LESSON PLAN

The Importance of the Sun: Solar Energy

Grade Level:
5-8

Subjects:
Science & Visual Arts

Length:
2-3 Class Periods

The Importance of the Sun:
Solar Energy Introduction and Overview

INTRODUCTION

In this lesson, students will investigate the development and use of solar power. They will examine the role of the sun as a source of energy and explore how humanity has relied on the sun to provide energy for our lives. Solar techniques ranging from using sunlight to warm houses to the latest technologies like advances in photovoltaic solar power will be discussed. Students will explore pre-Industrial Revolution uses of solar energy and technological advances using a Solar Decathlon house as an example. This lesson will also cover the potential energy inherent in the sun's daily output and include activities to enhance student understanding of our daily connection to the sun.

LESSON OVERVIEW

Grade Level & Subject: Grades 5 – 8: Science & Visual Arts

Length: 2 – 3 class periods

Objectives:

After completing this lesson, students will be able to:

- Explain the importance of the sun for life on earth
- Link the energy use of living objects to the sun
- Discuss various solar technologies
- Create a timeline to display advances in solar technology throughout the ages
- Draw and present information on a model home that uses solar technologies
- Recognize technological advances in solar energy by reading about a Solar Decathlon house

National Standards Addressed:

This lesson addresses the following National Science Education Standards from the National Academies of Science:[1]

- **Content Standard: NS.5-8.5 SCIENCE AND TECHNOLOGY**
  In grades 5-8, all students should develop:
  - Comprehension related to abilities of technological design
  - Understanding about science and technology
- **Content Standard: NS.5-8.7 HISTORY AND NATURE OF SCIENCE**
  In grades 5-8, all students should develop an understanding of:
  - Science as a human endeavor
  - Nature of science

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[1] National Science Education standards are from the National Academies of Science, 2011: http://www.nas.edu. National Science Education standards can also be found at: http://www.education-world.com/standards.

    - History of science
- **Content Standard: NS.5-8.6 PERSONAL AND SOCIAL PERSPECTIVES**
  In grades 5-8, all students should develop an understanding of:
    - Populations, resources, and environments
    - Risks and benefits
    - Science and technology in society

This lesson addresses the following National Standards for Arts Education from the Consortium of National Arts Education Associations:[2]

- **Content Standard: NA-VA.5-8.5 REFLECTING UPON AND ASSESSING THE CHARACTERISITICS AND MERITS OF THEIR WORK AND THE WORK OF OTHERS**
  Achievement Standard:
    - Students compare multiple purposes for creating works of art.
- **Content Standard: NA-VA.5-8.6 MAKING CONNECTIONS BETWEEN VISUAL ARTS AND OTHER DISCIPLINES**
  Achievement Standard:
    - Students describe ways in which the principles and subject matter of other disciplines taught in the school are interrelated with the visual arts.

21st Century Skills:

This lesson addresses the following 21st Century Skills from the Partnership for 21st Century Skills by asking students to:[3]

- Focus on 21st century skills, content knowledge, and expertise.
- Build understanding across and among core subjects as well as 21st century interdisciplinary themes.
- Foster interactive communication, such as team-building, collaboration, individual responsibility, social responsibility, and interactive communication.
- Investigate and analyze environmental issues, and make accurate conclusions about effective solutions.
- Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate).
- Investigate and analyze environmental issues, and make accurate conclusions about effective solutions.

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[2] National Art Education standards are from the National Art Education Association, 2011: http://www.arteducators.org. National Art Education standards can also be found at: http://www.education-world.com/standards.

[3] "P21 Framework Definitions." Partnership for 21st Century Skills, 2011. http://www.21stcenturyskills.org/documents/P21_Framework_Definitions.pdf.

Key Questions:

- Can students understand that solar power has played a significant role in human life for much of human history?
- Can students understand that solar power has experienced considerable technological changes over the ages, in particular over the last 50 years?
- Can students understand that solar energy has incredible potential for growth and may affect multiple areas of society?

Materials Needed:

- **Reproducible #1 – Six Degrees of the Sun Game**
- **Reproducible #2 – Where Solar Energy Goes**
- **Reproducible #3 – Where Solar Energy Goes – Answer Key**
- **Reproducible #4 – Solar Energy Cartoon**
- **Reproducible #5 – Solar Timeline (Part 1 and Part 2)**
- **Reproducible #6 – Solar Timeline Part 2 – Sample Answer Key**
- **Reproducible #7 – My Solar House**
- Blank poster paper
- Markers, colored pencils, crayons
- Bulletin board paper, white

Assessment:

Students will be assessed through the following activities:

- Completion of **Reproducible #2 – Where Solar Energy Goes**
- Active participation in **Reproducible #1 – Six Degrees of the Sun Game**
- Completion of **Reproducible #4 – Solar Timeline**
- Group contribution to designing a section of **Solar Timeline**
- Completion of **Reproducible #5 – My Solar House**
- Group contribution to the drawing and presentation of **My Solar House**

LESSON BACKGROUND

Relevant Vocabulary:

- **Conduction:** The movement of heat through matter, such as a solid.[4]
- **Convection:** The movement of heat through air or liquids.[5]
- **Fossil Fuel:** A fuel (such as coal, oil, or natural gas) formed in the earth from plant or

[4] *Conduction Entry*. Merriam- Webster Online Dictionary. Retrieved March 2011 from http://www.merriam-webster.com/dictionary/conduction?show=0&t=1301600245.
[5] *Convection Entry*. Merriam- Webster Online Dictionary. Retrieved March 2011 from http://www.merriam-webster.com/dictionary/convection.

animal remains.[6]

- **Luminosity:** The relative quantity of light.[7]
- **Photovoltaic:** The direct conversion of light into electricity at the atomic level.[8]
- **Radiation:** The emission of energy as electromagnetic waves or moving subatomic particles.[9]
- **Renewable:** Capable of being replaced by natural ecological cycles or sound environmental management practices.[10]
- **Solar:** Produced or operated by the sun's light or heat.[11]
- **Watt:** A basic unit for measuring electrical power.[12]

Background Information:

From solar ovens to solar panels, **solar energy** has been harnessed by humans since the beginning of human history. As far back as the 5th century, humans were constructing homes and buildings to maximize the energy of the sun.

Today, we know the sun as our closest star in the universe. This ball of gas has a large build-up of heat and pressure in its core that causes it to emit heat and radiant energy. Solar energy supports all life on earth and is the basis for almost every form of energy we use. The sun makes plants grow, which provide energy to humans in the form of food. Plant matter can also be burned as biomass fuel or, if compressed underground for millions of years, form fossil fuels like coal or oil. Heat from the sun also causes different temperatures, which produce wind that can power turbines. More energy from the sun falls on the earth in one hour than humans consume in one year.

Unlike various forms of conventional types of energy like coal, oil or natural gas, solar energy is a **renewable** form of energy. Though a variety of technologies have been developed to take advantage of solar energy in recent years, solar power accounts for less than one percent of electricity use in the United States.[13] However, given the abundance of solar energy and its popular appeal, this resource is likely to play a prominent role in our energy future.

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[6] *Fossil Fuel Entry*. Merriam- Webster Online Dictionary. Retrieved March 2011 from http://www.merriam-webster.com/dictionary/fossil%20fuel.
[7] *Luminosity Entry*. Merriam- Webster Online Dictionary. Retrieved March 2011 from http://www.merriam-webster.com/dictionary/luminosity.
[8] *Photovoltaic Entry*. Merriam- Webster Online Dictionary. Retrieved March 2011 from http://www.merriam-webster.com/dictionary/photovoltaic.
[9] *Radiation Entry*. Merriam- Webster Online Dictionary. Retrieved March 2011 from http://www.merriam-webster.com/dictionary/radiation.
[10] *Renewable Entry*. Merriam- Webster Online Dictionary. Retrieved August 2011 from http://www.merriam-webster.com/dictionary/renewable.
[11] *Solar Entry*. Merriam- Webster Online Dictionary. Retrieved March 2011 from http://www.merriam-webster.com/dictionary/solar?show=0&t=1301598955.
[12] *Watt Entry*. Merriam- Webster Online Dictionary. Retrieved March 2011 from http://www.merriam-webster.com/dictionary/watt.
[13] *Solar Power*. National Atlas of the United States, United States Department of the Interior, 2011. Retrieved May 10, 2011 from http://www.nationalatlas.gov/articles/people/a_energy.html#three.

Resources:

- **Solar Energy and The History of Solar** – *Department of Energy:* www.energy.gov/energysources/solar & www1.eere.energy.gov/solar/pdfs/solar_timeline.
- **Solar Energy Basics** – *National Renewable Energy Laboratory* http://www.nrel.gov/learning/re_solar.html.
- **Solar Decathlon** – *Department of Energy* http://www.solardecathlon.gov.

LESSON STEPS

Teacher Preparation

1. To prepare for Activity One, laminate and cut out the cards from **Reproducible #1 – Six Degrees of the Sun Game** before the beginning of class. The game will work best if you take your class to an open space, such as outside or the gym. You can also move desks and chairs toward the walls of the classroom so there is an open space in the middle of the room.

Warm-up: *Why Is the Sun So Important?*

1. Begin this lesson by discussing with your class the role of the sun and its importance to life on earth. Ask the following questions:
    a. What is the sun?
    The sun is a star that is the source of light and heat for the planets in our solar system.
    b. What are some reasons that the earth needs the sun?
    Life on earth would not exist without the heat and light provided by the sun. The sun's gravity also helps keep the earth in its orbit, causes weather phenomena, and plays a role in ocean tides.
2. Share the following facts:
    - In terms of energy generated, burning all the coal, oil, gas, and wood on earth would only equal a few days of energy output by the sun.
    - The total amount of energy humans have derived from burning fossil fuels since the start of civilization is less than all the energy provided by the sun in just 30 days.
    - More energy from the sun falls on the earth in one hour than everyone on earth uses in one year.
    - Renewable energy could account for almost 80% of the world's energy supply within four decades, but only if governments, businesses, and individuals pursue the policies needed to promote it.[14]

[14] Special Report on Renewable Energy Sources and Climate Change Mitigation. Intergovernmental Panel on Climate Change, 2011. Retrieved 8 August 2011. http://srren.ipcc-wg3.de/report.

Activity One: *Six Degrees of the Sun Game*

1. Assign one student to become the sun and have him/her stand in the middle of the room. Ask the remainder of the students to draw a card out of the pile. The card will have a picture or a word on it that links to another picture/word and will eventually come back to the sun. Give the students ten minutes to find classmates so they can trace their energy back to the sun. For instance, a student who has a card with a picture of a **hamburger** will find the student who has a picture of a **cow**, who will find a student with a picture of **grass**. Together, they will line up in order (i.e., grass, cow, and hamburger) next to the **sun**. Eventually, the class should form "rays" around the sun in their lines.
2. Give students **Reproducible #2 – Where Solar Energy Goes**. Ask them to use the drawing to answer the questions on the reproducible.
3. Give students the following homework assignment to complete before coming to class the next day. Hand out **Reproducible #5 – Solar Timeline**. Divide the class into groups of two, three, or more as needed. Assign each group one section of the timeline to research as homework and come prepared to discuss with their group during the next class. The sections are as follows:

   Group 1 – Prehistoric-1950
   Group 2 – 1951-1980
   Group 3 – 1981-2000
   Group 4 – 2001-present
   Group 5 – Future of solar energy

Activity Two: *Solar Timeline*

1. Show students the solar energy cartoon from **Reproducible #4 – Solar Energy Cartoon**. If possible, use the interactive whiteboard or an overhead projector so you can write student responses for the entire class to see. Ask students the following questions:
   a. What idea is the artist of this cartoon trying to convey?
      That energy from the sun is an ever-present and powerful resource that people should use instead of searching for more fossil fuels.
   b. What are some of the potential benefits of solar energy compared to traditional energy sources like fossil fuels?
      Solar energy is a clean energy resource. While the production of solar technologies, such as solar panels, creates some pollution, it is far less than the pollution created by mining, refining, and burning fossil fuels. If you use solar energy, you may not have to depend on anyone for your energy needs.
2. Ask students to form groups according to their research section from the previous day. Ask students to think about why some groups had shorter time periods to research. Allow time for students to discuss and then present their responses, either as a group or individually.
   More technological breakthroughs were made in recent years, thus the time period were shorter for such groups.
3. Roll out a long section (about 8 feet) of bulletin board paper on the floor and divide it into six equal sections. Ask students to follow the directions in part two of the **Reproducible #5 – Solar Timeline** to complete their section of the timeline.
4. Refer to the Solar History Timeline to make sure students did not omit any important factors in our solar history. See http://www1.eere.energy.gov/solar/pdfs/solar_timeline.pdf.
5. Display the completed timeline on the wall of the classroom or in the hallway of the school.

Activity Three: *Your Solar House*

1. Ask students to look at the "future" section of their solar timeline activity from the previous day and present the following question to discuss: Would they do anything differently? After the brief discussion, tell students that in today's activity, each group will have an opportunity to develop their ideas on how a house can use solar power. Have students investigate at least one of the Solar Decathlon 2011 houses to learn how innovative solar technologies are being used today.[15]
2. Divide the class into groups of four and give each group markers, crayons, colored pencils, and poster paper.
3. Have each group of students discuss and then draw a house that uses solar energy to its fullest potential. Encourage students to be creative. The drawing does not need to incorporate elements from any one Solar Decathlon 2011 house.
4. After they are finished drawing, give each student a copy of **Reproducible #7 – My Solar House** and ask them to work with their group to answer the questions.
5. Once the drawings are complete, have each group come to the front of the room and present their work. Ask them to try to persuade the audience that their design is the best option. They should discuss the relative efficiency of their house and how this is helpful or detrimental to the environment.
6. After all presentations have been made, have students select and investigate one additional home out of the Solar Decathlon 2011 homes to compare and contrast their models with one of the collegiate demonstrations.[16]
7. Finally, have a class discussion on the advantages and disadvantages of each group's design with a special emphasis on the basic functionality of the official Solar Decathlon 2011 homes. Have the class vote on the best overall presentation.

Wrap Up:

1. Review the major components of this lesson by reminding students that they investigated the importance of the sun to living things, the history and development of solar energy, and the great potential that solar energy has to create a cleaner planet.
2. Discuss with students if the presentations changed their idea of how solar energy can be used. If they had one opportunity to redesign their solar house, is there anything they would change? What would that be? Do they have a better understanding of solar energy and how it can be used as a power source? Why or why not? Finally, ask students what they believe to be the future of solar energy and assess the responses.

Extension:

1. Hand out copies of **Reproducible #4 – Solar Energy Cartoon**. Invite students to create their own cartoon about renewable energy. Ask them to explain how their cartoon may or may not encourage people to use clean energy sources like solar power.
2. Have students stand next to their section of the timeline and talk about the most important advancements during their assigned time period. Have the entire class pose next to the

[15] U.S. Department of Energy Solar Decathlon 2011. www.solardecathlon.gov/teams.html.
[16] U.S. Department of Energy Solar Decathlon 2011. www.solardecathlon.gov/teams.html.

timeline and take a picture to share with Earth Day Network's Education Department (contact information below). Selected photos will appear on the website.[17]

CONCLUSION

This lesson focused on the development and use of solar power throughout human civilization. Students engaged in games and group activities to enhance their understanding of our reliance on the sun. They conducted research on advancements in solar energy and how solar energy has been used throughout the ages by participating in the construction of a timeline. Students expanded their knowledge of solar power by devising a blueprint for their own solar house and compared their results with the houses from the U.S. Department of Energy's Solar Decathlon 2011.

LESSON PLAN CREDITS

Sharvari Chwastyk – Author, Middle School Science Teacher, Cabin John Middle School, Potomac, MD
Sean S. Miller – Author, Education Director, Earth Day Network
Maggie Ollove – Editor, Education Associate, Earth Day Network

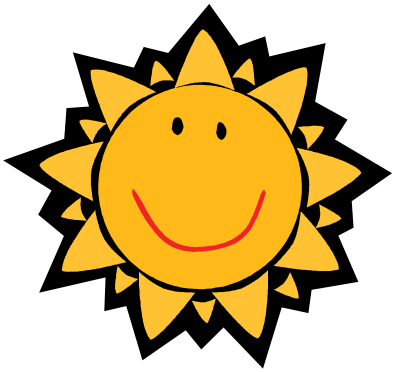
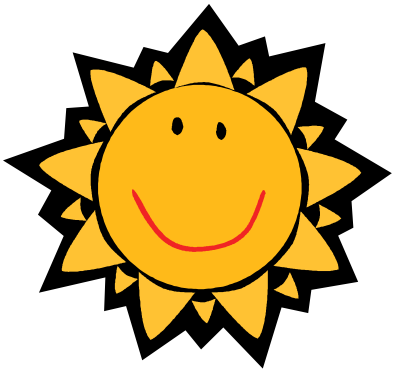
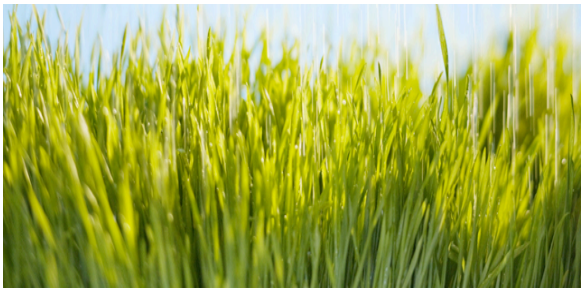
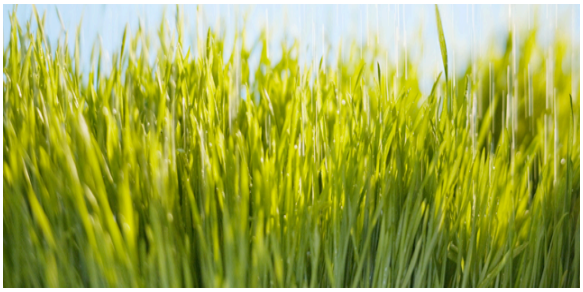
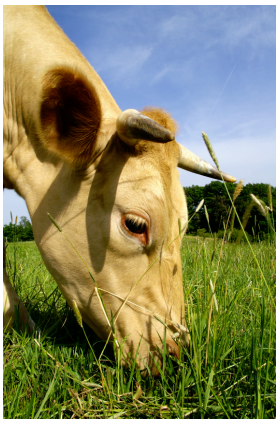
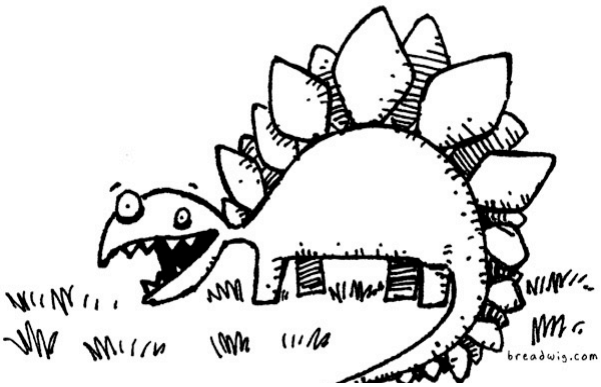
[17] Earth Day Network. www.earthday.org/education.

REPRODUCIBLES FOR CLASSROOM USE

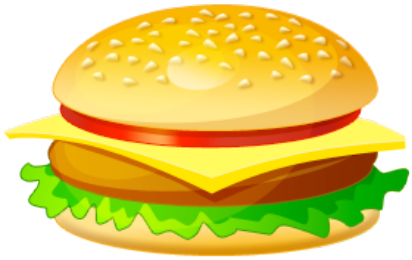
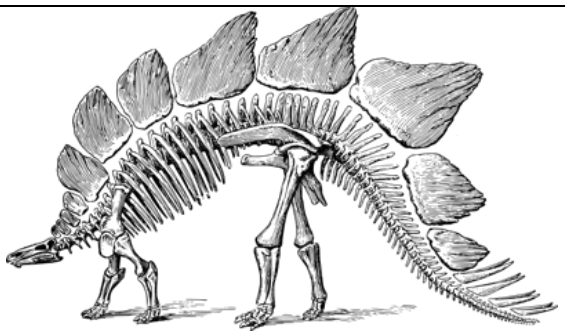
This lesson plan contains the following reproducible documents for classroom use:

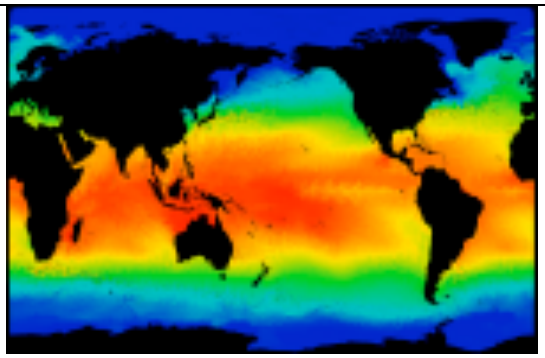
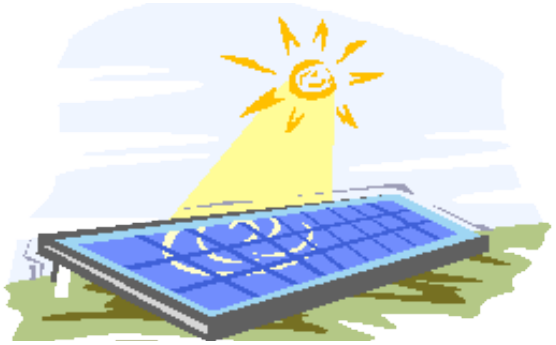
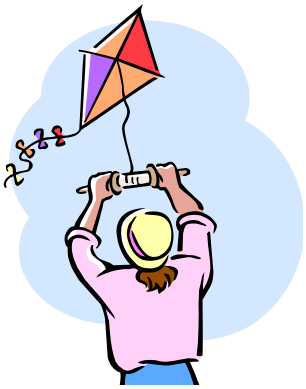
- **Reproducible #1 – Six Degrees of the Sun Game**
- **Reproducible #2 – Where Solar Energy Goes**
- **Reproducible #3 – Where Solar Energy Goes – Answer Key**
- **Reproducible #4 – Solar Energy Cartoon**
- **Reproducible #5 – Solar Timeline (Part 1 and Part 2)**
- **Reproducible #6 – Solar Timeline Part 2 – Sample Answer Key**
- **Reproducible #7 – My Solar House**

Six Degrees of the Sun Game[18]

 **THE SUN**	 **THE SUN**
STRAND 1	**STRAND 2**
 **GRASS**	 **GRASS**
 **COW EATING GRASS**	 **DINOSAUR EATING GRASS**

[18] All images for this activity from public domain.

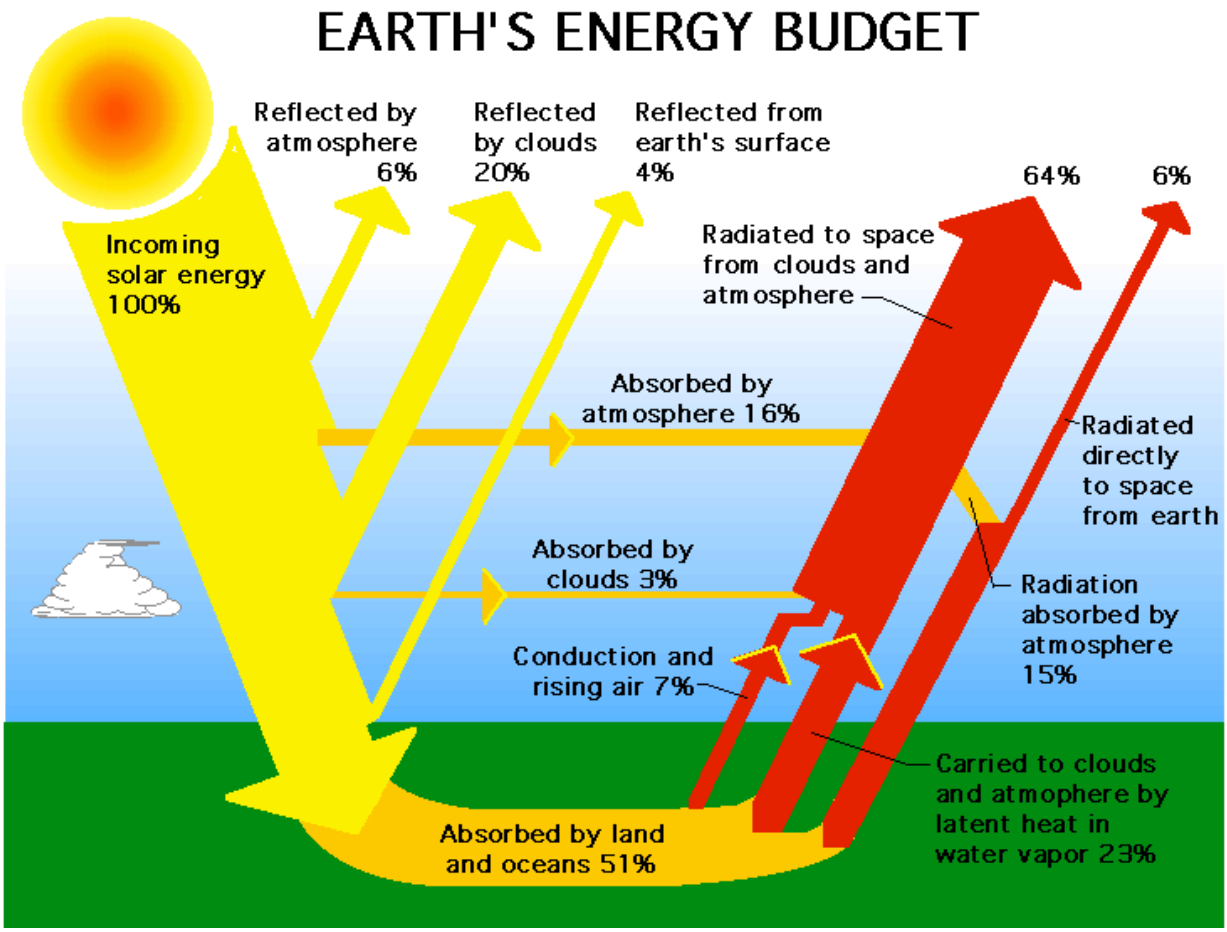
 HAMBURGER	 DINOSAUR FOSSIL
 EATING A HAMBURGER	 FOSSIL FUELS
 PLAYING SOCCER	 CAR GETTING FUEL

STRAND 3	STRAND 4
 TEMPERATURES – HOT EQUATOR, COLD POLES	 SOLAR PHOTOVOLTAIC PANEL
 WINDS	 ELECTRIC TRANSMISSION
 FLYING A KITE	 ELECTRIC PLUG

STRAND 5	STRAND 6
 RUBBER TREE	 CHARGING YOUR SMART PHONE
 BASKETBALL	 ANGRY BIRDS

Name_____Date_____

Where Solar Energy Goes

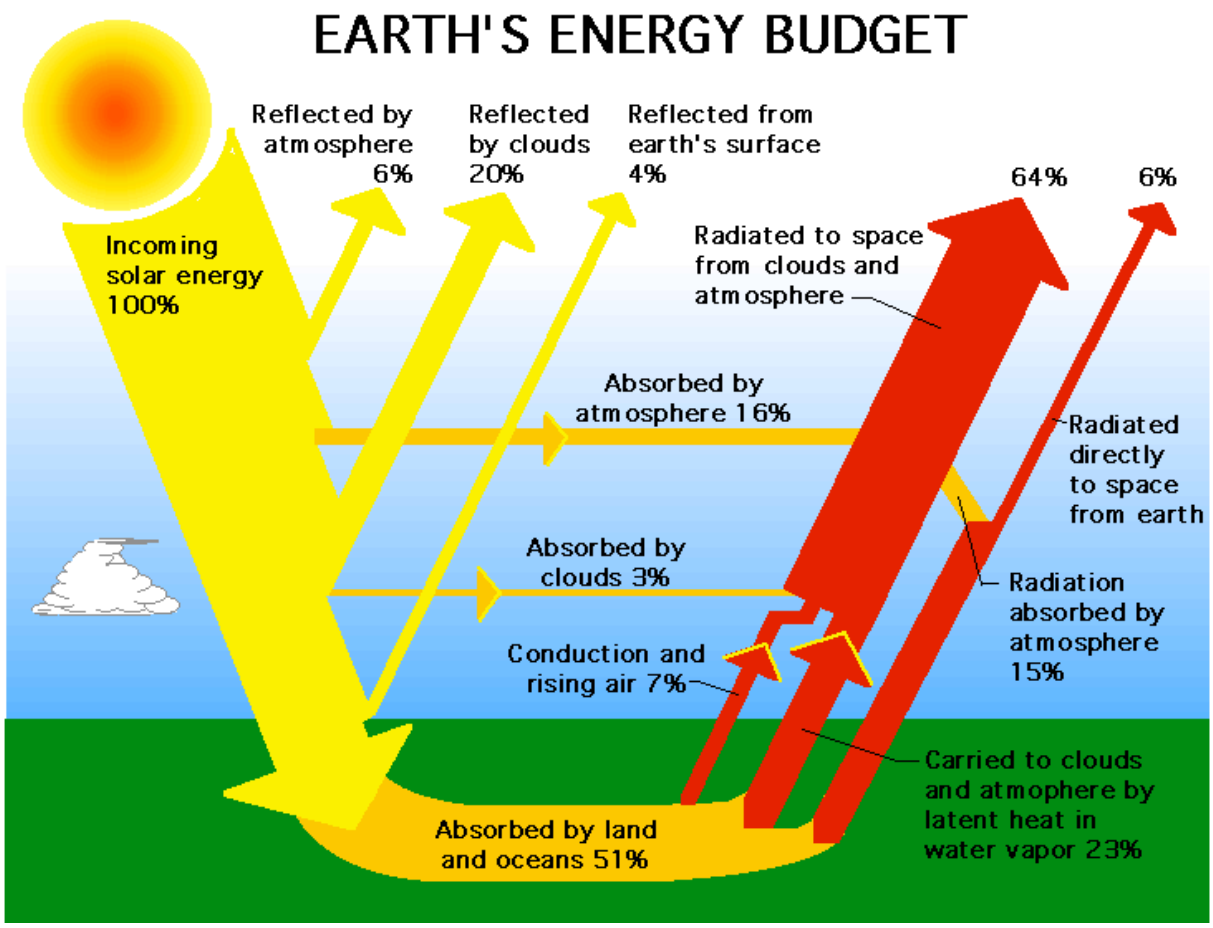


"Earth's Radiation Budget Facts." Atmospheric Science Data Center- NASA. Retrieved April 2011from http://eosweb.larc.nasa.gov/EDDOCS/radiation_facts.html.

ANALYSIS QUESTIONS:

1. What percentage of incoming solar energy is absorbed by the earth's surface?
2. Why isn't more energy absorbed by the earth's surface?
3. What type of surface might reflect incoming solar radiation?
4. Of the incoming solar radiation, how much is reflected by the atmosphere?

Where Solar Energy Goes - ANSWER KEY



"Earth's Radiation Budget Facts." Atmospheric Science Data Center- NASA. Retrieved April 2011from http://eosweb.larc.nasa.gov/EDDOCS/radiation_facts.html.

ANALYSIS QUESTIONS:

1. What percentage of incoming solar energy is absorbed by the earth's surface?
   51%

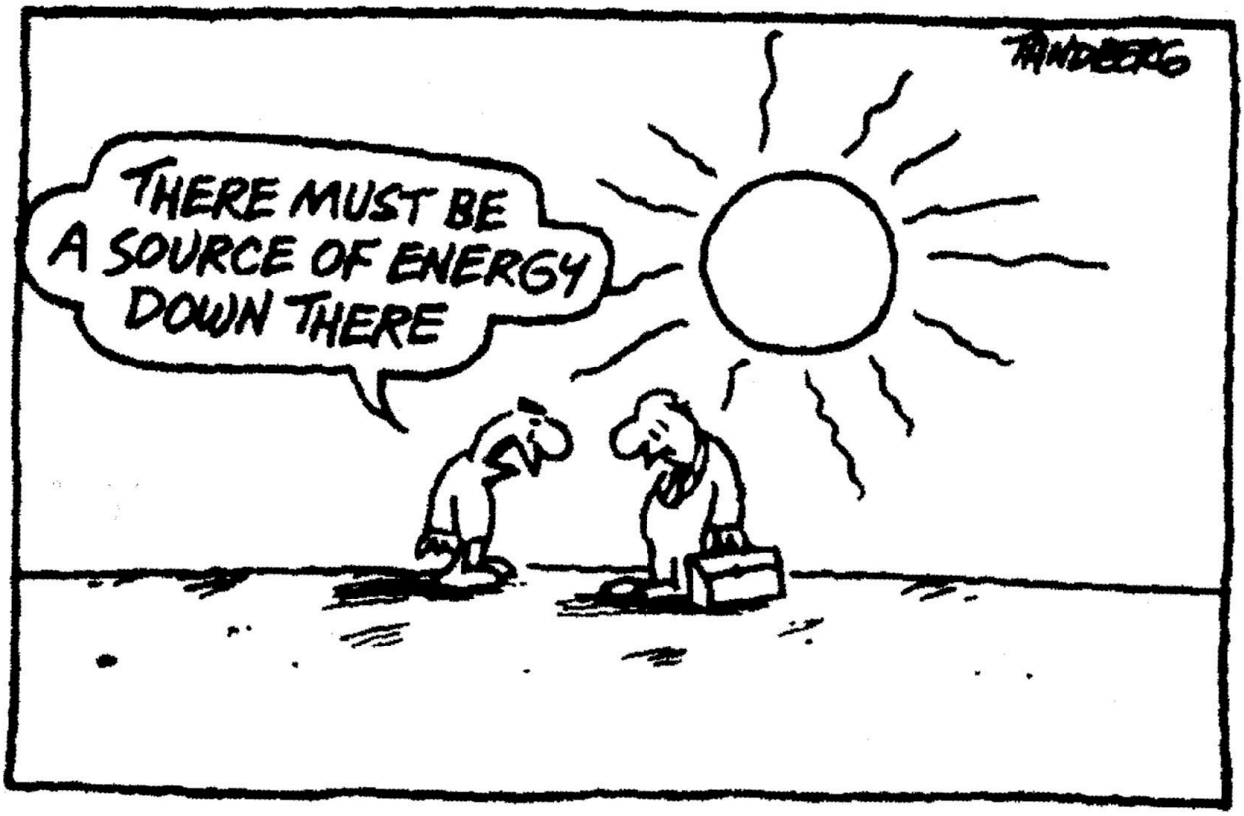
2. Why isn't more energy absorbed by the earth's surface?
   Some is immediately reflected back into space by clouds and the atmosphere itself.

3. What type of surface might reflect incoming solar radiation?
   Clouds, ice, and snow increase the amount of solar radiation that is reflected.

4. Of the incoming solar radiation, how much is reflected by the atmosphere? Absorbed?
   Six percent is reflected and 16 percent is absorbed.

Name_____**Date**_____

Solar Energy Cartoon



Cartoon Credit: "Solar Cartoon." Michael Shellenberger. The Breakthrough Institute. 2011. With permission from Roy Tandberg.

Name_____**Date**_____

Solar Timeline
Part One

Homework

Research a section of history on advancements in solar energy use. My assigned time period to research is:

_____

Research Info:

_____

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Name_____**Date**_____

Solar Timeline
Part Two

Using the information that your group has gathered, construct your section of the solar timeline on the bulletin board paper. Consider the following questions before you begin:

- What are the major advancements that occurred during your assigned time period?
- What illustrations can you include that would complement the information?
- How can you make your section of the timeline both informative and visually appealing?

When your group is finished with its section of the timeline, answer the analysis questions below.

ANALYSIS QUESTIONS:

1. What significant advances in the use of solar energy occurred during this time period?

   _____

   _____

2. How does solar energy use during this section of the timeline compare with the time period immediately before?

   _____

   _____

3. What about the time period immediately after?

   _____

   _____

4. During what time period were the greatest advances in solar technology made? Why do you think this is the case?

   _____

   _____

Solar Timeline (Part Two) – Sample Answer Key

Using the information that your group has gathered, construct your section of the solar timeline on the bulletin board paper. Consider the following questions before you begin:

- What are the major advancements that occurred during your assigned time period?
- What illustrations can you include that would complement the information?
- How can you make your section of the timeline both informative and visually appealing?

When your group is finished with its section of the timeline, answer the analysis questions below.

ANALYSIS QUESTIONS:

1. What significant advances in the use of solar energy occurred during your time period?
   In 1767, Horace de Saussure built the world's first solar collector. In 1839, Edmond Becquerel discovered the photovoltaic effect. In 1873, Willoughby Smith discovered the photoconductivity of selenium.

2. How does solar energy use during this section of the timeline compare with the time period immediately before?
   The period of 1767 to 1899 saw more solar events than any previous time in history. For the first time, inventors started trying to understand solar power and its potential.

3. What about the time period immediately after?
   In the next time period, scientists and inventors began to receive recognition for their work.

4. During what time period were the greatest advances in solar technology made? Why do you think this is the case?
   Answers will vary, but it is commonly understood to be advances in recent years, especially since the 1950s.

Name_____**Date**_____

My Solar House

Working with your group, take a close look at your solar house design and answer the following questions:

1. How does your solar house use power from the sun?

_____

_____

The Impacts of Your Design on Society	Advantages	Disadvantages
Environmental Impacts		
Economic Impacts		
Physical Impacts		
Cultural Impacts		

My Solar House – Sample Answer Key

Working with your group, take a close look at your solar house design and answer the following questions:

1. What are some ways that your solar house uses power from the sun?
   Answers will vary but may include solar-powered cars, solar panels, greenhouses, solar thermal water heating systems, solar ovens, solar powered electricity, etc.

Impacts of Your Design on Society	Advantages	Disadvantages
Environmental Impacts	*Reduces carbon footprint, results in cleaner air and cleaner water, uses natural energy from the sun to reduce oil drilling.*	*The mining and manufacturing might increase the carbon footprint.*
Economic Impacts	*Saves money in the long run, creates job opportunities.*	*High initial costs, some people believe jobs will be lost.*
Physical Impacts	*Helps reduce pollution*	*Potential for vandalism, solar panels aren't visually appealing to everyone.*
Cultural Impacts	*Increases jobs, saves money, improves morale. Results in a healthier environment, healthier people.*	*A change in mindset would occur challenging accepted notions of energy.*

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