NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 1 HR 15 MINS

Electrical Energy from Source to Destination

Students analyze a diagram showing how the energy obtained from a resource gets to homes to power a light bulb. They describe the process by which electricity gets from its source to its destination, track and graph how much energy is transferred out of the system at each step, and write a statement about energy based on what they have learned.

GRADES

6 - 8

SUBJECTS

Mathematics

CONTENTS

17 Images, 4 PDFs

OVERVIEW

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For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/electrical-energy-source-destination/

Program

CONNECT! TRANSFORM THE FUTURE

DIRECTIONS

1. Activate students' prior knowledge about energy and energy sources.

Engage students in a discussion about energy. Ask:

- *What are some ways we use energy?*
- *How is the energy we use produced?*
- *Where does it come from?*

Show students the Energy Resources photo gallery, and use the images to discuss the different energy resources that are used to produce electricity. Point out coal as a fossil fuel and non-renewable energy source that is commonly used to produce electricity in the United States. Ask: *How does the energy from these resources get to our homes as electricity? Does all the energy available from the energy resource make it to our homes? Explain*. If needed, implement the modification for kinesthetic learners to model how energy escapes from the system. Explain that students will explore these questions further using a diagram.

2. Discuss the process by which energy is transformed from its original resource into electricity and transmitted to our homes.

Project the Transfer of Energy diagram for all students to see. Explain that the diagram is one way to describe the process of how energy gets from an energy source to objects that students use in their homes; for example, light bulbs. Have students look at the number of units at the start and end of the diagram. Ask: *What does the difference in number of units tell you about energy efficiency?* Elicit from students that a large amount of energy escapes from the system before it lights the bulbs in their homes. Then have students look closely at the diagram. Ask:

- *What energy resource is being used to produce electricity in this diagram?*
- *Is it a renewable energy resource or a non-renewable energy resource?*
- *Where is the energy from the coal transformed into electricity?*
- *How does that electricity get to our homes?*
- *In the diagram, how is the electricity used?*

Invite volunteers to describe the process shown in the diagram in their own words. Discuss the process as a class, pointing out that this is just one example of an energy resource being used to produce electricity. Point out that the amount of electricity used by a light bulb will depend greatly on the type of light bulb, which is one of the reasons that many people are switching to newer, more efficient types of lighting, such as incandescent bulbs. As you discuss each step, have a student volunteer come up and number that step on the diagram. When you reach the last step, have a student add arrows to show how the energy flows from one point to another on the diagram. Have the student use a color other than red or yellow to distinguish the energy flow from the diagram.

3. Have students identify and chart the energy that escapes the system at each step of the process.

Divide students into pairs. Distribute the Electrical Energy worksheet to each pair. Have partners look at the projected diagram again. Point out the yellow arrows on the diagram and ask students what they might mean. Explain that "energy loss" means that energy escapes the system as heat or as other forms of energy, not that the energy disappears or is destroyed. Explain that one type of energy can be transformed into other types of energy. In an electrical system like the one shown in the diagram, energy can be transformed into heat or other forms of energy other than electricity. When this happens, that energy is transferred out of the electrical system and cannot be used as electricity to do things like power a light bulb or a computer. Using the diagram, begin with the information at the power plant (Step 1) and demonstrate how to record energy in, energy out, and energy transformed into other forms of energy on the worksheet. Have students complete the chart.

4. Have students create bar graphs showing the amount of energy available at each step of the process.

Distribute the Transfer of Energy from Power Plant to Home worksheet. Explain that students will create a graph using the data from the diagram. If necessary, remind students how a bar graph works. Read the worksheet directions out loud. Demonstrate how to make the graph using the data for energy going into the power plant. Have students work with their partners to complete the graph. Create a large version of the graph on the board by having four student volunteers each add one bar. Introduce the concept of energy efficiency by explaining that the more efficient something is, the less initial energy it takes to do a given

task over a given time, such as power a light bulb for seven days. Ask students to use their bar graph to identify the most and least efficient parts of the system about which they have been learning.

5. Have students write an argument based on what they learned.

Have students refer to the Transfer of Energy diagram and the Transfer of Energy from Power Plant to Home and Electrical Energy worksheets. Ask students to make a statement about energy based on the diagram. Accept a few answers and write them on the board so all students can see them. Select one or two statements, and ask students if they can offer evidence—a fact from their notes, the reading, or the diagram—to back up each statement. Explain that students should each write a statement about energy based on what they have learned and back it up using specific facts from the reading and diagram. Have each student draw and label a diagram to accompany his or her argument.

6. Have students work in small groups to answer the guiding questions.

Divide students into small groups. Read the guiding questions again, and ask students to discuss them. Have each group report their answers to the class.

TipTeacher Tip

Create a word wall of new vocabulary terms for students to refer to during discussions and the writing assignment.

TipTeacher Tip

In Step 3, remind students that although the reading and the diagram focus on coal, there are several other possible sources for producing electricity.

TipTeacher Tip

Make sure that students understand what is meant by “energy loss” in this context. Energy is not destroyed in the process, but rather transformed along the way into other forms of energy that are not harnessed for use.

Modification

For kinesthetic learners, use a simulation to demonstrate how electrical energy escapes the system as it is transferred and transformed. Have students stand in a line. Measure three tablespoons of salt (or rice) into the first student's hand. Have students pass the salt down the line and measure how much remains at the end. Be sure to point out that although the salt that escaped their hands along the way was not destroyed, it was not available for use at the end.

Informal Assessment

Use the provided answer keys to the worksheets Electrical Energy and Transfer of Energy from Power Plant to Home to assess students' bar graphs.

When assessing students' written arguments, look for students to note that most of the available energy they began with is transformed into other forms of energy in the process of turning coal into electricity, transmitting the electricity to a home, and using the electricity to power a light bulb. Students should include actual numbers from the graph to support their response.

The response should include some of the information below:

Most of the energy in coal is transformed into other forms of energy before it reaches a home in the form of electricity. For example, in order to end up with 2 units of energy to power an incandescent light bulb, you have to start with enough coal for 100 units of energy. In the process of transforming coal into electricity, more than half the energy (64 units) is transformed into heat. That leaves us with 34 units of available energy. This number is reduced to 32 units as the electricity travels along power lines. From the 32 units available to power an incandescent bulb, only 2 units are actually used to power the light bulb. The rest (30 units) are transformed into heat.

Extending the Learning

- Have students work with their families to complete a scavenger hunt for items discussed in the activity. Students should find: low-voltage power lines, higher-voltage power lines, the

location of the nearest power plant on a map, and an electrical meter.
- Have students investigate how wind and water are used to generate electricity. Ask them to create a chart to show ways in which the process is similar to and different from generating electricity by burning coal.
- Have students research the conversion efficiencies of other energy resources, such as wind, hydropower, or natural gas. Have them investigate the efficiencies of different types of light bulbs, such as CFLs and LEDs. Have them recreate the Transfer of Energy diagram using the data for a different energy resource and a different type of light bulb and compare the results.

OBJECTIVES

Subjects & Disciplines

- Mathematics

Learning Objectives

Students will:

- create a bar graph from the information in the Transfer of Energy diagram showing the amount of electrical energy available in each step from source to destination
- determine energy in, energy out, and amount of energy transformed into different forms of energy at each step in an energy transfer process
- draw conclusions about electrical energy from the Transfer of Energy diagram
- formulate and write an argument explaining their observations and supporting it with evidence from the data

Teaching Approach

- Learning-for-use

Teaching Methods

- Discussions
- Information organization
- Reading

- Writing

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
- Critical Thinking Skills
  - Applying
- Science and Engineering Practices
  - Analyzing and interpreting data
  - Engaging in argument from evidence

National Standards, Principles, and Practices

ENERGY LITERACY ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

• **Fundamental Concept 1.4:**
Energy available to do useful work decreases as it is transferred from system to system.
• **Fundamental Concept 4.4:**
Humans transport energy from place to place.

NATIONAL SCIENCE EDUCATION STANDARDS

• **(5-8) Standard B-3:**
Transfer of energy

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Craft and Structure, RST.6-8.4
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**

Integration of Knowledge and Ideas, RST.6-8.7

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Pencils
- Multi-colored dry erase markers
- Salt or rice (3 TBSP)
- Writing paper

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per classroom, Projector

PHYSICAL SPACE

- Classroom

GROUPING

- Large-group instruction

BACKGROUND & VOCABULARY

Background Information

As of 2011, 68% of electricity in the United States comes from the burning of fossil fuels, including coal, oil, and natural gas. Coal makes up about 42% of the sources used to generate electricity, while natural gas accounts for 25%, nuclear energy accounts for 19%, hydropower for 8%, other renewables for 5%, and petroleum for 1%. Energy is stored in a fossil fuel as chemical energy. Electricity is generated when a fossil fuel is burned. For example, coal is mined, brought to a power plant, crushed, and burned to produce thermal energy. That thermal energy is used to heat water and create steam, which turns a turbine. The turbine spins a magnet inside a coil of heavy copper wire to produce electricity. Electricity travels along a

system of wires called the electrical grid. As the electricity leaves the power plant, it first goes through a transformer, which increases the voltage of the electricity. A higher voltage allows for a more efficient transfer of electricity over long distances. When the electricity gets closer to homes and businesses, it goes through another set of transformers to decrease the voltage for safe use.

Much of the energy originally stored in coal is transferred out of the electrical system as it is transformed into electrical energy, transferred to its destination, and then transformed into other useful forms of energy such as light or thermal energy. In this context, “energy loss” refers to energy that escapes the electrical system. Energy does not disappear, nor is it destroyed. Rather, energy is transformed into other types of energy, such as heat, and transferred out of the electric system. Since it is no longer available to be used to power lights, computers, etc., it is considered “lost” to the system. Losses also occur when electricity is generated by renewable resources, such as wind or solar energy.

Improving efficiency at all points of the process of getting electricity to our homes and businesses can help to improve our overall energy outlook. Some approaches to increasing efficiency include improving how energy is transformed into electricity and the development of more efficient ways to store energy. Improvements to the electrical grid, such as the use of superconducting cables and grid modernization, can also improve efficiency. Energy efficiency measures taken at homes and businesses can also have a big effect on overall energy use. These measures can be simple, such as turning off lights when they are not in use or using more energy efficient appliances. They can also be more complex, such as reusing the thermal energy that is normally wasted in manufacturing processes to generate electricity. Efficiency measures of all kinds can help to reduce the amount of energy resources humans need.

Prior Knowledge

["Energy Literacy Principle 1: Energy is a physical quantity that follows precise natural laws.","Energy Literacy Principle 2: Physical processes on Earth are the result of energy flow through the Earth system.","<a href=\"http://energy.gov/eere/education/energy-literacy-essential-principles-and-

fundamental-concepts-energy-education\">Energy Literacy Principle 3: Biological processes depend on energy flow through the Earth system."]

Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
argument	*noun*	reason or set of reasons given with the aim of persuading others that an action or idea is right or wrong.
bar graph	*noun*	graph using parallel bars of varying lengths to compare and contrast data.
electrical energy	*noun*	energy associated with the changes between atomic particles (electrons).
electrical system	*noun*	groups of electrical components connected to carry out some operation.
electricity	*noun*	set of physical phenomena associated with the presence and flow of electric charge.
energy	*noun*	capacity to do work.
energy efficiency	*noun*	use of a relatively small amount of energy for a given task, purpose, or service; achieving a specific output with less energy input.
energy resource	*noun*	source of energy found in nature that has not been subject to any human-induced energy transfers or transformations; for example, oil, coal, gas, wind, or sunlight.
energy source	*noun*	location in which the energy resource (oil, coal, gas, wind, etc.) is converted into electrical energy.
evidence	*noun*	data that can be measured, observed, examined, and analyzed to support a conclusion.
fossil fuel	*noun*	coal, oil, or natural gas. Fossil fuels formed from the remains of ancient plants and animals.
grid modernization	*noun*	improving an electricity grid system by using digital technologies to monitor and control electricity flow, coordinate between electricity producers and users, maximize efficiency and reliability, and minimize cost.

Term	Part of Speech	Definition
incandescent	*adjective*	a type of electric light in which light is produced by a filament heated by electric current.
non-renewable energy	*noun*	energy resources that are exhaustible relative to the human life span, such as gas, coal, or petroleum.
power grid	*noun*	network of cables or other devices through which electricity is delivered to consumers. Also called an electrical grid.
power plant	*noun*	industrial facility for the generation of electric energy.
renewable energy	*noun*	energy obtained from sources that are virtually inexhaustible and replenish naturally over small time scales relative to the human life span.
transform	*verb*	to change in appearance or purpose.
transmit	*verb*	to pass along information or communicate.

For Further Exploration

Articles & Profiles

- National Geographic Magazine: Electrical Grid

Interactives

- National Geographic Environment: Light Bulb Savings Calculator

Maps

- National Geographic Environment: Global Electricity Outlook
- National Geographic Maps: Energy Realities

Websites

- U.S. EIA: Energy Kids—Electricity in the U.S.

PARTNER