K-W-L

Student Objective
The student:
- will be able to list what they have learned about solar energy
- will understand how knowledge of a subject creates further questions

Key Words:
energy
photovoltaic
solar
solar thermal

Materials:
- 4 sheets of large paper, flip chart size
- markers of various colors

Time:
½ hour each discussion

Background Information
Our Sun
- The Sun is a medium-sized yellow star. It is a main sequence star sometimes referred to as a yellow dwarf.
- The Earth is 93,000,000 miles away from the Sun.
- If you were to drive a car from the Earth to the Sun at 70 miles per hour it would take you 151 years to reach the Sun.
- It would take about 109 Earths lined up end to end, to equal the diameter of the Sun.
- Our Sun provides the Earth with heat and light.
- The Sun is expected to burn out in another 4.5 to 7 billion years.
- It takes approximately 8 minutes for sunlight to reach Earth.
- The Sun is the center of our solar system. All of the planets orbit the Sun. .
- Without the Sun, life would not exist on our planet.
- If you were to draw the Sun on the board one meter in diameter, the Earth you would draw would be approximately one centimeter in diameter.
- Sunlight intensity varies in different places around the world. It is affected by latitude, altitude and seasons.
- Sun blockers can prevent the Sun's rays from reaching the Earth. They include clouds, wind, and pollution.
- The energy from sunlight can be transformed to electricity by photovoltaic cells and this energy can be stored in batteries.
- The Sun is a giant ball of gas, mostly hydrogen and helium.
- In a series of reactions in the Sun, four atoms of hydrogen are fused into helium atoms. The loss of atomic matter (photons) is radiated into space and hits the Earth, providing light and heat.

Solar Energy

The Sun is the ultimate source of all energy on earth. Even our fossil fuels were created by solar energy thousands of years ago. In general, solar energy can be grouped into eight types: photosynthesis, wind energy, hydroelectric power, ocean energy, passive solar heating, active solar heating and photovoltaics.

Solar energy is using the energy radiated by the chemical reactions of our Sun for heat and electricity. During the nuclear fusion process in our Sun, four hydrogen atoms combine to form one helium atom with a release of matter that is emitted and travels outward from the Sun as radiant energy. The unit of measure for this energy is the *photon*. It takes these photons of energy a little under eight minutes to travel to Earth. There is so much energy radiating from our Sun that it produces more energy in one second than the Earth has used since time began.

Of the total energy from the Sun that reaches the Earth, about 30% is immediately bounced back into space by the atmosphere. The atmosphere, land masses and oceans absorb 45% in the form of heat. Almost 23% operates the water cycle, about 1% is used in air and ocean circulation, and less than 1% is used by plants.

Sunlight provides energy through **photosynthesis**. This energy is recoverable through burning of wood and fossil fuels such as coal, petroleum, and natural gas which are created through the process of photosynthesis. Photosynthesis is also the basis of all food energy; our food chain on Earth begins with the Sun.

Sunlight heating the ground and the lower atmosphere produces wind which powers wind turbines. **Wind power** has the potential to become a very significant alternative fuel in many areas of the world.

Sunlight stored as the gravitational energy of water through the water cycle can be extracted with dams and electric generators. **Hydroelectric power** is renewable and considered a "clean" energy since no burning is required, but it is limited in quantity.

Ocean Energy - The use of the ocean tides has been harnessed to make electricity along with a variety of other methods which make use of the motions and thermal gradients in the ocean. A heat engine can derive useful energy through the use of the temperature difference between the sun-warmed surface layers of the ocean and the colder depths, in a process called ocean thermal energy conversion (OTEC). This technology is complex, therefore limiting the use of the tremendous amount of stored energy in the ocean thermal gradients.

Solar thermal uses the energy of the Sun to make heat; solar thermal is mainly used to heat water for domestic and industrial use or for heating a building interior; however, it has also been used experimentally to create steam from a liquid that can then be turned into electricity with a turbine. **Photovoltaic** refers to the process of turning the energy of the Sun directly into electricity. Photovoltaic cells (commonly called solar cells) are made from silicon that undergoes a chemical process to add electrons and increase its instability, then 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, causing the electrons to flow. The action of the electrons starts an electric current. This conversion of sunlight to electricity happens silently and instantly with no moving parts to wear out and no depletion of resources.

Documented use of solar thermal dates back at least to ancient Greek and Roman times. Recent research indicates that they used glass as a passive solar thermal collector. However, photovoltaic technology is relatively new; as a viable energy source, it is only 50 years old.

Solar energy has great potential now and 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 high 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 (Introductory Lesson)

1. Title two of the sheets of paper *Solar Energy* (the other two sheets will be used on the follow-up day).
2. Under the title, label one sheet, **K** - Things I know about solar energy, and the other sheet, **W** - Things I want to find out about solar energy.
3. Lead a brainstorming session with the class to fill in the first sheet. Write all of the information offered by the students. Alternate the color of the marker for each statement. It is very important to use the words stated by the children or to ask permission to paraphrase. If they give false information, refrain from correcting them!
4. Then, ask the students what they would like to learn about solar energy. Use their questions to fill in the second sheet in the same manner.
5. Save the K and W sheets for the follow-up lesson.

Procedure (Follow-up Lesson–to be used at the end of the solar unit)

1. Hang the K and W sheets from the first lesson.
2. Hang the third sheet and title it *Solar Energy* and under the title, label it **L** - Things I learned about solar energy.
3. Lead a brainstorming session with the class to fill in the last sheet. Refer back to the first two sheets and make sure the items listed in the second column have either been answered, or the students know where they could go to find their answers. At this time they should also revise misconceptions that they had at the beginning of the unit.
4. On the fourth sheet of paper write the title *Further Study*.
5. Explain to students how scientific study spawns new questions of inquiry. Brainstorm with the students what new questions they now have about solar energy. Write these on the *Further Study* sheet.

Further Activities

1. Pick one or more of the questions on the *Further Study* sheet that you created as a class in the beginning lesson, to research in groups or as a class project.

Related Reading

- ***Sun*** by Steve M. Tomecek (National Geographic Society, 2001)
  This book follows two kids and a purple cat as they learn about sunspots and solar flares, see how the Sun creates night and day and the seasons, and learn how the Sun warms the Earth. It shows the Earth's place in the solar system, scientists studying the Sun through special telescopes, and the bounty of life on Earth nurtured by the heat-giving rays of our

star.

- ***Sun*** by Lynda Sorensen (Rourke Publishing, 1993)
  Sorensen explains what composes the Sun, how the light gets to the Earth, and what the surface of the Sun is like as well solar eclipses, the orbit of our Earth and gravity.
- **Sun** by Franklyn Mansfield Branley (HarperCollins Children's Books, 2002)
  This book explains how large, hot and distant the Sun is, as well as how its energy is stored not only in the foods we eat, but also in the fossil fuels we use.

EnergyWhiz

The class can submit questions that they want answered to "Ask Professor Sunny" on the Energy Whiz website: **http://energywhiz.com/** Professor Sunny will post the answers to their questions as well as recognize the school and post a picture of the class if desired.

K-W-L

			.1	.2	.3	.4	.5
Energy	**Standard 1**	**SC.B.1.1-**	**X**	**X**	**X**	**X**	
	Standard 2	**SC.B.2.1-**	**X**				

Benchmark SC.B.1.1.1 - The student knows that the Sun supplies heat and light energy to Earth.

Grade Level Expectations

The student:

Kindergarten

- knows the effects of Sun and shade on the same object

First

- knows that heat from the Sun has varying effects depending on the surface it strikes

Second

- knows that a thermometer measures the amount of heat absorbed by an object.

Benchmark SC.B.1.1.2 - The student knows that light can pass through some objects and not others.

Grade Level Expectations

The student:

Kindergarten

- knows that light can pass through some objects, but cannot pass through other objects

First

- predicts which materials will allow light to pass through and which ones will not

Second

- understands that some materials will allow light to pass and others will not.

Benchmark SC.B.1.1.3 - The student describes a model energy system.

Grade Level Expectations

The student:

First

- understands that models can be used to observe processes and changes over time

Second

- understands that models can be used to illustrate how energy flows through a system.

Benchmark SC.B.1.1.4 - The student knows that heat can be produced in many ways.
Grade Level Expectations
The student:
Second
- knows different heat sources.

Benchmark SC.B.2.1.1 - The student recognizes systems of matter and energy.
Grade Level Expectations
The student:
Second
- understands ways energy and matter interact.

K-W-L

energy - the ability to do work. Also, a source of usable power**.**

photovoltaic (PV) - the effect of producing electric current using light
'photo': light
'voltaic': relating to electricity (volt)

solar - having to do with the Sun

solar thermal - using the Sun's energy to heat something. Common uses include water heaters and pool heaters