RESOURCE LIBRARY
ACTIVITY : 45 MINS

Energy Efficiency

Students explore data from the Energy Information Administration (EIA) on electricity flows and electricity consumption in the United States. Using the data, students propose how electricity generation and use can be made more efficient.

GRADES

7 - 12+

SUBJECTS

Earth Science

CONTENTS

1 Image, 1 Link

OVERVIEW

Students explore data from the Energy Information Administration (EIA) on electricity flows and electricity consumption in the United States. Using the data, students propose how electricity generation and use can be made more efficient.

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

Content Created by

The Concord Consortium

DIRECTIONS

1. Activate students' prior knowledge about the energy efficiency.

Show the **Electricity Flow Graph**. (In the media carousel; click the download arrow lower right.) Tell students that not all of the electricity that is generated makes it to homes and businesses. Ask:

- *How much of the electricity is lost?* (According to the graph, 26.03 quadrillion BTUs go to conversion losses. The blue lines show the proportion of each generating source that is lost during energy conversion.)

- *Where does the lost energy go?* (Converting between different forms of energy is not efficient. The "lost" energy goes to heat.)

- *How do you think the amount of electricity losses can be minimized?* (Answers will vary. The number of conversions between different types of energy can be minimized. The waste heat can be recovered to make more electricity or to heat homes and businesses.)

- *Why are there transmission and delivery losses from the generated electricity?* (Resistance in the wires can reduce the efficiency of transmission. At the power plants, the voltage is increased to transmit electricity over long distances. Nearer to consumers, the voltage is decreased. Transformers are not 10 percent efficient at up-converting and down-converting voltages.)

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

Tell students science is a process of learning how the world works and scientists do not know the “right” answers when they start to investigate a question. In science, sources of uncertainty arise for a variety of reasons: Natural systems are inherently variable, measuring things comes with uncertainty, and predicting the future is arguably imperfect. Talk to students about the theory “tragedy of the commons,” where "individuals, acting independently and rationally according to each one's self-interest, behave contrary to the whole group's long-term best interests by depleting some common resource." For example, a common area is used for grazing cows; each person grazes all of their cattle there, and eventually, the grass is all gone. Ask:

- *Could the people have predicted that the cattle would eat all of the grass?* (It is difficult for them to have predicted that everyone would take maximum advantage of the common resource.)

- *Do you think it is possible to know in advance how much energy you need?* (Student answers will vary. There are ratings on electrical devices that tell the maximum amount of electricity used. You can make predictions about how long you will need to use each device.)

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 Energy Efficiency interactive.

Provide students with the link to the Energy Efficiency interactive. Divide students into groups of two or three, with two being the ideal grouping to allow students to share computer workstations. Tell students they will be working through a series of pages of models with questions related to the models and encourage them to work through the activity 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 6 of **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. Ask:

- *During what season is electricity usage the highest?* (Summer usage is highest because of air conditioner use.)
- *How could people use electricity more efficiently in the summer?* (They could insulate their homes and businesses so that cooling losses are minimized. They could prevent solar gain

by closing shades during the day. They could keep the thermostat set higher to reduce the load on the air conditioner. They could use fans instead of air conditioners.)

- *How can your school be made more efficient?* (Answers will vary. Insulation, using electricity only when clearly needed, and unplugging unused devices could make a building more efficient.)
- *How does energy efficiency affect the electrical grid?* (If energy is used more efficiently, less energy will be needed. This lowers the stress on the electrical grid, and less electricity needs to be generated.)
- *Is it better for the environment to put solar panels on your roof or be more energy efficient?* (Energy efficiency is better than solar panels on your roof. Solar panels are intermittent, so you still need to rely on the electrical grid to provide a steady supply of electricity.)
- *What do you think the energy mix for electricity generation will be in the future?* (Answers will vary. Students should back up their answers with reasons for why the energy mix would change.)

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.

Informal Assessment

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

- How can electricity losses be minimized?
- How can buildings be made more energy efficient?
- What can you do to avoid needing to build new power plants in your state?

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

OBJECTIVES

Subjects & Disciplines

Earth Science

Learning Objectives

Students will:

- describe why useful energy is lost during energy conversions
- describe how buildings can be made more energy efficient
- explain how energy conservation can reduce the environmental impact of resource extraction

Teaching Approach

- Learning-for-use

Teaching Methods

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

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information, Communications, and Technology Literacy
  - Learning and Innovation Skills
    - Critical Thinking and Problem Solving
- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Evaluating
  - Understanding

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 B-3:**

Transfer of energy

• **(5-8) Standard E-1:**

Abilities of technological design

• **(5-8) Standard E-2:**

Understandings about science and technology

• **(5-8) Standard F-1:**

Personal health

• **(5-8) Standard F-3:**

Natural hazards

• **(5-8) Standard F-5:**

Science and technology in society

• **(5-8) Standard G-2:**

Nature of science

- **(9-12) Standard A-1**:

Abilities necessary to do scientific inquiry

- **(9-12) Standard A-2**:

Understandings about scientific inquiry

- **(9-12) Standard B-3**:

Chemical reactions

- **(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-5**:

Natural and human-induced hazards

- **(9-12) Standard F-6**:

Science and technology in local, national, and global challenges

- **(9-12) Standard G-2**:

Nature of scientific knowledge

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.9-10.1

- **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.6-8.3
• **Reading Standards for Literature 6-12**:
Key Ideas and Details, RL.9-10.3
• **Reading Standards for Literature 6-12**:
Craft and Structure, RL.9-10.4

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 2**:
Cause and effect: Mechanism and prediction
• **Crosscutting Concept 3**:
Scale, proportion, and quantity
• **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 pair, 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
- Small-group work

BACKGROUND & VOCABULARY

Background Information

The demand for electricity has increased. More people around the world are gaining access to electricity. Electricity is generated from many different sources. All electricity-generating sources have negative effects on the environment and human health. Using less electricity and using electricity more efficiently can minimize the negative effects of resource extraction and generation on the environment and human health.

Much of the generated electricity is lost before it can ever do any useful work. These losses are called conversion losses. In addition to the losses inherent in converting between different forms of energy, much of the energy is lost during transmission. Generating electricity closer to where it will be used reduces the amount of transmission losses.

Using more efficient electrical devices ensures that more of the electricity is used for useful purposes, rather than being lost as waste heat. One notable example is in lighting; incandescent bulbs get very hot when they are on. LED lighting remains cool to the touch. This is because the LEDs are more efficient at providing light. The incandescent bulbs provide light, but a large amount of the electricity used to operate them is "lost" as heat energy—electricity that was not able to be used for the primary purpose of providing light.

Prior Knowledge

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Recommended Prior Activities

- Electricity: Sources and Challenges
- Evaluating Natural Gas
- Evaluating Other Energy Sources
- Extracting Gas from Shale

Vocabulary

Term	Part of Speech	Definition
conservation	*noun*	management of a natural resource to prevent exploitation, destruction, or neglect.
efficient	*adjective*	performing a task with skill and minimal waste.
electricity	*noun*	set of physical phenomena associated with the presence and flow of electric charge.
energy consumption	*noun*	use of power, usually defined as power produced by human beings in plants run on electricity, fossil fuels, or nuclear fission.
kilowatt-hour	*noun*	(kWh) unit of energy equal to 1,000 watt hours.

Term	Part of Speech	Definition
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.
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: nuclear energy
- National Geographic Encyclopedic Entry: geothermal energy
- National Geographic Encyclopedic Entry: tidal energy
- National Geographic Encyclopedic Entry: hydroelectric 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

FUNDER

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