Youth Education & Interpretation It's in Our Nature

The Power of Choice

MISSOURI DEPARTMENT OF NATURAL RESOURCES

GRADE LEVEL:

Upper Middle School to High School

SUBJECT AREAS:

Sciences, English Language Arts, Social Studies

DURATION:

Preparation Time: 30 minutes

Activity Time: three to four 50-minute class sessions

SETTING:

Classroom

SKILLS:

Comprehension, Application, Analysis, Synthesis, Evaluation

KEY WORDS:

Energy, Society, nonrenewable, renewable, fossil fuels, coal

SUMMARY

Students will learn about various choices in energy systems designed to provide energy to large communities. Through a role-playing activity they will participate in a community decision-making process. After researching the various choices in power production methods, the students will defend a specific approach and learn from other classmates who will advocate a different facility. The students will discover what factors are involved when choosing a power production facility to meet a community's expanding energy needs.

OBJECTIVES

THE STUDENT WILL:

- Explain how various energy systems can be used to produce electrical power
- List the positive and negative attributes of each power-producing facility
- Research, develop and communicate an argument for each type of power production approach
- Role play a community decision-making process

Extension

- Plan an integrated approach to meet a community's energy needs.

MATERIALS

- Background section on each energy type
- Pleasantville community background
- Pros and Cons graphic organizer

BACKGROUND

Energy is a critical factor in our daily lives. Humans began to manipulate energy sources thousands of years ago. With the advent of the modern industrial age our relationship with energy has become more sophisticated than ever. Energy is used to drive to work, heat and cool our homes, provide light indoors and at night, and power most of our technology-based tools. One of the most common and convenient forms of energy is electricity. With new developments in energy generating systems, energy can now be provided in ways that are renewable, while significantly reducing our impact on our natural resources.

For current statistics on Missouri's energy use, please visit the Missouri Department of economic Development Division of Energy (https://energy.mo.gov/energy/stay-informed/statistics) and the US Energy Information Administration (https://www.eia.gov/state/index.php?sid=MO#tabs-4).

NONRENEWABLE ENERGY SOURCES

Energy sources based on limited reserves created several million years ago by unique geological and physical conditions. Such reserves will eventually run out as the available deposits are depleted.

Examples:

- Petroleum (gasoline, diesel fuel, heating oil)
- Coal
- Natural gas

RENEWABLE ENERGY SOURCES

Energy sources based on natural cycles that are replenished in a relatively short time frame. These resources can be managed to provide long-term power needs and will not run out. Trees and crops can be replanted. The Sun shines each day. Rivers flow to the sea and winds can be expected to continue to blow.

Examples:

- Geothermal energy
- Solar energy
- Biomass energy
- Wind energy
- Hydropower

MAJOR ENVIRONMENTAL ISSUES RELATED TO ENERGY USE:

Global Climate Change: Warming of the planet as a result of so-called greenhouse gases. Fossil fuels produce large amounts of carbon dioxide during their use.

Air Pollution: Most metropolitan areas, including St. Louis and Kansas City, are facing problems with smog, ozone levels and a general degradation of air quality. The majority of air pollution issues are the result of energy applications such as automobile exhausts and power plant emissions.

Acid Deposition: "Acid Rain" has been linked to coal-fired power plant emissions and automobile exhausts. Acidic precipitation (rain and snow) causes damage to forest and aquatic ecosystems. As a result of prevailing weather patterns and local geology this problem is especially pronounced in the northeastern United States.

Land Disturbance and Water Quality Degradation: Mine tailings and mining land disturbance have been associated with water quality problems related to toxic metals, acidification and sedimentation.

Ecosystem Disturbance: Biological systems are often adversely impacted from energy related activities. Impacts occur during mining and drilling (Example: strip mining for coal), transport (Example: Exxon oil spill), fuel use (Example: mercury emissions from coal/related fish consumption advisories) and disposal (Example: used motor oil and water quality impacts).

PROCEDURE

WARM UP

Ask the students to discuss how their lives would change if a power outage occurred for several days.

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PART A

Review with the class renewable energy sources versus nonrenewable energy sources. Discuss with the class some of the environmental issues associated with energy production facilities.

Divide the class up into groups and assign each group one of the following categories of energy producing systems:

HYDROPOWER
WIND POWER
SOLAR POWER
NUCLEAR POWER
GEOTHERMAL POWER
BIOMASS POWER
FOSSIL FUEL POWER

Ask each group to review the Power for Pleasantville background sheet and to review the background information for their assigned power source.

The students should prepare a visual presentation showing how electrical power can be generated from their assigned power source.

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PART B

The group should generate a list of the advantages and disadvantages of their power source using the Graphic Organizer.

The instructor can help guide each group concerning the issues associated with using their assigned power source. For example: cost, aesthetics, geography, renewable / nonrenewable, and other environmental issues such as air and water quality, wastes, etc.

Instruct each group to prepare a 10-minute presentation of their energy production system. The group will be presenting their findings before a mock city council. They should use their visuals to show how electrical energy can be generated from this source and discuss the advantages and disadvantages of their power source.

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PART C

Create a mock city council. This may be made up of volunteer faculty, or one member from each student *group can be selected.* The council is charged with determining a new energy production system to be used to meet the cities growing energy needs. Have each group present their findings to the city council. At the end of the presentations the teacher should moderate a question and answer period, allowing the city council to ask each group questions concerning their power source.

Following this question and answer session, have the city council perform a closed vote. Tabulate the results and announce the city council's decision. (Alternatively, the class as a whole could be led through discussions on the final power facility choice.) Following a city council decision, ask the class as a whole to consider the following questions:

- Did the council make a well-informed decision?
- Are there any ways that a combination of various power sources could be used to provide for the city's needs?
- Who is affected by the city's choice of power (other communities, other states, etc.)?
- What is the balance between the least expensive source of power and a power source that has less impact on the environment?
- Should everyone be willing to pay more for cleaner power?

ASSESSMENT

Following the exercise the students should be able to answer the following questions:

1. List three advantages for each of the following power sources.

HYDROPOWER
WIND POWER
SOLAR POWER
NUCLEAR POWER
GEOTHERMAL POWER
BIOMASS POWER
FOSSIL FUEL POWER

2. List three disadvantages for each of the following power sources.

HYDROPOWER
WIND POWER
SOLAR POWER
NUCLEAR POWER
GEOTHERMAL POWER
BIOMASS POWER
FOSSIL FUEL POWER

3. Which power production facility would you be willing to have built near your house? (Specifically explain why)

4. What is the difference between renewable energy systems and nonrenewable energy systems?

EXTENSIONS

Have the class explore strategies to combine various power production systems to meet community power needs. For example: Missouri winds are strongest in winter. Could wind power be used in winter to balance solar power (used during the summer)?

GOING FURTHER

ENVIRONMENTAL JUSTICE

Lead the class in a discussion concerning the following issues:

- Where would they put the power plant they chose for Pleasantville?
- What part of town is appropriate?
- What impact does this have on the local residents?
- Will the more affluent residents welcome a power plant in their backyard?
- Who is often impacted by site location of industrial facilities?

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MISSOURI DEPARTMENT OF NATURAL RESOURCES

MISSOURI LEARNING STANDARDS: Grades 6-8 [K-5 Correlations]

SCIENCE GRADE LEVEL STANDARDS:

Earth and Space Sciences

ESS3 — Earth and Human Activity

Concept A: Natural Resources

- **6-8.ESS3.A.1:** Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes and human activity. [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]

Concept D: Global Climate Change

- **6-8.ESS3.D.1:** Analyze evidence of the factors that have caused the change in global temperatures over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities.]

ENGLISH LANGUAGE ARTS STANDARDS:

Writing

1. Approaching the Task as a Researcher

A. Research [K-5 correlation W3A]

- Conduct research to answer a question, drawing on several sources; integrate information using a standard citation system.

Speaking and Listening

2. Presenting

A. Verbal Delivery [K-5 correlation SL4A]

- Speak clearly, audibly, and to the point, using conventions of language as appropriate to task, purpose and audience when presenting including appropriate volume.

SOCIAL STUDIES GRADE LEVEL EXPECTATIONS:

2. Government Systems and Principals

Theme 1: Tools of Social Science Inquiry

6-8 Geography

- **A.** Using a geographic lens, analyze laws, policies and processes to determine how governmental systems affect individuals and groups in society.
- **B.** Analyze current human environmental issues using relevant geographic sources to propose solutions.

NGSS:

MS-ETS1 Engineering Design

- **MS-ETS1-1:** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- **MS-ETS1-3:** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Science and Engineering Practices

Asking Questions and Defining Problems

Asking questions and defining problems in grades 6-8 builds on grades K-5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

- Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS -ETS1-1)

Analyzing and Interpreting Data

Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints include consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1)

ETS1.B: Developing Possible Solutions

- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3)
- Sometimes part of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)

ETS1.C: Optimizing the Design Solution

- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3)

Crosscutting Concepts

Influence of Science, Engineering, and Technology on Society and the Natural World

- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1)
- The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

POWER FOR PLEASANTVILLE

Pleasantville is a city of 100,000 residents and a great place to live and work. As a result, the city is growing in population by 6 percent every year. More and more homes are being built and each of them will require electrical services. The city has traditionally supplied electrical power to its citizens using a coal-fired electrical plant that was built over 20 years ago. During the summer months when electrical demand is high, the city struggles to supply its power needs. During these peak power times the city is forced to buy power from distant power facilities at very high prices. In light of Pleasantville's growth projections, the city municipal utility has decided to build an additional power plant to meet its present and future electrical power needs.

The goals of the municipal utility are to guarantee the quality of electricity supply, while keeping rates low. The citizens of Pleasantville are proud of their community and have previously supported curbside recycling, stormwater run-off regulations and other proenvironmental initiatives. City leaders have expressed their desire to find an additional electrical power facility that can keep rates low as well as minimize environmental concerns. Sites for the future plant have been discussed, each of which is close to a major river that runs through town and all the sites are close to neighborhoods and schools.

TYPICAL PHYSICAL CHARACTERISTICS OF PLEASANTVILLE

MAJOR RIVER ON EDGE OF TOWN (75 CUBIC FEET PER MINUTE AVERAGE FLOW)

RAIL (TRAIN) SYSTEM CONNECTS TO TOWN

98 SUNNY DAYS A YEAR

103 PARTLY CLOUDY DAYS A YEAR

164 CLOUDY DAYS A YEAR

AVERAGE TEMPERATURE: 51.3 DEGREES FAHRENHEIT

86 DAYS BELOW 32 DEGREES FAHRENHEIT

20 DAYS ABOVE 90 DEGREES FAHRENHEIT

AVERAGE RAINFALL: 41.5 INCHES (3-4 INCHES A MONTH)

60 WINDY DAYS A YEAR (ABOVE 15 MILES PER HOUR; WINTER MONTHS)

SMALL HOT SPRING LOCATED IN A COMMERCIAL SPA; 102 DEGREE FAHRENHEIT

GRAPHIC ORGANIZER
Advantages

Topic:

First advantage

Reference:

Statistics and/or Support Statements:

1.

2.

3.

Second advantage

Reference:

Statistics and/or Support Statements:

1.

2.

3.

Third advantage

Reference:

Statistics and/or Support Statements:

1.

2.

3.

GRAPHIC ORGANIZER
Disadvantages

Topic:

First disadvantage

Reference:

Statistics and/or Support Statements:

1.

2.

3.

Second disadvantage

Reference:

Statistics and/or Support Statements:

1.

2.

3.

Third disadvantage

Reference:

Statistics and/or Support Statements:

1.

2.

3.