Lesson One

Lesson 1

THE IMPORTANCE OF THE SUN

TEP BRIGHT STUDENTS: THE CONSERVATION GENERATION

Grade level appropriateness: Grades 6-8

Lesson Length: 2-3 full class periods (~120-180 minutes)

Additional documents:

- Six Degrees of the Sun Game
- Where Solar Energy Goes
- Where Solar Energy Goes – Answer Key
- Solar Energy Cartoon
- Solar Timeline Part 1
- Solar Timeline Part 2
- Solar Timeline Part 2 – Sample Answer Key
- My Solar House (optional activity)
- The History of Solar (timeline from the US DOE)

Note: *This lesson has been adapted from the lesson "The Importance of the Sun: Solar Energy" from www.solardecathlon.gov*

TEP

Tucson Electric Power

LESSON 1

Intro

Introduction/Overview

THE IMPORTANCE OF THE SUN

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 2013 Solar Decathlon house as an example (optional activity). 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.

Core Concepts

Humans have harnessed solar energy since the beginning of 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 on the Earth itself, which produce wind that can power turbines. More energy from the sun falls on the Earth in one hour than all 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. However, given the abundance of solar energy and its popular appeal, this resource is likely to play a prominent role in our energy future.

Learning Objectives

After completing this lesson, students will be able to do the following:

- 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 history
- Draw and present information on a model home that uses solar technologies (optional My Solar House activity)
- Recognize technological advances in solar energy by reading about a 2013 Solar Decathlon house (optional My Solar House activity)

Advance Preparation

MATERIALS NEEDED

- Six Degrees of the Sun Game
- Where Solar Energy Goes- one copy per student
- Where Solar Energy Goes – Answer Key
- Solar Energy Cartoon – to be displayed using an overhead projector or Smart Board
- Solar Timeline (Part 1 and Part 2) – one copy per student
- Solar Timeline (Part 2) – Sample Answer Key
- My Solar House (optional activity – one copy per student)
- The History of Solar (timeline from the US DOE)
- Blank poster paper
- Markers, colored pencils, crayons
- Bulletin board paper, white
- Access to the Internet to view information on the Solar House (optional activity)

GENERAL PREP

Below is a list of terms that are helpful to define for your students:

- **Conduction:** The movement of heat through matter, such as a solid
- **Convection:** The movement of heat through air or liquids
- **Fossil Fuel:** A fuel (such as coal, oil, or natural gas) formed in the Earth over geologic time from plant or animal matter
- **Luminosity:** The relative quantity of light
- **Photovoltaic:** The direct conversion of light into electricity at the atomic level
- **Radiation:** The emission of energy as electromagnetic waves or moving subatomic particles
- **Renewable:** Capable of being replaced by natural ecological cycles or sound environmental management practices
- **Solar:** Produced or operated by the sun's light or heat (of the sun)
- **Watt:** The basic unit for measuring electrical power

To prepare for Activity One, print Six Degrees of the Sun Game (preferably on cardstock), then cut out the cards and laminate. 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.

Advance Preparation *(Continued)*

GENERAL PREP

Helpful Resources:

- Solar Energy Basics – National Renewable Energy Laboratory
  http://www.nrel.gov/learning/re_solar.html
- Solar Decathlon – Department of Energy
  http://www.solardecathlon.gov.

Suggested Procedure

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. There are billions of stars in the universe, and our sun is the closest star to Earth.
   - *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 tides.
2. Share the following two 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.
   - More energy from the sun falls on the Earth in one hour than everyone on Earth uses in one year.

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 from the pile or, alternatively, pass out the remaining cards to the rest of the class. 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,

Suggested Procedure *(Continued)*

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. Hand out Where Solar Energy Goes, one copy per student. Ask students to use the drawing to answer the questions.
3. Give students the following homework assignment to complete before coming to class the next day. Hand out Solar Timeline (Parts One and Two), one copy per student. 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. Students will need access at home to research materials (e.g., the Internet). 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

Note: Activity Two happens the day after Activity One, building off of the work students did for homework.

1. Display the Solar Energy Cartoon using an overhead projector or Smart Board. Ask students the following questions, and write student responses for the entire class to see:

   a) What idea is the artist of this cartoon trying to convey?

   Energy from the sun is an ever-present and powerful resource that people should use instead of searching for more fossil fuels that are more and more difficult to access.

   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 to generate electricity. Use of solar energy can reduce or even eliminate dependence upon other countries for our energy needs.

Suggested Procedure *(Continued)*

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 periods were shorter for such groups. (A helpful analogy is the evolution of the Internet and comparable technology advances that have exploded in recent years.)
3. Roll out a long section (about 8 feet) of bulletin board paper on the floor (or use multiple white boards in the front of the room) and divide it into six equal sections. Ask students to follow the directions in Part Two of Solar Timeline to complete their section of the timeline.
4. Refer to the History of Solar 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. Optional: Display the completed timeline on the wall of the classroom or in the hallway of the school.

Optional Activity Three: My Solar House

Note: Activity Three happens the day after Activity Two, building off of the work students did for homework. This activity is optional.

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 2013 houses to learn how innovative solar technologies are being used today. The houses that were part of the 2013 Solar Decathlon can be viewed at http://www.solardecathlon.gov/teams.html by clicking on each team.
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 of the Solar Decathlon 2013 houses, though they are helpful examples.
4. After they are finished drawing, give each student a copy of My Solar House and ask them to work with their group to answer the questions. Or, if you prefer to not make a photocopy for each student, project the information and have students copy the chart and questions onto their own papers.

Suggested Procedure *(Continued)*

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 from the Solar Decathlon 2013 homes and compare and contrast their models with one of the collegiate demonstrations. The ASU/UNM home is a great example, as it highlights a desert environment similar to Southern Arizona (http://www.solardecathlon.gov/team_asu_unm.html).
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 2013 homes. Optional: 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 and more energy efficient planet.
2. Discuss with students whether or not 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.

Assessment Ideas

Students will be assessed through the following activities:

- Completion of Where Solar Energy Goes
- Active participation in Six Degrees of the Sun Game
- Completion of Solar Timeline
- Group contribution to designing a section of Solar Timeline
- Completion of My Solar House (optional activity)
- Group contribution to the drawing and presentation of My Solar House (optional activity)

Extension Ideas

1. Refer to the 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 timeline and take a picture to share with the school community, newsletters, class website, etc.
3. Have students contact the teams from the 2013 Solar Decathlon with follow-up questions and/or to learn more about solar house design (contact information is available for each team on the website).

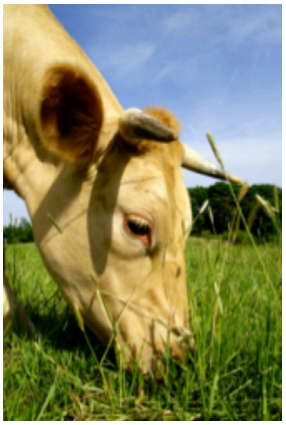
ADDITIONAL DOCUMENTS

Six Degrees of the Sun Game

The Sun

Strand 1

Grass

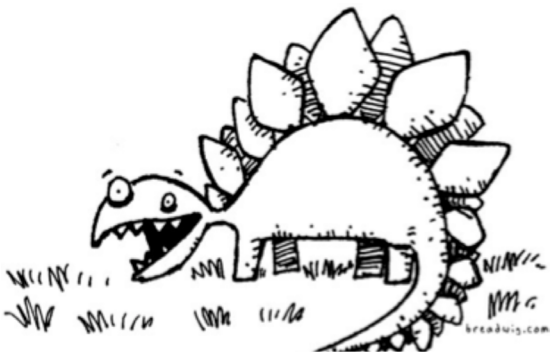


Cow eating grass

The Sun

Strand 1

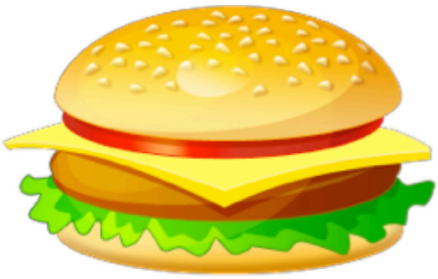
Grass



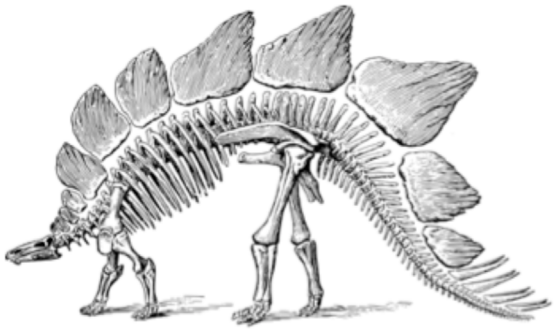
Dinosaur eating grass

ADDITIONAL DOCUMENTS

Six Degrees of the Sun Game *(Continued)*



Hamburger



Dinosaur fossil

Eating a Hamburger

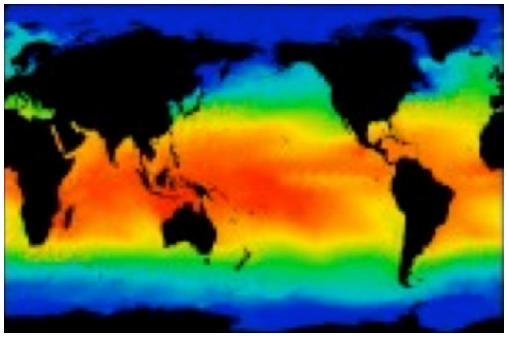
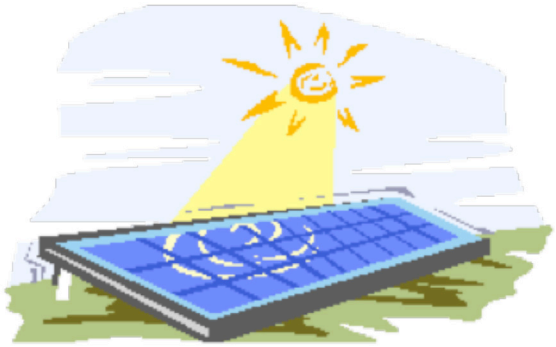
Fossil fuels

Playing soccer

Car getting fuel

ADDITIONAL DOCUMENTS

Six Degrees of the Sun Game *(Continued)*

Strand 3	Strand 4
 Temperatures - Hot equator, cold poles	 Solar photovoltaic panel
 Winds	 Electric transmission
 Flying a kite	 Electric plug

ADDITIONAL DOCUMENTS

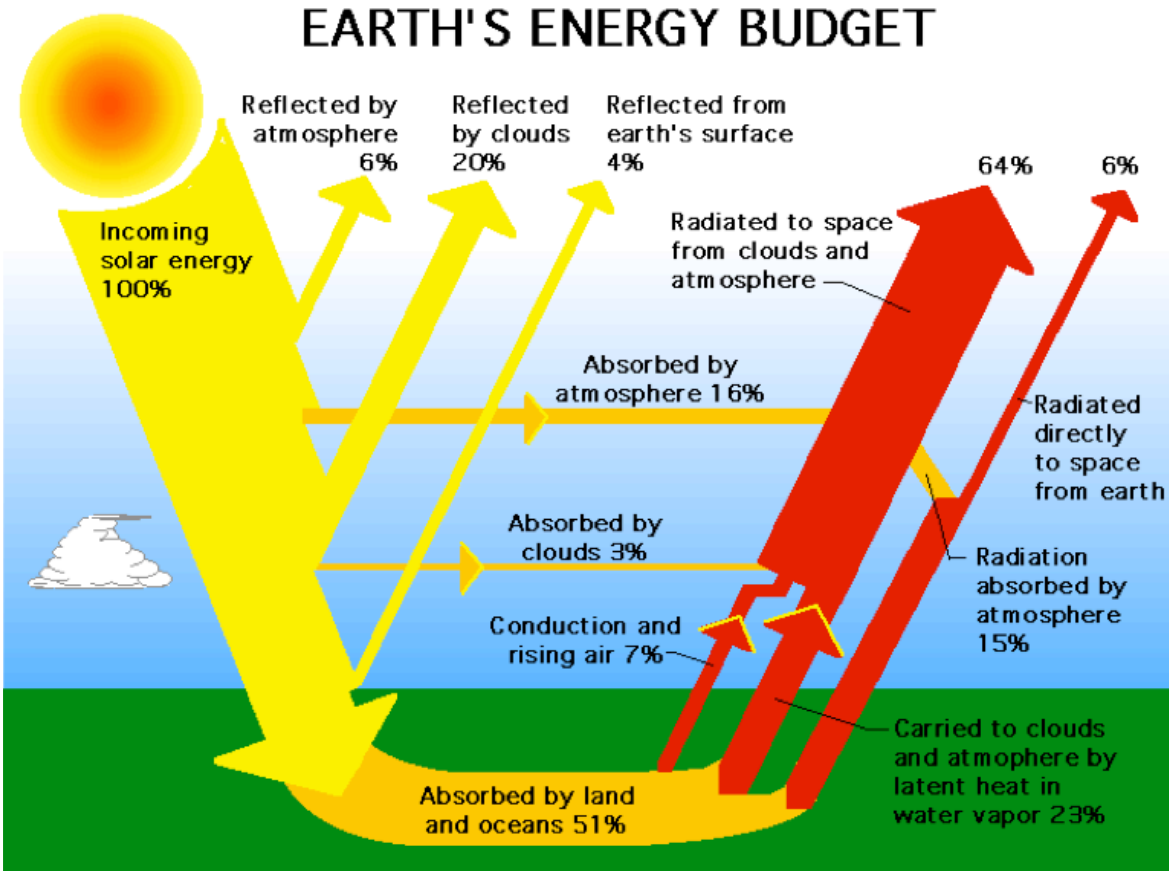
Six Degrees of the Sun Game *(Continued)*

Strand 5	Strand 6
 Rubber tree	 Charging your smart phone
 Basketball	 Angry Birds

ADDITIONAL DOCUMENTS

Where Solar Energy Goes

Name: _____ Date: _____



"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?

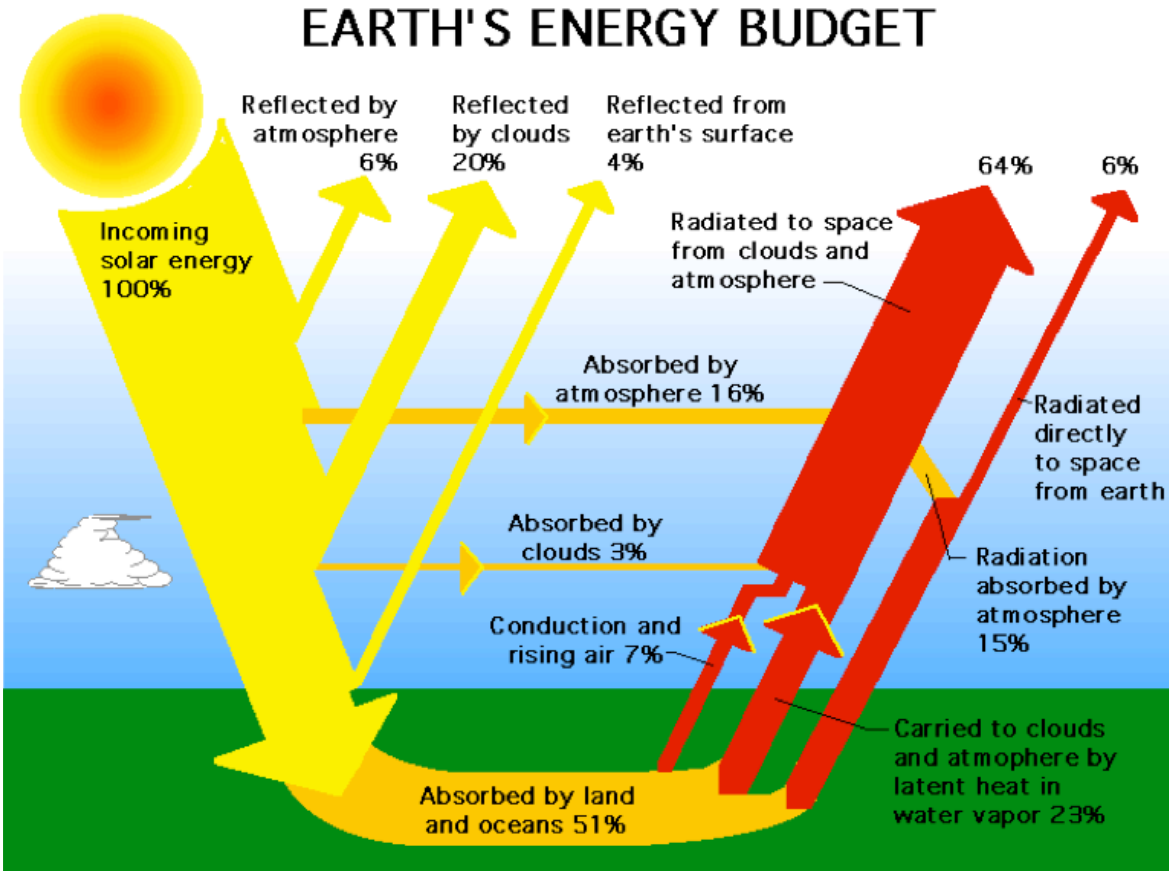
3. What type of surface might reflect incoming solar radiation?

4. Of the incoming solar radiation, how much is reflected by the atmosphere?

ADDITIONAL DOCUMENTS

Where Solar Energy Goes – Answer Key

Name: _____ Date: _____



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

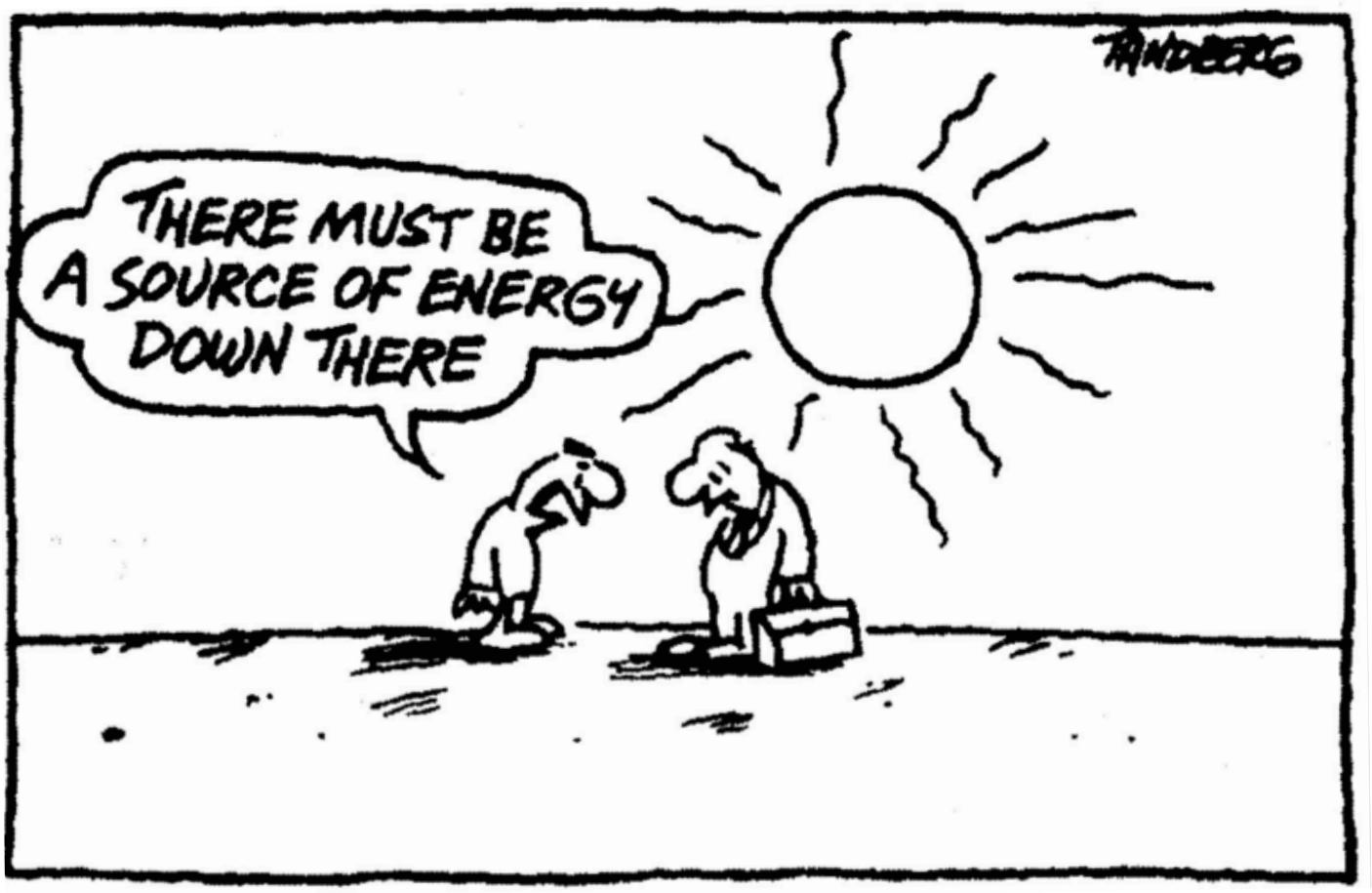
ANALYSIS QUESTIONS:

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?
   6% is reflected and 16% is absorbed.

ADDITIONAL DOCUMENTS

Solar Energy Cartoon

Name: _____ Date: _____



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

ADDITIONAL DOCUMENTS

Solar Timeline Part One

Name: _____ Date: _____

Homework

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

_____

Research Info. Remember to list your sources, too:

_____

_____

_____

_____

_____

_____

_____

_____

Research Info (Continued):

ADDITIONAL DOCUMENTS

Solar Timeline Part Two

Name: _____ Date: _____

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. How does solar energy use during this section of the timeline compare wit the time period immediately after?

_____

_____

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

_____

_____

ADDITIONAL DOCUMENTS

Solar Timeline Part Two – Sample Answer Key

Name: _____ Date: _____

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?

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 which 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.

ADDITIONAL DOCUMENTS

My Solar House

Name: _____ Date: _____

Working with your group, take a close look at your solar house design and answer the following question and fill out the chart below:

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

_____

_____

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

ADDITIONAL DOCUMENTS

My Solar House – Sample Answer Key

Name: _____ Date: _____

Working with your group, take a close look at your solar house design and answer the following question and fill out the chart below:

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

Answers will vary but may include solar-powered cars, solar panels, green houses, 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.*