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:
electromagnetic spectrum
photovoltaic
radiation
solar energy
solar thermal

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

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.
- 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.

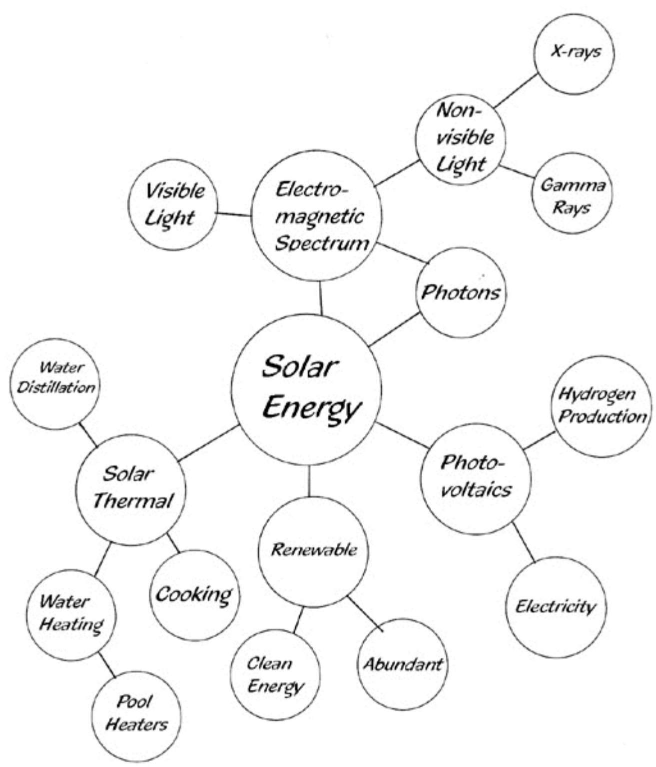
Procedure (Introductory Lesson)

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 know about solar energy, and the other sheet, **W** - Things I want to find out 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–to be used at the end of the 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 any misconceptions that they had at the beginning of the unit.
4. Have the students help you create a concept map on the board. Write Solar Energy in the center circle. If the students are unfamiliar with concept mapping, you may want to write a few more concepts and their connections to get them started. Invite students to come up to the board, a few at a time to add to the concept map. For each concept that a student adds, they should draw arrows to any of the other concepts that form a cause and effect relationship. The object is for the class to create a large and interconnected web. Encourage students to use large concepts/classifications (photovoltaics, renewable energy), specific uses (pool heaters, electricity generation), drawbacks/benefits (high cost, no pollution), as well as scientific concepts (radiation, convection, conduction, electromagnetic spectrum, etc).

Concept Map example:



5. On the fourth sheet of paper write the title *Further Study*
6. 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.
7. Students should complete questions 3 and 4 in their Science Journal.

Related 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 into 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 in a collage format. 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

- ***A Look at the Sun*** by Ray Spangenburg & Kit Moser (Franklin Watts, 2002)
  This detailed yet accessible book unravels the scientific wonders of the Sun—including nuclear fusion, fiery solar prominences shooting into space and the sprinkling of dark spots on its surface.
- ***The Sun*** by Ron Miller (21st Century, 2002)
  As well as describing the Sun's origins and internal processes, its effects on Earth's biosphere and atmosphere, and the likely stages of its final few million years, Miller lays out instructions for a simple but safe pinhole projector for young astronomers to construct.

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

Stanford University's Solar Center answers frequently asked questions about the sun and solar energy. Included are facts on myths and history, the gravitational sun, magnetic sun, solar evolution and other solar facts.

EnergyWhiz

Submit your solar questions to "Ask Professor Sunny" 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	.7
Nature of Matter	**Standard 1**	**SC.A.1.3-**							
	Standard 2	**SC.A.2.3-**			X				
Energy	**Standard 1**	**SC.B.1.3-**	X	X	X				
	Standard 2	**SC.B.2.3-**							
Earth and Space	**Standard 1**	**SC.E.1.3-**			X				
	Standard 2	**SC.E.2.3-**							
How Living Things Interact With Their Environment	**Standard 1**	**SC.G.1.3-**					X		
	Standard 2	**SC.G.2.3-**	X						

Benchmark SC.A.2.3.3 - The student knows that radiation, light, and heat are forms of energy used to cook food, treat diseases, and provide energy.

Grade Level Expectations

The student:

Sixth

- knows forms of radiant energy and their applications to everyday life

Seventh

- knows uses of radiation, light, and thermal energy to improve the quality of life for human beings

Eighth

- extends and refines knowledge of uses of forms of energy to improve the quality of life.

Benchmark SC.B.1.3.1 - The student identifies forms of energy and explains that they can be measured and compared.

Grade Level Expectations

The student:

Sixth

- knows different types of energy and the units used to quantify the energy
- understands that energy can be converted from one form to another

Seventh

- knows examples of uses of energy in the home and ways to measure its use

Eighth

- understands that energy can be transferred by radiation, conduction, and convection
- knows examples of natural and man-made systems in which energy is transferred from one form to another.

Benchmark SC.B.1.3.2 - The student knows that energy cannot be created or destroyed, but only changed from one form to another.
Grade Level Expectations
The student:
Sixth
- understands that energy can be changed in form
- uses examples to demonstrate common energy transformations

Eighth
- understands how the principle of conservation of energy is applied during an energy transfer.

Benchmark SC.B.1.3.3 - The student knows the various forms in which energy comes to Earth from the Sun.
Grade Level Expectations
The student:
Sixth
- knows types of radiant energy that come to Earth from the Sun

Seventh
- knows that useful energy is lost as heat energy in every energy conversion

Eighth
- knows that energy conversions are never 100% efficient and that some energy is transformed to heat and is unavailable for further useful work.

Benchmark SC.E.1.3.3 - The student understands that our Sun is one of many stars in our galaxy.
Grade Level Expectations
The student:
Sixth
- understands that our Sun is one of many stars in our galaxy.

Benchmark SC.G.1.3.5 - The student knows that life is maintained by a continuous input of energy from the sun and by the recycling of the atoms that make up the molecules of living organisms.
Grade Level Expectations
The student:
Seventh
- knows that life on earth is dependent upon a continuous supply of energy from the sun.

Benchmark SC.G.2.3.1 - The student knows that some resources are renewable and others are nonrenewable.
Grade Level Expectations

The student:

Sixth

- knows renewable and nonrenewable energy sources

Seventh

- understands the importance of informed use of natural resources

Eighth

- knows that some resources are renewable and others are nonrenewable.

K-W-L

electromagnetic spectrum - the radiant energy that is emitted from the sun which is made up of varying wavelengths. From longest to shortest, these are: radio waves, radar/microwave, infrared, visible light, ultraviolet, x-rays and gamma rays.

photovoltaic (PV) - the effect of producing electric current using light

'photo': light

'voltaic': relating to electricity (volt)

radiation - the way we receive heat from the sun each day. The energy is emitted in the form of waves/particles, and can move from one object to another without heating the area in between.

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 the things you know about solar energy.

2. List below 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.