solar energy is energy from the sun. The sun is a giant ball of hydrogen and helium gas. The enormous heat and pressure in the interior of the sun cause the nuclei of the two hydrogen atoms to fuse, producing one helium atom in a process called fusion. During fusion, nuclear energy is converted into thermal (heat) energy and radiant energy. The radiant energy is emitted from the sun in all directions and some of it reaches Earth. Radiant energy is energy that travels in electromagnetic waves or rays. Radiant energy includes visible light, x-rays, infrared rays, microwaves, gamma rays, and others. These rays have different amounts of energy depending upon their wavelength. The shorter the wavelength, the more energy they contain.

Information from The NEED Project Exploring Solar Energy Teacher guide
www.need.org

**Materials:**

- 2 poster boards or sheets of butcher paper (Something to write down two lists from students)
- Markers (To write down students answers.)
- Class set of Student information sheets (One set to copy off included below)

**Procedure:**

1. Introduce solar energy as the topic the class is going to explore today. Have the students come up with a list of what they know (as a class) about solar energy. Write it down on one sheet of poster board or butcher paper.
2. Next, have the students create a list of questions that they have about solar energy. Write the questions down on second sheet of poster board or butcher paper.
3. Hand out Student information sheets. Have the students read the sheets and see if they can answer any of the questions that are written down. If they find the answer to one of the questions have them write down the answer. Discuss the answers they find as a class.

**Assessment:**

The answers students find in the sheets can be used as part of the assessment. The students part in the classroom discussion before and after reading the information sheets.

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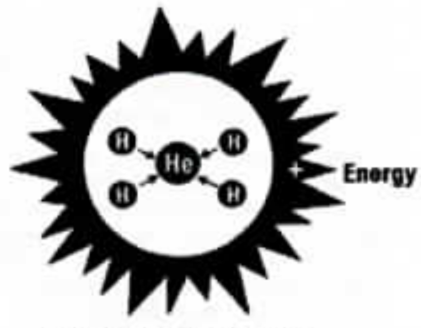
Here are the student information pages. These pages can be used as stated above.

### WHAT IS SOLAR ENERGY?

Every day, the sun radiates (sends out) an enormous amount of energy. It radiates more energy in one second than the world has used since time began. This energy comes from within the sun itself. Like most stars, the sun is a big gas ball made up mostly of hydrogen and helium atoms. The sun makes energy in its inner core in a process called **nuclear fusion.**

During nuclear fusion, the high pressure and temperature in the sun's core cause hydrogen (H) atoms to come apart. Four hydrogen nuclei (the centers of the atoms) combine, or **fuse**, to form one helium atom. During the fusion process, radiant energy is produced.

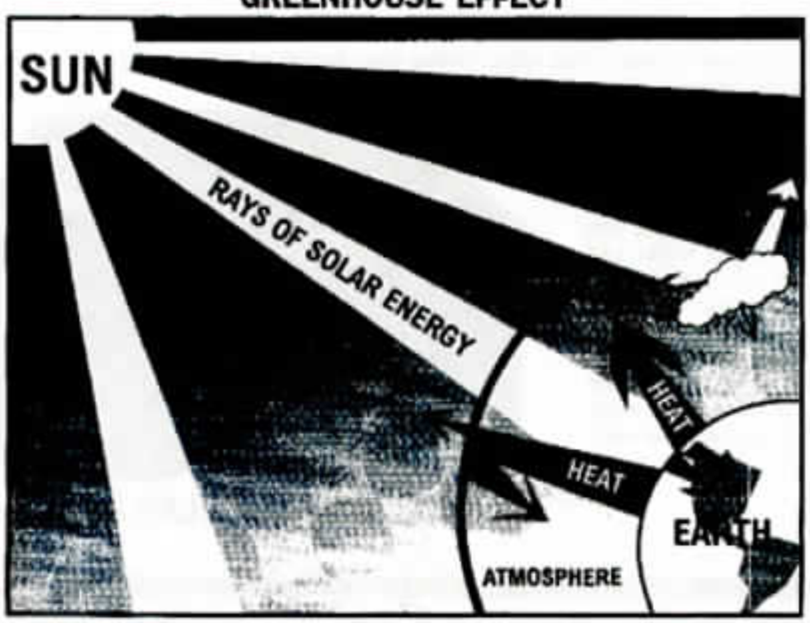



NUCLEAR FUSION

It takes millions of years for the radiant energy in the sun's core to make its way to the solar surface, and then just a little over eight minutes to travel the 93 million miles to earth. The radiant energy travels to the earth at a speed of 186,000 miles per second, the speed of light.

Only a small portion of the energy radiated by the sun into space strikes the earth, one part in two billion. Yet this amount of energy is enormous. Every day enough energy strikes the United States to supply the nation's energy needs for one and a half years. About 15 percent of the radiant energy that reaches the earth is reflected back into space. Another 30 percent is used to evaporate water, which is lifted into the atmosphere and produces rainfall. Radiant energy is also absorbed by plants, the land, and the oceans.

GREENHOUSE EFFECT



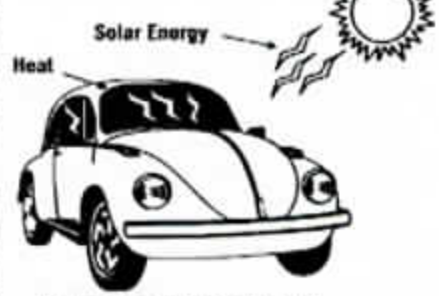
# SOLAR ENERGY
## WHAT IS IT? HOW CAN IT BE USED?

### SOLAR COLLECTORS

Heating with solar energy is not as easy as you might think. Capturing sunlight and putting it to work is difficult because the solar energy that reaches the earth is spread out over a large area. The amount of solar energy an area receives depends on the time of day, the season of the year, the cloudiness of the sky, and how close you are to the earth's equator.

A **solar collector** is one way to capture sunlight and change it into usable heat energy. A closed car on a sunny day is like a solar collector. As sunlight passes through the car's windows, it is absorbed by the seat covers, walls, and floor of the car. The absorbed energy changes into heat. The car's windows let radiant energy in, but they don't let all the heat out.

SOLAR COLLECTOR




On a sunny day, a closed car is a solar collector. Solar energy passes through the glass, hits the inside of the car and changes into heat. The heat gets trapped inside.

### SOLAR SPACE HEATING

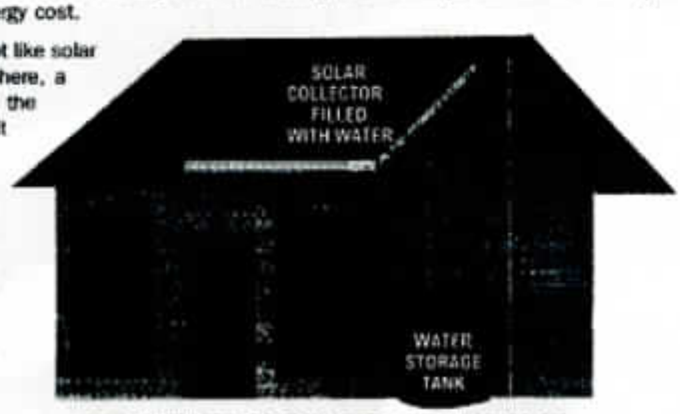
**Space heating** means heating the space inside a building. Today, many homes use solar energy for space heating. A **passive solar home** is designed to let in as much sunlight as possible. It is like a big solar collector. Sunlight passes through the windows and heats the walls and floor inside the house. The light can get in, but the heat is trapped inside. A passive solar home does not depend on mechanical equipment, such as pumps and blowers, to heat the house.

An **active solar home**, on the other hand, uses special equipment to collect sunlight. An active solar house may use special collectors that look like boxes covered with glass. These collectors are mounted on the rooftop facing south to take advantage of the winter sun. Dark-colored metal plates inside the boxes absorb sunlight and change it into heat. (Black absorbs sunlight better than any other color.) Air or water flows through the collector and is warmed by the heat. The warm air or water is distributed to the rest of the house, just as it would be with an ordinary furnace system.

### SOLAR WATER HEATING

Solar energy can be used to heat water. Heating water for bathing, dishwashing, and clothes washing is the second biggest home energy cost.

A solar water heater works a lot like solar space heating. In our hemisphere, a solar collector is mounted on the south side of a roof where it can capture sunlight. The sunlight heats water and stores it in a tank. The hot water is piped to faucets throughout a house, just as it would be with an ordinary water heater. Today, more than 1.5 million homes in the United States use solar water heaters.




SOUTH-FACING SOLAR HOUSE

### SOLAR ELECTRICITY

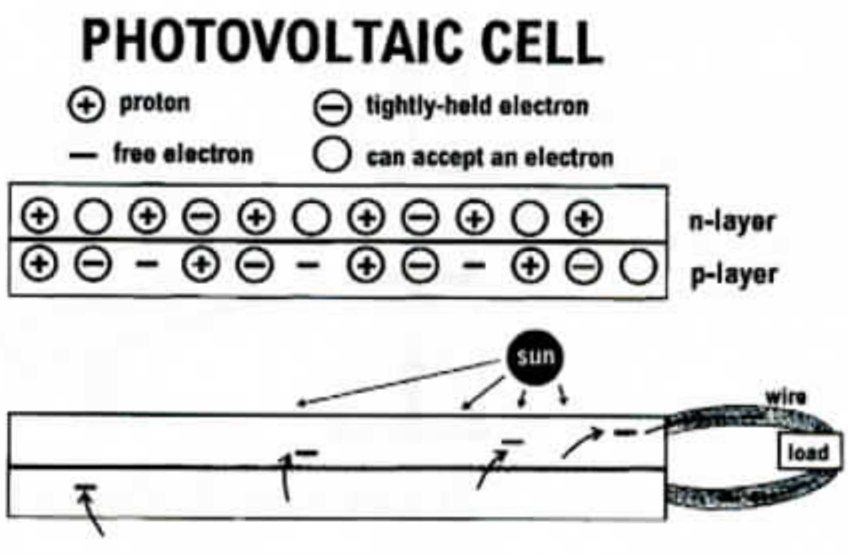
Solar energy can also be used to produce electricity. Two ways to make electricity from solar energy are photovoltaics and solar thermal systems.

**Photovoltaic** comes from the words *photo* meaning *light* and *volt*, a measurement of electricity. Photovoltaic cells are also called PV cells or solar cells for short. You are probably familiar with photovoltaic cells. Solar-powered toys, calculators, and roadside telephone call boxes all use solar cells to convert sunlight into electricity.

Solar cells are made of two thin pieces of **silicon**, the substance that makes up sand and the second most common substance on earth. One piece of silicon has a small amount of boron added to it, which gives it a tendency to attract electrons. It is called the **p-layer** because of its positive tendency. The other piece of silicon has a small amount of phosphorous added to it, giving it an excess of free electrons. This is called the **n-layer** because it has a tendency to give up electrons, a negative tendency. When the two pieces of silicon are placed together, some electrons from the n-layer flow to the p-layer and an electric field forms between the layers. The p-layer now has a negative charge and the n-layer has a positive charge.

When the PV cell is placed in the sun, the radiant energy energizes the free electrons. If a circuit is made connecting the layers, electrons flow from the n-layer through the wire to the p-layer. The PV cell is producing electricity—the flow of electrons. If a load such as a lightbulb is placed along the wire, the electricity will do work as it flows. The conversion of sunlight into electricity takes place silently and instantly. There are no mechanical parts to wear out.

Compared to other ways of producing electricity, PV systems are expensive. It costs 10-20 cents a kilowatt-hour to produce electricity from solar cells. On average, people pay about eight cents a kilowatt-hour for electricity from a power company using fuels like coal, uranium or hydropower. Today, PV systems are mainly used to generate electricity in areas that are a long way from electric power lines.



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## WHAT IS IT? HOW CAN IT BE USED?

### CONCENTRATED SOLAR POWER

Like solar cells, concentrated solar power systems use solar energy to make electricity. Since the solar radiation that reaches the earth is so spread out and diluted, it must be concentrated to produce the high temperatures required to generate electricity. There are three types of technologies that use mirrors or other reflecting surfaces to concentrate the sun's energy up to 5,000 times its normal intensity.

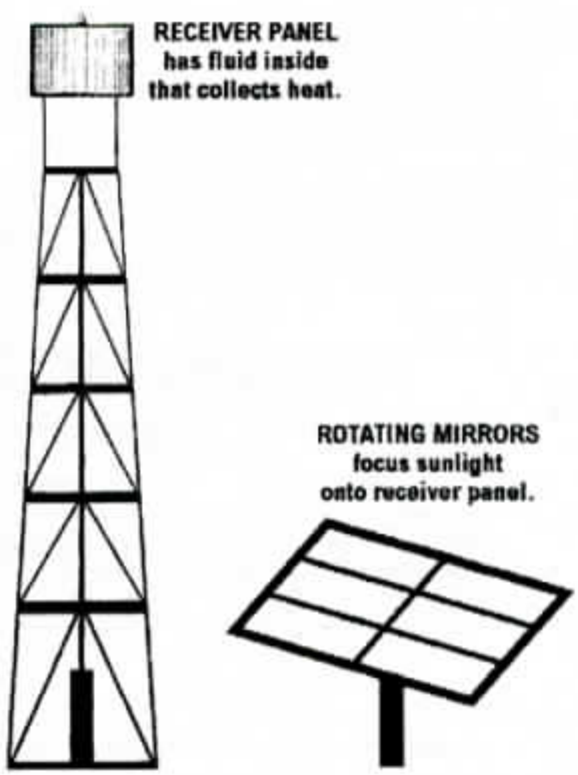
**Parabolic Troughs** use long reflecting troughs that focus the sunlight onto a pipe located at the focal line. A fluid circulating inside the pipe collects the energy and transfers it to a heat exchanger, which produces steam to drive a conventional turbine. The world's largest parabolic trough is located in the Mojave Desert in California. This plant has a total generating capacity of 354 megawatts, one-third the size of a large nuclear power plant.

**Solar Power Towers** use a large field of rotating mirrors to track the sun and focus the sunlight onto a heat-receiving panel on top of a tall tower. The fluid in the panel collects the heat and either uses it to generate electricity or stores it for later use.

**Dish/Engine Systems** are like satellite dishes that concentrate sunlight rather than signals, with a heat engine located at the focal point to generate electricity. These generators are small mobile units that can be operated individually or in clusters, in urban and remote locations.

**Concentrated Solar Power (CSP)** technologies require a continuous supply of strong sunlight, like that found in hot dry regions such as deserts. Developing countries with increasing electricity demand will probably be the first to use CSP technologies on a large scale.

Solar energy has great potential for the future. Solar energy is free and its supplies are unlimited. It does not pollute or otherwise damage the environment. It cannot be controlled by any one nation or industry. If we can improve the technology to harness the sun's enormous power, we may never face energy shortages again.




SOLAR POWER TOWER

**Additional Content:**

One way to extend this lesson is assign several of the questions that the class came up with as a homework research project. Have the students find and answer the question with a paragraph or more as you decide.

You can also assign students in groups to design a way that they could use solar energy at home based on what they talked about in class. Have them create their design and write instructions on how to make their design and use it.

**References:**


Adapted from The NEED Project's 2008 Exploring Solar Energy Activity 1
http://www.need.org/


Adapted by Jill Williams as a part of the INL Educational Science writing team.