K-W-L

Student Objectives
The student:
- will list what they have learned about solar energy
- will generate one or more new questions about solar energy
- understands how knowledge of a subject creates further questions.

Key Words:
photon
photosynthesis
photovoltaic
radiant energy
radiate
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.
- 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 millions 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 for plants 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 a little more than 70 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 having to pay for electricity "up front" instead of monthly (through monthly utility billing, and the public opinion that photovoltaic electricity is more expensive than traditional commercially produced electricity is limiting its use. This is expected to change as photovoltaics become more widespread, and new ways of financing are promoted.

Procedure (Introductory Lesson)

1. Title two 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–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.

Key Words and Definitions

- **photon** – a massless particle of energy that is in sunlight
- **photosynthesis –** the process through which plants use water and carbon dioxide and energy from sunlight to create their food, grow and release excess oxygen into the air
- **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**.**

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

- ***Solar Power (Energy For Today)*** by Tea Benduhn (Gareth Stevens Publishing, 2008)
  An introductions to solar power that includes photos and diagrams of several solar applications.
- ***The Sun (Eye on the Universe)*** by Niki Walker and Bonna Rouse (Crabtree Publishing Company, 2000)
  This book explains what type of star the Sun is, what fuels its enormous energy, and what the Sun's position is in our galaxy. Kids will be intrigued to learn about eclipses, solar activity, and space weather but, more importantly, they'll gain an insight into the crucial relationship between the Sun and Earth.

Internet Sites

http://solar-center.Stanford.EDU/FAQ/
Frequently asked questions about the Sun – physics, astronomy, history and links to other sun FAQ sites**.**

http://sunearthday.nasa.gov/spaceweather/#
NASA daily Sun image

https://video.nationalgeographic.com/video/101-videos/sun-101
National Geographic video, Sun 101

http://www.neok12.com/Sun.htm
Neo K-12 Education. A good site for teachers that has quizzes, games, presentations, links to videos and lessons about the Sun.

https://www.youtube.com/watch?v=uK4a7kWb6Ro
NASA, Sun For Kids video

https://www.youtube.com/watch?v=6FB0rDsR_rc
Here Comes the Sun: Crash Course Kids #5.1

K-W-L

Florida NGSS Standards & Related Subject Common Core

			.1	.2	.3	.4	.5	.6	.7	.8
Grade 3										
The Practice of Science	**Big Idea 1**	**SC.3.N.1**	X		X		X			
Earth in Space and Time	**Big Idea 5**	**SC.3.E.5**		X	X					
Earth Structures	**Big Idea 6**	**SC.3.E.6**	X							
Forms of Energy	**Big Idea 10**	**SC.3.P.10**	X							
Interdependence	**Big Idea 17**	**SC.3.L.17**		X						
Grade 4										
The Practice of Science	**Big Idea 1**	**SC.4.N.1**	X					X		
Earth in Space and Time	**Big Idea 5**	**SC.4.E.5**			X	X				
Earth Structures	**Big Idea 6**	**SC.4.E.6**						X		
Forms of Energy	**Big Idea 10**	**SC.4.P.10**	X							
Interdependence	**Big Idea 17**	**SC.4.L.17**			X					
Grade 5										
The Practice of Science	**Big Idea 1**	**SC.5.N.1**						X		
The Characteristics of Scientific Knowledge	**Big Idea 2**	**SC.5.N.2**	X							
Forms of Energy	**Big Idea 10**	**SC.5.P.10**	X							
Language Arts	**Third Grade:** LAFS.3.W.3.8, LAFS.3.SL.1.1, LAFS.3.SL.2.4 **Fourth Grade:** LAFS.4.SL.1.1 **Fifth Grade:** LAFS.5.SL.1.1									

Third Grade Benchmarks
Science--Big Idea 1: The Practice of Science

- SC.3.N.1.1 - Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.
- SC.3.N.1.3 - Keep records as appropriate, such as pictorial, written, or simple charts and graphs, of investigations conducted.

- SC.3.N.1.5 - Recognize that scientists question, discuss, and check each others' evidence and explanations.

Science--Big Idea 5: Earth in Space and Time

- SC.3.E.5.2 - Identify the Sun as a star that emits energy; some of it in the form of light.
- SC.3.E.5.3 - Recognize that the Sun appears large and bright because it is the closest star to Earth.

Science–Big Idea 6: Earth Structures

- SC.3.E.6.1 - Demonstrate that radiant energy from the Sun can heat objects and when the Sun is not present, heat may be lost.

Science–Big Idea 10: Forms of Energy

- SC.3.P.10.1 - Identify some basic forms of energy such as light, heat, sound, electrical, and mechanical.

Science–Big Idea 17: Interdependence

- SC.3.L.17.2 - Recognize that plants use energy from the Sun, air, and water to make their own food.

Language Arts–Writing

- LAFS.3.W.3.8 - Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

Language Arts–Standards for Speaking and Listening

- LAFS.3.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly.
- LAFS.3.SL.2.4 - Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.

Fourth Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- SC.4.N.1.1 - Raise questions about the natural world, use appropriate reference materials that support understanding to obtain information, conduct both individual and team investigations through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.
- SC.4.N.1.6 - Keep records that describe observations made, carefully distinguishing actual observations from ideas and inferences about the observations.

Science–Big Idea 5: Earth in Space and Time

- SC.4.E.5.3 - Recognize that Earth revolves around the Sun in a year and rotates on its axis in a 24-hour day.
- SC.4.E.5.4 - Relate that the rotation of Earth and apparent movements of the Sun, Moon, and stars are connected.

Science–Big Idea 6: Earth Structures

- SC.4.E.6.6 - Identify resources available in Florida (water, phosphate, oil, limestone, silicon, wind, and solar energy).

Science–Big Idea 10: Forms of Energy

- SC.4.P.10.1 - Observe and describe some basic forms of energy, including light, heat, sound, electrical, and the energy of motion.

Science–Big Idea 17: Interdependence

- SC.4.L.17.3 - Trace the flow of energy from the Sun as it is transferred along the food chain through the producers to the consumers.

Language Arts–Standards for Speaking and Listening

- LAFS.4.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.

Fifth Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- SC.5.N.1.6 - Recognize and explain the difference between personal opinion/interpretation and verified observation.

Science–Big Idea 2: The Characteristics of Scientific Knowledge

- SC.5.N.2.1 - Recognize and explain that science is grounded in empirical observations that are testable; explanation must always be linked with evidence.

Science–Big Idea 10: Forms of Energy

- SC.5.P.10.1 - Investigate and describe some basic forms of energy, including light, heat, sound, electrical, chemical, and mechanical.

Language Arts–Standards for Speaking and Listening

- LAFS.5.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 5 topics and texts, building on others idease and expressing their own clearly.

National Common Core Science Standards

Third Grade Standards

Note: Related Common Core Language Arts Standards are listed in the Florida section above.

Fourth Grade Standards

Science--Earth and Human Activity

- 4-ESS3-1- Obtain and combine information to describe that energy and fuels are derived from natural resources and their use can affect the environment.
- 4-ESS3-2 - Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

Science--Energy

- 4-PS3-1 - Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Note: Related Common Core Language Arts Standards are listed in the Florida section above.

Fifth Grade Standards

Science--Earth's Place in the Universe

- 5-ESS1-1 - Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.
- 5-ESS1-2 - Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.

Science--Energy

- 5-PS3-1 - Use models to describe that energy in animals' food was once energy from the

sun.

Note: Related Common Core Language Arts Standards are listed in the Florida section above.

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.