Energy Transformations

Strand		Force, Motion, and Energy
Topic		Investigating transformation of energy into electricity
Primary SOL	6.2	The student will investigate and understand basic sources of energy, their origins, transformations, and uses. Key concepts include e) energy transformations.
Related SOL	6.2	The student will investigate and understand basic sources of energy, their origins, transformations, and uses. Key concepts include b) the role of the sun in the formation of most energy sources on Earth.
	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
- Large index cards
- White drawing paper

Vocabulary

energy transformation, nonrenewable, renewable

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

1. Explain the process of generating electricity. (Numerous Web sites provide information on this process and provide graphics.)
2. Lead a class discussion in which you list the steps in the process of generating electricity in a power plant using a fossil fuel (petroleum, natural gas, or coal). Be sure to remind students that the sun is the original source of the energy stored in the fuel. Write each step on a large index card.
3. Divide the class into groups, distribute one card to each group, and have the members of each group illustrate their step on drawing paper.
4. Have the groups present their illustrations *in order of the process* and describe their steps.

Assessment

- **Questions**
  - What transformations of energy take place during the process of generating electricity from fossil fuels?
  - How can you compare and contrast the three common fossil fuels (petroleum, natural gas, and coal) used as energy sources for the generation of electricity? What are the advantages and disadvantages of each fuel?
  - Using your Sources of Energy chart, how can you compare and contrast the generation of electricity using the other energy sources? Which sources use similar techniques? Which sources use unique processes?
- **Journal/Writing Prompts**
  - List the steps for the generation of electricity from the renewable energy sources—i.e., sun, wind, water motion (hydro and tidal), and Earth's heat.
  - Explain how extensive the use of each of the renewable energy sources is. Explain the advantages and disadvantages of using each source.
- **Other**
  - Have students follow the same process of step illustration and discussion for the production of electricity from each of the other energy sources.

Extensions and Connections (for all students)

- Have students investigate the reasons that wood is not used as an energy source for the generation of electricity. Have them investigate biomass—a new technology similar to wood that is being developed for this purpose.

Strategies for Differentiation

- Have students act out each source as a lead-in to giving an explanation of how it is used to generate electricity, as follows:
  - Wind: Students might blow air loudly.
  - Sun: Students might hold hands out with fingers spread, suggesting radiant energy.
  - Water: Students might enact a wave.
  - Coal: Students might simulate digging with a shovel.
  - Oil: Students might simulate the pumping action of an oil pump.
- Have students create a foldable to compare and contrast the three fossil fuels for Question 2 above. (A foldable is a three-dimensional graphic organizer made by folding a piece of paper into a number of sections—halves, thirds, quarters, etc.—based on the amount of information that needs to be learned. After the appropriate information is recorded in the folded sections, the foldable can then be used to help the student organize, remember, and review the information.)
- Ask students to use a compare/contrast matrix for comparing the three common fossil fuels and the advantages and disadvantages of each.
- Ask students to monitor their energy consumption at home for one week by recording the information on a graphic organizer. Then, have students combine their consumptions of energy and create a graph to represent the total amount of energy used by the class.
- Have students access the Internet to take virtual tours of power plants fueled by different fossil fuels. Have them use a table or Venn diagram to the compare and contrast elements of the tours, identifying how the different plants' processes are alike and different.