

# COAL COOKIES

## A LIMITED RESOURCE



Missouri  
Department of  
Natural Resources

### **GRADE LEVEL:**

Elementary/Middle School

### **SUBJECT AREA:**

Sciences

### **DURATION:**

Preparation time: 20 minutes  
Activity time: one to two 50-minute class sessions

### **SETTING:**

Classroom

### **SKILLS:**

Application, Analysis,  
Synthesis, Evaluation

### **KEY WORDS:**

Raw Materials  
Nonrenewable  
Renewable  
Fossil Fuels  
Coal

### **CORRELATIONS TO SHOW-ME STANDARDS:**

Performance Standards  
1.10, 2.3 3.1 3.3 3.5 3.6 4.7

Knowledge Standards  
SC-1,5,7,8  
M-1.

### **SUMMARY**

*Students will mine a cookie for “coal” (chocolate chips) and compare the estimated amount of chocolate chip reserves with the actual amount recovered. The activity is designed to help students experience the limited nature of nonrenewable fuel resources and issues of predicting how long fossil fuel resources will last.*

### **OBJECTIVES**

#### **THE STUDENTS WILL:**

- ✓ Estimate the amount of resources, as represented by chocolate chips, found in a chocolate chip cookie.
- ✓ “Mine” the cookie to determine the actual amount of chocolate chip reserves and compare to estimated yields.

- ✓ Evaluate the environmental impact caused by coal mining and coal consumption.
- ✓ Discuss the difference between the total amount of coal available and the amount that can be practically obtained.
- ✓ Explore the difference between nonrenewable and renewable energy sources.
- ✓ Predict the role of renewable energy sources in the future.

### **MATERIALS**

#### **Per student:**

- Chocolate chip cookie (large chocolate chip type)
- Paper clip or toothpick
- Paper plate or napkin
- Small paper cup
- *Chocolate Chip Reserves Chart* for recording the estimated and actual chocolate chip amounts. (one per student)
- Question worksheet (one per student)

**BACKGROUND**

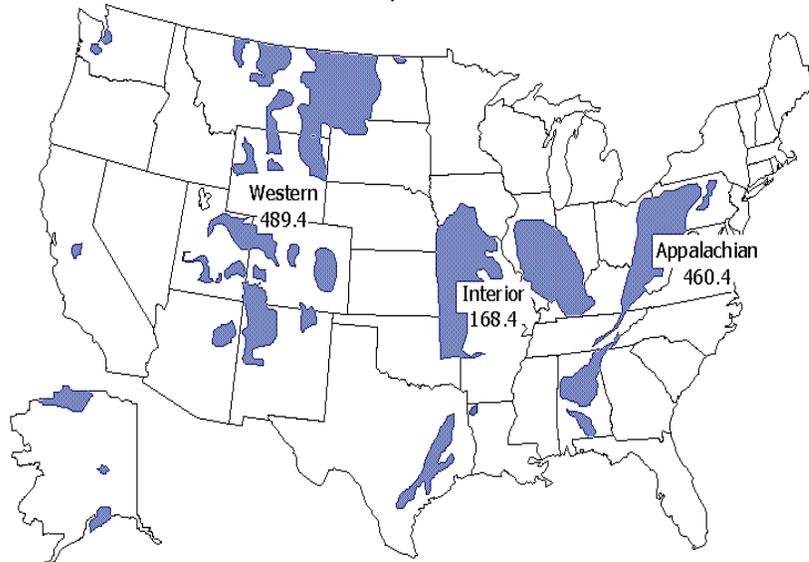
**RENEWABLE ENERGY SOURCES:**

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 of renewable energy systems include geothermal energy, solar energy, biomass energy, wind energy and hydropower.

**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. The most common of these types of fuels are often referred to as fossil fuels and include petroleum, coal, and natural gas.

U.S. Total 1,118.1 Million Short Tons



**INTRODUCTION**

As recently as 200-300 years ago humans met most of their energy needs using renewable energy sources such as wood for heat, watermills for grinding crops or wind to propel sailing vessels. Fossil fuels such as oil, gas and coal now provide the majority of the energy we use to fuel our modern technological and industrial based societies.

**CHARACTERISTICS OF COAL**

In the past coal has been used to power steamships and railroad engines, to heat homes and provide heat for steel production. Today the primary use for coal is in the

generation of electrical power. More than half the electricity generated in the United States comes from combusting coal and Missouri gets more than eighty percent of its electricity by burning coal.

Coal generates more environmental impacts than any other energy source. Coal mining disturbs large areas of land creating surface water quality problems and ecosystem impacts. Burning coal produces large amounts of air pollutants that have been linked to mercury contamination, smog, global warming and other environmental problems. High sulfur coals are especially problematic,

creating greater levels of air pollution and problems with acid rain. Although Missouri has deposits of coal, the high sulfur content prevents its use as an energy source.

## HOW LONG WILL IT LAST?

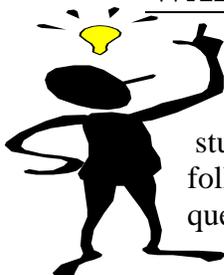
Of all the fossil fuels by far the most abundant is coal. North American coal beds are widely distributed (see map) with significant variation in the quality of the coal and its accessibility.

Estimating the exact amount of coal available and how long such reserves will last is difficult. Factors such as the current rates of consumption, the expense of mining in remote areas along with increasing environmental costs must all be considered. The United States is estimated to have enough low sulfur coal to last at least 100-200 years.

The world will not only require energy in the future, but those energy needs are predicted to grow. We will most certainly eventually run out of fossil fuels and the development of renewable energy systems such as hydroelectric, geothermal, wind and solar will only become more critical.

## PROCEDURE

### WARM UP



Set the stage by asking the students the following questions:

- *What is the difference between renewable energy sources and nonrenewable energy sources?*
- *How long will our current supplies of coal last?*
- *What are some alternative sources of energy to fossil fuels?*

Review with the class the basic concepts of *renewable* and *nonrenewable* energy sources (refer to background section). Present the class with some information on the use of coal, where coal resources in the United States are located and the environmental effects of coal mining and use.

### MINING THE COOKIE FOR COAL (CHOCOLATE CHIPS)

- Each student is given a paper plate, a chocolate chip cookie, a paper cup and a paper clip.

- Instruct the students to perform all their “mining operations” on top of the paper plate (to contain the “mining wastes”).
- Each student should first estimate the expected chocolate chip reserves that will be mined from their cookie and record this on the chocolate chip reserves chart.

*The students will estimate how much of the chart they think will be covered with chocolate chips mined from the cookie and should mark this estimation on the chart.*

- Have the students straighten-out a paper clip and begin to “mine” their cookie for chocolate chips. As the chocolate pieces are separated they should be placed in the dixie cup.

*Instruct the students not to use their hands to break the cookie but rather they should try to perform all operations using the paper clip. The students should try to separate as much of the cookie material from their chocolate chips as possible.*

- Once the students have mined all the chocolate they can from their cookie, they should pour the extracted chocolate chips onto the chart and

compare the amount recovered to their initial estimation.

- Have the students observe what is left of their cookie and discuss how this reflects the impacts of mining operations.
- Instruct the students to “clean up” their mining site by using their digestive systems to *bioremediate* the mining wastes and extracted ore deposits.

*...In other words they can eat the cookie remains along with the chocolate chips!!!*

## ASSESSMENT

Have each student answer the following questions (see question worksheet).

Alternatively these questions can be addressed during teacher led class discussions.

1. Think about how your cookie looked after you finished mining. How does this relate to environmental impacts associated with real coal mining?
2. Based on your experience *cookie*

*mining* can you explain why in actual coal mining situations some deposits of coal are more expensive to obtain?

3. Why is it difficult to predict exactly how long the fossil fuels in the earth will last?
4. Define the following terms and give some examples:

Renewable energy source:

Nonrenewable energy source:

## EXTENSIONS



Have the students mine another cookie and this time only remove deposits of chocolate that can be mined without significant environmental disturbance.

- Were the students able to mine all the chocolate reserves available?
- Ask the students to discuss ways to reduce the environmental impacts of actual coal mining.
- Have the students research renewable

sources of energy that could be used to replace fossil fuels and present their findings to the class.

## GOING FURTHER

During both the mining and use of coal, significant environmental impact occurs. Have the class discuss the following issue.

*What is the balance between how much coal resources are technically available and the increasing environmental and economic costs associated with obtaining and using all of this coal?*

*This activity was adapted from the National Renewable Energy Laboratory (NREL) Teacher Activity Guide.*

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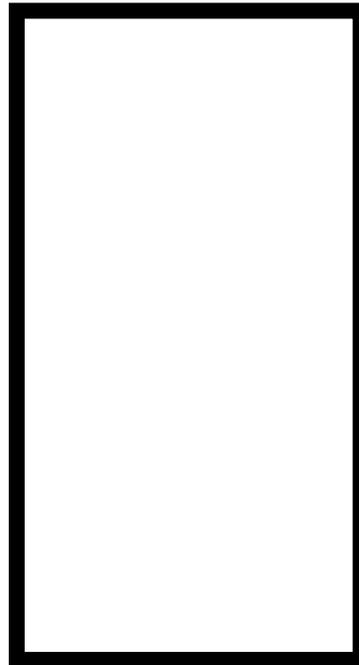
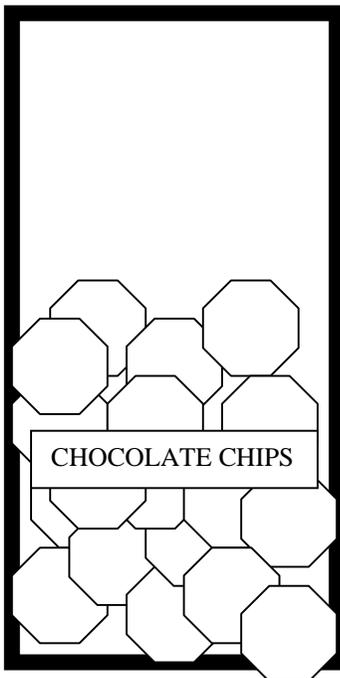
### RESERVES CHART

CHOCOLATE CHIPS  
MINED

CHOCOLATE CHIPS  
MINED

EXAMPLE:

STUDENT RESULTS:



INSTRUCTIONS: In the space provided to the right estimate how much of the space you think will be filled with mined chocolate chips and draw a line to mark your estimate. When you get done mining your cookie pour out the chocolate chips collected and mark how much of the space is covered. This actual mining yield will then be compared to the estimated yield.



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# QUESTION WORKSHEET

1. Define the following terms and give some examples:

**Renewable energy source:**

**Nonrenewable energy source:**

2. Based on your experience while *cookie mining*, can you explain why during actual coal mining situations some deposits of coal are more expensive to remove?
  3. Think about how your cookie looked after you finished mining. Compare these results to what might happen in a real coal mining operation.
  4. Was there a difference between your estimated and measured reserves of chocolate chips? Why is it difficult to predict exactly how long the fossil fuels in the earth will last?
  5. What are some renewable sources of energy that could be used to replace fossil fuels?
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