NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 1 HR 50 MINS

Non-Renewable Energy Resources

Students take on the roles of consumers, utility companies, and fuel companies to simulate the effect of a finite supply of non-renewable energy resources on our supply of electricity.

GRADES

4, 5

CONTENTS

16 Images, 1 Link, 5 PDFs

OVERVIEW

Students take on the roles of consumers, utility companies, and fuel companies to simulate the effect of a finite supply of non-renewable energy resources on our supply of electricity.

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

Program

DIRECTIONS

1. Have students brainstorm how they used electrical energy today.

Divide students into small groups and ask them to brainstorm some ways they used electricity today. Have small groups share some responses with the class, and list them for the class to see. If necessary, expand students' thinking of the ways they used electricity with additional

examples. Ask students where the electricity we use comes from. Ask: *What are some examples of energy resources? How are these resources converted to electrical energy?* Briefly describe the difference between renewable energy resources and non-renewable energy resources, and explain how fossil fuels form. Draw a T-chart on the board with the labels "Renewable" and "Non-Renewable." Use the Energy Resources photo gallery to show different energy resources that are used to produce electricity. As students discuss the resources, have them categorize each one as renewable or non-renewable, and place the name of each resource in the appropriate column of the T-chart.

2. Use the information from the How a Power Plant Works website to describe the basic process used to convert energy resources to electrical energy.

Check to be sure students understand the basics of how a typical power plant works before moving on to the simulation.

3. Introduce the simulation to students.

Explain that students will participate in a simulation. Describe a simulation as a type of game that can help people see something complicated or something that happens over a long time in a simpler way. Explain that in the simulation some students will represent cities, others will represent utility companies, and others will represent fuel companies. The cities will buy electrical energy from the utility companies, which in turn will buy fuel from fuel companies. Explain that cities will use payment tokens to buy electrical energy from utility companies. These companies in turn will use the payment tokens to buy fuels. Explain that in the simulation, energy chips are used to represent fuels (or energy resources). The color of a chip indicates the type of energy resource it represents (red=coal, black=petroleum, yellow=natural gas). Post a color key where everyone can see it. Show students the Payment Tokens and explain that each token can buy 100 million units/hour of electricity.

4. Assign roles to students.

Assign students the following roles:

- Kansas City (2–6 students)

- Virginia Beach (2–6 students)
- Atlanta (2–6 students)
- San Francisco (2–6 students)
- utility companies (4 students, divided into 2 pairs)
- fuel companies (4 students)

If there are more than three students assigned to a city, the students should be divided into pairs. Have students geo-locate the cities represented in the simulation on a wall map of the United States:

- Kansas City, MO (pop. 459,787)
- Virginia Beach, VA (pop. 437,994)
- Atlanta, GA (pop. 402,003)
- San Francisco, CA (pop. 805,235)

List the population of each city on the board. Ask students what they notice about the cities' populations. Ask: *Which cities have similar populations? Which do not?* Explain that how much electricity people use is measured in units/hour of electricity. In each of the states represented on the board, except California, about 14,000 units/hour of electricity is used per person each year. In California, only about half that much electricity is used per person each year. Ask students to offer ideas about why this might be the case. Encourage them to consider factors such as climate, as well as intentional measures by the people of California. Explain that in the simulation, each city needs to buy 500 million units/hour of electricity each cycle to power the homes and businesses in their city. Ask students to explain why each city will need to buy about the same amount of electricity, even though California uses less electricity/hour per person than the other states (California has a larger population). Explain that students will use payment tokens to buy the electricity their city needs. The job of the students representing the utility companies will be to accept payment tokens from the cities and provide electrical energy in exchange. The utility companies in turn pay the fuel companies, and get the fuel that will be converted into electrical energy. Fuel companies will sell their energy resources—coal, oil, and natural gas—to utility companies in exchange for payment tokens.

5. Have students set up their cities and companies.

Assign students representing the cities an area of the classroom. Give each city group at least five payment tokens. Point out the trash can or box where cities will place their energy chips once they have been used. Assign students representing the utility companies an area of the

classroom. Give them cardboard tubes to simulate the conversion of energy resources into electricity. Assign students representing the fuel companies an area of the classroom. Give the fuel companies a separate box of energy chips for each energy resource—coal (55 chips), petroleum (18 chips), or natural gas (18 chips)—that they will be selling. Have the fuel companies designate one student to accept payment tokens, and have the three remaining students each take charge of extracting one type of energy resource. Give each student in charge of extracting an energy resource an Energy Supply Chart worksheet. Demonstrate how they will track the energy resources they extract by counting the available energy resources represented by the energy chips before the first cycle and then charting the energy resources they extracted at the end of each cycle and recording them on the chart. Explain that they should leave the column for amount of energy remaining blank until the end of the simulation.

6. Model the simulation.

Distribute the Energy Use Simulation Guide to each group. Explain the process for the simulation: A city will give a utility company the required number of tokens to buy the electricity the city needs for that cycle. The utility companies will then use the tokens to buy fuels from the fuel companies. The fuel companies will "extract" energy resources (represented by energy chips) from the box and give them to the utility companies. The fuel companies will indicate the number of energy resources they sell on the Energy Supply chart. The utility companies will then "convert" the energy resources to electricity by running them through a cardboard tube and will give that electricity to the cities. The cities will simulate using that electricity by placing it in the designated trash can or box. Model this process using three student volunteers, one representing each role in the simulation. Make sure that all students understand their roles and responsibilities.

7. Run the simulation.

Before beginning the simulation, have the fuel companies count the number of energy resources (represented by energy chips) they have available and record the information on the Energy Supply chart. After conducting one cycle of the simulation, have students pause. Ask fuel company groups to chart the number of energy resources they extracted during the cycle on the Energy Supply chart. Briefly discuss with the class what happened during this cycle of the simulation. Then have students go through additional cycles of the simulation until one of the fuel companies runs out of resources. Be sure to pause after each cycle of the

simulation for a brief discussion and for fuel companies to chart the energy resources they extracted. Using the number of payment tokens and energy chips described in the preparation section, the simulation should last approximately five cycles. Toward the end of the simulation, ask students to predict what they think will happen.

8. Discuss the simulation.

Ask: *What happened to the energy resources in the simulation? Why? Do you think that we could really "run out" of energy resources?* Explain that we have limited supplies of fossil fuels and that those fuels might become more costly and difficult to extract. Ask:

- *What do you think would happen in the cities as supplies of fossil fuels become more limited or more expensive?*
- *What are some problems this would cause?*
- *What are some actions that could be taken to avoid these problems?*

9. Have students graph the results of the simulation and answer reflection questions.

Create three charts on the board, one for each energy resource used in the simulation. Each chart should include a row for start, a row for each cycle, a column for "used," and a column for "left." Enter the data from the Energy Supply Charts for coal, oil, and natural gas. Have students use these data to create the graph described on the Simulation Reflection worksheet. Then have students answer the discussion questions below the graph.

TipTeacher Tip

In Step 1, review or introduce new vocabulary with students before beginning to explain the simulation in Step 2.

TipTeacher Tip

In Step 4, students might be unfamiliar with tally marks. If so, demonstrate how to keep a running tally by making a tally mark for each energy chip as it is extracted.

TipTeacher Tip

With the exception of San Francisco, which was selected as an outlier, all selected cities have similar populations and are located in states with similar per capita energy consumption rates. Please make sure that students understand that the units/hour they purchase per cycle are based on approximations for the purpose of the simulation, and that each city does not actually use exactly the same amount of electricity.

Modification

Complete Steps 1–6 in one session; then complete the analysis and discussion in a second session.

Modification

In Step 3, assign mixed levels to each group.

Modification

In Step 8, challenge advanced students to compile the data from the Energy Supply Charts on to the master chart.

Modification

The numbers for supplies are approximate, based on a five-cycle simulation using all four cities. Increase or decrease the number of payment tokens and chips to change the number of cycles or to include more or fewer cities.

Informal Assessment

Use the provided Simulation Reflection Answer Key to assess student learning.

You can also check for student understanding during the discussion. Students should be able to describe how there were fewer energy resources available each cycle because students were using them up and they could not be replaced.

Extending the Learning

- Re-run the simulation with adjustments made for students' action ideas from the whole-class discussion. For example, set up additional renewable energy companies that students could continue to buy from when non-renewables run out, or reduce the amount of energy students need to buy if they suggest energy efficiency measures.
- Have students examine charts and graphs from the U.S. Department of Energy and the U.S. Energy Information Administration showing projections for future supplies of fossil fuels. Discuss how these projections are similar to and different from what students observed during the simulation.
- Read the book *Energy Island* by Allan Drummond aloud with students. Discuss how the people on this Danish island addressed their concerns about non-renewable resources. Provide additional books about conserving energy for students to read. Start a class list of ways to conserve energy and have students add to it as they read.

OBJECTIVES

Subjects & Disciplines

Learning Objectives

Students will:

- explain that there is a limited supply of non-renewable energy resources such as coal and natural gas
- identify potential problems related to limited supplies of non-renewable energy resources that are used to generate electricity
- identify actions that could be taken to meet the energy challenges of the future

Teaching Approach

- Learning-for-use

Teaching Methods

- Brainstorming
- Cooperative learning
- Discussions
- Simulations and games

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Critical Thinking and Problem Solving
- Geographic Skills
  - Analyzing Geographic Information
- Science and Engineering Practices
  - Developing and using models

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 6.4:**
Earth has limited energy resources.

NATIONAL GEOGRAPHY STANDARDS

• **Standard 16:**
The changes that occur in the meaning, use, distribution, and importance of resources

NATIONAL SCIENCE EDUCATION STANDARDS

• **(5-8) Standard B-3:**
Transfer of energy
• **(K-4) Standard F-3:**
Types of resources

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **Speaking and Listening Standards K-5:**
Comprehension and Collaboration, SL.3.1
• **Speaking and Listening Standards K-5:**
Comprehension and Collaboration, SL.4.1
• **Speaking and Listening Standards K-5:**
Comprehension and Collaboration, SL.5.1

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Cardboard tubes (2)
- Color key
- Pencils
- Plastic chips in 3 colors (55 red, 18 black, 18 yellow)
- Small cardboard boxes (4)
- Trash can (optional)
- Wall map of the United States
- Writing paper

REQUIRED TECHNOLOGY

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

PHYSICAL SPACE

- Classroom

SETUP

Arrange the classroom for easy movement. Designate one area for energy companies and another area for each city.

GROUPING

- Large-group instruction

OTHER NOTES

Before starting the activity:

- Print and cut out enough copies of the payment tokens for each city group to have at least five.
- Label one of the small boxes as Used Energy Resources and place it in the area the city groups will use.
- Label each of the three remaining small boxes as coal, petroleum, and natural gas (one label per box). Place 55 red chips in the coal box, 18 yellow chips in the natural gas box, and 18 black chips in the oil box.
- Create a color key showing which color chip represents which energy resource and post it.
- Place the three small cardboard boxes in the area the fuel companies will use.
- Place the cardboard tubes in the area the utility companies will use.

This activity can be completed over one or two sessions.

BACKGROUND & VOCABULARY

Background Information

The energy we use for electricity can come from a variety of renewable and non-renewable resources, all of which have advantages and limitations. Renewable resources, such as wind, water, and solar energy, can be used indefinitely; however, non-renewable resources cannot. Ancient carbon fossil fuels, including coal, petroleum, and natural gas, are non-renewable

resources. These energy resources formed from carbon-containing plants and organisms that lived hundreds of millions of years ago, mostly in the Carboniferous period. Plants died and sank to the bottom of the oceans and swamps that were common during this period. Over time, these plants were compressed by layers of sand and rock building up on top of them, eventually forming coal, oil, and natural gas. Because these resources took millions of years to form, and because the conditions under which they formed no longer exist, these resources cannot be renewed in our lifetimes.

Although our supply of these resources is finite, the majority of the electrical power in the United States is derived from fossil fuels, particularly coal. An analysis by the Colorado River Commission of Nevada estimates that the world has less than 100 years of petroleum and less than 250 years of coal left, based on current consumption rates and known supplies. Looking ahead will help governments, companies, and individuals to avoid an energy crisis in the future by devising new ways to harness energy and to make our use of energy more efficient in the present. There are a number of ways to reduce the use of fossil fuels for electricity. We can choose to use less energy, make the ways we use energy more efficient, and replace some of our fossil fuel use with renewable energy. Using a diversity of energy sources to produce electricity can help to reduce problems associated with fossil fuel use while still maintaining a steady and reliable supply of electricity. Electrical energy is measured by the kilowatt-hour (kWh). One kWh is equal to one thousand watts used for a period of one hour.

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.","Energy Literacy Principle 3: Biological processes depend on energy flow through the Earth system."]

Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
climate	*noun*	all weather conditions for a given location over a period of time.
convert	*verb*	to change from one thing to another.
electrical energy	*noun*	energy associated with the changes between atomic particles (electrons).
electricity	*noun*	set of physical phenomena associated with the presence and flow of electric charge.
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.
fossil fuel	*noun*	coal, oil, or natural gas. Fossil fuels formed from the remains of ancient plants and animals.
kilowatt-hour	*noun*	(kWh) unit of energy equal to 1,000 watt hours.
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.
simulation	*noun*	copy or reenactment.

For Further Exploration

Maps

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

Websites

- U.S. EIA: Energy Kids

FUNDER

PARTNER