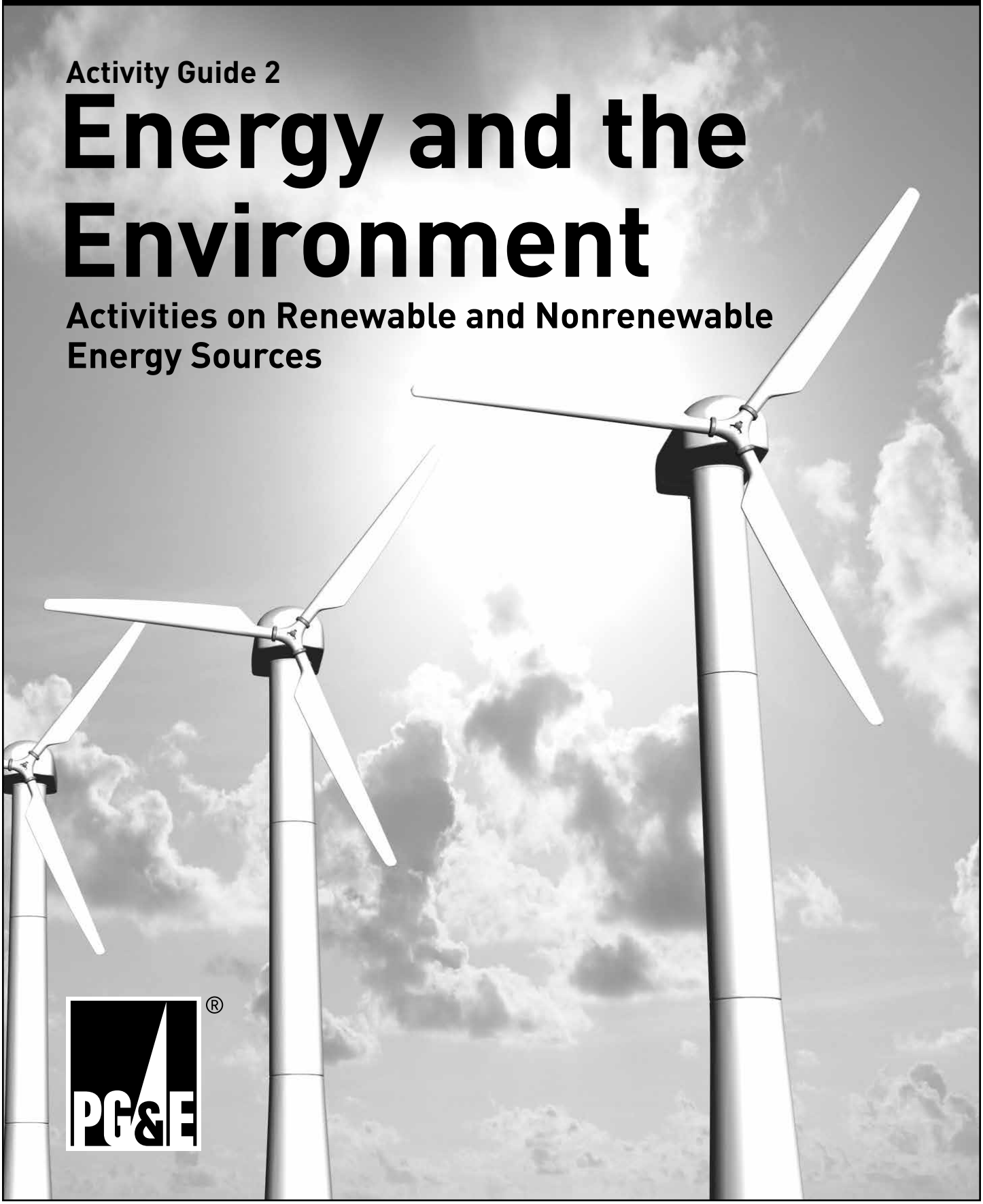
Energenius® Out-of-School Time Program

Activity Guide 2

Energy and the Environment

Activities on Renewable and Nonrenewable Energy Sources



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Introduction

Energy and the Environment is a series of exercises for children and youths who attend out-of-school time (OST) programs. It is designed to engage participants in understanding how energy is produced, where energy comes from, and the impact of energy use and production on the environment.

The exercises focus on the renewable and nonrenewable sources of energy that power our daily lives. A hands-on experiment on the greenhouse effect is included in the exercises.

Guide to Activities

The three activities in *Energy and the Environment* can be used as standalone units or as part of a larger study of energy and the environment. Each activity is designed to be completed in three to six sessions. Overviews of activities are provided, along with information pertaining to objectives, preparation, materials needed, and vocabulary.

Written materials that can be taken home to parents, guardians, and other caregivers are also included in the *Energy and the Environment* program. This includes the Home Energy Information Packet that should be distributed to all participants in the program.

Training

Energy and the Environment is provided as a resource for OST programs and is offered along with training by the California School-Age Consortium for OST staffs to implement these activities.

The Energenius Out-of-School Time Program guides and training were developed by the California School-Age Consortium with funding from Pacific Gas and Electric Company.

Contents

Activity 1:
Renewable and Nonrenewable Energy Sources

Overview:

This activity takes children and youths through an exploration of renewable and nonrenewable energy sources. They will learn about the varying characteristics of these energy sources and create pinwheels to demonstrate wind energy and how it works.

This activity sets the stage for developing an understanding of how energy is generated and travels to where it is used. This activity also helps children and youths understand the different environmental impacts of energy production and their own energy use.

Objectives:

- Children and youths will be able to tell the difference between a renewable and a nonrenewable energy source.
- Children and youths will be able to identify the advantages and disadvantages of various energy sources.
- Children and youths will be able to demonstrate how wind is used as a source of energy.

Preparation:

- Read through the entire activity, making adjustments as necessary for the age(s) of the children and youths, group size, and session time.
- Make and cut out copies of the **Renewable and Nonrenewable Signs** (Handout 1) for each participant.
- Make copies of the following handouts: **Pinwheels, Wind Turbine Diagrams,** and **Energy-Saving Tips** (Handouts 2 through 5), plus **Wind Power** (page 26 from the Energy Sources section), one set for each participant.

Materials:

- **Renewable and Nonrenewable Signs** (Handout 1)
- **Pinwheels** (Handout 2)
- **Wind Turbine Diagram** (Handout 3)
- **Energy-Saving Tips** (Handout 4)
- **Wind Power** (page 26)
- Scissors, tape, and glue
- Colored pencils, markers, or crayons
- Thumbtacks or pushpins
- Pencils with full erasers
- Optional (see modification tips for pinwheels on page 5): string, cups, milk cartons, or liter bottles

Vocabulary:

biomass – Organic materials such as agricultural crops, plants, garbage, or wood that can be used for the production of energy.

coal – A black or brownish rock that can be burned for fuel, made from the remains of plants and animals that lived over 70 million years ago.

fossil fuels – Fuels formed from the remains of plants and animals that lived over 70 million years ago. Coal, oil, and natural gas are fossil fuels.

generator – A device used to convert mechanical energy into electrical energy.

geothermal energy – Heat from the Earth's core that is used to generate electricity.

hydropower – Electricity that is generated by the flow of water.

kinetic energy – Energy in motion, such as moving water or wind.

natural gas – An air-like substance found in the Earth that can be burned for heat or fuel, made from the remains of plants and animals that lived over 70 million years ago.

nonrenewable energy – A resource such as coal or oil that cannot be easily replenished.

petroleum (oil) – A natural, thick, flammable liquid made from the remains of plants and animals that lived over 70 million years ago.

renewable energy – An energy source such as solar or wind that can be restored by nature after it is used.

solar energy – Energy directly from the sun.

uranium – An element found in the crust of the Earth. The fuel for nuclear power plants comes from uranium ore.

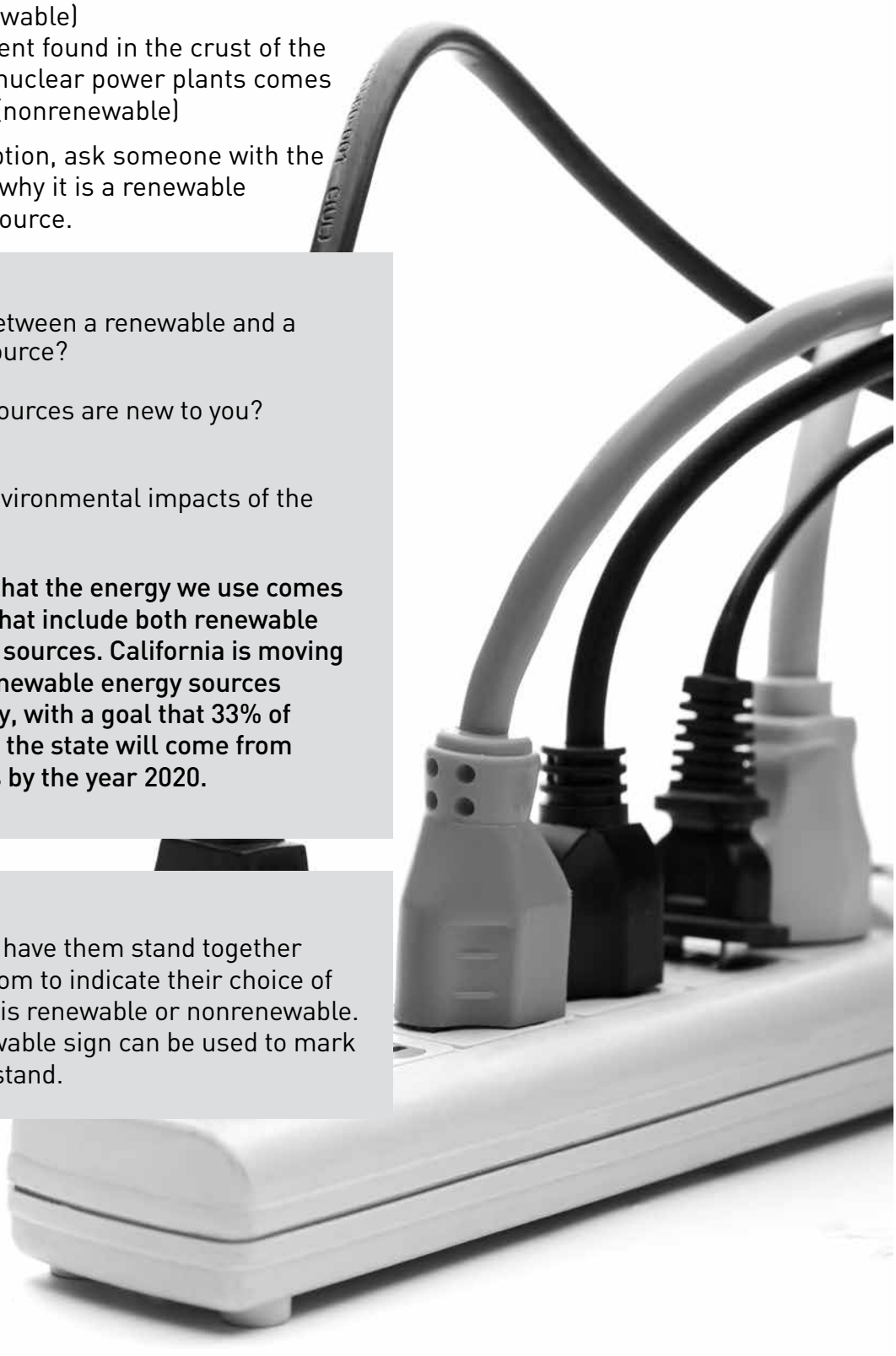
wind power – Electricity generated from the wind.

Activity Procedure

1. Begin the activity by asking: "Do you know where your energy (electricity) comes from?"
2. Discuss that (electricity) is generated from many sources, including water, the sun, the wind, coal, oil, and natural gas.
3. Explain that we're going to explore different energy sources and also learn about the environmental impacts of the energy sources used to produce our electricity.
4. Discuss that our energy sources are either renewable or nonrenewable. A renewable energy source is one that can be restored by nature after it is used, such as solar or wind energy. A nonrenewable energy source cannot be easily replaced. Fossil fuels, for example, which include oil, coal, and natural gas, took millions and millions of years to form.
5. Distribute a set of **Renewable and Nonrenewable Signs** (Handout 1) to each child and youth. Read the following descriptions of energy sources (without the answers) and have them hold up the sign they think is correct:
    a. oil or petroleum – A natural, thick, flammable liquid made from the remains of plants and animals that lived over 70 million years ago. (nonrenewable)
    b. biomass – Organic materials such as agricultural crops, plants, garbage, or wood that can be used for the production of energy. (renewable)
    c. hydropower – Electricity that is generated by the flow of water. (renewable)
    d. natural gas – An air-like substance found in the Earth that can be burned for heat or fuel, made from the remains of plants and animals that lived over 70 million years ago. (nonrenewable)
    e. geothermal energy – Heat from the Earth's core that is used to generate electricity. (renewable)
    f. wind power – Electricity generated from the wind. (renewable)
    g. coal – A black or brownish rock that can be burned for fuel, made from the remains of plants and animals that lived over 70 million years ago. (nonrenewable)

h. solar energy – Energy which comes directly from the sun. (renewable)
i. uranium – An element found in the crust of the Earth. The fuel for nuclear power plants comes from uranium ore. (nonrenewable)

6. After reading each description, ask someone with the correct answer to explain why it is a renewable or nonrenewable energy source.



Debrief Questions:

a. What is the difference between a renewable and a nonrenewable energy source?

b. Which of these energy sources are new to you? Which are not?

c. What are some of the environmental impacts of the various energy sources?

Reminder: Tell the group that the energy we use comes from a variety of sources that include both renewable and nonrenewable energy sources. California is moving toward the use of more renewable energy sources for production of electricity, with a goal that 33% of all electricity generated in the state will come from renewable energy sources by the year 2020.

Modification Tip:

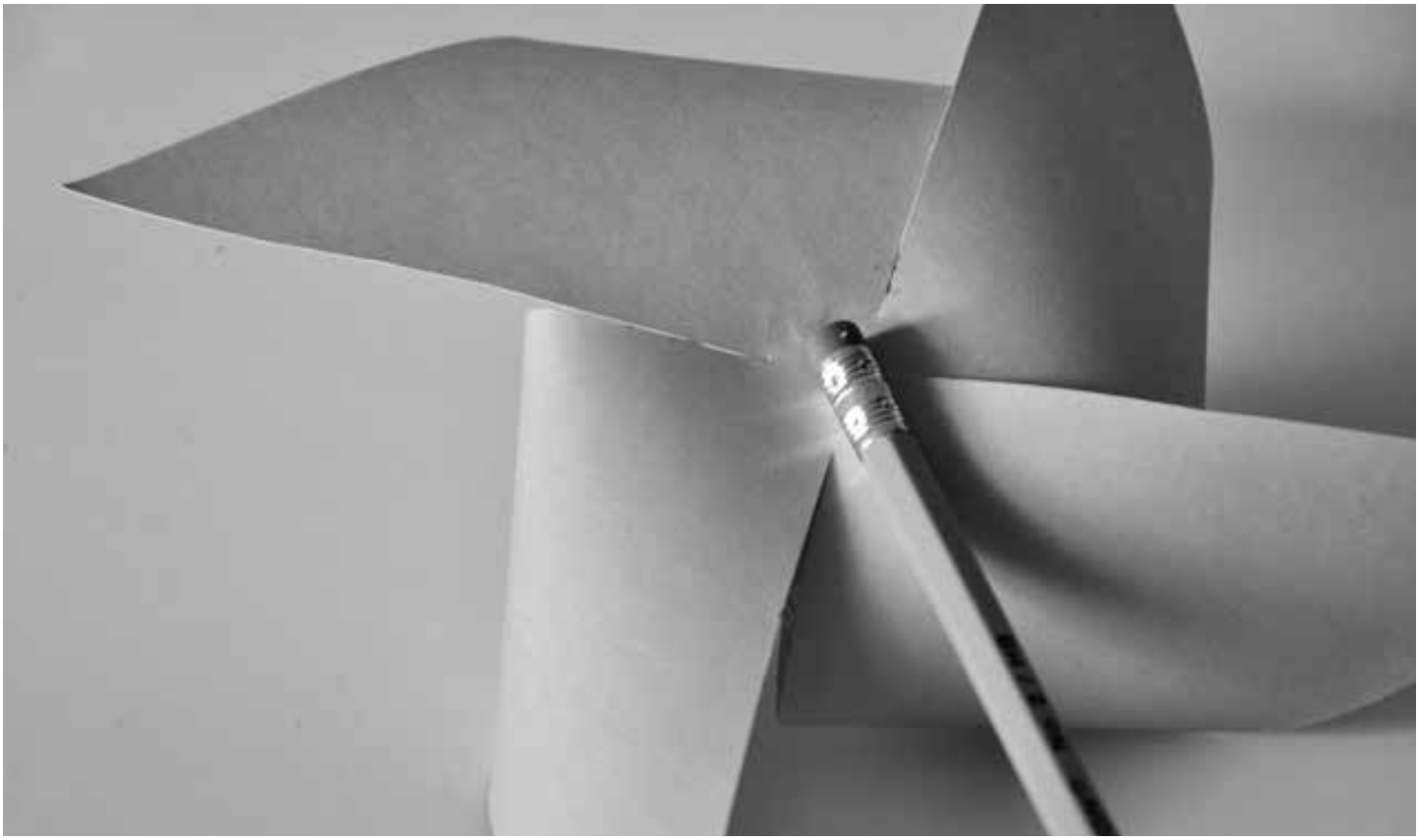
For youths 6th–8th grade, have them stand together on opposite sides of the room to indicate their choice of whether an energy source is renewable or nonrenewable. A renewable and nonrenewable sign can be used to mark where each group should stand.

How Does Wind Power Work?

1. Explain that we're going to explore one renewable energy source and that is wind power.
2. From the Energy Sources section, distribute **Wind Power** (page 26). Have children and youths read it "popcorn style," with one member of the group reading the first sentence, then another reads the next sentence, and so on.
3. Ask the group if anyone has ever seen a wind turbine and where it was seen. Explain that wind turbines create electricity by using the angle of the blades to "catch" the wind to make it turn.
4. Tell the group that they will be able to recreate what a wind turbine does by making pinwheels. Distribute **Pinwheels** (Handout 2), along with markers, scissors, and glue.
5. Have participants decorate their pinwheels before cutting them out. After cutting, have them glue the corners of their pinwheels to the center, overlapping each slightly.
6. When the pinwheels are ready, help by sticking a pushpin through each pinwheel and a pencil eraser on the other end. Once the pinwheels are finished, have them blow on their pinwheels to make them spin. Encourage them to try different angles to see what works best.
7. Explain that wind is a renewable resource because it can be restored by nature after it is used. Tell them that the pinwheels we've just created are like wind turbines that collect wind energy from nature to create electricity.
8. Show the **Wind Turbine Diagram** (Handout 3) explaining that the blades of the turbine are connected to a rotor (like the pin of your pinwheel). The rotor spins a generator to create electricity. For a more detailed explanation, view an online video at: http://energy.gov/eere/wind/how-does-wind-turbine-work.
9. Review that nonrenewable energy sources are limited, and using technology like wind turbines to access wind energy will help ensure that wind is part of the renewable mix.

Take-Home Activity:
Distribute copies of **Energy-Saving Tips** (Handout 4) with a reminder to show it to family members.

Modification Tip:
Older participants could design and build pinwheels in different sizes and shapes. They could also attach pinwheels to a larger base, like a milk carton, and use a string to attach a light weight—like a cup or paper ball—to hang down from one part of the pinwheel. Let them try out different ways of generating enough wind to lift the cup (e.g., try to blow on it, bring it outside, or use a fan). They can also place objects inside the cup or add weights to make it heavier to test the strength of the wind.



Handout 1: Renewable and Nonrenewable Signs

Nonrenewable

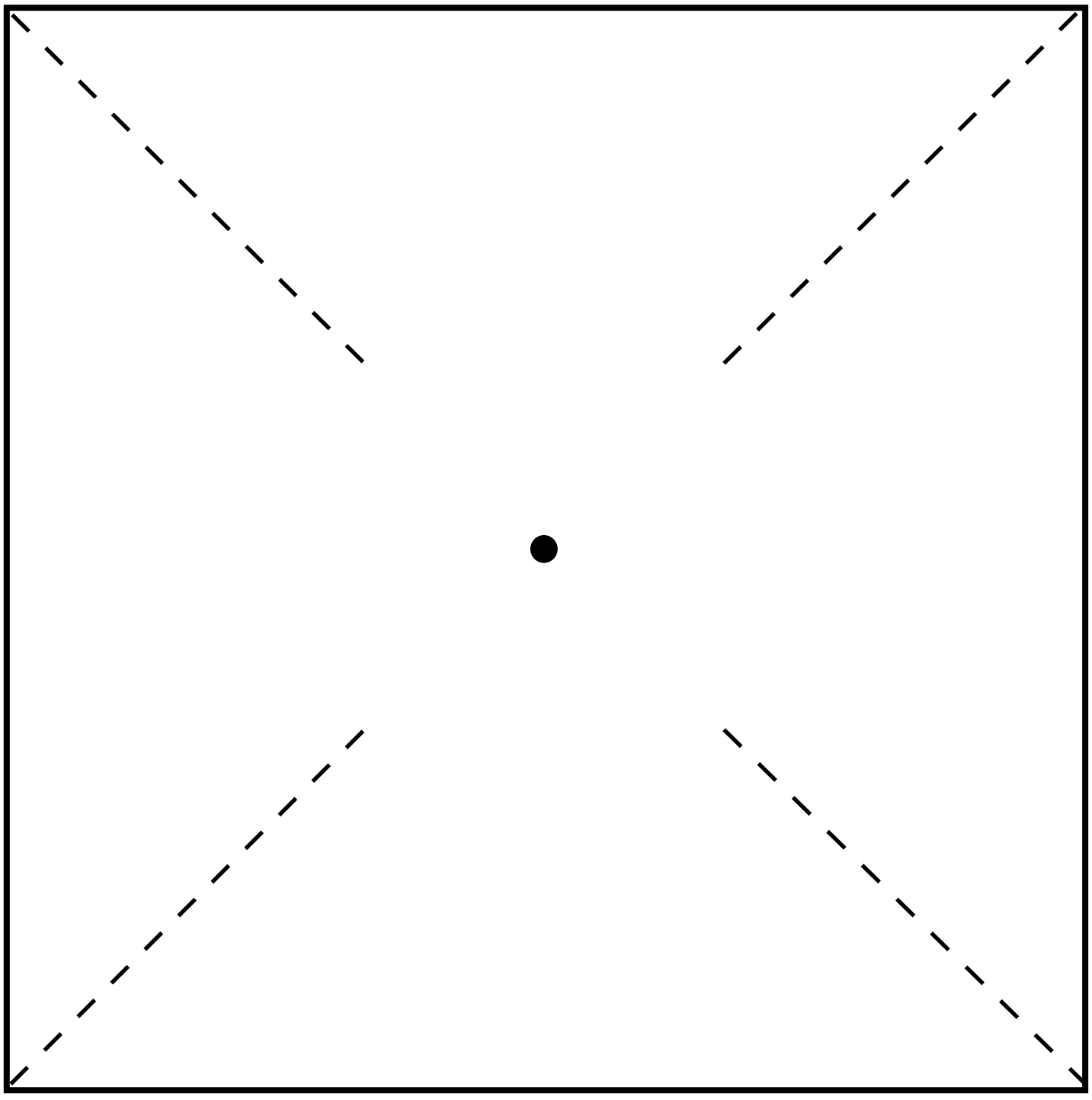
A nonrenewable energy source cannot be easily replenished. Fossil fuels, for example, were formed many millions of years ago.

Renewable

A renewable energy source can be restored by nature after it is used, such as solar or wind.

Handout 2: Pinwheels

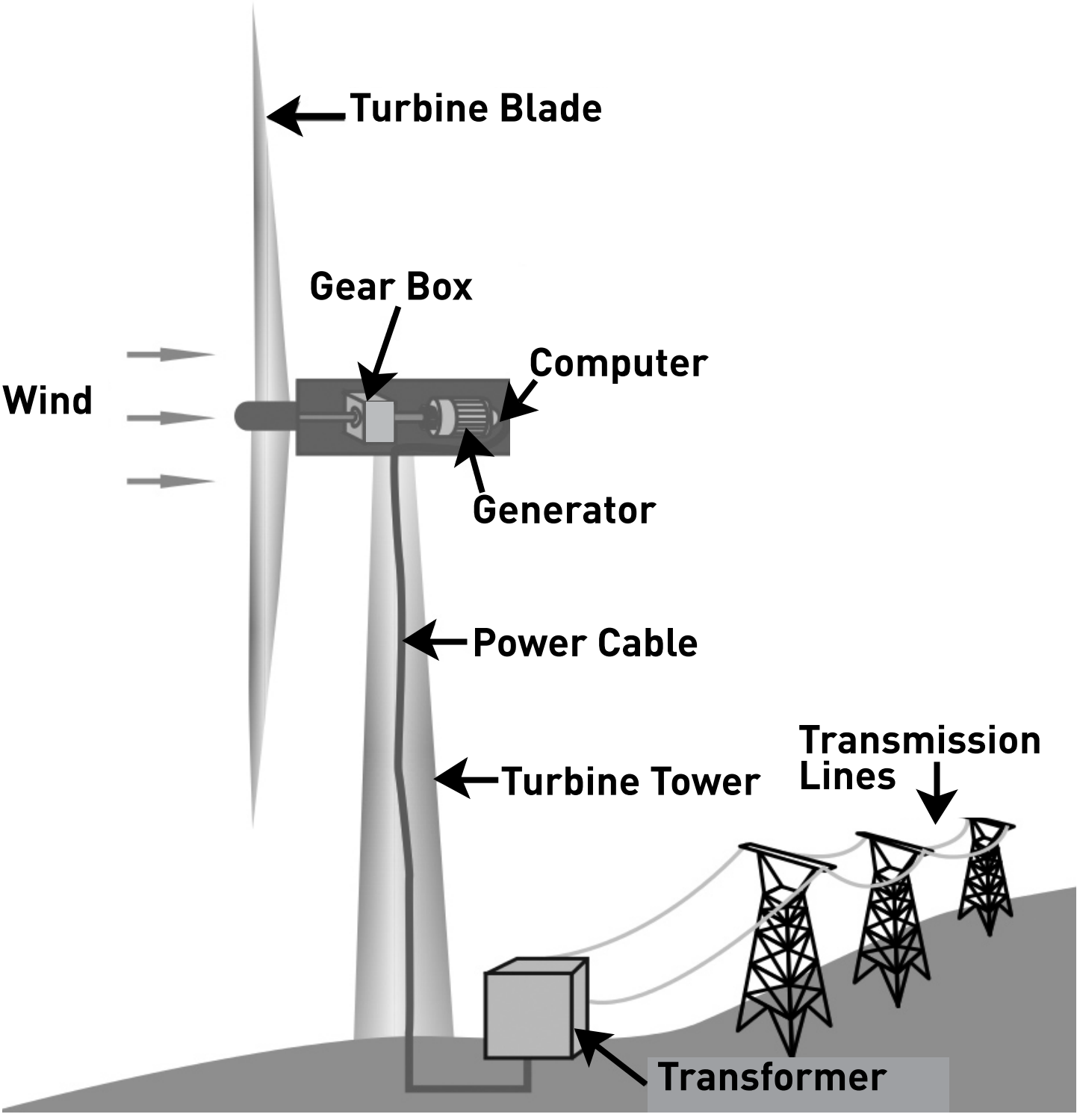
Instructions:
1. Cut out the square.
2. Cut along each dashed diagonal line.
3. Gently bend (do not fold) one of the cut corners toward the center point. Glue or tape it into place.
4. Skip the next corner and bend the next one.
5. Repeat until four corners are in the middle.
6. Stick a pushpin through the center of the pinwheel and attach it to your pencil eraser.



Handout 3: Wind Turbine Diagram

Wind can be caught using large "windmills" (called turbines) that spin to generate electricity.

- Computer systems control the direction of turbine blades to match the direction of the wind.
- Wind pushes the turbine blades into rotation.
- Blades turn a generator to convert mechanical energy into electricity.
- The generator sends electricity through transmission lines to the power grid, bringing electricity to homes and businesses.



Handout 4: Energy-Saving Tips

1 Close the Door!

Don't leave the refrigerator door open when not in use. It allows the cold air to escape and costs money.

2 Bundle Up!!

Wear a sweater indoors in cold weather. Keeping a home's room temperature a little lower in winter months saves energy.

3 Keep Recycling!

Recycle paper, plastic, glass, and cans. Making things from new materials uses up valuable resources.

4 Watch for Drafts!

Check windows for drafts. If you can feel air coming through a closed window, you may be losing heat in the winter and cool air in the summer.

5 Be Water-Wise!

Turn off the water immediately after use. If you wash dishes by hand, turn off the water while you are scrubbing. Not wasting water saves not just water, but energy too.

Activity 2:
Where Does My Energy Come From?

Overview:
This activity gives children and youths an opportunity to explore energy sources that power their daily lives. It also illustrates the path that electricity takes from its generation to where it is used to power our lives. A group research project focuses on various energy sources and their pros and cons.

Objectives:
- Children and youths will be able to explain how energy sources are generated into electricity.
- Children and youths will be able to identify energy sources used to generate electricity.
- Children and youths will be able to list the advantages and disadvantages of various energy sources.

Preparation:
- Read through the entire activity, making adjustments as necessary for the age(s) of the children and youths, group size, and session time.
- Make copies of the twelve **Energy Path Squares** (page 15) and cut them out to make one set for every five participants.
- Make four copies of each page of the **Energy Sources** (pages 17-26).
- Make copies of the **Energy Sources in Your Area** (Handout 5), one for each child or youth.
- Gather materials for posters.

Materials:
- Chart paper
- Markers, colored pencils, or crayons
- **Energy Path Squares** (page 15)
- **Energy Sources** (pages 17-26)
- **Energy Sources in Your Area** (Handout 5)

Vocabulary:

biogas – A type of biofuel that contains methane (CH_4) produced from animal waste, garbage, and other decomposing waste materials.

biomass – Organic materials such as agricultural crops, plants, garbage, or wood that can be used for production of energy.

coal – A fossil fuel and nonrenewable energy source. Coal comes from the remains of dead plant life that lived millions of years ago.

decomposition – The process where a substance is broken down into basic elements. Plant and animal matter decomposes under the right conditions of air, light, and moisture.

fossil fuels – Fuels formed from the remains of plants and animals that lived over 70 million years ago. Coal, oil, and natural gas are fossil fuels.

geysers – Hot water and steam rising out of the earth.

landfill – An area of land where waste materials and trash are dumped.

magma – Hot liquefied or molten rock located deep below the Earth's surface.

nonrenewable energy source – A resource that cannot be replaced or made again by nature. Fossil fuels, for example, were created over millions of years from the remains of plants and animals.

nuclear energy – Energy that comes from the splitting of atoms of radioactive materials, such as uranium. (Nuclear energy is classified as a nonrenewable energy source because the uranium is nonrenewable.)

nuclear fission – A process that occurs when atoms are split apart to form smaller atoms that release energy. Fission takes place in reactors inside nuclear power plants.

organic waste – Waste material of either plant or animal origin.

photovoltaic cell – A device, which converts some of the energy from the sun (radiant energy) into electrical energy. These cells are usually made from silicon. Also known as solar cells.

propane – A nonrenewable energy source produced as a by-product from natural gas processing and oil refining.

renewable energy source – Energy that comes from a source such as the sun, wind, or water. Renewable energy sources can be restored or made again by nature after use.

reservoir – A natural or artificial lake where a water supply is stored.

solar energy – Energy which comes directly from the sun.

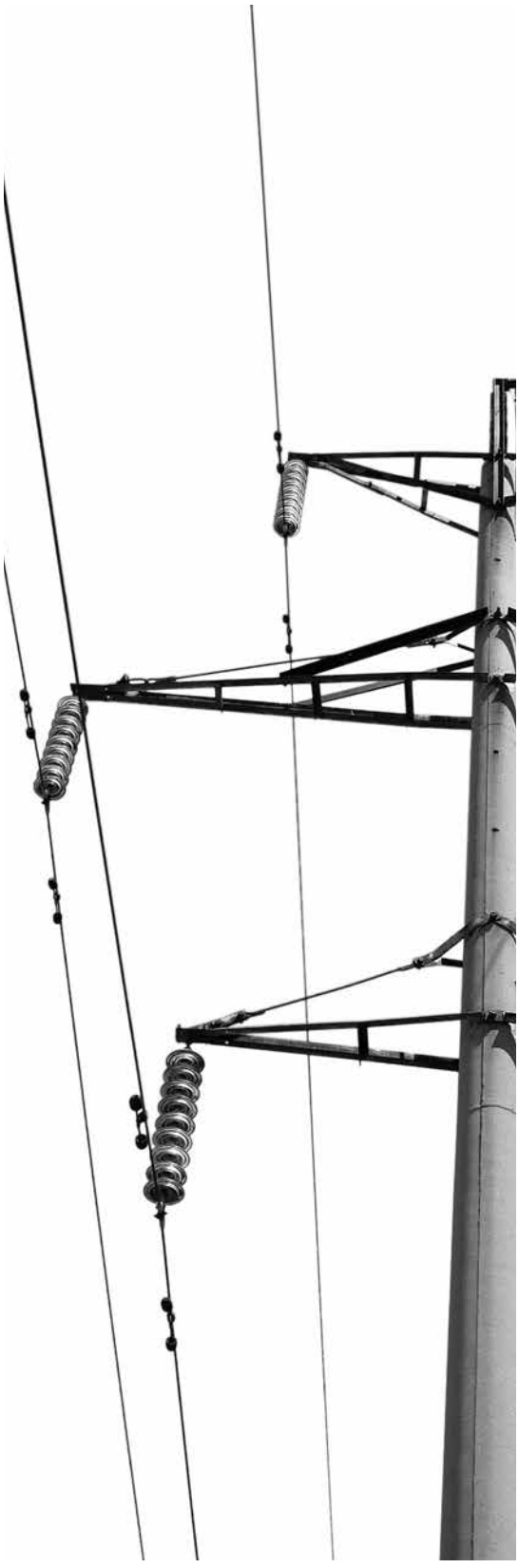
steam – Water in vapor form. In power plants, steam is used to move the turbine generators, producing electricity.

uranium – An element found in the crust of the Earth. The fuel for nuclear power plants comes from uranium ore.

wind power – Electricity produced by wind turbines.

Activity Procedure

1. Ask for a show of hands whether anyone has used electricity today. Follow up by asking if anyone in the group knows where that electricity came from.
2. Discuss that today we're going to learn about power plants, which create the electricity that we use every day to light and heat our homes and to run electric appliances and electronics.
3. Explain that electricity typically travels a long distance, usually from a power plant, where utility companies produce electricity using different energy sources. Most of the electricity used in the U.S. today comes from fossil fuels, such as oil, coal, and natural gas.
4. Explain how the group will follow the path that oil takes once it has been extracted from the ground.
5. Organize children and youths into groups of five and distribute a set of **Energy Path Squares** (page 15) to each group. Tell each group to put the pieces in the correct order based on the description under the picture.
6. Once the groups have finished, ask for a volunteer to indicate what the first step in the path is. Ask the rest of the group if that is what they have as well. Repeat the process until each group has the steps in the right order.
7. Explain that it is important to know how energy sources are converted into electricity.



Debrief Questions:

a. What is something that you already knew about the path of electricity from a power plant?

b. What is something new that you learned?

c. Do you have any more questions about how oil or other energy sources are used to generate electricity?

Modification Tips:

Younger children in the group could be asked to draw some of the "path," such as oil wells or power lines. Older students could be asked to define words under the photos that are new to them.

Group Research

1. Divide children and youths into groups of three or four and assign two energy sources per group, provided from corresponding **Energy Sources** (pages 17-26).
2. Have each group read about their two energy sources and create a poster presentation to share the information. Make sure they include the following information:
    a. Where does this energy source come from?
    b. Is it a renewable or nonrenewable energy source? How do you know?
        * Renewable energy sources provide energy that can be restored or made again by nature after it is used. An example is wind energy. It can be used to generate electricity and is constantly being renewed.
        * Nonrenewable energy sources cannot be replaced or made again by nature. Fossil fuels, for example, were created millions of years ago from the remains of plants and animals.
    c. What makes this energy source unique?
    d. What are the advantages and disadvantages of this energy source?
3. Provide 30 to 40 minutes for completion of research and presentation preparation.
4. After each group presentation, lead a discussion on the pros and cons of their energy sources. Chart the answers on a flipchart or on the whiteboard.

Debrief Questions:

a. What surprised you about the energy sources we just learned about?

b. We know that there is no perfect energy source, but based on the information you have, which one do you think is the best? Why?

Modification Tips:

For 5th through 8th grades, this activity can be changed from a poster to an informal oral presentation. They can prepare arguments aimed at convincing others in the group that their energy source "is the best." The group as a whole can then vote to choose the most convincing presentation.

For younger children, reduce the number of energy sources investigated or split the activity into two sessions.

Take-Home Activity:

1. Distribute **Energy Sources in Your Area** (Handout 5).
2. Explain that there are different energy sources used across California, and utility companies like PG&E use a mix of energy sources to supply electricity to their customers.
3. Encourage children and youths to research the mix of energy sources used in our state and region. Remind them that they can research using books, the Internet, or by asking their family members.

Energy Path Squares

1

Crude oil is extracted from under the ground and sent to a refinery for purification.

2

From the refinery, the oil is transported by ship, train, truck, or pipeline to a power plant.

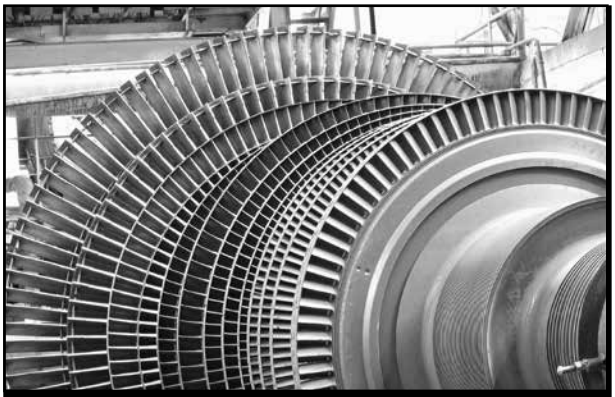
3

Inside the power plant, the oil is burned in large boilers to create steam.

4

The steam inside a generator makes a large turbine spin.

5



The spinning turbine drives an electro-magnetic shaft and generates electricity.

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The voltage of the electric current (electricity) is increased in transformers.

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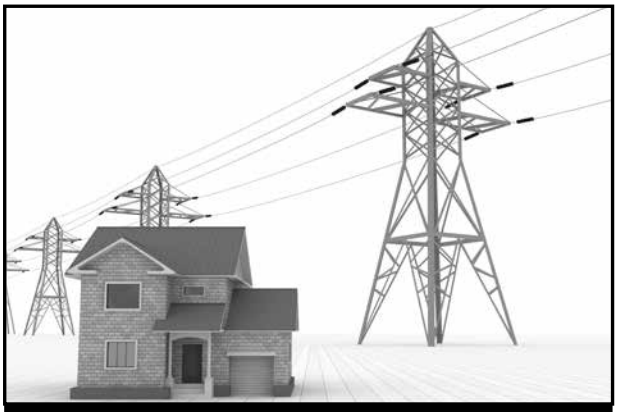

From a power plant, electricity travels in a circuit. The journey starts on high-voltage transmission lines on tall towers.

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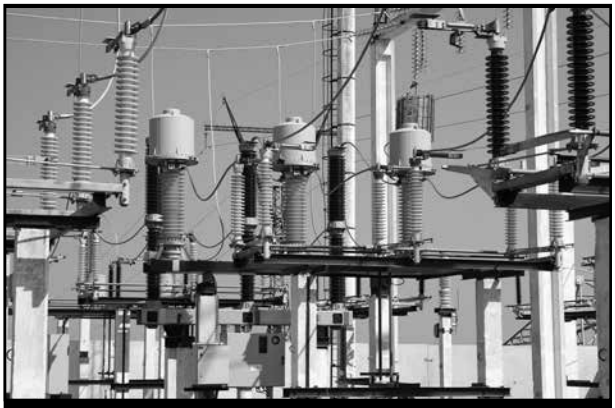

The next stop is at a substation, where the voltage is lowered and sent over smaller power lines. These power lines can be overhead or buried underground.

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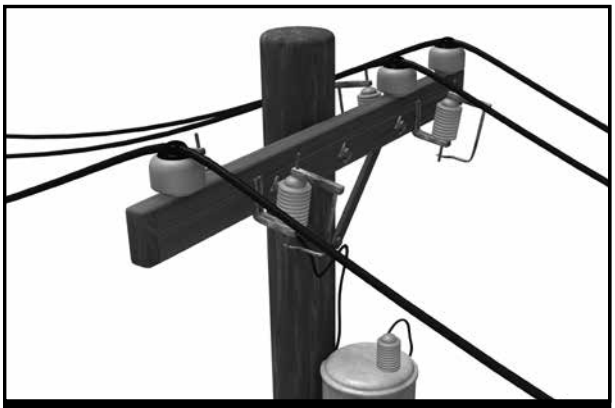

The electric current travels to areas like your own neighborhood, where smaller transformers again reduce the voltage.

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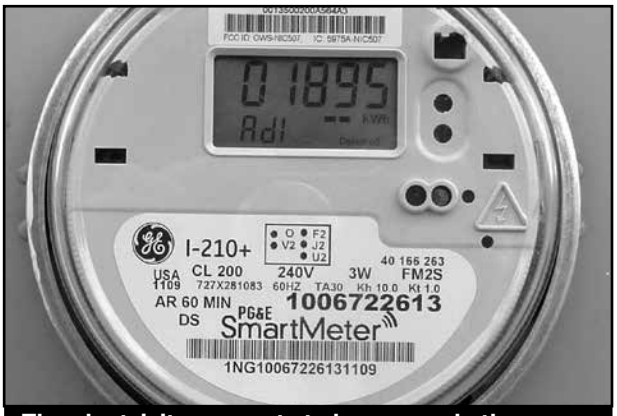

The electricity connects to homes and other buildings through service wires. The electricity passes through a meter that measures how much electricity is used.

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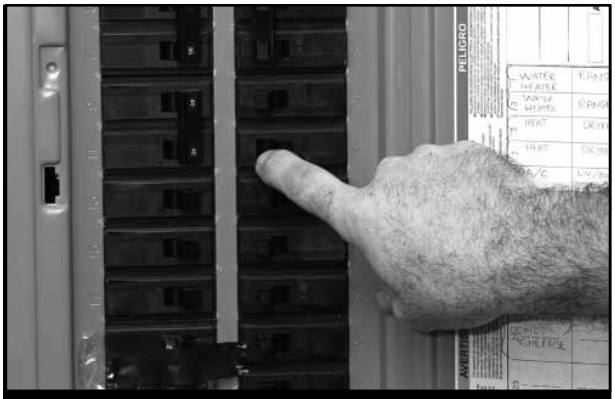

The electricity goes into a service panel, where fuses protect the wires inside a home from being overloaded.

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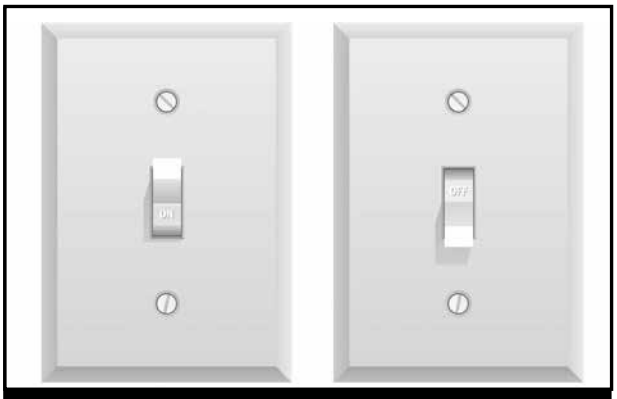
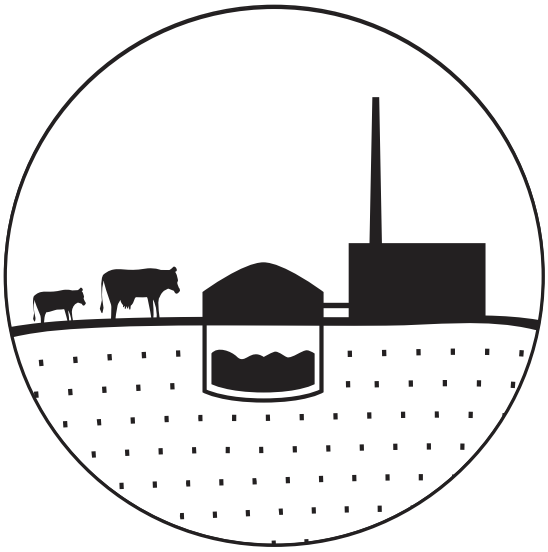


The electricity needed to power lights, electronic equipment, and the rest of a home or building travels through wires inside the walls. At the flip of a switch, the electricity is at work.

Biomass Energy



The use of wood for heating is probably the most familiar and oldest use of biomass. Although wood is our largest biomass energy resource, it is just one form of a biomass material. Yard clippings, corn, soybeans, sawdust, manure (animal waste), forest residues, almond shells, industrial waste, switchgrass, and household garbage are all biomass.

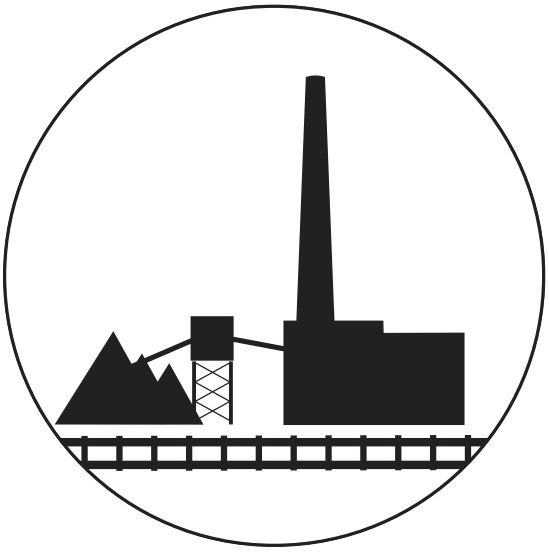
Biomass energy is any organic material that can be used as a source of fuel. The Earth's biomass is a huge source of energy which is constantly being renewed by the sun through a process called photosynthesis. When wood or similar biomass material is burned, the stored chemical energy is released as heat. This heat can be used at power plants to produce steam that turns the generators for making electricity.

Burning biomass converts waste materials to energy, but also creates carbon dioxide (CO_2), a greenhouse gas that contributes to global climate change.

A gas containing methane is given off as materials rot and decompose in landfill sites. This gas, called biogas, can be collected by gas wells and, like natural gas, can be burned in power plants to create the steam to turn the turbines that rotate the generators to make electricity.

The manure (waste) produced by cows and other farm animals can also be captured to produce electricity. Biogas, also called methane gas, is produced in large tanks where the manure is collected. These tanks are called anaerobic digesters or just digesters. The bacteria in these digesters decompose the manure and methane is released and captured. This methane is used to produce electricity.

Coal



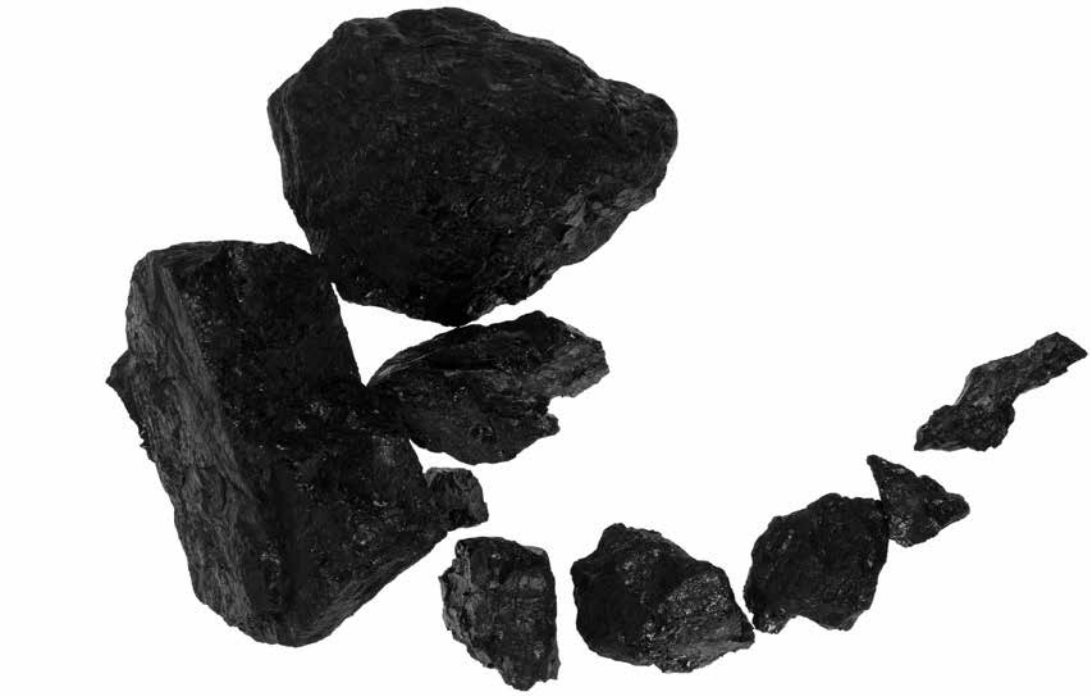
Coal is a brown or black sedimentary rock that can be burned for energy. It is a nonrenewable energy source because it takes millions of years to form.

There was a time some 300 million years ago when swampy forests partly covered the Earth. Over millions of years, dead plants in these vast primeval forests were covered by layers and layers of dirt and water. The pressure and heat from the top layers turned the dead plants from those swampy forests into coal.

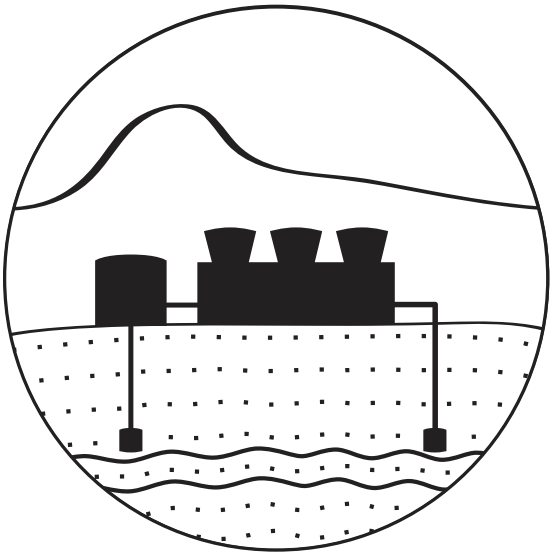
Coal miners use large machines to remove coal from the ground. Many U.S. coal beds are near the ground's surface, and about two-thirds of U.S. coal production comes from surface mines. Modern mining methods allow coal miners to easily reach most of the nation's coal reserves.

Coal is the fossil fuel that is used to generate about 37 percent of the electricity used in the U.S. There are impacts on the environment when fossil fuels are extracted, processed, stored, delivered, and burned in power plants. Air pollution and greenhouse gas (GHG) emissions that contribute to global climate change are some of the impacts.

Coal, oil (petroleum), and natural gas are at the present time the primary energy sources used in the United States and around the world. Oil, coal, and natural gas are known as fossil fuels.



Geothermal Energy



For thousands of years, humans have enjoyed the benefits of hot springs—hot water which "springs" from deep inside the Earth. The Romans in ancient times bathed in water from hot springs. Many people still do today.

Springs are places where hot water comes to the surface from a source inside the Earth. Hot water coming out of springs has been warmed by the natural heat of molten rocks deep under the surface of the Earth. Very, very deep in the ground, when water and these molten rocks touch, the water becomes hot and gushes to the surface along with hot steam. Old Faithful is a geyser in Yellowstone Park, Wyoming, where hot steam gushes out every 60–110 minutes. Geyser is a word that comes from Iceland, where the word geyser means gush.

Miners digging for coal know that the deeper you dig down into the Earth, the hotter it gets. It is hotter because of the heat that radiates from the Earth's molten core. This is the heat used by geothermal energy plants to generate electricity. It is the energy in hot steam that is used to turn turbines and generators to make electricity. This renewable energy source from the Earth is called geothermal. The word geothermal comes from two Greek words, geo for Earth and therme for heat.

In some areas, the heated underground water rises naturally to the surface. Where this does not occur naturally, bore holes are drilled and cold water is pumped underground and heated by the hot rocks. The hot water is returned to the surface to turn the turbines and generators to generate electricity. The earliest type of geothermal plant, called the dry steam power plant, takes steam directly from the Earth and delivers it up to large turbines and generators to produce electricity.

The most common type of plant in use today, the flash steam plant, pumps hot water under high pressure to power generation equipment at the surface, where it becomes steam. The steam (vapor) drives a turbine which, in turn, drives a generator to produce electricity.

Most geothermal resources and power plants in the United States are located in the Western states. California is the largest generator of electricity from geothermal energy in the U.S.

The Geysers comprise 45 square miles between the borders of Lake and Sonoma counties. They are the largest complex of geothermal plants in the world.

Hydropower

Hydropower is electricity that is generated by the flow of water. We can witness the incredible power of moving water by watching a river rushing by after a heavy rain. Waterfalls cascading down cliffs also illustrate the tremendous power of water.

This power of water has been used for many hundreds of years to do things like grinding wheat into flour and even to cut wood. However, it was not until about 1880 in the U.S. that the power of water was used to generate electricity. It is the kinetic energy of this moving water that is used to generate electricity. The process usually begins with dams that capture and store river water in large reservoirs. These hydroelectric dams trap the flowing water and then release it again under great pressure. This pressure of the water flow turns a turbine (a large revolving wheel) that then turns a generator. The generator is a machine that contains coils of wire and powerful magnets. When the wire coils are spinning quickly inside the magnets, electricity is produced.

In order for electricity to be generated, the water has to move with enough speed and volume to move the generator. The difference in height between the upstream and downstream water levels and the strength of the water flow will both affect the amount of electricity that is generated.

Hydropower, or hydroelectricity, is a renewable energy source because water is a natural resource. Hydropower produces more electricity in the U.S. than any of the other renewable energy sources.

Natural Gas

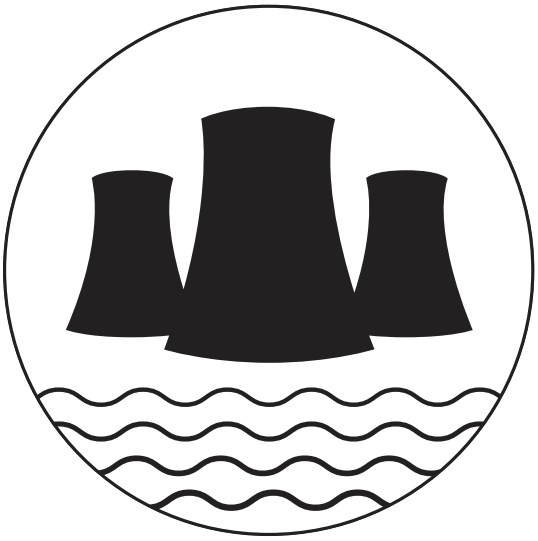
Natural gas is an air-like substance found in the Earth that can be burned for heat or fuel. It is formed from the organic remains of marine organisms buried on the ocean floor for millions of years. It is believed that the heat and pressure of the Earth changed what was organic living material into natural gas. Since it takes millions of years to form, natural gas cannot be replenished easily and is a nonrenewable resource.

Natural gas is captured via a well, where pressure helps it rise to the surface. The gas is cleaned by removing sand, dust, and water. For safety purposes, an odor is added to natural gas so leaks can be detected.

Natural gas is used to generate electricity in power plants. About 30 percent of our electricity uses natural gas as an energy source. This energy source is also used directly in homes and other buildings for heating and cooking. This gas is pumped through underground pipes directly to where it is being used.

Coal, oil (petroleum), and natural gas are at the present time the primary energy sources used in the United States and around the world. Oil, coal, and natural gas are fossil fuels.

Nuclear (Uranium)



Nuclear energy is a form of stored energy that comes from the tiny protons and neutrons in the nucleus of an atom. Stored energy is energy that is latent and not active until certain conditions exist. At nuclear power plants, this stored energy becomes active and is released through the splitting of uranium atoms. Nuclear energy creates heat through the splitting of atoms. The heat from the splitting of uranium atoms is used to heat water to produce steam, which spins large turbines that generate electricity.

Uranium is the fuel for nuclear power plants. Uranium is an element that is found in the crust of the Earth. When a uranium atom splits, energy is released from its nucleus. The process is called fission and takes place in reactors at nuclear power plants.

The first commercial nuclear power plant in the U.S. began producing electricity in 1957 in Shippingport, Pennsylvania. At present, nuclear power provides about 19 percent of all the electricity used in our country. Only coal, natural gas, and petroleum (oil) produce a greater amount of electric power used in our homes, schools, and businesses. California has one operating nuclear plant, Diablo Canyon, which is located near San Luis Obispo.

Petroleum (Oil)

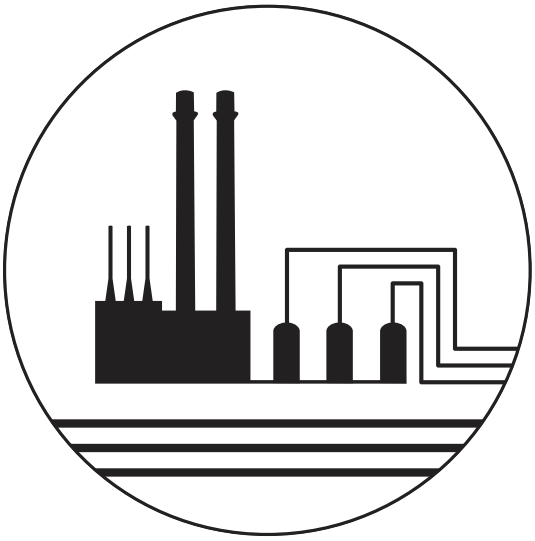
Petroleum is a natural, thick, flammable liquid that comes from the remains of plants and animals that lived over 70 million years ago. It is a fossil fuel.

Petroleum was formed from the organic remains of marine organisms buried on the ocean floor for millions of years. It is believed that the heat and pressure of the Earth changed what was organic living material into petroleum. Since it takes millions of years to form, petroleum cannot be replenished easily and is a nonrenewable resource.

Today, we drill down through layers of sand, silt, and rock to reach the rock formations that contain oil and natural gas deposits.

In the U.S., only about one percent of our electricity comes from oil (petroleum). Most of the oil used in our country is for transportation and is not used as fuel for power plants. Coal, oil (petroleum), and natural gas are at the present time the primary energy sources used in the United States and around the world.

Propane



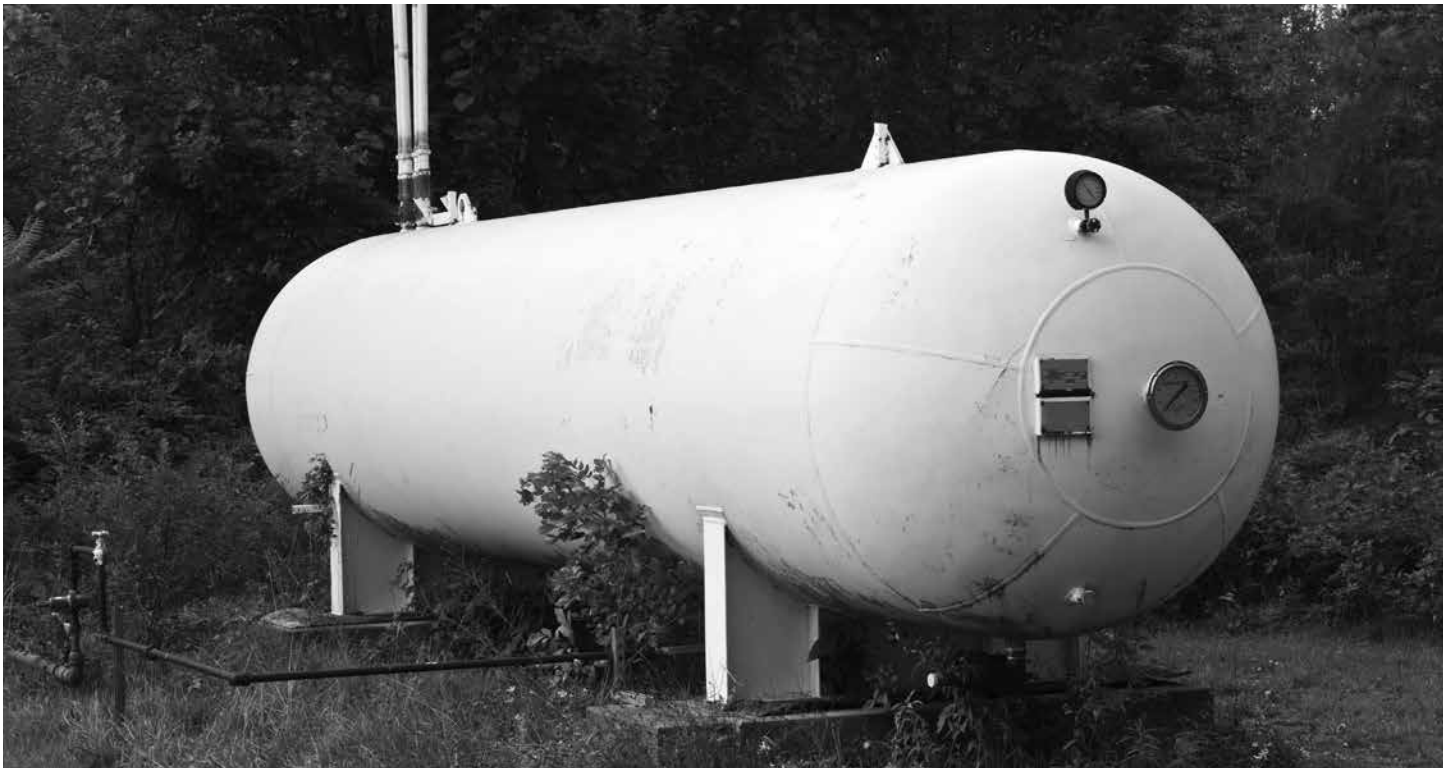
Propane is a colorless and odorless gas that is a nonrenewable energy source. Propane is also known as liquefied petroleum gas (LPG). LPG is produced as a by-product of petroleum refining and natural gas processing. During the processing of propane, it is turned into a liquid and stored in huge tanks.

In California, most homes use natural gas or electricity to provide their heat. However, in rural areas, beyond the reach of natural gas pipelines, people often use propane as a source of heat or power. Recreational vehicles use propane as well for their cooking, washing, and heating needs. Your own family might use propane in an outdoor barbecue grill or even on a camping trip.

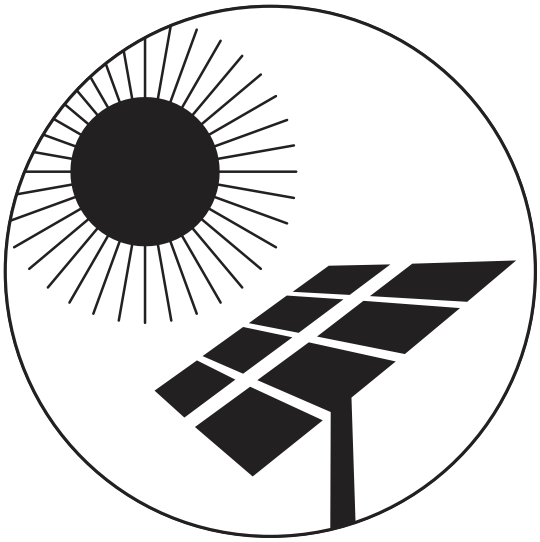
Since propane is an odorless gas, an artificial odor is added so people can easily detect this gas if it leaks. Some call the odor foul-smelling, but it is added for the safety of people using propane or working around propane tanks.

When propane is intended for home use, the fuel is delivered by truck to individual users. It is delivered as a liquid when it is pumped into smaller tanks outside the home. Before it is used as a fuel for uses such as space heating, water heating, and cooking, the liquid propane changes back into a gas.

Propane has many important uses in agriculture. It is a fuel for irrigation pumps, grain dryers, and standby generators. Propane is also used for crop drying and weed control. Besides home and agricultural uses, propane is also used to fuel some motor vehicles.



Solar Energy



Each day the sun showers the Earth with enormous amounts of renewable energy. The energy from the sun is what makes life possible on our planet. The sun, either directly or indirectly, gives us all the energy we use. The sun provides the energy in the foods we eat. Wind energy and tidal energy can power homes using the heat from the sun to generate electricity.

Solar energy can be captured and used in a variety of ways. The two main technologies for generating electricity from solar energy are photovoltaic (PV) and solar thermal. Photovoltaic (PV) cells, for example, turn the energy in sunlight directly into electricity. PV cells can be arranged on rooftops of homes and other buildings.

Solar thermal energy technology captures the sun's light to produce heat to make steam for electric power plants. Solar collectors in homes are used to heat the water for bathing and cleaning. Some homes, parks, and hotels also use this technology to heat swimming pools.

Wind Power

Humans have used the power of the wind for a very, very long time. The ancient Egyptians, for example, traveled upstream 5,000 years ago on the Nile River in wind-propelled boats with sails. European explorers in the 15th century traveled across the world to unknown destinations in ships powered only by the winds in their canvas sails. For many hundreds of years, windmills have harnessed the power of the wind mainly for the pumping of water and the grinding of grains. Today's wind turbines are no longer called windmills because they do not mill (grind) grain or pump water. These wind turbines use the power of the wind to generate electricity.

Just like windmills, wind turbines are mounted on tall towers in order to capture the most wind. At a height of 100 feet or more above ground, they are able to capture the faster and less turbulent winds. Each wind turbine usually has two or three giant propeller-like blades to collect kinetic energy—the energy from the motion of the winds. The energy from the wind turns the blades around the rotor. The rotor is connected to a main shaft, which is connected to a generator—a machine with coils of powerful magnets and wires. When spun quickly, electricity is produced. Wind turbines can be used to produce electricity for individual homes, small farms, and other buildings. Wind power that serves a number of people is generated on wind farms. Wind energy is a renewable resource.

By 2020 in California, under state law, 33 percent of electricity must be generated from renewable sources. Wind is part of this mix.

Handout 5: Energy Sources in Your Area

1. What energy sources are used to generate electricity in California?

a. Where did you find your answer?

2. What is the mix of energy sources used by the utility that serves your area?

a. Where did you find your answer?

b. List the percentages of each energy source used.

NOTES:

Activity 3:
Our Warming Planet

Overview:
This activity gives children and youths (as age appropriate) an opportunity to understand the greenhouse effect by conducting a hands-on experiment. They will learn that greenhouse gases that trap heat in the atmosphere are increasing and warming the Earth. They will also explore the connection between greenhouse gas emissions and energy use through interactive activities and discussion.

Objectives:
- Children and youths will be able to demonstrate how the greenhouse effect works.
- Children and youths will be able to explain the connections between the greenhouse effect and energy production and use.

Preparation:
- Read through the entire activity, making adjustments as necessary for the age(s) of the children and youths, group size, and session time.
- Make copies of **Earth and Its Atmosphere** (Handout 6) and **The Greenhouse Effect** (Handout 7) or each child or youth.
- Prepare a flipchart listing the following:
  biomass – Organic materials such as agricultural crops, plants, garbage, or wood that can be used for the production of energy.
  coal – A black or brownish rock that can be burned for fuel, made from the remains of plants and animals that lived over 70 million years ago.
  geothermal energy – Heat from the Earth's core that is used to generate electricity.
  hydropower – Electricity that is generated by the flow of water.
  natural gas – An air-like substance found in the Earth that can be burned for heat or fuel, made from the remains of plants and animals that lived over 70 million years ago.
  oil or petroleum – A natural, thick, flammable liquid made from the remains of plants and animals that lived over 70 million years ago.
  solar energy – Energy that comes directly from the sun.
  uranium – An element found in the crust of the Earth. The fuel for nuclear power plants comes from uranium ore.
  wind power – Electricity generated from the wind.

Materials:
- Glass jars with lids
- Plastic bags
- Thermometers
- **Earth and Its Atmosphere** (Handout 6)
- **The Greenhouse Effect** (Handout 7)
- Optional: Ice cubes

Vocabulary:
atmosphere – The whole mass of air surrounding the Earth.

climate change – Refers to any significant change in measures of climate (such as temperature, precipitation, wind) lasting for an extended period of time (decades or more).

global warming – Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, "global warming" refers to the warming of the Earth resulting from

increased emissions of greenhouse gases stemming from human activities.

greenhouse effect – The effect produced when greenhouse gases trap solar radiation in the Earth's atmosphere and warm the planet. This process occurs naturally and has kept the Earth's temperature about 60 degrees Fahrenheit warmer than it would be without it. Current life on Earth could not continue without the greenhouse effect.

greenhouse gas (GHG) – A gas, such as carbon dioxide (CO_2), methane (CH_4), or nitrous oxide (N_2O) that traps the heat of the sun in the Earth's atmosphere.

greenhouse gas emissions – A discharge of greenhouse gases (GHGs) into the atmosphere.

Activity Procedure

1. Ask children and youths if they know what greenhouse gases are. Tell them that if they don't know, it is okay because they will know about these gases at the end of this activity.
2. Divide the children and youths into groups of six. Distribute **Earth and Its Atmosphere** (Handout 6) for each group and provide them with two glass jars with lids, one plastic bag, and a thermometer.
3. Explain how they are going to conduct an experiment to see how the greenhouse effect works. They will fill the jars with cold water and place them outside for an hour. One of the jars will be inside a plastic bag, the other jar will not.
4. Ask group members to write down their predications on what will happen to the water in the two jars over time.
5. Fill each jar with two cups of cold water and have group members measure the temperature in each jar. Ask them to write down the temperatures. Ask the groups to place the jars in a sunny spot and take additional temperature readings after 30 minutes and after one hour.

Debrief Questions:

a. Ask what was the final temperature of the jar without the plastic bag and the temperature of the jar with the bag?" (The jar with the plastic bag should be warmer than the jar without the plastic bag.)
b. In our experiment, what does the glass jar represent? (the Earth)
c. In our experiment, what does the plastic bag represent? (greenhouse gases)
d. Ask the groups why they thought one jar was warmer than the other.
e. How does this experiment demonstrate the greenhouse effect?

Modification Tips:

For younger children, as age appropriate, use ice cubes in the jars instead of thermometers. Organize them into two groups or keep them in a single group. When predicting what will happen, ask them which jar will get hotter. Have them tell or draw what they think will happen.

Greenhouse Effect

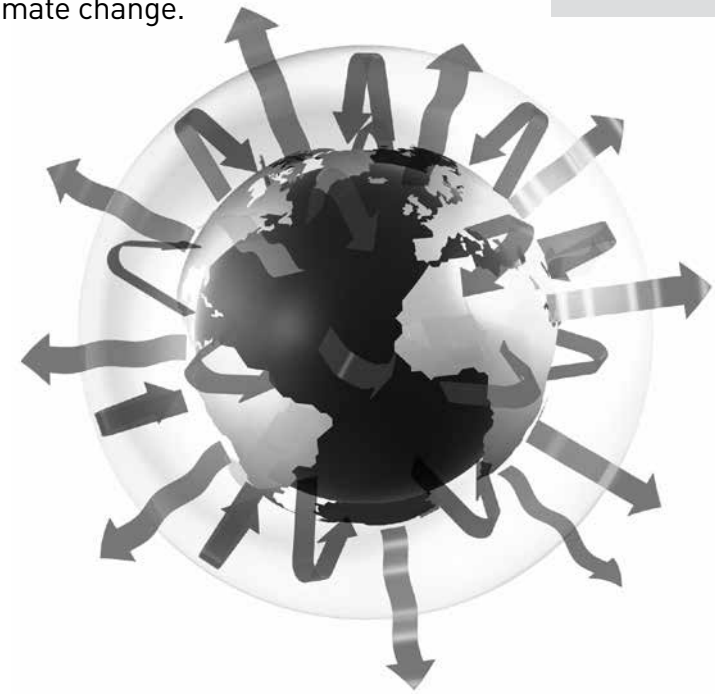
1. Distribute the **Greenhouse Effect** (Handout 7) while group members are waiting to do temperature readings on their jars. Introduce and/or review the following:
    a. Our planet is heated by the sun. When the sun's rays reach the Earth, some of the heat is absorbed by the land and water on our planet.
    b. Our atmosphere keeps some of the heat on Earth, while the rest is released back into space.
    c. We need some greenhouse gases to keep our planet warm enough to sustain life on our planet, but when there are too many greenhouse gases, not enough heat is released back out into space and our atmosphere heats up.
    d. Greenhouse gases are generated when fossil fuels such as oil, natural gas, and coal are burned to produce electricity or power motor vehicles.
    e. The heating of the Earth is contributing to global climate change.
2 . Remind children and youths of the energy sources discussed in the last activity and review the flipchart with sources and definitions.
3. Review that when generating electricity from sources such as coal or oil, greenhouse gases are released into the Earth's atmosphere. Reducing our own use and waste of electricity can help reduce the greenhouse gas emissions that are contributing to global climate change.

Debrief questions:

a. What would happen to Earth if there were no greenhouse gases at all?
b. How do we know that the Earth absorbs some of the heat of the sun?
c. Have you ever noticed what happens to the natural environment during a drought? What did you observe?
d. Can you think of ways to reduce greenhouse gas emissions? Would saving energy help?

Take-Home Activity:

Ask children and youths, as age appropriate, to talk with their family members about what they learned in this activity about the greenhouse effect. Encourage them to learn more about global climate change by doing research.



Handout 6: Earth and Its Atmosphere

My prediction: _____

_____

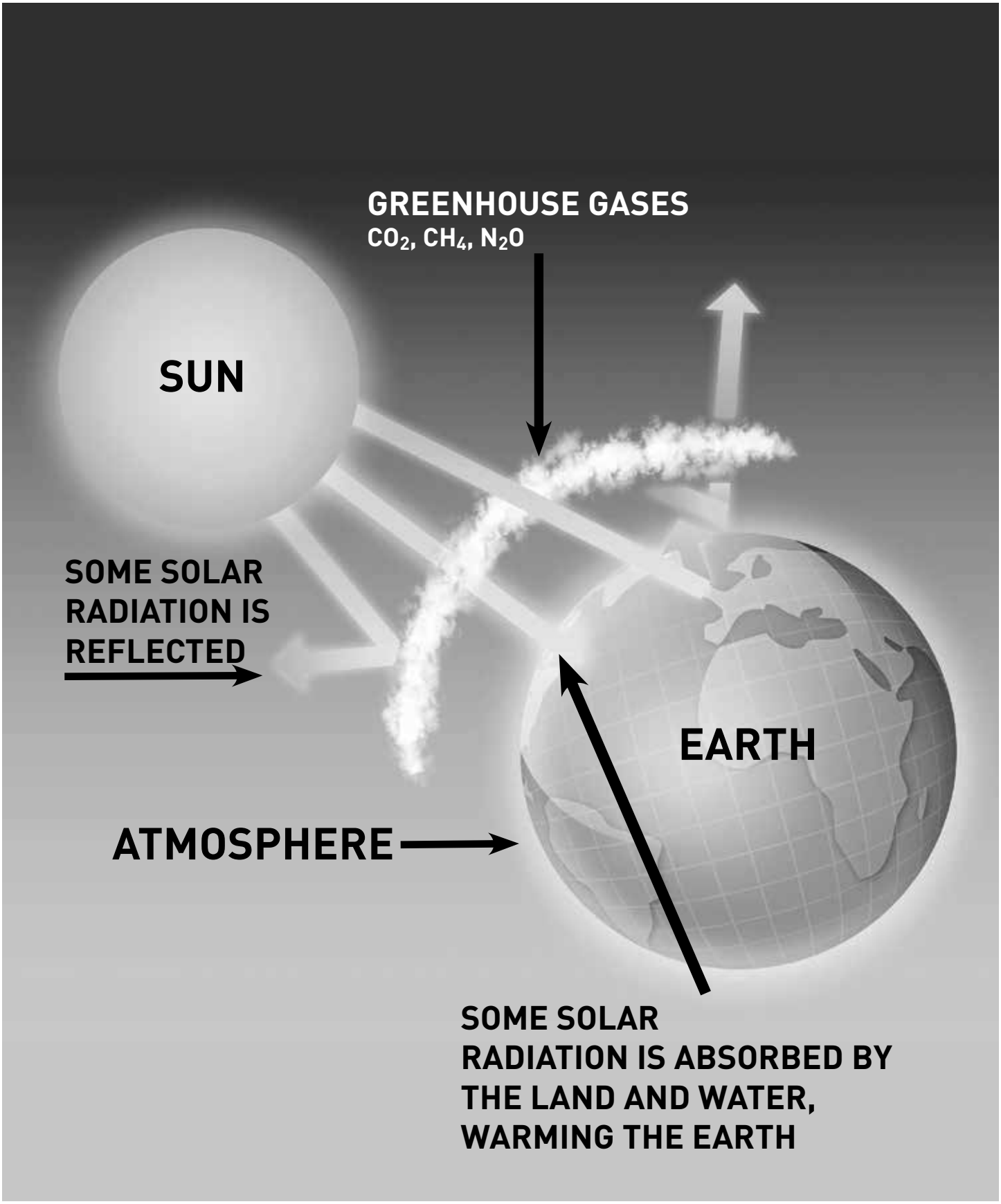
_____

_____

_____

	Jar #1 (No plastic bag)	Jar #2 (plastic bag)
Starting temperature		
Temperature reading #1		
Temperature reading #2		
Change in temperature: **(subtract reading #2 from starting temperature)**		

Handout 7:
The Greenhouse Effect



NOTES:

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