

# THE POWER OF CHOICE



Missouri  
Department of  
Natural Resources

## **GRADE LEVEL:**

Upper Middle School to  
High School

## **SUBJECT AREA:**

Sciences, Social Studies,  
Communication Arts

## **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

## **CORRELATION'S TO**

### **SHOW-ME**

### **STANDARDS:**

Performance standards  
1.1, 1.2, 1.4, 1.6, 1.10, 2.1,  
2.3 3.1 3.3 3.4 3.5, 3.6, 3.7,  
3.8, 4.1, 4.6, 4.7

Knowledge Standards

SC-1, 4, 5, 8

SS-3, 4, 5, 6

CA-6

## **SUMMARY**

*In this activity 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 STUDENTS 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.
- ✓ Roll play a community decision-making process

### *Extension*

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

## **MATERIALS**

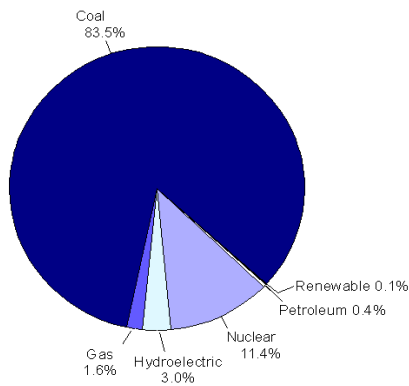
- Background section on each energy type
- Pleasantville community background
- Pros and cons graphic organizer.

## **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.

**HOW ELECTRICITY IS CURRENTLY PRODUCED IN MISSOURI BY SOURCE-U.S. DEPARTMENT OF ENERGY**



**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

Useful Facts:

- Nine out of every 10 tons of coal mined in the United States is used to generate electricity-*Energy Information Administration*
- Generating electricity from coal is not very efficient (<35 percent) with most of the energy being lost as heat or during electrical generation and transmission-*Energy Information Administration*
- Missouri spends more than \$635 million importing coal to the state-*Energy Information Administration*.
- Only 12 other states in the U.S. use more coal than Missouri - *U.S. Department of Energy*.
- Missouri generates 83.5 percent of its electrical needs using coal while the average for the rest of the United States is 54 percent. Worldwide coal is used for 55 percent of the electricity generated-*Energy Information Administration*.
- In Missouri coal-fired power plants emitted 70 million tons of carbon dioxide in 1999-*U.S. Department of Energy*
- The United States consumes 2 million tons of coal per day (equivalent to 20 pounds per person every day)-*Union of Concerned Scientists*
- Coal is actively mined in 27 states, with the leading states being Wyoming, Kentucky, W. Virginia, Pennsylvania and Texas-*U.S. Department of Energy*
- Missouri has significant deposits of coal, but the high sulfur content of Missouri coal limits its current use as an energy source.
- Natural gas meets 22 percent of the United States energy needs-*U.S. Department of Energy*

**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

Useful Facts:

- Only 7.5 percent of the energy used in the United States comes from renewable energy sources. Most of this amount is in the form of hydropower and biomass (wood burning) -*National Renewable Energy Lab*
- Wind power is the fastest growing renewable energy source in the world-*Worldwatch Institute*
- Wind power could be practically developed to provide as much as 20 percent of the United States' electrical needs-*U.S. Department of Energy*
- In areas with excellent wind resources, wind energy costs an average of 3 to 4 cents per kilowatt-hour and is now about the same as coal. Wind power may well be cheaper than coal if reductions in environmental costs

are also considered -*Journal of Science*

- The United States is the Worlds leading supplier of hydroelectric power-*Energy Information Agency*
- An estimated 28.4 billion kilowatt-hours could be generated using renewable Biomass fuels in Missouri. This is enough power to meet the needs of more than 2 million homes -*U.S. Department of Energy*
- The United States produces more than 1.4 billion gallons of ethanol from Biomass annually. Approximately 12% of the nations gasoline is now blended with ethanol -*Missouri Corn Growers Association*

### **MAJOR ENVIRONMENTAL ISSUES RELATED TO ENERGY USE:**

Global Climate Change. Warming of the planet is occurring as a result of so-called greenhouse gases. Global levels of carbon dioxide have increased 25 percent in the last 100 years. 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, low-level ozone 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 related 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, 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).

- Americans use a billion gallons of motor oil a year, with 350 million gallons (35 percent) of this oil ending up polluting the environment-*U.S. Department of Energy*
- Approximately 81 tons of mercury are produced every year by coal-fired electric plants in the United States-*Environmental Protection Agency*

- Seventy-five percent of air emission problems in Missouri are the result of energy processes such as motor fuels, coal-fired electric plants and the use of natural gas -*Missouri Environmental Improvement and Energy Resources Authority*
- Coal combustion produces 80% more carbon dioxide than natural gas and 20% more carbon dioxide emissions than fuel oils -*Energy Information Administration.*

## **PROCEDURE**

### **WARM UP**

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

## **PART A**

Review with the class renewable energy sources as 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**

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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**

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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. The teacher should 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 communities 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?



## THE POWER OF CHOICE

### 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:

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First advantage

Reference:

Statistics and/or Support Statements:

1.

2.

3.

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Second advantage

Reference:

Statistics and/or Support Statements:

1.

2.

3.

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Third advantage

Reference:

Statistics and/or Support Statements:

1.

2.

3.

**GRAPHIC ORGANIZER**  
**Disadvantages**

Topic:

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First disadvantage

Reference:

Statistics and/or Support Statements:

1.

2.

3.

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Second disadvantage

Reference:

Statistics and/or Support Statements:

1.

2.

3.

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Third disadvantage

Reference:

Statistics and/or Support Statements:

1.

2.

3.