NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 45 MINS

Electricity: Sources and Challenges

Students explore real-world data to learn about electricity consumption trends worldwide. They watch a video to discover how different energy sources are transformed into electricity. Then they use an interactive map with data from the Energy Information Administration (EIA) to investigate the sources of electricity in their state (and across the United States) from 2001 to 2011.

GRADES

7 - 12+

SUBJECTS

Earth Science

CONTENTS

2 Images, 2 Links

OVERVIEW

Students explore real-world data to learn about electricity consumption trends worldwide. They watch a video to discover how different energy sources are transformed into electricity. Then they use an interactive map with data from the Energy Information Administration (EIA) to investigate the sources of electricity in their state (and across the United States) from 2001 to 2011.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/electricity-sources-and-challenges/

Content Created by

DIRECTIONS

1. Activate students' prior knowledge about sources of electricity.

Show the pie charts in **U.S. Electricity Usage 2001-2011.** (In media carousel; click the download arrow lower right.) Tell students electricity in the United States is generated from many different sources. Ask:

- *How did the United States' usage of coal change between 2001 and 2011?* (Coal usage decreased.)
- *How did the United States' usage of nuclear power change between 2001 and 2011?* (Nuclear power usage stayed about the same.)
- *How did the United States' usage of natural gas change between 2001 and 2011?* (Natural gas usage increased.)

Inform students they will be exploring how electricity is produced in the 50 states.

2. Discuss the role of uncertainty in the scientific process.

State that science is a process of learning how the world works and that scientists do not know the "right" answers when they start to investigate a question. Show students the **Load Forecast** graphs. (In media carousel; click the download arrow lower right.) Let them know that in the graph they can see examples of scientists' uncertainty in forecasting electrical demand (load). Ask:

- *Did the scientists forecast the power demand exactly?* (No. The red line fluctuates above and below zero, showing that sometimes, the forecast load was higher than the actual load and sometimes the forecast load was lower than the actual load.)
- *Why do you think scientists did not accurately predict the forecast load?* (Student answers will vary. One reason actual load could have been higher is if the temperature was higher or

lower than forecast. This could lead people to use more or less air conditioning or heat than was forecast.)

Tell students they will be asked questions about the certainty of their predictions and they will need to think about what scientific data is available as they assess their certainty with their answers. Encourage students to discuss the scientific evidence with each other to better assess their level of certainty with their predictions.

3. Have students launch the Electricity: Sources and Challenges interactive.

Provide students with the link to the Electricity: Sources and Challenges interactive. Divide students into groups of two or three, with two being the ideal grouping to allow students to share computer work stations. Tell students they will be working through a series of pages of data with questions related to the data. Ask students to work through the interactive in their groups, discussing and responding to questions as they go.

NOTE: You can access the Answer Key for students' questions—and save students' data for online grading—through a free registration on the High-Adventure Science portal page.

Tell students this is Activity 2 in the **What Are Our Energy Choices?** lesson.

4. Discuss the issues.
After students have completed the activity, bring the groups back together and lead a discussion focusing on these questions:

- *How is electricity generated from coal, natural gas, and biomass?* (The coal, natural gas, and biomass are burned. The energy trapped in their chemical bonds is turned into heat energy. The heat energy is used to heat water to steam. The steam is used to spin a turbine, turning the heat energy into mechanical energy. The spinning turbine magnets generate an electrical current in the wires around the turbine. The electrical energy travels through the power lines to homes and businesses.)

- *What energy transformations happen once electricity arrives at your home?* (The electrical energy is transformed into heat energy [electric space heaters, toasters, electric ovens], light energy [lighting], sound energy [radios], and mechanical energy [fans].)

- *Why isn't electricity demand constant?* (There are fluctuations in electricity demand because people use electricity for heating and cooling purposes. Air conditioners and

heating are not used equally across all months of the year. Even on a daily basis, electricity demand is not constant. Less electricity is used at night when most people are sleeping.)

- *What sources are used to generate electricity in your state?* (Answers will vary. Use the interactive **Electricity Generation Sources in the United States** to explore electricity generation sources in your state and others from 2001 to 2011.)

- *How do you think electricity generation will change in the future?* (Answers will vary. Renewable energy sources may increase. Fossil fuel sources may decrease. Nuclear power may decrease. There are many uncertainties about the energy landscape for the future.)

TipTeacher Tip

To save students' data for grading online, register your class for free at the High-Adventure Science portal page.

Tip

This activity is part of a sequence of activities in the What Are Our Energy Choices? lesson. The activities work best if used **in sequence**.

Modification

This activity may be used individually or in groups of two or three students. It may also be modified for a whole-class format. If using as a whole-class activity, use an LCD projector or interactive whiteboard to project the activity. Turn embedded questions into class discussions. Uncertainty items allow for classroom debates over the evidence.

Alternative Assessment

1. Check students' comprehension by asking them the following questions:

- What energy conversions happen to generate electricity from coal?
- What energy conversions happen in your home?
- How did electricity generation change in the United States from 2001 to 2011?

2. Use the answer key to check students' answers on embedded assessments.

OBJECTIVES

Subjects & Disciplines

Earth Science

Learning Objectives

Students will:

- explain how energy is converted from one form to another in the generation of electricity
- describe how electricity generation sources in the United States changed from 2001 to 2011

Teaching Approach

- Learning-for-use

Teaching Methods

- Discussions
- Multimedia instruction
- Self-paced learning
- Visual instruction
- Writing

Skills Summary

This activity targets the following skills:

- Critical Thinking Skills
  - Analyzing
  - Evaluating
  - Understanding
- Science and Engineering Practices
  - Analyzing and interpreting data
  - Asking questions (for science) and defining problems (for engineering)
  - Constructing explanations (for science) and designing solutions (for engineering)

- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information
- Using mathematics and computational thinking

National Standards, Principles, and Practices

NATIONAL SCIENCE EDUCATION STANDARDS

• **(5-8) Standard A-1:**
Abilities necessary to do scientific inquiry
• **(5-8) Standard A-2:**
Understandings about scientific inquiry
• **(5-8) Standard E-2:**
Understandings about science and technology
• **(5-8) Standard F-5:**
Science and technology in society
• **(5-8) Standard G-1:**
Science as a human endeavor
• **(9-12) Standard A-1:**
Abilities necessary to do scientific inquiry
• **(9-12) Standard A-2:**
Understandings about scientific inquiry
• **(9-12) Standard B-5:**
Conservation of energy and increase in disorder
• **(9-12) Standard D-1:**
Energy in the earth system
• **(9-12) Standard E-1:**
Abilities of technological design
• **(9-12) Standard E-2:**
Understandings about science and technology
• **(9-12) Standard F-3:**
Natural resources
• **(9-12) Standard F-6:**
Science and technology in local, national, and global challenges
• **(9-12) Standard G-1:**
Science as a human endeavor

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.6-8.3
- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.9-10.1
- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Craft and Structure, RST.9-10.4
- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.6-8.1
- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.11-12.1
- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.11-12.3
- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Craft and Structure, RST.11-12.4
- **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:**
Key Ideas and Details, RST.9-10.3

ISTE STANDARDS FOR STUDENTS (ISTE STANDARDS*S)

- **Standard 3:**
Research and Information Fluency
- **Standard 4:**
Critical Thinking, Problem Solving, and Decision Making

NEXT GENERATION SCIENCE STANDARDS

- **Crosscutting Concept 1:**
Patterns
- **Crosscutting Concept 3:**
Scale, proportion, and quantity
- **Crosscutting Concept 5:**
Energy and matter: Flows, cycles, and conservation
- **Crosscutting Concept 7:**

Stability and change

• **HS. Earth and Human Activity:**

HS-ESS3-2. Evaluating competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

• **Science and Engineering Practice 1:**

Asking questions and defining problems

• **Science and Engineering Practice 4:**

Analyzing and interpreting data

• **Science and Engineering Practice 5:**

Using mathematics and computational thinking

• **Science and Engineering Practice 6:**

Constructing explanations and designing solutions

• **Science and Engineering Practice 7:**

Engaging in argument from evidence

• **Science and Engineering Practice 8:**

Obtaining, evaluating, and communicating information.

Preparation

What You'll Need

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per learner, 1 computer per small group, Interactive whiteboard, Projector

PHYSICAL SPACE

- Classroom
- Computer lab
- Media Center/Library

GROUPING

- Heterogeneous grouping
- Homogeneous grouping
- Large-group instruction
- Small-group instruction

Background Information

Electricity is generated from many different sources. Most methods of generating electricity involve water. Coal, natural gas, biomass, and oil are burned to generate heat. The chemical energy stored in the bonds is turned into heat energy. Nuclear power heats water as a result of atomic decay. The heat energy is used to heat water, which is turned to steam, which turns turbines. Thus, the heat energy is turned into mechanical energy. The mechanical energy spins the turbines, and the spinning action of the copper wire generates electricity. Thus, the chemical energy in the bonds of coal, natural gas, biomass, and oil and the nuclear energy in uranium is turned into heat energy, mechanical energy, and finally electrical energy that can flow through power wires into houses to do work. In the house, the electrical energy is transformed again to power electrical devices.

In hydropower and wind operations, the water and wind turn the turbine directly—a transformation of mechanical energy into electrical energy as the spinning turbine generates electricity. Solar energy can be used to generate electricity in two different ways. One way involves heating water to spin a turbine. The other way, commonly seen on rooftops, involves direct generation of electricity. The solar energy moves electrons on a silicon panel, turning light energy into electrical energy in a single step.

The demand for electricity has increased. More people around the world are gaining access to electricity. The energy sources for electricity generation in the United States changed between 2001 and 2011. The amount of natural gas used to generate electricity has increased, while coal use has declined. More renewable energy sources are being used. What sources will generate electricity in the future?

Prior Knowledge

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Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
consumption	*noun*	process of using goods and services.
electricity	*noun*	set of physical phenomena associated with the presence and flow of electric charge.
kilowatt-hour	*noun*	(kWh) unit of energy equal to 1,000 watt hours.
megawatt hour	*noun*	equal to 1,000 kilowatt hours (Kwh), or 1,000 kilowatts of electricity used continuously for one hour. One megawatt-hour equals one million (1,000,000) watt-hours or 3,600,000,000 joules.
model, computational	*noun*	a mathematical model that requires extensive computational resources to study the behavior of a complex system by computer simulation.
renewable resource	*noun*	resource that can replenish itself at a similar rate to its use by people.

For Further Exploration

Reference

- National Geographic Encyclopedic Entry: geothermal energy
- National Geographic Encyclopedic Entry: tidal energy
- National Geographic Encyclopedic Entry: hydroelectric energy
- National Geographic Encyclopedic Entry: nuclear energy
- National Geographic Encyclopedic Entry: coal
- National Geographic Encyclopedic Entry: natural gas
- National Geographic Encyclopedic Entry: oil shale
- National Geographic Encyclopedic Entry: petroleum
- National Geographic Encyclopedic Entry: renewable energy

Video

- National Geographic Video: Energy 101: Solar PV
- National Geographic Video: Energy 101: Wind Turbines
- National Geographic Video: Solar Power

- National Geographic Video: Energy Conservation

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