Electricity Generation

Strand		Force, Motion and Energy
Topic		Investigating generation of electricity
Primary SOL	6.2	The student will investigate and understand basic sources of energy, their origins, transformations, and uses. Key concepts include c) nonrenewable energy sources; d) renewable energy sources; and e) energy transformations.
Related SOL	6.9	The student will investigate and understand public policy decisions relating to the environment. Key concepts include a) management of renewable resources; b) management of nonrenewable resources.

Background Information

Suggested sequence for Enhanced Scope and Sequence lessons related to SOL 6.2:

1. Energy
2. Energy Transformations
3. Energy Sources
4. Electricity Generation

Energy causes things to happen all around us. The sun gives out light and heat energy. At night, street lamps use electrical energy to make light. Cars driving by are powered by gasoline, which contains stored energy. We eat food, which has energy in it and which our bodies use to play or study. Energy makes everything happen.

Energy can be divided into two different types, depending on whether the energy is stored or moving:

- *Potential energy* is energy that is stored.
- *Kinetic energy* is energy that is moving.

Energy cannot be created or destroyed; it can only be changed, or transformed, into other forms. Some examples of the transformation of energy from one form to another are the following:

- The sun shines on a plant, which transforms the solar energy into food through the process called photosynthesis. Fortunately for us, plants often produce more food than they need, which they store in stems, roots, seeds, or fruit. We can obtain this energy directly by eating the plant itself or its products.
- Humans eat a plant, transforming the potential chemical energy stored in it into kinetic mechanical energy or into another form of potential chemical energy stored as fat.
- Potential chemical energy in flashlight batteries is transformed into electrical energy and then light energy when the flashlight is turned on.
- A car engine transforms the potential chemical energy in gasoline into heat, which creates kinetic mechanical energy to power the car.
- A toaster transforms electrical energy into thermal energy.
- A television transforms electrical energy into light and sound energy.

- A power plant transforms some form of potential or kinetic energy into electrical energy (i.e., electricity). Most power plants burn a fuel to make thermal energy. In some power plants, thermal energy is used to boil water to make steam. The steam is fed under high pressure to a turbine, which spins. The turbine's spinning shaft is connected to a turbogenerator that changes the mechanical spinning energy into electricity.

The most commonly used *sources of energy* are the following:

- **Sun.** *Solar energy* comes to Earth from the sun in two forms—heat and light. Solar radiation can be used directly to make electricity in a solar cell, or it can be changed into steam for making electricity, heating homes, or heating water.
- **Wind.** Wind, like the sun, is a source of energy that has been used by mankind throughout history. Wind is still used to turn blades on windmills, and the resulting movement can be used to pump water or produce electricity.
- **Water motion—hydro.** Moving water, such as water flowing in a stream or river or falling over a waterfall or dam can be used to generate electricity, called *hydro power.* The water turns wheels that run turbines that, in turn, run generators that make electricity.
- **Water motion—tidal.** Water in motion because of the ebb and flow of the ocean tides can also run turbines that generate electricity.
- **Earth's heat.** *Geothermal energy* is the natural heat of the Earth, originating in the interior of the Earth and flowing outward to the surface. This heat can be used in its unchanged form to heat homes, among other things, or it can be harnessed in the form of steam to turn turbines and generate electricity.
- **Fossil fuels.** Fossil fuels, like petroleum (oil), natural gas, and coal, are the results of solar energy being transformed in the distant past into potential chemical energy. These fuels are found under the ground or ocean, and it is usually necessary to drill deeply into the Earth to extract them. These fuels are used to make heat and/or electricity, as well as other products like gasoline.
- **Wood.** Wood is another example of solar energy being transformed into potential chemical energy. Unlike fossil fuels, however, it is a renewable resource, as more trees can always be grown to make more wood. When wood is burned, it gives off heat, which can be used for various purposes.
- **Atomic fuel.** *Nuclear energy* is made in power plants by splitting the nuclei of heavy atoms such as uranium. This splitting of nuclei, or *nuclear fission,* releases a very large amount of heat energy. This heat can be used to boil water and make steam, which then turns turbines to make electricity.

People and other living organisms are dependent upon many renewable and nonrenewable sources of energy, but use of these resources must be considered in terms of their cost/benefit tradeoffs. All living organisms also depend on having clean air and water—i.e., a healthy environment. Many sources of energy are managed and supplied by the private sector (private individuals and corporations), often at considerable cost to the environment. Local, state, and federal governments have significant roles in managing and protecting the environment. The need for sources of energy and the need for protecting the environment are often at odds, and the government must set priorities. Ultimately, however, resource conservation and environmental protection begin with the individual.

Materials

- Sources of Energy handout from the "Energy Sources" lesson
- Copies of the attached handouts
- Colored pencils or markers (black, orange, red, blue, yellow, green)

Vocabulary

energy transformation, kinetic energy, potential energy, source of energy

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction

1. Discuss the things students have learned from previous activities—e.g., what energy sources should be developed and why; what energy sources should be phased out and why.
2. Tell students that the following activity will help them form and defend an informed opinion of the current status of electricity generation in the United States.

Procedure

1. Have students investigate the energy sources most commonly used for electricity production in Virginia. Direct them to visit (or provide them with information from) the Virginia Naturally Web page "Virginia's Minerals & Energy Resources," or the Project NEED Web page.
2. Give each student a copy of the attached U.S. Electrical Energy Sources handout and the U.S. Electrical Energy Sources Data Table. Have students investigate the energy sources most commonly used for electricity production in the U.S. by following the directions on the handout. Have them use this data to formulate and defend opinions about energy production in the U.S.

Observations and Conclusions

1. Ask, "What conclusions can we draw from analysis of the completed map? How do the actual sources of energy being used compare with the class discussion of sources to be developed or phased out? Was anything you learned in this activity a surprise?"
2. Ask, "What implication does the conclusion of this activity have? How could the data be used to raise awareness of the need for greater use of renewable, clean energy sources in the U.S.?"

Assessment

- **Questions**
  - What are the most commonly used sources of energy in the United States?
  - Which sources of energy do you predict will be most popular in 25 years? Why?
- **Journal/Writing Prompts**
  - Describe the energy source you think the United States should use to supply the growing demand for electricity. Explain why you think this.
  - Describe energy transformations, and explain its importance in the use of sources of energy to produce electricity.

- **Other**
  - Have students make a collage poster that compares renewable and nonrenewable sources of energy.
  - Have students work in groups to demonstrate the use of a renewable energy resource as a source of energy.

Extensions and Connections (for all students)

- Brainstorm extension activities that could be used to create awareness in the community of the need for greater use of renewable, clean energy sources.
- Have students research careers relative to the evolution of energy source options.

Strategies for Differentiation

- Have students work in pairs or small groups to research the new options for fueling automobiles. Challenge teams to design a car that runs on a renewable source of energy, with special attention to refueling design.
- Have students conduct interviews of local community leaders in energy sources, using the questions and journal prompts. Have them work in pairs or small groups to report/present findings to the class.

U.S. Electrical Energy Sources

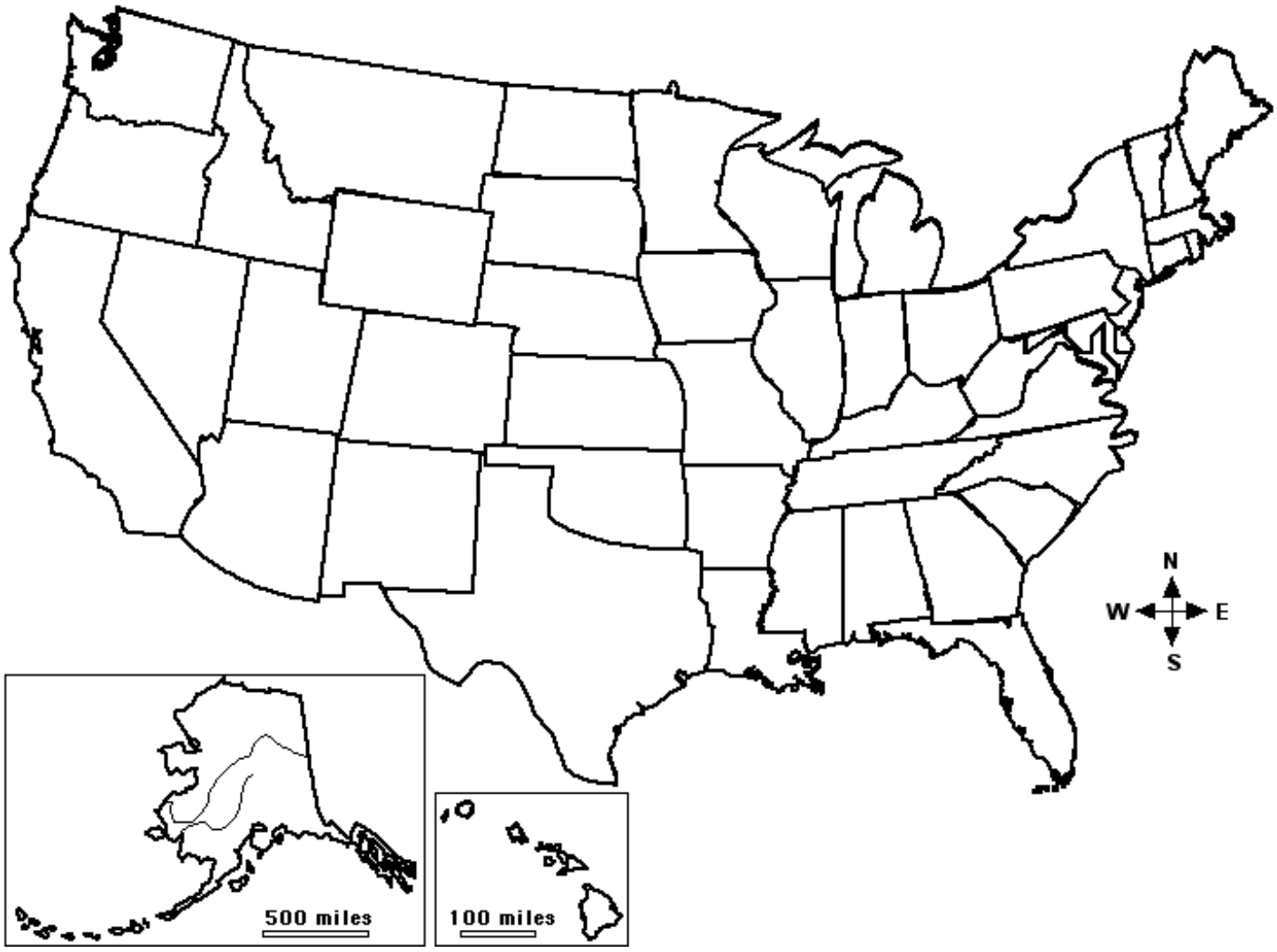
Name: _____ **Date:** _____ **Class:** _____

Directions

1. On the accompanying U.S. Electrical Energy Sources Data Table, highlight the most used energy source for each state.
2. List the state(s) that use the *most* of each of the following energy sources, and list the percentage used.

Coal:	Nuclear:
Petroleum:	Hydro:
Natural gas:	Other renewables:
Other gases:	Other:

3. Color each state on the map below to indicate its *primary* energy source—i.e., the energy source used to generate the *most* electricity in that state. Color key: coal = black; petroleum = orange; natural gas = red; hydro = blue; nuclear = yellow; other sources = green



U.S. Electrical Energy Sources Data Table

State	Coal	Petroleum	Natural Gas	Other Gases	Nuclear	Hydro	Other Renewables	Other
Alabama	58%	0%	8%	<1%	24%	7%	4%	<1%
Alaska	8%	14%	58%	0%	0%	20%	<1%	0%
Arkansas	52%	2%	6%	0%	31%	5%	3%	<1%
Arizona	45%	<1%	14%	0%	32%	9%	<1%	0%
California	0%	2%	56%	1%	17%	13%	10%	<1%
Colorado	77%	<1%	20%	0%	0%	3%	<1%	0%
Connecticut	10%	19%	14%	<1%	50%	1%	6%	0%
Delaware	50%	25%	23%	2%	0%	0%	0%	0%
Florida	36%	21%	23%	<1%	17%	<1%	3%	<1%
Georgia	63%	1%	3%	0%	28%	2%	3%	0%
Hawaii	15%	77%	0%	<1%	0%	<1%	6%	0%
Idaho	1%	<1%	16%	0%	0%	77%	6%	<1%
Iowa	85%	<1%	1%	0%	10%	2%	1%	0%
Illinois	44%	1%	2%	<1%	52%	<1%	<1%	0%
Indiana	95%	<1%	2%	2%	0%	1%	<1%	0%
Kansas	71%	1%	4%	0%	23%	<1%	0%	0%
Kentucky	95%	<1%	<1%	0%	0%	4%	0%	0%
Louisiana	24%	4%	47%	<1%	20%	<1%	3%	<1%
Massachusetts	29%	22%	31%	0%	13%	0%	5%	0%
Maryland	58%	6%	4%	1%	27%	2%	1%	0%
Maine	3%	11%	51%	<1%	0%	12%	22%	1%
Michigan	61%	1%	12%	<1%	24%	<1%	2%	<1%
Missouri	83%	1%	5%	0%	11%	1%	<1%	0%
Minnesota	66%	1%	2%	0%	24%	8%	5%	0%
Mississippi	37%	10%	32%	0%	19%	0%	<1%	0%
Montana	70%	2%	<1%	<1%	0%	27%	<1%	0%
North Carolina	62%	<1%	1%	<1%	32%	2%	2%	<1%
North Dakota	95%	<1%	<1%	<1%	0%	4%	<1%	0%
Nebraska	66%	1%	1%	0%	29%	4%	1%	0%
New Hampshire	25%	3%	1%	0%	58%	7%	7%	0%
New Jersey	16%	2%	28%	<1%	51%	0%	2%	0%
New Mexico	84%	<1%	15%	0%	0%	1%	<1%	0%
New York	16%	12%	27%	<1%	28%	15%	2%	0%
Nevada	52%	3%	34%	0%	0%	7%	4%	<1%
Ohio	87%	<1%	1%	<1%	11%	<1%	<1%	0%
Oklahoma	63%	<1%	32%	<1%	0%	4%	<1%	0%
Oregon	10%	<1%	24%	0%	0%	63%	2%	0%
Pennsylvania	56%	2%	2%	0%	38%	1%	1%	0%
Rhode Island	0%	1%	98%	0%	0%	<1%	1%	0%
South Carolina	41%	<1%	1%	<1%	55%	<1%	2%	0%
South Dakota	49%	1%	4%	0%	0%	46%	<1%	0%
Tennessee	62%	<1%	1%	<1%	30%	6%	1%	0%
Texas	37%	1%	49%	1%	1%	<1%	1%	<1%
Utah	94%	<1%	4%	1%	0%	1%	<1%	0%
Virginia	51%	8%	6%	0%	35%	0%	2%	0%
Vermont	0%	1%	<1%	<1%	76%	16%	7%	0%
Washington	11%	<1%	11%	<1%	10%	66%	2%	0%
Wisconsin	70%	1%	4%	0%	20%	3%	2%	0%
West Virginia	98%	<1%	<1%	<1%	0%	1%	<1%	<1%
Wyoming	96%	<1%	1%	<1%	0%	2%	1%	<1%
U.S. TOTAL	**51%**	**3%**	**17%**	**2%**	**21%**	**6%**	**2%**	**<1%**

Source: National Energy Information Center, United States Department of Energy. 2001 data released in March 2003 report