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.

Materials:
- 4 sheets of large paper, flip chart size
- marker
- Science Journal

Key Words:
photon
photovoltaic
radiant energy
radiate
solar energy
solar thermal

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

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.

There are two types of solar energy technologies currently being used commercially – **solar thermal** and **photovoltaic**. Solar thermal uses the energy of the Sun to make heat; photovoltaic refers to the process of turning the energy of the Sun directly into electricity. 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 cells (commonly called solar cells) are made from silicon that undergoes a chemical process to add electrons and increase its instability. The silicon mixture is then 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 start 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 less than 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 <u>know</u> about solar energy, and the other sheet, **W** - Things I <u>want to find out</u> about solar energy.
3. Give the students a few minutes to answer questions 1 and 2 in their Science Journals.
4. Lead a brainstorming session with the class to fill in the first sheet. Write all of the information offered by the students. 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!
5. Then, ask the students what they would like to learn about solar energy. Use their

questions to fill in the second sheet.

6. Save the K-W-L for the follow-up lesson.

Procedure (Follow-up Lesson–use 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.
6. Students should complete questions 3 and 4 in their Science Journal.

Further Research

1. Divide class into groups of 2 - 4 students per group. Give each group a piece of poster board or a large sheet of paper divided in quarters. On the top of each section the team writes one of the 'W' questions (these could either be assigned or chosen by the groups). The group's job is to 'investigate' this question throughout the unit and record the answers they discover. These could be written, drawn or made into a collage. At the end of the unit have the groups present their answers to the rest of the class.
2. After the follow-up, assign "Further Study" questions to groups of students to research and report to the class.

Related Reading

- ***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 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.
- ***The Sun*** (Starting with Space) by Paulette Bourgeois and Bill Slavin (Kids Can Press, 1999)
  This book includes not only basic scientific observations, but also briefly told myths and legends and instructions for easy, homespun demonstrations all illustrated with a combination of color photos and lively cartoons. After a look at the past and future of The Sun, she discusses its visible and invisible emissions, seasons, the ozone layer, and

the northern lights, the last accompanied by a particularly spectacular photo taken from space.

- ***The Sun*** by Seymour Simon (HarperTrophy, 1989)
  The Sun discusses the sun as a star; its distance from earth, size, and temperature; the solar system; the sun's hydrogen-fueled nuclear power; the parts of the sun and its atmosphere; eclipses, sunspots, prominences, flares, and the aurorae.

Internet Sites

http://www.omsi.edu/explore/whatzit

Oregon Museum of Science and Industry. Science Whatzit answers scientific questions from "what makes electric eels electric?" to "why do leaves change color in the fall?" Site includes interactive component that allows you to ask your own questions**.**

http://solar-center.Stanford.EDU/FAQ/

Frequently asked questions about the Sun – physics, astronomy, history and links to other sun FAQ sites**.**

http://library.thinkquest.org/15215/

Extensive site about the Sun. Contains links to activities, books, and other information.

http://planetarium.org/

Allentown School District Planetarium. Extensive site includes articles and links to various astronomical subjects, including sun astronomy, archaeoastronomy, and astronomical misconceptions.

EnergyWhiz

Submit your solar questions to "Ask Professor Soleil" on the EnergyWhiz web site at **http://energywhiz.com/**. See your class and school name online as well as the answer to your question!

K-W-L

			.1	.2	.3	.4	.5	.6
Energy	**Standard 1**	**SC.B.1.2-**	**X**	**X**	**X**	**X**		**X**
	Standard 2	**SC.B.2.2-**						
Force and Motion	**Standard 1**	**SC.C.1.2-**						
	Standard 2	**SC.C.2.2-**	**X**	**X**				
Earth and Space	**Standard 1**	**SC.E.1.2-**			**X**			
	Standard 2	**SC.E.2.2-**						
Nature of Science	**Standard 1**	**SC.H.1.2-**						
	Standard 2	**SC.H.2.2-**						
	Standard 3	**SC.H.3.2-**				**X**		

Benchmark SC.B.1.2.1 - The student knows how to trace the flow of energy in a system.
Grade Level Expectations
The student:
Fourth
- knows that most living things use energy from the Sun to live and grow
- knows how to trace the flow of energy in a system

Fifth
- knows how to trace the flow of energy in a system.

Benchmark SC.B.1.2.2 - The student recognizes various forms of energy.
Grade Level Expectations
The student:
Third
- knows different forms of energy

Fourth
- knows that there are a variety of sources for electricity.

Benchmark SC.B.1.2.3 - The student knows that most things that emit light also emit heat.
Grade Level Expectations
The student:
Third
- knows that the Sun provides energy for the Earth in the form of heat and light.

Benchmark SC.B.1.2.4 - the student knows that many ways in which energy can be transformed from one type to another.

Grade Level Expectations

The student:

Fourth

- knows ways that energy can be transformed.

Benchmark SC.B.1.2.6 - The student knows ways that heat can move from one object to another.

Grade Level Expectations

The student:

Fifth

- understands that convection, radiation, and conduction are methods of heat transfer.

Benchmark SC.B.2.2.1 - The student knows that some source of energy is needed for organisms to stay alive and grow.

Grade Level Expectations

The student:

Third

- knows that some source of energy is needed for organisms to stay alive and grow.

Benchmark SC.B.2.2.2 - The student recognizes the costs and risks to society and the environment posed by the use of nonrenewable energy.

Grade Level Expectations

The student:

Third

- classifies resources as renewable or nonrenewable.

Benchmark SC.E.1.2.3 - The student knows that the Sun is a star and that its energy can be captured or concentrated to generate heat and light for work on Earth.

Grade Level Expectations

The student:

Fourth

- knows how the energy of the Sun can be captured as a source of heat and light on Earth.

Benchmark SC.H.3.2.4 - The student knows that, through the use of science processes and knowledge, people can solve problems, make decisions, and form new ideas.

Grade Level Expectations

The student:

Third

- knows that, through the use of science processes and knowledge, people can solve problems, make decisions, and form new ideas

Fourth

- knows ways that, through the use of science processes and knowledge, people can solve problems, make decisions, and form new ideas

Fifth

- extends and refines knowledge of ways that, through the use of science processes and knowledge, people can solve problems, make decisions , and form new ideas.

K-W-L

photon - a massless particle of energy that is in sunlight

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

radiant energy - energy that transmits away from its source in all directions. For example, solar energy created by the sun is a form of radiant energy.

radiate - to send out rays, illuminate, shine brightly

solar energy - energy derived from the sun

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

K-W-L

1. List below some of the things you know about solar energy.

2. List below some of the things you would like to find out about solar energy.

Follow-up K-W-L

3. List below some of the things you learned about solar energy.

4. List below some of the new questions you have about solar energy.