NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 45 MINS

Evaluating Other Energy Sources

Students analyze various energy sources, comparing the costs and benefits of natural gas, coal, biomass, nuclear, wind, hydropower, and solar power for generating electricity. Students use real-world data to evaluate the relative costs and benefits of using different fuel sources to generate electricity.

GRADES

7 - 12+

SUBJECTS

Earth Science

CONTENTS

1 Link

OVERVIEW

Students analyze various energy sources, comparing the costs and benefits of natural gas, coal, biomass, nuclear, wind, hydropower, and solar power for generating electricity. Students use real-world data to evaluate the relative costs and benefits of using different fuel sources to generate electricity.

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

Content Created by

DIRECTIONS

1. Activate students' prior knowledge about the environmental effects of extracting energy resources.

Introduce students to the idea that all electricity-generating sources have an effect on the environment. Ask:

- *What kinds of effects do different energy sources have on the environment?* (Resource extraction can affect air, water, and land resources. These resources can be contaminated [e.g., oil spills]. Resource extraction could make it impossible to use the land for other purposes [surface mining, drilling pads, windmills, solar panels]. Fossil fuel resources can pollute the atmosphere. Disposing waste can contaminate land and groundwater [natural gas, nuclear].)

Tell students that in this activity they will explore the costs and benefits of using different resources for electricity generation.

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

Discuss the concept that 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. Tell 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 of a resource there is?* (Student answers will vary. There are ways of measuring approximate amounts of resources, but it has

not been very predictive in the past [i.e. the continuing idea that we will run out of oil in a certain year, and the fact that new resources keep being discovered].)

- *Do you think it is possible to know in advance how humans use of a resource will affect the environment?* (Student answers will vary. There are some effects that are known, and there are others that are unknown. Some risks are bigger than others.)

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 Evaluating Other Energy Sources interactive.

Provide students with the link to the Evaluating Other Energy Sources 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 models with questions related to the models. Ask students 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 that this is Activity 5 of 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:

- *Which electricity-generating sources have the lowest effect on global warming?* (Energy sources that don't emit greenhouse gases have the lowest effect on global warming. These

include solar, wind, geothermal, and nuclear power.)

- *Which electricity-generating sources have effects on the water supply?* (Many electricity-generating sources have an effect on the water supply. Hydroelectric dams keep water dammed up, preventing its flow downstream. Water is used in coal, natural gas, and nuclear plants to make steam to turn the turbines. Wind and solar resources do not use water directly.)

- *What is the effect of renewable energy sources (hydroelectric, solar, and wind) on land resources?* (The renewable energy sources take up a lot of land. They are not as energy dense as fossil fuels or nuclear fuels.)

- *Which electricity-generating source is most abundant in your area?* (Answers will vary. Refer the slideshow on **page 3 of the activity** to discuss the relative abundance of electricity-generating sources in your area.)

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:

- Why is the location of a resource important in its usefulness as an electricity-generating source?
- Why is the abundance of a resource important in its usefulness as an electricity-generating source?
- Which electricity-generating sources emit greenhouse gases?
- What are the benefits of using renewable resources for electricity generation?
- What effects do different electricity-generating sources have on water supply and quality?

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

OBJECTIVES

Subjects & Disciplines

Earth Science

Learning Objectives

Students will:

- describe the effects of different electricity-generating sources on water supply quantity and quality
- describe the effects of different electricity-generating sources on air quality
- describe the effects of different electricity-generating sources on local habitats
- compare the abundance of different electricity-generating sources in a given area
- compare the energy density (how much energy per unit of area) of different electricity-generating sources

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
  - 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 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-4:**

Risks and benefits

- **(5-8) Standard F-5:**

Science and technology in society

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

Abilities necessary to do scientific inquiry

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

Understandings about scientific inquiry

- **(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-1:**

Personal and community health

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

Natural resources

- **(9-12) Standard F-4:**

Environmental quality

- **(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:**

Craft and Structure, RST.11-12.4

- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**

Key Ideas and Details, RST.9-10.3

- **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.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 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

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

MATERIALS YOU PROVIDE

- Computers with Internet connection

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

Every electricity-generating resource has costs and benefits. All electricity-generating sources have negative effects on the environment. Each electricity-generating source has some benefits. Resources can be compared based on their geographical abundance, energy density, effects on water quality, effects on air quality, and the amount of land needed for extraction and generation.

Prior Knowledge

[]

Recommended Prior Activities

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

Vocabulary

Term	Part of Speech	Definition
biomass	*noun*	living organisms, and the energy contained within them.
fossil fuel	*noun*	coal, oil, or natural gas. Fossil fuels formed from the remains of ancient plants and animals.
global warming	*noun*	increase in the average temperature of the Earth's air and oceans.
greenhouse gas	*noun*	gas in the atmosphere, such as carbon dioxide, methane, water vapor, and ozone, that absorbs solar heat reflected by the surface of the Earth, warming the atmosphere.
habitat	*noun*	environment where an organism lives throughout the year or for shorter periods of time.
hydroelectric energy	*noun*	energy generated by moving water converted to electricity. Also known as hydroelectricity.
methane	*noun*	chemical compound that is the basic ingredient of natural gas.
model, computational	*noun*	a mathematical model that requires extensive computational resources to study the behavior of a complex system by computer simulation.
natural gas	*noun*	type of fossil fuel made up mostly of the gas methane.

Term	Part of Speech	Definition
non-renewable energy	*noun*	energy resources that are exhaustible relative to the human life span, such as gas, coal, or petroleum.
renewable energy	*noun*	energy obtained from sources that are virtually inexhaustible and replenish naturally over small time scales relative to the human life span.

For Further Exploration

Articles & Profiles

- National Geographic: Daily News: Breaking Fuel From the Rock
- National Geographic Magazine: Bakken Shale Oil

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: petroleum
- National Geographic Encyclopedic Entry: renewable energy
- National Geographic Encyclopedic Entry: natural gas
- National Geographic Encyclopedic Entry: oil shale

Video

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

FUNDER

This material is based upon work supported by the National Science Foundation under Grant No. DRL-1220756. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

PARTNER

The Concord Consortium

NATIONAL GEOGRAPHIC