Electricity from the Sun

RENEWABLE ENERGY
THE INFINITE POWER OF TEXAS

For Grades 4 and 5

OVERVIEW

This lesson introduces students to electricity and reviews methods of generating electricity using renewable energy resources. Students will learn about wind, solar, and photovoltaic systems as well as biomass and hydroelectric sources of energy. Explanations of these systems are presented along with connections to students' life experiences. Students will familiarize themselves with electricity from the sun by engaging in an introductory class discussion, reading and answering questions from the Reading Passage, and conducting a Lab Activity to build an electric circuit in the form of a renewable energy trivia game. Each student should have a science notebook (a spiral notebook is suggested) to write their vocabulary words, information-organizing webs, and the lab report.

OBJECTIVES

See Elementary School Teacher Resource Guide for TEKS objectives and additional information regarding this and other elementary school units.

SUGGESTED TIMEFRAME

Teacher will need to determine how many class periods to devote to each activity, based on the suggested timeframe and length of classes.

Day	Time	Activity Title	Content Area	Activity Task
1	***70 minutes***			
	10 minutes	**Activity 1 –** Teacher Introduction	Science	Information synthesis
	30 minutes	**Activity 2 –** Assessment of Student Knowledge	Assessment	Identify and describe learned knowledge
	30 minutes	**Activity 3 –** Vocabulary	Vocabulary & Language Arts	Vocabulary development and application
2	***60 minutes***	**Activity –** Reading and Cooperative Group Work	Reading & Language Arts	Reading for meaning Looking for vocabulary in context Use of graphic organizer
3	***80 minutes***	**Activity –** Group Presentations	Language Arts	Application of learned knowledge in verbal & graphical format
4	***130 minutes***			
	60 minutes	**Activity 1 –** Lab: Preparing the learning station folders	Science	Plan and implement descriptive investigations
	60 minutes	**Activity 2 –** Lab: Building the electric circuit	Science	Demonstrate that electricity can flow in a circuit and produce light
	10 minutes	**Activity 3 –** Homework Assignment		Review of learned material
5	***45 minutes***	**Activity – Assessment – Learning Stations:** Electronic Game	Science Math	Demonstrate that electricity can flow in a circuit and produce light Review of learned material

REQUIRED MATERIALS

- copy of Reading Passage for each student
- list of vocabulary words displayed so the entire class can view it (i.e. overhead transparency, chalkboard, poster, etc.)
- a roll of hookup wire (18 awg, at least 60 feet in length)
- an equipment kit for each lab group containing the following:
  - manila folder (or equivalent)
  - straight-edge ruler
  - hole puncher
  - 9 push button switches
  - double-sided tape
  - 6- or 9-volt battery with screw terminals
  - 7 pieces of wire of various lengths (strip ½" insulation off the ends of each piece)
  - 1 light bulb with holder to place on tabletop
  - small plastic or paper tray to hold the battery and light bulb holder (a shoebox cover can be used)
- copy of Assessment Questions for each student
- six (6) large sheets of paper

SUMMARY OF LAB ACTIVITY

The Lab Activity in this unit involves students working in groups to build a simple electric circuit. The circuit will be applied like a trivia game that will serve as the assessment for the unit. Students will work in 6 equal groups to create their own learning station out of a manila folder with electric circuitry. Using the manila folders and light bulbs, students will create a circuit that connects a pushbutton switch to a light bulb; when the switch is pressed, the light bulb will be lit. The front cover of each folder will have 3 questions written on the left column of the folder and their respective answer choices will be written in random order on the right column of the folder. Three circuits consisting of wire, a contact switch, a battery and a light bulb will be created on the interior of the folder representing each correct answer. "Dummy switches" or switches that are not connected to anything will represent incorrect answers. A contact switch at the correct answer will be connected to the light bulb. Students will complete the circuit by pressing the switch representing the correct answer. When the correct answer is selected, the circuit is complete and the light bulb will be lit. Incorrect answers that are selected will yield no response. Student groups will generate the questions for their learning station based on concepts presented in the Reading Passage during the Reading and Cooperative Group Work Activity. Students will submit their list of questions to the teacher for approval before creating the game folder. After student groups have built their circuit with their questions, the teacher will distribute the list of (assessment) questions to the class as a homework assignment. The next day, students will check the answers to their questions by visiting each learning station and answering the questions using the electric circuit. Students will self-grade their assessment question handout.

Note: The actual connections for the electric circuit may vary depending on the type of equipment (contact switches, battery, and light bulb) available. As with all the Units, the teacher should conduct the activity first so that any variations to the instructions due to differing supplies may be noted and forwarded to the students. All of the equipment is available at science or electrical hobby shops.

DAILY ACTIVITIES

Day 1 – 70 minutes

Activity 1 – Teacher Introduction (10 minutes)

Begin the unit with an anticipatory set that sparks the class's attention and makes the subject relevant to the students' lives. (See Teacher Resource Guide for suggestions.) Continue the introduction by telling students that for the next unit of study they will learn the basic concepts of electricity and how renewable resources can generate it. Students will engage in a Lab Activity in which they will construct a simple electric circuit that will be used as a game for renewable energy.

Activity 2 – Assessment of Current Student Knowledge (30 minutes)

To assess what students already know, prompt a class discussion based on the 3 questions listed below. A graphic organizer (such as a web) is a good tool to use during this discussion because it allows visual learners to make connections to concepts they already know. Organizing webs can be any shape or size and can be drawn quickly on the board or a large sheet of paper. A model web is included in the Teacher Resource Guide. The graphic organizer should be formatted so that information can be added to it throughout the unit of study.

Questions for class discussion:

1. How does electricity work?
2. What are some sources to generate electricity?
3. Has anyone ever replaced a battery in a handheld toy or other device? Why is it important that the battery is inserted in the right direction and

is in contact with the metal tabs? (Generate a discussion as preparation for the Lab Activity to create a simple electric circuit)

Activity 3 – Vocabulary Review (30 minutes)
Have the students use dictionaries to find the definitions of the vocabulary words and record them in their science notebooks. See list of vocabulary words on page 8. They should create meaningful sentences with each word that reflect an understanding of the definition. If you began the alternative vocabulary activity suggested in the Teacher Resource Guide, ask students to pull the cards with words relevant to this unit. Students can first quiz each other using the flash cards they prepared, or students can play the board game they created, and then create sentences in their science notebooks using each word.

Day 2 – 60 minutes

Activity – Reading and Cooperative Group Work

1. On the large sheets of paper, write down a topic heading and its respective questions (see "Group Reading Section Topics and Questions" below). Each topic with its respective questions should appear on a separate page.
2. Organize the students into 6 equal groups, attempting to cluster reading skills. Assign each group to one of the Group Reading Section Topics based on sections from the Reading Passage. Assign the longer sections to the more advanced readers. Distribute to each group the large sheet of paper with its topic and questions written on it.
3. In the small groups, instruct the students to read aloud individual sentences or paragraphs from their assigned section of the Reading Passage.
4. Once all of the paragraphs have been read, each group should answer the assigned questions for their section written on the large sheet of paper. Instruct each group to create a new graphic (chart, image, etc.) with a caption that illustrates the concepts described in their assigned section. Each group will make a presentation on the following day about the information they learned from their Reading Passage. (See Teacher Resource Guide for group presentation guidelines.) Inform the class that Assessment Questions will include information from each group.
5. Based on their assigned section, instruct students to create 3 questions and answers to the questions. These questions will be used for their game learning station. The answers to the questions should be simple, such as one-word answers. Review the questions developed by each group. Once approved, remind students that their presentations should also cover these questions.

Group Reading Section Topics and Questions

Group 1 – Using the sun's energy

1. How does the Earth use the sun's energy?
2. Is solar energy renewable? Why or why not?
3. How much power does the Earth get from the sun at noon?

Group 2 – Wind energy

1. How is electricity created from the wind?
2. How much power could Texas make with wind energy?
3. How much does Texas make now?

Group 3 – Biomass energy

1. What is biomass?
2. How can electricity be made at landfills?

Group 4 – Hydroelectric energy

1. What is hydroelectric energy?
2. How is hydroelectric power created?
3. What determines how much power can be made by water?

Group 5 – Sunlight and thermal energy

1. How can the sun heat your home?
2. How can water heated by the sun make electricity?
3. What is an example of this being done in Texas?

Group 6 – Sunlight and photovoltaics

1. What is the name of the process that allows sunlight to make electricity?
2. What does it mean?
3. What are some examples of how PV is used in Texas today?

Day 3 – 80 minutes

Activity – Group Presentations (80 minutes)

1. Allow students 5 – 10 minutes to meet in their groups from Day 2 and review the material they will include in their presentation (topics from the discussion questions, new graphic created, and the 3 game questions for their learning station). Remind the students that everyone will be assessed on the topics from the presentations, so they should all pay close attention.
2. Bring students together as a class and have each group present their topic (allow 5 – 10 minutes for each group).

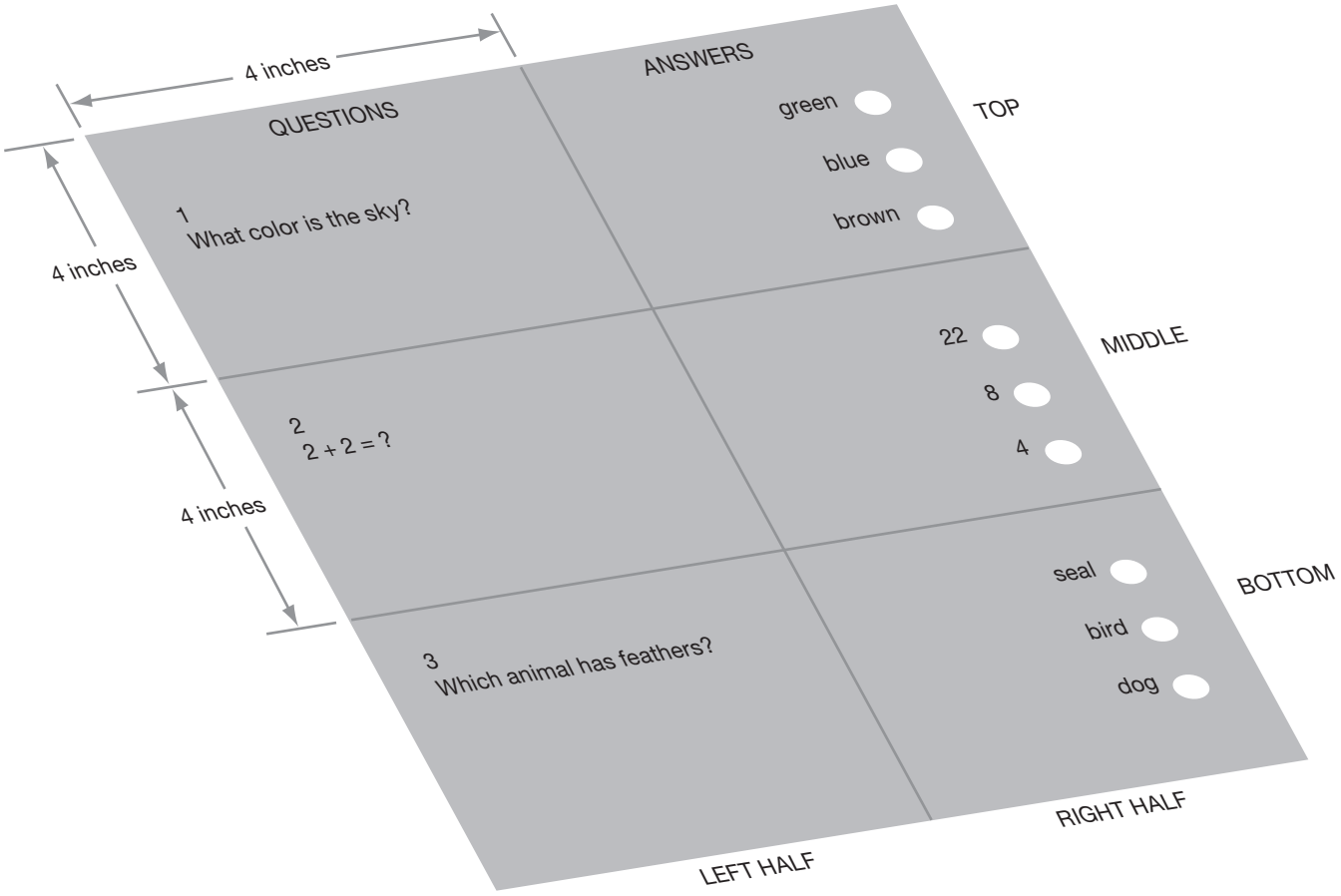


Figure 1. Folder cover when closed (opens to the left like a book)

3. After all the groups have presented their information, refer to the graphic organizer created on Day 1. With the entire class, add to the graphic organizer any new concepts that the students learned.

Day 4 – 130 minutes

Activity 1 – Lab Activity: Preparing the Learning Station Folders (60 minutes)

1. Prepare a materials kit for each class group.
2. Working in the same groups from the Reading and Cooperative Group Work, each group should obtain a materials kit.
3. Instruct students to prepare the folder for the trivia questions. See Figure 1 for sample. As this activity involves many steps, the teacher should give the instructions one at a time and demonstrate to the groups how to do each step as they go.
   a. Draw a vertical line down the middle of the folder cover (approximately 4 inches from the left edge) dividing it into a right half and a left half. Each half should be equal in size. Explain that the left half is for the questions and the right half is for the answers. Students can label the columns as "Questions" and "Answers."
   b. Draw 2 horizontal lines across the folder dividing it further into 3 equal sections (top, middle and bottom). The first line can be drawn 4 inches from the top edge, and the second line can be drawn 4 inches below the first line. Each section should be approximately equal in size. Explain that each section is for each of their 3 questions. Students can label each section "1" "2" and "3" corresponding to their 3 questions.
   c. The folder is now divided into 6 equal sections.
   d. In each section of the right half, punch 3 holes near the right edge of the folder. (Note: The holes should be large enough to allow the contact switches, when attached to the inside cover, to come through the front. The holes should be spaced far enough apart so that the contact switches, when attached to the inside cover, do not touch.) These 3 holes in each section (top, middle and bottom) represent answer choices for each of the 3 questions.
   e. After punching the holes and with the folder closed, use a pen to mark the location of the hole inside the folder. When you open the folder, you will have 9 marks that align with the location of each hole. This will assist students to know where the contact switches should be located.
   f. In each section on the left half of the folder when closed, have the students neatly write the approved questions for their group.
   g. In each section on the right half of the folder near each hole, neatly write the correct answer to the question and 2 incorrect answers. Remind students that the correct answer does not have to appear near the first of the 3 holes but should appear in random order to make it more challenging for the class.

Activity 2 – Lab Activity: Building the Electric Circuit (60 minutes)

Instruct students to build the circuit as follows:

   a. Open the folders so that you can work with the 2 folder halves (called panels). All the circuitry will be contained on the right half of the open folder.
   b. Screw the light bulb into its holder. Place the light bulb holder on the table near the top of the folder as shown in Figure 2. The light bulb holder should have 2 screw terminals representing the positive and negative terminals for the bulb.
   c. Place the battery with screw terminals next to the light bulb as shown in Figure 2.
   d. Take a small piece of wire and strip off ½" of insulation from both ends. (Teacher can prepare stripped wire pieces ahead of time.)
   e. To connect the light bulb to the battery, attach one end of the wire to one battery terminal (choose the terminal closest to the light bulb to avoid crossing wires) by unscrewing the cap and twisting the stripped wire around the metal terminal.
   f. Attach the other end of the wire to the terminal on the light bulb holder (choose the terminal closest to the battery to avoid crossing wires). The wire can be attached to the light bulb holder by slightly unscrewing the screw of the terminal on the holder and wrapping the stripped part of the wire around the metal terminal.
   g. Attach the contact switches to the right half of the right panel on the marks noting the location of the holes. Depending on the type of switches that were available, the method of attaching to the folder will vary. Double-sided tape can be laid over the marks noting the holes, and the switches can be placed on top of the double-sided tape. If the contact terminals of the switch project downward, bend them so that they will be horizontal when placed on top of the tape so they can be easily accessed for making wire connections.
   h. You will have 9 contact switches taped to the right half of the right panel.
   i. Mark the 3 switches that correspond to the location of the 3 correct answers noted on the front

cover of the panel. These are the switches that will be included in the electric circuit. These switches will be called Contact Switches 1, 2, and 3. The remaining switches will be called Dummy Switches.

j. Take a piece of wire (with ½" of insulation stripped from both ends) long enough to reach from Contact Switch 1 to the battery terminal.
k. Attach one end of the wire to one terminal of Contact Switch 1 (making this connection may vary depending on the type of switch that is obtained). Typically, loop the stripped portion of the wire through the hole of the terminal. A small piece of electrical tape can be used to cover this connection.
l. Attach the other end of the wire to the unused terminal on the battery. We will call this the Switch Terminal of the battery.
m. Take another piece of wire (with ½" of insulation stripped from both ends) long enough to reach from Contact Switch 1 to the light bulb holder.
n. Attach one end of the wire to the unused terminal of Contact Switch 1 using the same connection method in step k.
o. Attach the other end of the wire to the unused terminal on the light bulb holder. We will call this the Switch Terminal of the light bulb holder.
p. When this switch is depressed, the circuit is closed, and the light bulb will light. Note: If the light bulb does not light when pressed, check your wire connections and make sure all the wire ends are in good contact with their respective terminals. If the light bulb still does not light when the contact switch is pressed, you can try the following troubleshooting steps: verify that the battery has full charge; replace the contact switch with another one; verify that the light bulb has not burned out and replace it if needed.
q. Repeat steps j-p for the 2 remaining Contact Switches corresponding to the correct answers. The Switch Terminals on both the battery and the light bulb holder will each have 3 wires connected to them for the 3 Contact Switches. The 6 dummy switches will remain unconnected. If the dummy switch is pressed (indicating the wrong answer is selected), the light bulb will not light. However when a Contact Switch that is connected to the light bulb/battery is pressed (indicating a correct answer is selected) the light bulb will light up.
r. Close the folder making sure the pushbutton switches come through the holes. Make adjustments to the hole size or positioning of the switches if needed.
s. Once all the circuits are working correctly, place the light bulb holder and battery in the tray for easy transporting and storage.

Activity 3 – Homework Assignment – due on Day 5 (10 minutes)

1. Create an Assessment Question handout based on the multiple choice questions prepared by each group for the learning stations and instruct each student to complete the handout for homework. (As an alternative, you may write or instruct someone from each group to write the questions on the chalkboard or overhead transparency and instruct students to copy all the multiple choice questions and possible answers in their science notebooks.)
2. Explain to the class that the next day they will self-grade their homework assignment by visiting each learning station and testing their answers to the questions.

Day 6 – 45 minutes

Assessment Evaluation

1. Explain to the class that they will work in groups but individually take their Assessment Questions handout or science notebook with questions written in it to each learning station and grade their homework assignment.
2. Instruct students to visit each learning station and find the respective set of questions on their homework handout of Assessment Questions. Students should answer each question at the learning station by pushing the switch that corresponds to the answer they have selected. If they have selected the correct answer, the light bulb will be lit. Students should grade their own handouts as they complete each question. Coordinating this activity will depend on the classroom arrangement and space available. Students can rotate from station to station, or you may assign groups one at a time to a particular station.
3. Demonstrate for the students how to use the light bulb assembly at each station to check the answers on their assessment handout.
4. When each student has finished his or her Assessment Questions handout, have the students turn in their handout for a final grade for this unit.

ADDITIONAL ACTIVITIES

Powering the Lab Activity with Solar

Obtain a small solar (photovoltaic) panel and replace the battery in the learning station circuit. Solar panels that are used for model solar cars will work. Carefully take the learning station outside and test the circuitry. Instruct the class to build similar learning stations using the solar cell but testing vocabulary words or other concepts in renewable energy.

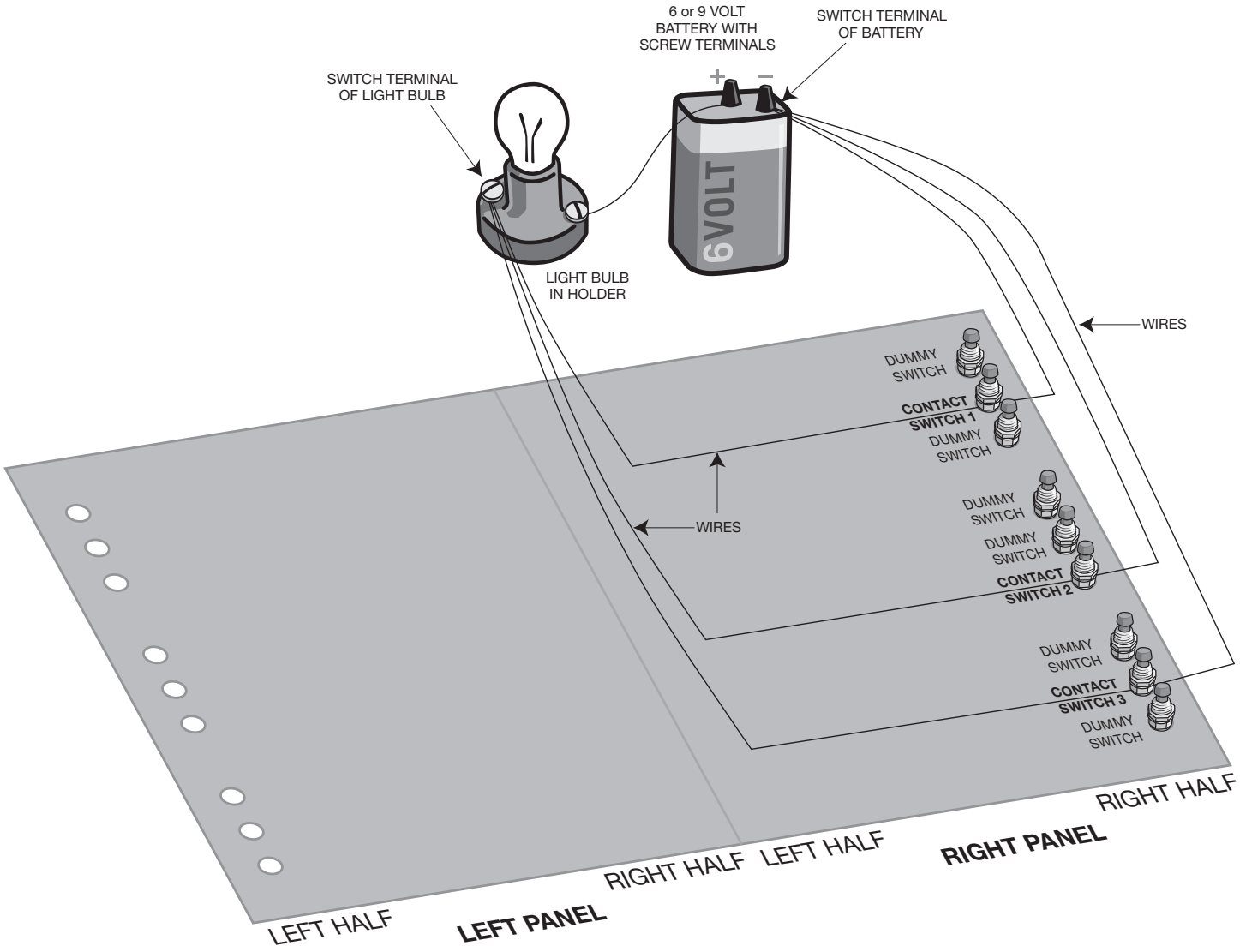


Figure 2. Circuit Diagram: Folder when opened (left panel and right panel)

Vocabulary Words

biomass – organic matter, such as plants or garbage, that can be used as an energy source

collector – an object or device that stores a desired item (such as water, energy, etc.)

direct current – electricity that always flows in the same direction, such as that provided by batteries and solar electric panels

evaporate – when moisture changes from liquid to gas in the air

foundation – the fundamental assumptions from which something is begun or developed or calculated or explained

kinetic energy – energy that is produced by motion

landfill – a site where trash is disposed of then buried beneath a layer of earth

megawatt – a million watts (1,000,000)

municipal – of a city

photovoltaic system – an energy generating system that converts sunlight into electricity

radiant – emitting heat or light

turbine – any machine that turns kinetic energy into mechanical power

vapor – gas formed from a substance that is usually a liquid or a solid; moisture in the air that can be seen, such as fog, steam, mist, etc.

voltage – a measure of the energy required to move an electric charge from one point to another

watt – a unit of electrical power

Group Reading Section Questions

Group 1 – Using the sun's energy

1. Solar energy makes it possible for plants, animals and people to live on Earth. Plants use the sun's energy to grow. The sun heats the air that causes wind. The sun causes the water cycles.
2. Solar energy is renewable. It can never be used up.
3. 1,000 Watts per square meter

Group 2 – Wind energy

1. Modern wind turbines use the kinetic energy of the wind to produce electrical power.
2. 135,000 MW
3. 1,300 MW

Group 3 – Biomass energy

1. Biomass is solar energy that has been stored as plant and animal material.
2. At landfills, where most of the waste is biomass, a gas called methane is naturally produced. Methane gas can be used to generate electricity.

Group 4 – Hydroelectric energy

1. power that is created by water
2. When water falls from a high point to a low point—like a waterfall—there is a lot of power involved. This power can be collected to make electricity.
3. The amount of power that is made from falling water depends on the amount of water falling and how far it falls.

Group 5 – Sunlight and thermal energy

1. through the sun shining into lots of windows that face south
2. The heat in the water is changed into electricity through special machines.
3. University of Texas at El Paso solar pond

Group 6 – Sunlight and photovoltaics

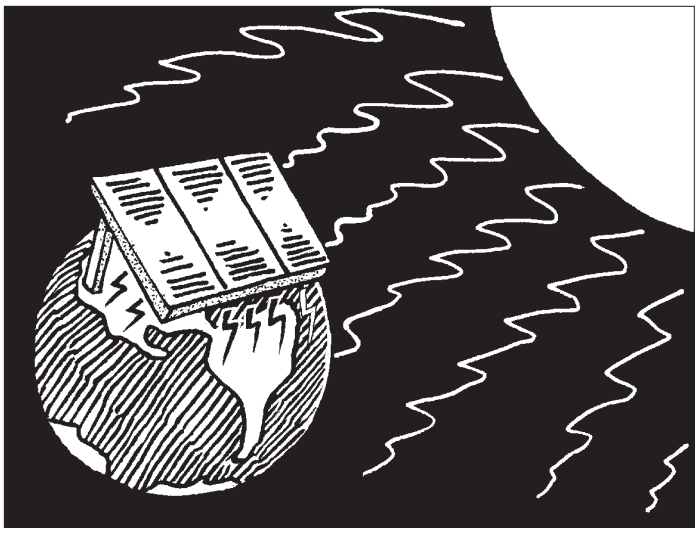
1. photovoltaics
2. "photo" refers to light and "voltaic" to voltage
3. powering homes, water pumps, school crossing signs and calculators

Electricity from the Sun

RENEWABLE ENERGY
THE INFINITE POWER OF TEXAS

HIGHLIGHTS

- Earth is a huge solar collector
- Winds and wind turbines
- Plants store sunlight
- Falling water, heat and light into watts



SUNLIGHT POWERS THE EARTH *The Earth is like a hug solar collector that turns sunlight into natural forces such as wind, rain and growing plants.*

USING THE SUN'S ENERGY

Sunlight helps all living things grow. Energy from sunlight is called solar energy. Solar energy makes it possible for plants, animals and people to live on Earth. The Earth is basically a huge solar energy collector because it collects the energy from the sun. This energy comes in different forms. One form is from direct sunlight used by plants to grow. Another form of energy heats the air that causes wind. Water is evaporated when sunlight falls on the oceans. Then when the evaporated water cools in the air, it falls back to Earth as rain and becomes rivers and lakes. All of these forms of energy are used indirectly as wind, biomass and hydroelectric power, and directly as solar energy. Solar energy is called thermal energy and photovoltaic energy.

Our supply of solar energy can never be used up and is readily available. Therefore solar energy is a type of renewable energy. It is not like fossil fuels, such as coal, oil and natural gas, which are also called non-renewable energy. Solar energy is a clean energy source that does not create pollution that can be harmful to all living things. If you use solar energy, you may not have to depend on anyone for your energy needs.

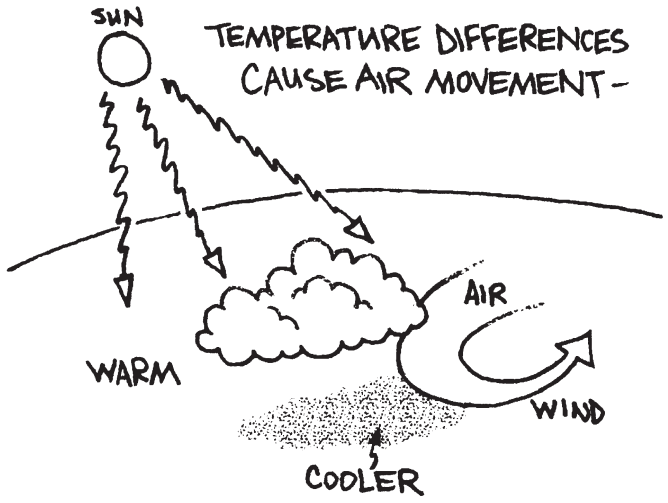
There is a great amount of power in the solar energy that arrives on Earth. This powerful energy is measured in units called watts per square meter. The amount of

power from the sun that reaches the earth at noon on a clear day is about 1,000 Watts per square meter. This would be the same as a 100-Watt light bulb completely focused on a surface the size of a large notebook.

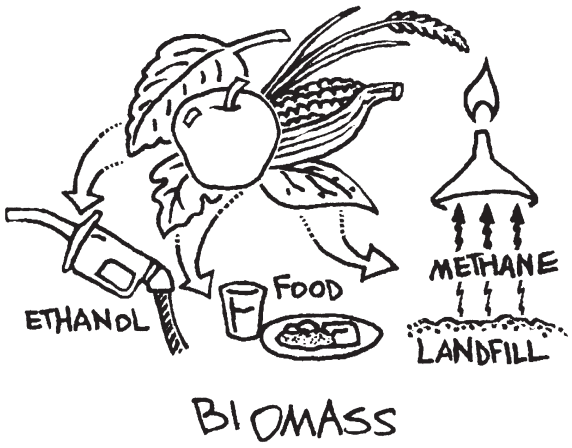
WIND ENERGY

Wind is created because the solar energy from the sun heats the Earth's surface and the atmosphere unevenly. This causes different temperatures within the atmosphere around our planet. Temperature differences cause the sections of air in the atmosphere to move in different directions around the planet. Warm air rises and cold air falls. The Earth's rotation also helps air to move around the planet.

Windmills use wind energy to pump water. But this energy can also be used to power our homes, businesses and other electric needs. Modern wind turbines use the kinetic energy of the wind to produce electrical power. Texas has become one of the leaders in wind energy in the United States. Texas has the second largest wind energy potential of any state with over 135,000 megawatts (MW) of potential. By 2003, Texas had developed almost 1,300 MW of power from wind energy.



WIND IS CAUSED BY THE SUN *Uneven solar heating of the Earth's land, water and atmosphere causes air to move around as wind.*



BIOMASS IS STORED SOLAR ENERGY *Energy stored in plants can be used for many useful purposes such as fuels, food, clothing and paper. Biomass can change form naturally like when old newspapers or food scraps turn into methane at a landfill.*

BIOMASS ENERGY

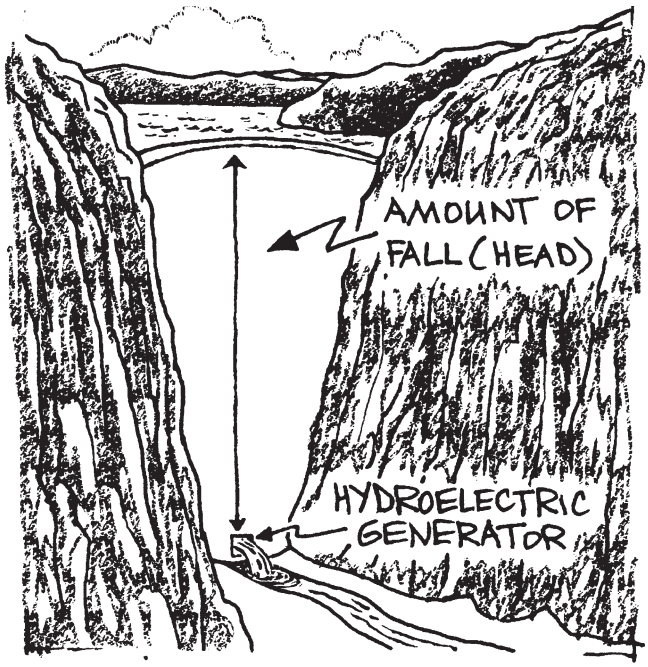
Biomass is solar energy that has been stored as plant and animal material. When you eat vegetables, you are consuming the sun's energy the plant stored as it grew. Your body uses the vegetables' biomass to give you energy to work and play.

When corn is used to make biomass energy, cleaner-burning fuels can be produced, such as ethanol.

At landfills, where most of the waste is biomass, a gas called methane is naturally produced. Methane gas can be used to generate electricity.

HYDROELECTRIC ENERGY

Water is the foundation of life on the Earth. There is always a supply of water on Earth because it is always flowing from our oceans,



MOVING WATER PRODUCES POWER *Water flowing through a dam runs through a turbine to make electricity. Tall dams produce more power than short dams since the water falls farther.*

rivers and lakes to our atmosphere and back down to Earth as rain. When water falls from a high point to a low point–like a waterfall–there is a lot of power involved. This power can be collected to make electricity. Power that is created by water is called hydroelectric. Some of the largest power plants in the world are hydroelectric power plants.

The amount of power that is made from falling water depends on the amount of water falling and how far it falls. In simple terms, one gallon of water falling one foot per second can light up a 10-Watt light bulb.

SUNLIGHT AND THERMAL ENERGY

Solar energy can be used to heat your home. This can be done best if you have lots of windows that face south and are shaded correctly. The window glass should be covered with a material called glazing that prevents too much heat from coming in during the summer and prevents heat from escaping in the winter.

Much of your hot water needs can be met with a simple solar water heating system.

Sunlight can also be used to make electricity. One way the sun can make electricity is through a heat process called thermal. At the University of Texas at El Paso, there is a pond of water about half the length of a football field that soaks up the sun's energy and makes heat, which is changed into electricity with special machines. It is called a solar pond. This solar pond can make about 60 kilowatts of electricity for the University. A food cannery nearby uses the heat made by the solar pond.

SUNLIGHT AND PHOTOVOLTAICS

Another way the sun can make electricity is through a process called photovoltaics or PV. "Photo" refers to light and "voltaic" to voltage. A thin silicon cell, four inches across, can produce about one watt of electrical power in full sunlight. Solar powered homes, water pumps, school crossing signs and calculators are a few common examples of how PV is used today in Texas.

Our future is bright for using renewable energy in Texas and around the world. Using renewable energy can supply electricity and create local jobs. And it's good for the Earth.

One day, it will be up to you, our future homeowners, politicians, scientists and decision-makers, to make sure our energy needs are met with renewable energy.

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Financial Acknowledgement This publication was developed as part of the Renewable Energy Demonstration Program and was funded 100% with oil overcharge funds from the Exxon settlement as provided by the Texas State Energy Conservation Office and the U.S. Department of Energy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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Texas Comptroller of Public Accounts
Publication #96-810B (03/05)