Power in South Carolina

Preparation Time:	Easy-to-do	**Moderate**	Extensive

Grade:	4 – 5 and 6 - 8
Focus:	The various forms of energy used to produce electricity in South Carolina
Subject:	Science, Social Studies
Materials:	Handouts included with this lesson
Teaching Time:	One class period plus student work
Vocabulary:	Fossil fuels, nuclear reactor, nuclear fission

Learning Objectives

In this lesson students will interpret charts, graphs, and illustrations to discover the story of power in South Carolina. Students will see how electricity is generated and distributed in South Carolina.

Materials

- Handout “Power in South Carolina”
- Copies of “The Energy FactBook: A Resource for South Carolina” (Optional: These are available from the S.C. Department of Health and Environmental Control’s Resource Center, 1-800-SO-USE-IT, or the South Carolina Energy Office, 1-800-851-8899).

Background

Excerpts from “The Energy FactBook: A Resource for South Carolina”

South Carolina is a growing state. As our economy has developed, so too have our energy needs. In the last several decades, only four states have had higher energy use rates than we in South Carolina have had. While we use energy in every sector of the economy, industry uses the most. It takes large supplies of energy to run the mills, factories and farms that make our state prosper. Industry accounts for 41.4 percent of the state’s energy use.

The transportation sector is the second largest user of energy. Being primarily a rural state, this is not surprising. We are, by necessity, a state of drivers. People in South Carolina travel extended distances to get where they need to go. It takes nearly 2 billion gallons of gasoline a year to keep South Carolinians on the move.

We use less energy in our homes. Almost 19.5 percent of the energy used in South Carolina serves to heat and cool residences, run appliances and heat swimming pools.

The commercial sector uses the least amount of energy. While this is true in most of the 50 states, South Carolina’s commercial sector uses proportionately even less. Only 14 percent of the state’s energy is used by businesses, schools and hospitals.

Now that you know how energy is used in our state, you may wonder what energy resources we have. Unfortunately, the answer is not encouraging. South Carolina does not have many natural energy resources of its own. The gasoline and other fossil fuels that make our economy grow must be imported from other states and countries. This carries a heavy price. It costs great sums of money to pay for the energy we need and use.

Our energy outlook, however, is far from dim. While we can’t do anything about our lack of natural resources, we can do something to make us less dependent on expensive, imported fuels. With this in mind, state officials and citizens alike are actively seeking ways to improve our energy situation.

Through science and conservation, we are now using proportionally less fossil fuels. More than one-third (37 percent) of the state's energy needs are met by energy resources other than fossil fuels, much better than the national average of 14.4 percent.

In the remaining chapters of "The Energy Factbook" you'll be able to read about the exciting advances being made in South Carolina. These include experiments with new fuels as well as widespread use of nuclear energy. South Carolina is diligently looking for ways to make its energy future a bright one.

Learning Procedure

1. **Ask the class:** When we switch on a light, what is the source of this power? *(Students may say power lines or power plants in general or they may be familiar with a local plant.)*

   Ask: How was this power created? (*Review with students the basics of electric power generation. You may use videos, such as Santee Cooper's* PowerHouse Tour *to review the generation process. The illustration,* Producing Electricity*, included with this lesson gives the basics.*)

   A**sk:** What can we tell about the different types of fuel sources that are used to produce electricity? *(They each create heat that is used to create steam that turns the turbine that creates electricity.)*

2. Tell the class that there is a lot that you can learn about power in South Carolina from interpreting charts, graphs and illustrations, just the way they interpreted the basic illustration, *Producing Electricity*.

   Give each student or small groups of students a copy of the handout, *Power in South Carolina*, and have them read the text and interpret the graphics to answer the questions and learn more about power in our state.

Extension Activities

1. Have students research an energy source – coal, oil, natural gas, nuclear, solar power, wind, etc. – used in creating energy. Students should be encouraged to find:

   - How was it formed (for fossil fuels) or the process that causes it (solar, etc.);
   - The availability in our state, country, world;
   - Environmental advantages/ disadvantages.

2. Have students consider a good way to reduce energy use in the state and then write several paragraphs to explain. For example, they may suggest the use of more public transportation to reduce energy used for transportation (petroleum), or ways to lower residential energy use through use of solar heating or other efficient usage practices, or ways factories could save energy.

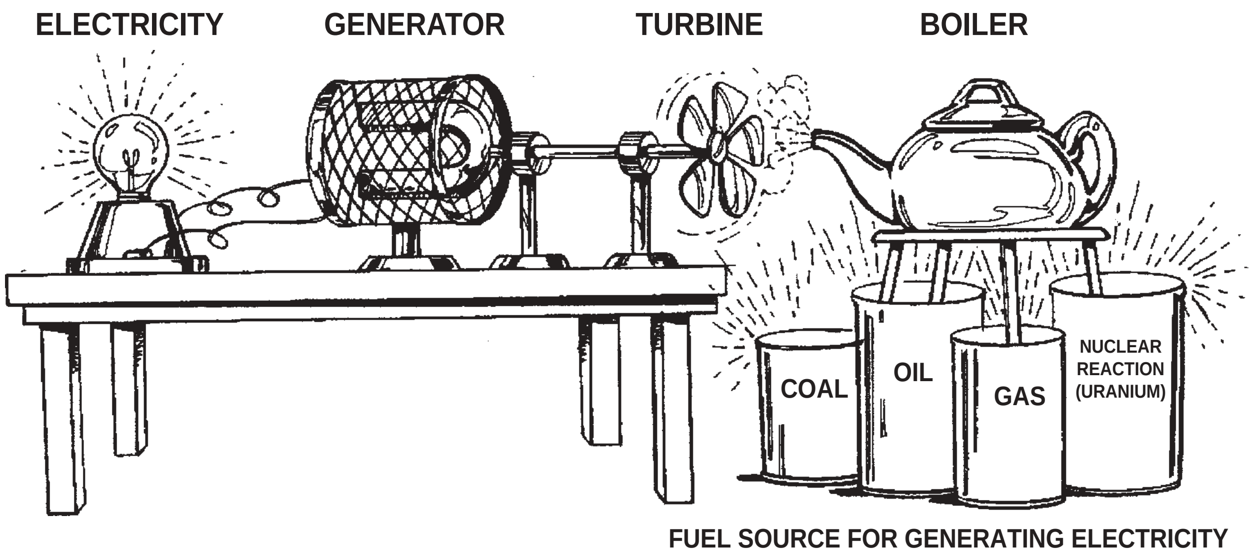
3. Have students write letters to the utility company that supplies their electricity asking about how power will be supplied in the future.

   Does your power company have any investments in renewable energy or other alternative energy technology? Why or why not?

4. Plan a field trip to a power generating facility in your area or invite a representative to come to your school.

Use energy wisely at home. Conduct a home energy audit to determine if your home is energy efficient. Your local power company can help.

Producing Electricity



Producing Electricity
Several fuel sources are used in South Carolina's electricity generating plants. Each of these fuel sources provides the heat that is used to create steam. This steam provides the power to turn the turbine that spins the magnet inside the coil, creating electricity. In South Carolina, a nuclear reaction creates the heat that provides about 60 percent of the electricity.

In hydroelectric facilities, no heat is needed. Falling water is used to spin the turbine.

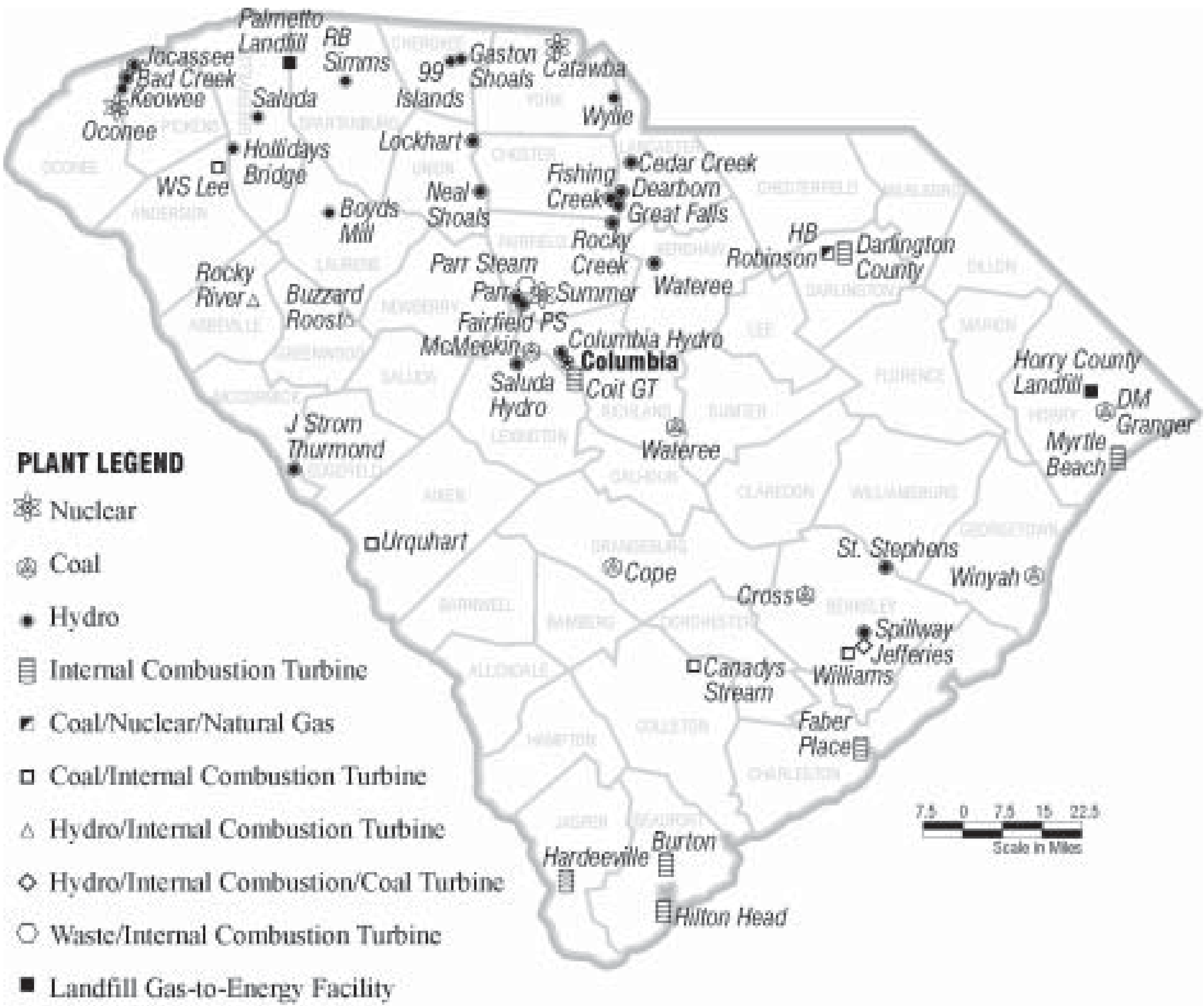
DOWN to Earth

South Carolina public schools, colleges, universities and state agencies spent over $145 millon on energy in 1998. Electricity accounted for 84 percent of this expense, while natural gas accounted for 13 percent.

Source: Energy Use in South Carolina's Public Facilities, Fiscal Year 1998

Power in South Carolina

Graphs, charts and illustrations about energy in South Carolina



Encourage your family to walk or ride bikes to nearby places.

South Carolina's Net Energy Consumption by Sector, 1999

RESIDENTIAL

Electricity	60.9 percent
Natural Gas	21.9 percent
Petroleum	10.2 percent
Biofuels	5.4 percent
Coal	1.5 percent

COMMERCIAL

Electricity	65 percent
Natural Gas	24.6 percent
Petroleum	8.3 percent
Biofuels	1.1 percent
Coal	4.1 percent

INDUSTRIAL

Electricity	24.2 percent
Natural Gas	24.1 percent
Petroleum	23.4 percent
Biofuels	16.6 percent
Coal	11.5 percent

TRANSPORTATION

Petroleum	99 percent
Natural Gas	1 percent

Source: 2001 S.C. Energy Use Profile

Use the information above to answer these questions about energy in South Carolina.

1. What are the sectors or categories of energy consumers in South Carolina?

____

2. What are the four types of energy used primarily in South Carolina?

____

3. Which sector uses the largest percentage of petroleum?

____

4. Which sector uses the largest percentage of natural gas?

____

Getting to Know Electricity in South Carolina

Use the information on the following pages of the *Energy FactBook* to answer these questions.

1. How many power plants are there in South Carolina?

2. How many nuclear plants are there in South Carolina?

3. What percentage of South Carolina's electricity is generated by nuclear power?

4. How many exclusively hydro plants are there in the state?

5. What percentage of the state's power comes from plants fueled by petroleum, natural gas or water?

6. What investor-owned company provides the most power to the people in this state?

7. Draw and label a pie chart that shows the fuel sources of the electricity generated by SCE&G.

8. What is South Carolina's public utility company?

9. How many people are served by this public-owned utility?

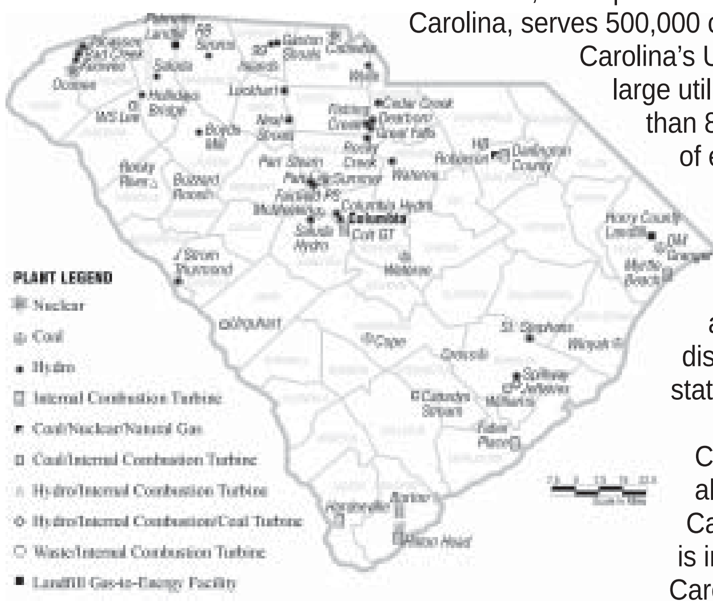
10. What percentage of electricity generated in the state is used by private homes?

11. What are "electric cities" in South Carolina?

Electricity in South Carolina

Reprinted with permission from the *Energy Factbook*

South Carolina's use of electricity continues to increase. In the past twenty years, the amount of electricity produced and used in the state has more than tripled.



As the state's economy has grown, so has its need for electricity. South Carolina power plants generate about 90 billion kilowatt hours of electricity each year. Nearly 57 percent of this electricity comes from nuclear power plants. Coal-fired plants produce almost all of the remaining electricity. Just under four percent of our electricity comes from plants powered by petroleum, natural gas or water.

South Carolina's electricity is provided by private investor-owned utilities, city-owned utilities, rural electric cooperatives and a state-owned utility.

The Investor-Owned Utilities

Four investor-owned utilities serve South Carolina: South Carolina Electric and Gas (SCE&G), Duke Power Company, Carolina Power and Light (CP&L) and Lockhart Power Company. These utilities each have an assigned service territory and a legal obligation to serve all the consumers in their territories, and are regulated by the South Carolina Public Service Commission and federal regulations. Each investor-owned utility is owned by thousands of investors who have stock in the company.

SCE&G has its headquarters in Columbia and is an important supplier of electricity in our state. It maintains 3,440 miles of transmission lines and 19,971 miles of distribution lines which serve more than 531,000 customers in the Midlands and Lowcountry. SCE&G generates and sells about 17 billion kilowatt hours of electricity each year.

Duke Power, headquartered in Charlotte, North Carolina, serves 500,000 customers in South Carolina's Upstate region. This large utility, which sells more than 82,000 gigawatt hours of electricity annually in South Carolina, maintains about 12,500 miles of transmission lines and 52,000 miles of distribution lines in the state.

CP&L, like Duke Power, also is based in North Carolina. Its headquarters is in Raleigh, North Carolina and it serves 165,000 customers in the Pee Dee region of South Carolina. CP&L sells 7 billion kilowatt hours of electricity each year in South Carolina and that electricity is sent to S.C. customers over its 1,900 miles of transmission lines and 8,123 miles of distribution lines.

Lockhart Power Company provides electric service to approximately 14,000 customers over its 90-mile transmission network. Lockhart maintains approximately 750 miles of distribution lines, sending 85 million kilowatt hours of electricity annually to its customers, and has the distinction of offering among the lowest electrical rates in South Carolina.

Santee Cooper: South Carolina's Public Utility

Santee Cooper is the state's own public utility. It was created in the 1930s to bring electricity to rural areas. When it started, less than three percent of South Carolina's farms had electricity. A decade later, Santee Cooper supplied electricity to 91 percent of the farms in the state, mostly by providing wholesale power to South Carolina's electric cooperatives.

Santee Cooper, which has its headquarters in Moncks Corner, now generates nearly 24 million megawatt hours of electricity annually. That electricity is sold to 135,000 retail customers and 15 of the state's 20 electric cooperatives. That electricity travels over 4,424 miles of transmission lines and 2,222 miles of distribution lines.

The Electric Cooperatives

About one-third of South Carolina's citizens get their power from an electric cooperative. Some co-ops are owned by the producers of the products or services they sell, but electric co-ops are owned by the users of the product (electricity). In other words, consumers also are member-owners of the co-op.

Electric cooperatives service more than 70 percent of the land area in South Carolina and serve consumers in every county in the state. Co-ops are located mostly in rural areas, small towns and suburbs of large towns. In order to reach rural locations the cooperatives have to use a lot of power lines. In fact, the co-ops use and maintain more than 82,000 miles of distribution lines, more than all other South Carolina utilities combined, in order to bring power to their more than 610,000 consumers.

S.C. electric cooperatives own power plants and also purchase almost 60 percent of the power generated by Santee Cooper. The co-ops operate on a not-for-profit basis, so all revenues above the cost of doing business are returned to the consumers in the form of capital credits.

Seventeen of South Carolina's 20 electric cooperatives are members of Touchstone Energy® - a national alliance of local, consumer-owned electric utilities committed to providing superior service and affordable rates to all customers large and small.

South Carolina's Electric Cities

South Carolina also has 22 municipal electric utilities. These 22 "electric cities" provide electricity as a public service. This electricity is often referred to as "public power." Local governments purchase electricity from investor-owned utilities and Santee Cooper at wholesale prices and then distribute the power to their customers at retail rates. Distribution systems are owned by the cities. Overall, South Carolina's electric cities sell more than 14 billion kilowatt hours of electricity to 288,000 customers each year. That electricity runs through 20,085 miles of distribution lines in order to reach its customers.

How We Use Electricity

The industrial sector uses most of the electricity produced in South Carolina. About 41.5 percent of the electricity generated goes to operate factories and mills. Most of South Carolina's industrial users of electricity are concentrated in the Piedmont counties of Greenville, Spartanburg and Anderson.

One-third of the energy produced in the state is used in private homes. Everything from the basic (refrigerators) to the frivolous (bath towel warmers) runs on electricity.

More than 13 percent of South Carolina's electric energy goes to commercial customers. Again, the biggest users are in Greenville and Spartanburg counties. Charleston County is one of the biggest users of both commercial and residential electricity.

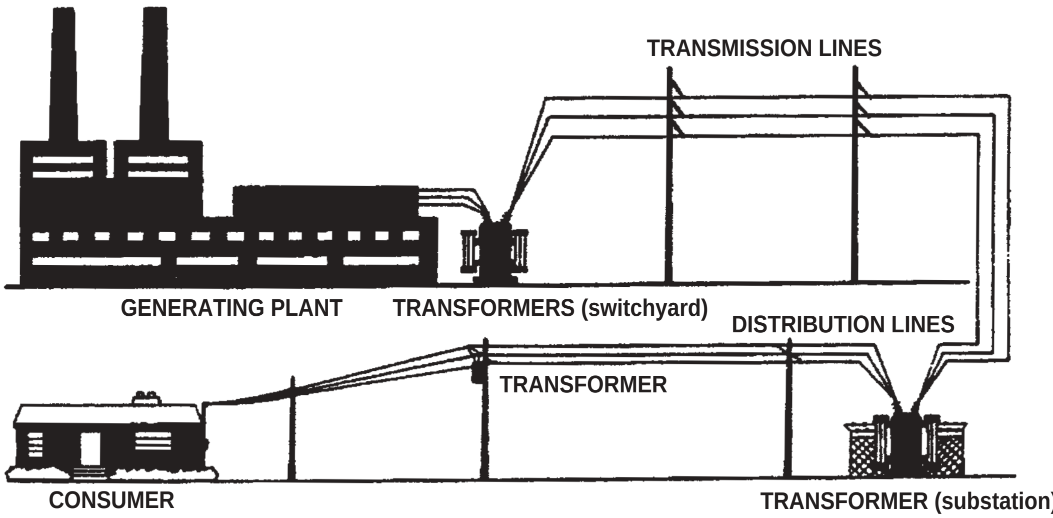
Conclusion

Electricity is an important part of South Carolina's energy past, present and future. Its utilities provide electricity to even the most rural areas. Modern technologies including the use of nuclear fuel and pumped-storage allow us to produce energy to meet the needs of all sectors of the South Carolina economy.

Turn off the dishwasher after the wash cycle. Let dishes air dry.

How Electric Energy is Transformed, Transmitted and Distributed

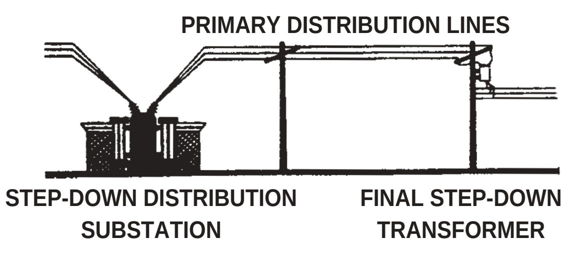
Use these illustrations to answer the questions below:

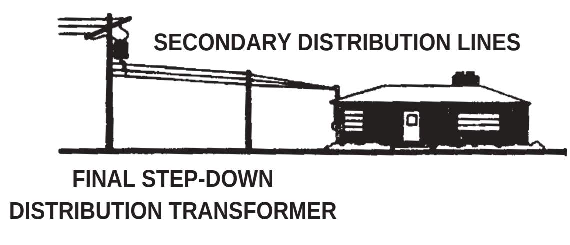


South Carolina's power plants generate over 90 billion kilowatt-hours of electricity each year. Power companies in the state maintain nearly 150,000 miles of transmission and distribution lines.

Electricity, as it comes from a turbine generator, cannot be sent directly to your house. This is because electricity flows through a wire much like water flowing through a garden hose. Unless there is pressure pushing the water through the hose, it will not comes out the other end. To get electricity through the wires to your home, it must be pushed under pressure. Voltage is the term that describes this pressure. Outside the power plant, **the switchyard has transformers that increase the voltage.** This increase in **voltage** gives the power the push it needs so that it can travel the long distances to reach homes and factories many miles away. The wires that carry this high voltage are called **transmission lines**.

When the electricity gets to your neighborhood, its voltage is too high to use in homes and factories. **At a substation, transformers reduce the voltage**. The electricity leaves the substation along wires called distribution lines. These are the lines along the streets in neighborhoods. Before the electricity comes into your house, the voltage is reduced one more time by a pole transformer.





True/False

T F 1. Transformers are used to increase and decrease the voltage of electricity as it is sent from a power plant to your home.

T F 2. The voltage of electricity is changed at substations.

T F 3. Voltage is increased when power moves from transmission lines to distribution lines.

Power In South Carolina

Use the charts, graphs, and illustrations in your handout to answer these questions about Power in South Carolina.

CIRCLE THE ANSWER

1. South Carolina depends on fossil fuels from:
   a. coal mines in South Carolina b. mines in other states c. nuclear power plants.

2. Residents use:
   a. 20 percent of the state's energy b. 50 percent of the state's energy c. 70 percent of the state's energy.

3. Fossil fuels make up:
   a. two-thirds of the state's energy b. one-third of the state's energy c. half of the state's energy.

4. The Foster Wheeler plant generates power from:
   a. nuclear fission b. coal c. municipal waste.

TRUE AND FALSE

5. _____ The residential sector in South Carolina uses more natural gas than electricity.

6. _____ The commercial sector in South Carolina uses more electricity than the residential sector.

7. _____ There are more hydroelectric plants in South Carolina than nuclear plants.

8. _____ The transportation sector is the single largest user of petroleum products.

9. _____ Transformers are used in various places in distributing power from the generation station to the consumer.

CHECK THE BOXES THAT CORRECTLY ANSWER THE QUESTIONS.
YOU MANY CHECK MORE THAN ONE FOR EACH.

10. The fuel source for generating heat in the production of electricity can be:

    _____ Coal _____ Nuclear reaction ______ Natural gas ______ Oil.

11. Check the kinds of problems caused by burning oil and coal.

    ____ Air pollution ____ Water pollution ____ Land destruction

    ____ Waste products ____ Noise pollution

12. Match the fossil fuel with its most important use:

_____ coal	a. generation of electricity
_____ petroleum	b. heating houses and stores
_____ natural gas	c. transportation

Energy from the Sun

Preparation Time:	Easy-to-do	Moderate	**Extensive**

Grade:	6 – 8
Focus:	How much energy comes to us from the sun
Subject:	Science, Math
Materials:	See list below
Teaching Time:	One class period
Vocabulary:	Solar energy, photovoltaic, active solar system, passive solar system

Learning Objectives
In this activity, students will:
- measure the amount of solar heat that comes from the sun;
- describe ways this energy might be used to help reduce our dependence on traditional fossil fuels and nuclear power.

Materials
This activity works well for small groups of students. For each student group performing the experiment, you'll need:
- two styrofoam cups
- two thermometers
- food coloring
- aluminum foil
- measuring cup
- metric ruler
- watch with second hand
- insulation materials (packing foam, shredded newspaper, etc.)
- cardboard box (should be the same height as the cups, trim the box if needed)
- cold water
- access to direct sunlight

Background
Excerpts from the *Energy Factbook, A Resource for South Carolina.*

The sun is our most powerful energy resource. It heats our planet and nourishes the plants we eat. Without the sun, we could not exist.

The energy from the sun is there for the taking. It is not only free, it never runs out. If we could harness all of the sun's energy that falls on one square meter of the Earth's surface for one hour, we could light up a whole city for one year. Also, the energy from the sun poses no environmental hazards.

The Challenge of Tapping the Sun's Energy
With these many advantages, why are we not using solar energy to meet all of our energy needs? The answer is that tapping the sun's energy is not a straightforward process.

To effectively use the sun, it must be constantly available. Yet, even under ideal weather conditions, the sun does not shine 24 hours a day, 365 days a year. To be useful, sunlight must be collected, moved to where it is needed, and stored. This is no easy challenge.

People have been using the sun's energy for thousands of years for space and water heating purposes. With the beginning of the space age, scientists were able to develop a system that converts sunlight into electricity. This is called a photovoltaic system. Utilizing the sun's energy is categorized into four main systems. These are (1) active systems, (2) passive systems, (3) photovoltaic systems, and (4) hybrid systems.

DOWN to Earth

One of the most promising solar-to-electric conversion technologies is Photovoltaic (PV) cells, made of thin layers of specially treated silicon or other semi-conductive materials that convert sunlight into electricity. The cells can be wired together to deliver a greater volume of electricity. PV technology is appealingly low-maintenance because no moving parts are required for the conversion process.

Source: Electric Power Research Institute

The last, a hybrid system is some combination of the other systems. In all of the systems, they must face the sun in order to work. We know that the sun moves across the sky during the day from the east to the west. This creates the problem of where to face the system to get the maximum amount of energy from the sun. The answer is to position the system so that it faces due south, or only slightly east or west of south.

Active Solar Systems

Active solar systems use mechanical equipment such as pumps and fans to move energy around. There are two types of active systems; one is for space heating and the other is for water heating. A house using active space heating will have to face south, with most of its windows on the south wall. This allows winter sunlight to enter the house, thereby heating the air inside. This heated air is then circulated throughout the house by fans.

When sunlight passes through glass into an enclosed space, the wavelength of the light changes. This new wavelength can not pass back through the glass, thereby entrapping it in the house. This is known as the greenhouse effect. Think of it just like getting into the car on a cold winter day and finding the inside of the car warm.

More equipment needs to be added to the system if night time heating is necessary. The air is heated in collectors and circulated through a rock bed storage compartment. This is an insulated box which contains small rocks. These rocks are heated during the day, and at night, the air inside the home is circulated through the rock bed. As it passes through the rocks, it extracts the stored heat, and heated air is circulated back through the house.

Water heating systems are more complicated than space systems and can be used year round. A collector panel is mounted on the roof (facing south). This consists of an insulated box with a clear glass or plastic cover. Inside this panel are many copper pipes and fins. These pipes are painted black to absorb and conduct the sun's heat to the water that is pumped through them.

This collector panel is attached to the water heater tank which is located inside the house. The water is circulated between the collector and the water tank by electric pumps. Cold water is pumped from the water tank to the collector, and hot water is pumped back from the collector to the water tank. Thermosensors, which recognize changes in temperature, tell the pump when to cut on and off.

Passive Solar Systems

Passive solar systems do not use any mechanical equipment to move the energy. In these systems, the actual building components become part of the system. These components, or thermal storage materials, are used to store heat during the day for use at night. Among the most commonly used thermal storage materials are tile, concrete, brick and water. All of these materials are very good at absorbing and holding heat.

As with all systems that utilize solar energy, location is a most important consideration in designing a passive solar house. To be most effective, the windows in a passive solar house must face south. In this position, they will be exposed to maximum sunlight. In addition, insulation should be placed around the glass to reduce heat loss. Windows, doors and walls need to be free of leaks so that trapped heat stays trapped.

Outside landscaping is another important part of passive solar systems. For example, evergreen trees that won't lose their leaves in winter can be planted on the north side of a home to provide winter wind protection. Trees that lose their leaves in winter can likewise be planted on the south side of a home to give it access to winter sunlight and to protect it from hot, summer sunshine.

Photovoltaic Solar Systems

Photovoltaic systems convert radiant energy from the sun into electricity. While photovoltaic technology has been around for 150 years, its actual development did not occur until 1954. It was first used in 1958 to provide electric power for U.S. spacecraft and satellites.

The cost of producing electricity through photovoltaic technology has dropped significantly in the past few years. Prices have gone from more than $50 per kilowatt to less than $0.30 per kilowatt. Photovoltaic systems, while once seen as too expensive, are becoming more commonplace.

Photovoltaic systems are often used in remote areas, where it is too expensive for power companies to bring in electric power lines. Also they are being used to light road signs and bus shelters. Researchers developing electric cars are also making use of photovoltaic technology. Scientists at York Technical College in South Carolina, for example, are among those working hard to develop this technology.

Learning Procedure

1. Review with the class the background information on solar energy. **Ask:** How can we measure solar energy? *(Solar energy is measured as heat, or calories.)*

2. Have students work in small groups to perform this experiment to measure solar energy. Have each group record their results.

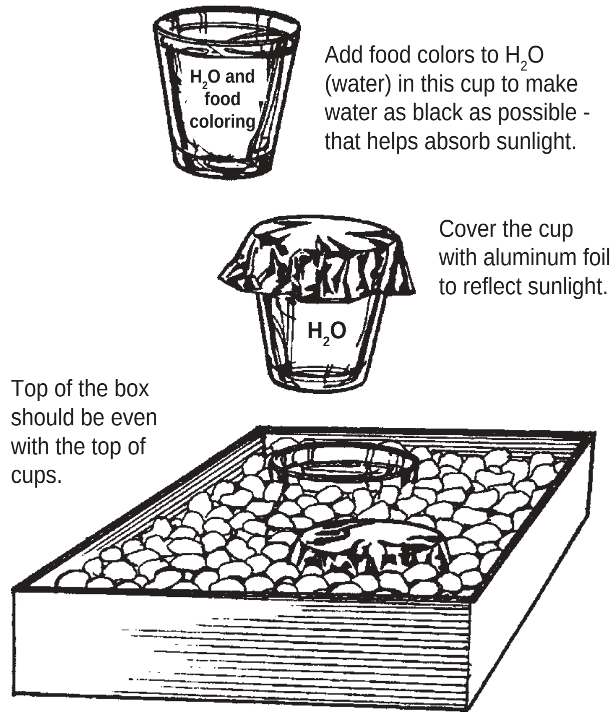
3. To set up the experiment, have students:

- Fill two foam cups with a measured amount of very cold water. (*Set a standard amount for students to use based on the size of the cups.*)

- To one of the cups of water, add several drops of food coloring to turn the water dark. (*Make the water as close to black as possible. Black absorbs sunlight.*)

- To the other cup of clear water, cover the top with a piece of aluminum foil. (This foil will reflect the sun.)

- Place the cups in the cardboard box. *(Be sure to trim the box if necessary so that the height is the same as the cups.)*



Pack insulation into all spaces around cups.

- Add insulation material around the cups. *(See illustration.)*

- Place the box in the sun for 10 minutes. The hottest time of the day is usually between 3 and 4 p.m.

- After 10 minutes, stir the water in the cups with the thermometers and record the temperatures. (*Note: these measurements should be taken at the same time.*)

- Use these results to do the following calculation to find out how many calories,

Calculation:

Area = $\frac{\pi d}{4}$ = ____________ square centimeters

Calories = $\frac{\text{ml of } H_2O \text{ in 1 cup x difference in temperature of both cups after being in the sun for 10 minutes}}{\text{Area (square centimeters) of water x 10}}$

The “calories” calculation is the same amount of solar heat received on one square centimeter in one minute at your location. Multiply x 10,000 to get results for 1 square meter.

or the amount of solar heat, received on 1 square centimeter in one minute at your location.

Scientist have measured the amount of solar energy beyond our atmosphere at about 2.0 calories per square centimeter per minute. About 1.5 calories per square centimeter per minute reaches earth after passing through atmosphere. This is the Solar Constant.

4. After the experiment, have students consider how this solar energy might be applied to their everyday lives. What inventions or modifications to existing systems do they see as practical for using solar energy? For example, could passive solar energy be used effectively by schools, since most school buildings are not used at night? What about electric school buses? Have students explain their idea and how it would save nonrenewable energy resources.

Just do it!

Select solar powered calculators and other solar powered items. They save energy and reduce waste and you never have to replace batteries!