State of Illinois
Department of Commerce and Economic Opportunity

Teacher's Curriculum Guide

From the COAL MINES TO THE POWER LINES

Tie-Ins and **Lessons** → / Standards ↓	*Rocks and Minerals*	*The Environment*	*Technology and Types of Mining*	*Illinois History*	*Social Studies and Money-Making Coal*	*Reading and Writing about Coal-Related Careers*	**What Good Does Coal Serve?**	**Reclamation: Our Productive Resources at Work**	**To Surface Mine or Underground Mine? That is the Question!**	*Economics*	*Careers*	*Botany*	*Mine Safety and Ventilation*	*Environmental Issues*	*Geology/Earth History*	**Density**	**The Demand for Coal**	**Discover the Power of Illinois Coal: Persuasive Essays**	*Do the Math: Coal By The Numbers*	*Laws Influencing the Coal Industry in Illinois*	*Early Coal Economics: Company Stores*	*Individuals and the Shaping of the Coal Industry*	*Illinois Coal as a Topic for Discovery*	*Coal, Chemistry, and the Environment*	**Can My Company Make a Profit in the Development of a New Coal Mine?**	**Illinois History: The Role of the Illinois Coal Industry in Illinois Economics**	**Coal, Clean Air and the Economy**
1A. Apply word analysis and vocabulary skills to comprehend selections																•											
1B. Apply reading strategies to improve understanding and fluency.																•	•	•									
1C. Comprehend a broad range of reading materials									•							•	•	•									
2B. Read and interpret a variety of literary works							•									•	•										
3A. Use correct grammar, spelling, punctuation, capitalization and structure							•									•	•	•									
3B. Compose well-organized and coherent writing for specific purposes and audiences.							•			•				•		•		•									
3C. Communicate ideas in writing to accomplish a variety of purposes.							•	•	•	•				•			•	•									
4A. Listen effectively in formal and informal situations.								•	•																		

Correlation of "From the Coal Mines to the Power Lines" Lessons and Tie-Ins with Illinois Learning Standards for English Language Arts

Tie-Ins and **Lessons** → / Standards ↓	*Rocks and Minerals*	*The Environment*	*Technology and Types of Mining*	*Illinois History*	*Social Studies and Money-Making Coal*	*Reading and Writing about Coal-Related Careers*	**What Good Does Coal Serve?**	**Reclamation: Our Productive Resources at Work**	**To Surface Mine or Underground Mine? That is the Question!**	*Economics*	*Careers*	*Botany*	*Mine Safety and Ventilation*	*Environmental Issues*	*Geology/Earth History*	**Density**	**The Demand for Coal**	**Discover the Power of Illinois Coal: Persuasive Essays**	*Do the Math: Coal By The Numbers*	*Laws Influencing the Coal Industry in Illinois*	*Early Coal Economics: Company Stores*	*Individuals and the Shaping of the Coal Industry*	*Illinois Coal as a Topic for Discovery*	*Coal, Chemistry, and the Environment*	**Can My Company Make a Profit in the Development of a New Coal Mine?**	**Illinois History: The Role of the Illinois Coal Industry in Illinois Economics**	**Coal, Clean Air and the Economy**
4B. Speak effectively using language appropriate to the situation and audience.								•	•									•									
5A. Locate, organize and use information from various sources to answer questions, solve problems and communicate ideas.									•									•									
5B. Analyze and evaluate information acquired from various sources.																		•									
5C. Apply acquired information, concepts and ideas to communicate in a variety of formats.							•		•	•							•	•									

Correlation of "From the Coal Mines to the Power Lines" Lessons and Tie-Ins with the Illinois Learning Standards for Mathematics

Tie-Ins and **Lessons** → Standards ↓	*Rocks and Minerals*	*The Environment*	*Technology and Types of Mining*	*Illinois History*	*Social Studies and Money-Making Coal*	*Reading and Writing about Coal-Related Careers*	**What Good Does Coal Serve?**	**Reclamation: Our Productive Resources at Work**	**To Surface Mine or Underground Mine? That is the Question!**	*Economics*	*Careers*	*Botany*	*Mine Safety and Ventilation*	*Environmental Issues*	*Geology/Earth History*	**Density**	**The Demand for Coal**	**Discover the Power of Illinois Coal: Persuasive Essays**	*Do the Math: Coal By The Numbers*	*Laws Influencing the Coal Industry in Illinois*	*Early Coal Economics: Company Stores*	*Individuals and the Shaping of the Coal Industry*	*Illinois Coal Mining as a Topic for Discovery*	*Coal, Chemistry, and the Environment*	**Can My Company Make a Profit in the Development of a New Coal Mine?**	**Illinois History: The Role of the Illinois Coal Industry in Illinois Economics**	**Coal, Clean Air and the Economy**
6A. Demonstrate knowledge and use of numbers and their representations in a broad range of theoretical and practical settings.									•							•									•	•	
6B. Investigate, represent and solve problems using number facts, operations (addition, subtraction, multiplication, division) and their properties, algorithms and relationships.							•	•	•							•										•	
6C. Compute and estimate using mental mathematics, paper-and-pencil methods, calculators and computers.							•	•	•							•			•							•	
6D. Solve problems using comparison of quantities, ratios, proportions and percents.																•			•								

Tie-Ins and **Lessons** → Standards ↓	*Rocks and Minerals*	*The Environment*	*Technology and Types of Mining*	*Illinois History*	*Social Studies and Money-Making Coal*	*Reading and Writing about Coal-Related Careers*	**What Good Does Coal Serve?**	**Reclamation: Our Productive Resources at Work**	**To Surface Mine or Underground Mine? That is the Question!**	*Economics*	*Careers*	*Botany*	*Mine Safety and Ventilation*	*Environmental Issues*	*Geology/Earth History*	**Density**	**The Demand for Coal**	**Discover the Power of Illinois Coal: Persuasive Essays**	*Do the Math: Coal By The Numbers*	*Laws Influencing the Coal Industry in Illinois*	*Early Coal Economics: Company Stores*	*Individuals and the Shaping of the Coal Industry*	*Illinois Coal Mining as a Topic for Discovery*	*Coal, Chemistry, and the Environment*	**Can My Company Make a Profit in the Development of a New Coal Mine?**	**Illinois History: The Role of the Illinois Coal Industry in Illinois Economics**	**Coal, Clean Air and the Economy**
7A. Measure and compare quantities using appropriate units, instruments and methods.								•					•			•									•	•	
7B. Estimate measurements and determine acceptable levels of accuracy.																•										•	
7C. Select and use appropriate technology, instruments and formulas to solve problems, interpret results and communicate findings.													•												•	•	
8A. Describe numberical relationships using variables and patterns.																•											
8B. Interpret and describe numerical relationships using tables, graphs and symbols.																	•										

Tie-Ins and **Lessons** → Standards ↓	*Rocks and Minerals*	*The Environment*	*Technology and Types of Mining*	*Illinois History*	*Social Studies and Money-Making Coal*	*Reading and Writing about Coal-Related Careers*	**What Good Does Coal Serve?**	**Reclamation: Our Productive Resources at Work**	**To Surface Mine or Underground Mine? That is the Question!**	*Economics*	*Careers*	*Botany*	*Mine Safety and Ventilation*	*Environmental Issues*	*Geology/Earth History*	**Density**	**The Demand for Coal**	**Discover the Power of Illinois Coal: Persuasive Essays**	*Do the Math: Coal By The Numbers*	*Laws Influencing the Coal Industry in Illinois*	*Early Coal Economics: Company Stores*	*Individuals and the Shaping of the Coal Industry*	*Illinois Coal Mining as a Topic for Discovery*	*Coal, Chemistry, and the Environment*	**Can My Company Make a Profit in the Development of a New Coal Mine?**	**Illinois History: The Role of the Illinois Coal Industry in Illinois Economics**	**Coal, Clean Air and the Economy**
8C. Solve problems using systems of numbers and their properties.																•	•										
8D. Use algebraic concepts and procedures to represent and solve problems.																•											
9A. Demonstrate and apply geometric concepts involving points, lines, planes and space.																									•		
9B. Identify, describe classify and compare relationships using points, lines, planes and solids.																											
9C. Construct convincing arguments and proofs to solve problems.																									•		
9D. Use trigonometric ratios and circular functions to solve problems.																											

Correlation of "From the Coal Mines to the Power Lines" Lessons and Tie-Ins with the Illinois Learning Standards for Mathematics

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10A. Organize, describe and make predictions from existing data.								•	•							•	•	•									
10B. Formulate questions, design data collection methods, gather and analyze data and communicate findings.									•									•									
10C. Determine, describe and apply the probabilities of events.																•											

Correlation of "From the Coal Mines to the Power Lines" Le..ons and Tie-Ins with the Illinois Learning Standards for Science

Tie-Ins and **Lessons** → Standards ↓	*Rocks and Minerals*	*The Environment*	*Technology and Types of Mining*	*Illinois History*	*Social Studies and Money-Making Coal*	*Reading and Writing about Coal-Related Careers*	**What Good Does Coal Serve?**	**Reclamation: Our Productive Resources at Work**	**To Surface Mine or Underground Mine? That is the Question!**	*Economics*	*Careers*	*Botany*	*Mine Safety and Ventilation*	*Environmental Issues*	*Geology/Earth History*	**Density**	**The Demand for Coal**	**Discover the Power of Illinois Coal: Persuasive Essays**	*Do the Math: Coal By The Numbers*	*Laws Influencing the Coal Industry in Illinois*	*Early Coal Economics: Company Stores*	*Individuals and the Shaping of the Coal Industry*	*Illinois Coal Mining as a Topic for Discovery*	*Coal, Chemistry, and the Environment*	**Can My Company Make a Profit in the Development of a New Coal Mine?**	**Illinois History: The Role of the Illinois Coal Industry in Illinois Economics**	**Coal, Clean Air and the Economy**
11A. Know and apply the concepts, principles and processes of scientific inquiry.		•							•							•	•	•							•	•	•
11B. Know and apply the concepts, principles and processes of technological design.		•	•	•				•																	•		•
12A. Know and apply concepts that explain how living things function, adapt and change.	•	•				•						•												•			
12B. Know and apply concepts that describe how living things interact with each other and with their environment.	•	•	•			•		•				•		•										•			
12C. Know and apply concepts that describe properties of matter and energy and the interactions between them.	•						•					•		•	•	•		•						•			•

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12D. Know and apply concepts that describe force and motion and the principles that explain them.			•	•																							
12E. Know and apply concepts that describe the features and processes of the Earth and its resources.	•	•	•	•			•	•	•			•			•			•		•	•				•	•	
13A. Know and apply the accepted practices of science.						•			•				•			•									•		•
13B. Know and apply concepts that describe the interaction between science, technology and society.		•	•	•	•	•	•		•		•	•	•	•	•	•	•	•					•				

Correlations of "From the Coal Mines to the Power Lines" Lesse..s and Tie-Ins with the Illinois Learning Standards for Social Science

Tie-Ins and **Lessons** → Standards ↓	*Rocks and Minerals*	*The Environment*	*Technology and Types of Mining*	*Illinois History*	*Social Studies and Money-Making Coal*	*Reading and Writing about Coal-Related Careers*	**What Good Does Coal Serve?**	**Reclamation: Our Productive Resources at Work**	**To Surface Mine or Underground Mine? That Is the Question!**	*Economics*	*Careers*	*Botany*	*Mine Safety and Ventilation*	*Environmental Issues*	*Geology/Earth History*	**Density**	**The Demand for Coal**	**Discover the Power of Illinois Coal: Persuasive Essays**	*Do the Math: Coal By The Numbers*	*Laws Influencing the Coal Industry in Illinois*	*Early Coal Economics: Company Stores*	*Individuals and the Shaping of the Coal Industry*	*Illinois Coal as a Topic for Discovery*	*Coal, Chemistry, and the Environment*	**Can My Company Make a Profit in the Development of a New Coal Mine?**	**Illinois History: The Role of the Illinois Coal Industry in Illinois Economics**	**Coal, Clean Air and the Economy**
14D. Understand the roles and influences of individuals and interest groups in the political systems of Illinois, the United States and other nations.																						•	•				
14F. Understand the development of United States political ideas and traditions																							•				
15A. Understand how different economic systems operate in the exchange, production, distribution and consumption of goods and services.	•			•	•	•				•	•	•				•	•		•		•	•				•	•
15B. Understand that scarcity necessitates choices by consumers.		•	•		•		•	•	•	•				•		•	•	•	•							•	
15C. Understand that scarcity necessitates choices by producers.		•	•		•		•	•	•	•				•		•	•	•				•			•	•	•
15D. Understand trade as an exchange of goods or services.		•			•	•				•	•				•	•		•							•		•

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15E. Understand the impact of government policies and decisions on production and consumption in the economy.				•		•				•	•		•		•	•		•					•	•		•	•
16A. Apply the skills of historical analysis and interpretation.																				•	•	•					
16C. Understand the development of economic systems.																					•		•				
16D. Understand Illinois, United States and world social history.																				•	•	•	•				
16E. Understand Illinois, United States and world environmental history.																				•			•				
17C. Understand relationships between geographic factors and society.																				•	•						
18B. Understand the roles and interactions of individuals and groups in society.																							•				

FROM THE COAL MINES
TO THE POWER LINES

Teacher's Curriculum Guide
Grades K - 4

PREPARED BY

ILLINOIS DEPARTMENT OF COMMERCE AND ECONOMIC OPPORTUNITY
OFFICE OF COAL DEVELOPMENT

AND

ILLINOIS COUNCIL ON ECONOMIC EDUCATION

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Illinois Department of Commerce and Economic Opportunity
Office of Coal Development

"From the Coal Mines to the Power Lines" Teachers Guide has been developed to give teachers sufficient information to incorporate coal education into their curriculum. Bituminous coal, Illinois' most abundant natural resource, underlies 37,000 square miles of Illinois, about 65 percent of the state's surface. Since the Illinois coal industry contributes nearly $1 billion to the Illinois economy annually and 49 percent of the electricity used in Illinois is generated from coal, it is important for teachers to provide a sound and meaningful understanding of coal and energy issues to their students. By including coal education in their curriculum, teachers will bring to their students and communities an awareness of our state's greatest natural resource and the positive role coal plays in our day-to-day lives and the economy of the state.

"From the Coal Mines to the Power Lines" addresses a variety of topics and skills in science, social studies, math, language arts and economics. Although the guide is divided into grade level sections of K-4, 5-8 and 9-12, the lessons and tie-ins can be used interchangeably with minor adjustments by the teacher. A matrix is included to show the correlation of the lessons and tie-ins to the Illinois State Learning Standards. A CD-ROM accompanies each of the three grade level sections. Each CD-ROM displays a PowerPoint Presentation that is designed to be a teaching tool for the instructor complementing the series by adding depth and understanding to the concepts and vocabulary inherent to the lessons and tie-ins that comprise the written portion of the curriculum. The presentations highlight glossaries of terms through the use of captions, questions, photos, clip art, descriptions, and music.

"From the Coal Mines to the Power Lines" will give teachers the knowledge, skills, and tools necessary to provide their students a sound and meaningful understanding of coal in Illinois. The curriculum covers the rich history of coal and coal mining, its role in the Illinois economy as well as its significance to the state's energy profile and the impact of clean coal technology on the environment.

For more information on Illinois coal, contact the Office of Coal Development at:

Illinois Department of Commerce and Economic Opportunity
Office of Coal Development
620 East Adams
Springfield, Illinois 62701
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NOTE

Copies of the coal curriculum may be obtained from:

Illinois Department of Commerce and Economic Opportunity

Office of Coal Development

620 East Adams

Springfield, Illinois 62701

217/524-3820

TDD: 217/785-6055

Illinois Council on
[redacted]

The EconomicsAmerica School Program

About the Illinois Council on Economic Education

The Illinois Council on Economic Education supports this curriculum through *curriculum consulting* and *professional development* programs for schools/teachers. A comprehensive set of *curriculum materials* to supplement the economics in "From the Coal Mines to the Power Lines," and to further address Illinois Learning Standards in economics, language arts, math and other areas, is available through the Council and its affiliated Centers for Economic Education around the state. In addition, ICEE offers **The Stock Market Game™** for students in grades 4-12; the **Economics Poster Contest** for students in grades 1-8, and the **Economics Challenge** for high school students.

For more assistance in teaching personal finance and economic education topics to your students, contact the Council at:

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E-mail: icee@niu.edu
Website: www.econed-il.org
The Stock Market Game™: www.smgww.org

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Lesson

WHAT GOOD DOES COAL SERVE?

OVERVIEW

In this lesson, students will examine the many ways coal is used in the United States. After careful analysis, students will classify those things produced with coal or coal products as either goods or services. Students will gain a better understanding of how their families utilize those goods and services in everyday life.

MATERIALS

- One piece of coal
- One paper bag with a question mark attached
- Chart paper
- Markers
- One copy of Teacher Resource Page A: *Coal: From Beginning to End*
- One copy of Teacher Resource Page B: *Coal Confusion – ANSWER KEY*
- One copy of Teacher Resource Page C: *Is It Worth the Weight? (Grades K-2) – ANSWER KEY*
- One copy of Teacher Resource Page D: *Is It Worth the Weight? (Grades 3-4) – ANSWER KEY*
- One copy of Student Activity Page A: *Coal Confusion* per student
- Samples of items weighing one pound (four small apples; one pound of sugar)
- One copy of Student Activity Page B: *Is it Worth the Weight? (Grades K-2)* per two students or one copy of Student Activity Page C: *Is it Worth the Weight? (Grades 3-4)* per two students depending on grade/ability level of students
- One copy of Student Activity Page D: *"Creative Coal" Story Map (Grades K-2)* per student or one copy of Student Activity Page E: *"Creative Coal" Story Map (Grades 3-4)* per student depending on grade/ability level of students
- One transparency of Student Activity Page D: *"Creative Coal" Story Map (Grades K-2)* or one transparency of Student Activity Page E: *"Creative Coal" Story Map (3-4)* depending on grade level
- One red and one blue crayon per student
- One calculator per two students
- Student writing journals
- Overhead projector

APPROXIMATE TIME REQUIRED

- Three to four forty-five minute class periods are required to complete the lesson.

VOCABULARY

- Coal
- Conservation
- Electricity

- Generate
- Goods
- Kilowatt
- Opportunity cost
- Produce
- Services
- Trade-offs

OBJECTIVES

After completing this lesson, students will be able to:

- identify everyday uses of goods and services which use coal in their production.
- explain the difference between a good and a service.
- classify coal-related products as goods or services.
- compute the amount of coal needed to generate specific electrical appliances.
- generate ideas about how to conserve electricity.
- recognize trade-offs and opportunity costs experienced when energy is conserved.
- create imaginative fictional stories applying newly learned vocabulary.

ENGLISH LANGUAGE ARTS STANDARDS

2.B.1c; 3.A.1; 3.A.2; 3.B.1b; 3.B.2b; 3.C.1a; 3.C.2a; 5.C.1a

MATH STANDARDS

6.B.1; 6.B.2; 6.C.1a; 6.C.2a; 6.C.1b; 6.C.2b

SCIENCE STANDARDS

12.C.1a; 12.C.2b; 12.E.1c; 13.B.1d; 13.B.2b; 13.B.2c

SOCIAL SCIENCE STANDARDS

15.B.2c; 15.C.1a

PROCEDURE

1. Introduce the lesson by telling students that a mysterious item was found on the playground during recess, and the school administration needs their help in solving the mystery and identifying the object.
2. Pass around a piece of coal concealed in a brown paper bag with a question mark attached.
3. Explain to the students that they may use three of their five senses when trying to identify the mysterious object in the bag. They may feel, listen to, and smell the object but not taste or see it.
4. After all students have had time to observe the "mystery" object, ask students to share their predictions on a large chart.
5. Once predictions have been listed, announce to the students that the "mystery" object is, indeed, coal.
6. Facilitate a discussion about how coal was formed (see Teacher Resource Page A: *Coal: From Beginning to End*) and its possible uses in the students' homes. Be sure to focus on the fact that almost 50 percent of the electricity in the United

States is produced by coal. In addition, explain that while coal is being cleaned, burned, etc., in order to produce electricity, coal products are also produced. Many of these coal products, such as coal tar, coke, and light oil are used as fuel in producing items used in their families' everyday lives.

7. Distribute one copy of Student Activity Page A: *Coal Confusion*, to each student, which illustrates many goods and services produced with the fuel made by coal or coal products. Encourage students to share their thoughts about why the coal miner on the sheet may be confused after reading the different words in the mine.
8. Explain to the students that coal and coal byproducts are used in the production of both *goods* and *services*. Give them an example of perfume being a good produced using coal tar (a byproduct of coal), while a microwave cooking their food is a service produced by coal creating electricity. It should be stressed that coal or coal tar is not a raw ingredient in the perfume.
9. Challenge the students to explain the difference between a good and a service after a few examples are given. Properly define goods as material things that provide satisfaction and services as actions that are done for you that provide satisfaction.
10. Once students seem to have an understanding of goods and services, instruct them to complete Student Activity Page A: *Coal Confusion* by using their red and blue crayons.
11. Explain to the students that different electrical services require different amounts of coal to run properly.
12. Displaying items that weigh about one pound, such as 4 small apples or a pound of sugar, explain that it takes about one pound of coal to generate or produce one kilowatt hour (kwh) of electricity. The amount of coal needed depends on the kilowatts needed per hour.
13. Provide the following example to aid in student understanding: (K-2) a dishwasher takes 1 kilowatt of electricity to run for one hour. Therefore, it takes 1 pound of coal to produce enough electricity for the dishwasher to run for one hour. If the dishwasher were to run for two hours, it would take 2 pounds of coal, for three hours, it would take 3 pounds of coal, and so on; (3-4) a dishwasher takes 1.2 kilowatts of electricity to run for one hour. Therefore, it takes 1.2 pounds of coal to produce enough electricity for the dishwasher to run for one hour. If the dishwasher were to run for two hours, it would take 2.4 pounds of coal, for three hours, it would take 3.6 pounds of coal, and so on. For older students, be sure to model addition and/or multiplication of decimals before the activity.
14. After completing the examples from the top of Student Activity Page B: *Is it Worth the Weight? (Grades K-2)* or Student Activity Page C: *Is it Worth the Weight? (Grades 3-4)* as a whole class, distribute a copy of the appropriate activity sheet to partners. Direct the students to alternate between figuring how many pounds of coal are needed in each problem and using a calculator to check for accuracy.
15. Once students have completed Student Activity Page B or C, discuss the importance of conserving (protecting or saving) energy. Ask partners to brainstorm at least two ways they and their classmates could conserve kilowatts of energy both at school and at home, as well as the trade-offs (things given up) or opportunity costs (the next best alternatives) that are experienced when

conserving goods and services produced by or with coal. *(See extensions for follow-up activity.)*

16. Review the new vocabulary discussed throughout the lesson and create a word bank on a large chart. (The list might include words like goods, services, coal, conservation, electricity, kilowatt, produce, trade-offs, etc.)
17. Once a substantial list has been formed, instruct the students to create fictional stories about coal and its uses in their homes. Require the students to use some of the new vocabulary from the word bank throughout their stories.
18. Before allowing the students to begin their creative writing, review the elements of theme, plot, characters, and setting in a fictional story by using a transparency of Student Activity Page D: *"Creative Coal" Story Map (Grades K-2)* or Student Activity Page E: *"Creative Coal" Story Map (Grades 3-4)* and distributing one copy of Student Activity Page D or E: *"Creative Coal" Story Map* to each student.
19. Encourage students to peer edit their work before completing final drafts to be shared with the class.

DEBRIEFING QUESTIONS

1. What three elements are most important in the formation of coal? (Answer: pressure, heat, and time.)
2. In what ways is coal used today in people's homes? (Answers will vary but may include: COAL AS FUEL – electricity for the refrigerator, hair dryer, computer, washing machine, etc.; COAL BYPRODUCTS USED IN PROCESSES FOR MAKING ITEMS – perfume, fertilizer, linoleum, medicine, buttons, etc.)
3. Why is it important to the coal-mining industry that coal be used in the production of both goods and services? (Answers will vary but may include: increased profits through greater production; more consumer need with a greater number of products, also meaning greater profits, etc.)
4. How might life be different if coal were not utilized as it is? (Answers will vary but may include: many household items may not be produced at all or might be sold at a higher price; life might be more difficult since coal provides many wants or luxuries to us, etc.)

GLOSSARY

- Coal – natural dark brown to black material used as a fuel, formed from fossilized plants and consisting of carbon
- Conservation – the protection or saving of something from loss or damage
- Electricity – electric current used or regarded as a source of power
- Generate – to produce as a result of a chemical or physical process
- Goods – material things that produce satisfaction
- Kilowatt – a unit of power equal to 1,000 watts
- Opportunity cost – the highest-valued alternative given up when a choice is made
- Produce – to make
- Services – actions that are done for you that provide satisfaction
- Trade-off – giving up some of one thing to gain some of another thing

EXTENSION ACTIVITIES

- Accept the challenge of trying not to use electricity for one hour each day for a one week period. Keep a diary or journal that explains what types of electricity were given up, the feelings that were experienced, the trade-offs and opportunity cost, and what could be done to conserve electricity in the future. *(Lower grades: draw pictures of types of electricity given up, add feeling words, and orally explain what could be done to save electricity in the future.)*
- Create a "Coal Conservation" booklet describing ways in which energy can be conserved on the front sides of the pages and the possible trade-offs or opportunity costs that might be experienced on the back sides. *(Lower grades: create a picture booklet of types of electricity given up and trade-offs/opportunity costs.)*
- Create a commercial or advertisement for coal, promoting its many uses in the production of both goods and services.
- Using the six examples from Student Activity Page B or C, create a pictograph *(lower grades)* or bar graph *(upper grades)* showing the amount of coal needed for one hour of electrical production per appliance.
- Research additional goods and services produced with or by coal, and develop bonus math problems.

ADDITIONAL RESOURCES

- http://www.eia.doe.gov/kids/energyfacts/sources/non-renewable/nonrenewable.html

CREDITS

- http://www.teachcoal.org/

TEACHER RESOURCE PAGES

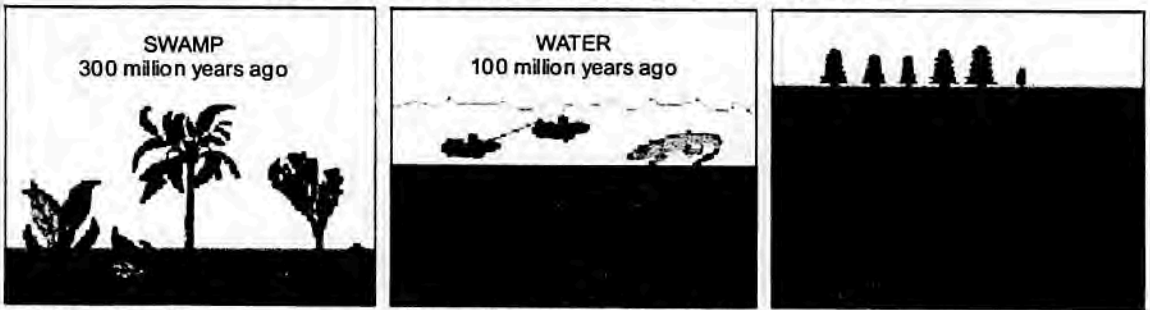
- Teacher Resource Page A: *Coal: From Beginning to End*
- Teacher Resource Page B: *Coal Confusion – ANSWER KEY*
- Teacher Resource Page C: *Is It Worth the Weight? (Grades K-2) – ANSWER KEY*
- Teacher Resource Page D: *Is It Worth the Weight? (Grades 3-4) – ANSWER KEY*

STUDENT ACTIVITY PAGES

- Student Activity Page A: *Coal Confusion*
- Student Activity Page B: *Is it Worth the Weight? (Grades K-2)*
- Student Activity Page C: *Is it Worth the Weight? (Grades 3-4)*
- Student Activity Page D: *"Creative Coal" Story Map (Grades K-2)*
- Student Activity Page E: *"Creative Coal" Story Map (Grades 3-4)*

Teacher Resource Page A: ***Coal: From Beginning to End***

HOW COAL WAS FORMED



Before the dinosaurs, many giant plants died in swamps.

Over millions of years, the plants were buried under water and dirt.

Heat and pressure turned the dead plants into coal.

<u>Examples of Everyday Goods Produced using Coal Byproducts</u>

Coal-based fuels (coal, coke, coal tar, light oil or carbolic acid) are used in making the following:

- Perfume
- Insulation
- Linoleum tile
- Medicine
- Moth Balls
- Beads
- Buttons
- Records
- Insecticides
- Sugar substitute
- Rubber cement)

<u>Examples of Everyday Services Produced with Coal as a Fuel:</u>

- Dishwasher running
- Microwave cooking
- Stovetop working
- Hair dryer blowing
- Vacuum cleaner running
- Television working
- Clothes dryer running
- Refrigerator cooling
- Computer running

Teacher Resource Page B: *Coal Confusion – ANSWER KEY*

Goods (Red)

- Medicine
- Perfume
- Rubber cement
- Linoleum flooring
- Fertilizer

Services (Blue)

- Computer working
- Dishwasher running
- Stovetop lighting
- Refrigerator cooling
- Television working

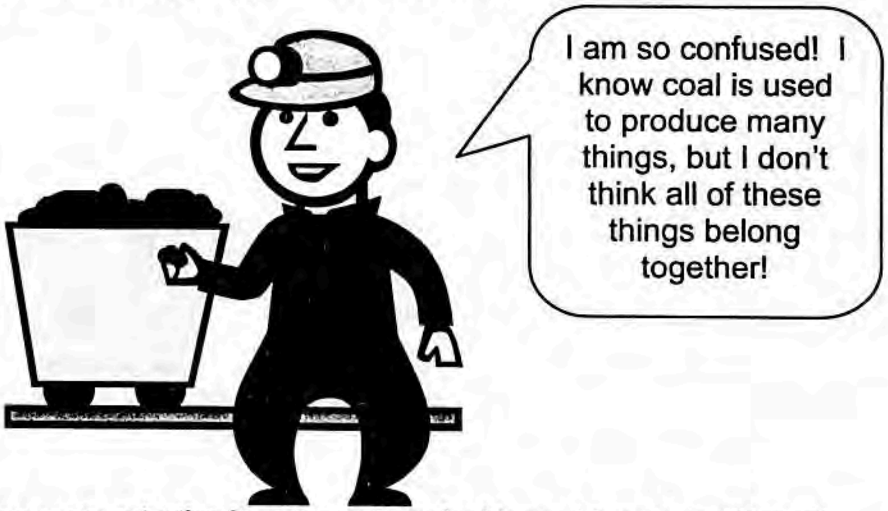
Teacher Resource Page C: ***Is it Worth the Weight? (Grades K-2) – ANSWER KEY***

1. 20 pounds of coal
2. 3 pounds of coal
3. 8 pounds of coal
4. 24 pounds of coal

Teacher Resource Page D: *Is it Worth the Weight? (Grades 3-4) – ANSWER KEY*

1. 19.44 pounds of coal
2. 1.02 pounds of coal
3. 0.42 pounds of coal
4. 36.6 pounds of coal

Student Activity Page A: *Coal Confusion*



Can you help this coal miner separate the items produced with coal into two different categories? Color all of the *goods* red and all of the *services* blue.

Medicine

Fertilizer

Computer working

Stovetop lighting

Dishwasher running

Rubber cement

Linoleum flooring

Television working

Refrigerator cooling

Perfume

Student Activity Page B: *Is it Worth the Weight?* ***(Grades K-2)***

Since it takes about one pound of coal to generate or produce one kilowatt hour (kwh) of electricity, figure out how many pounds of coal would be needed in the following situations. Use addition to find the answers. Show your work in the boxes provided, and check your answers with a calculator.

Example 1: If the microwave needs 1 kilowatt of electricity per hour to work properly, how many pounds of coal are needed for the microwave to run for three hours?
Addition: 1 + 1 + 1 = 3 pounds of coal
Example 2: If the vacuum cleaner takes 2 kilowatts of electricity per hour to work properly, how many pounds of coal are needed for the vacuum cleaner to run for six hours?
Addition: 2 + 2 + 2 + 2 + 2 + 2 = 12 pounds of coal

1. If the clothes dryer needs 5 kilowatts of electricity per hour to work properly, how many pounds of coal are needed for the clothes dryer to run for four hours?

2. If the washing machine needs 1 kilowatt of electricity per hour to work properly, how many pounds of coal are needed for the washing machine to run for three hours?

3. If the television needs 1 kilowatt of electricity per hour to work properly, how many pounds of coal are needed for the television to run for eight hours?

4. If the stovetop needs 12 kilowatts of electricity per hour to work properly, how many pounds of coal are needed for the stovetop to run for two hours?

Student Activity Page C: *Is it Worth the Weight? (Grades 3-4)*

Since it takes about one pound of coal to generate or produce one kilowatt hour (kwh) of electricity, figure out how many pounds of coal would be needed in the following situations. Use the mathematical operations of addition or multiplication to find the answers. Show your work in the boxes provided, and check your answers with a calculator.

<u>Example 1</u>: If the microwave needs 1.45 kilowatts of electricity per hour to function properly, how many pounds of coal are necessary for the microwave to run for three hours?

Addition: 1.45 + 1.45 + 1.45 = 4.35 Multiplication: 1.45 x 3 = 4.35

<u>Example 2</u>: If the vacuum cleaner takes 0.63 kilowatts of electricity per hour to function properly, how many pounds of coal are necessary for the vacuum cleaner to run for two hours?

Addition: 0.63 + 0.63 = 1.26 Multiplication: 0.63 x 2 = 1.26

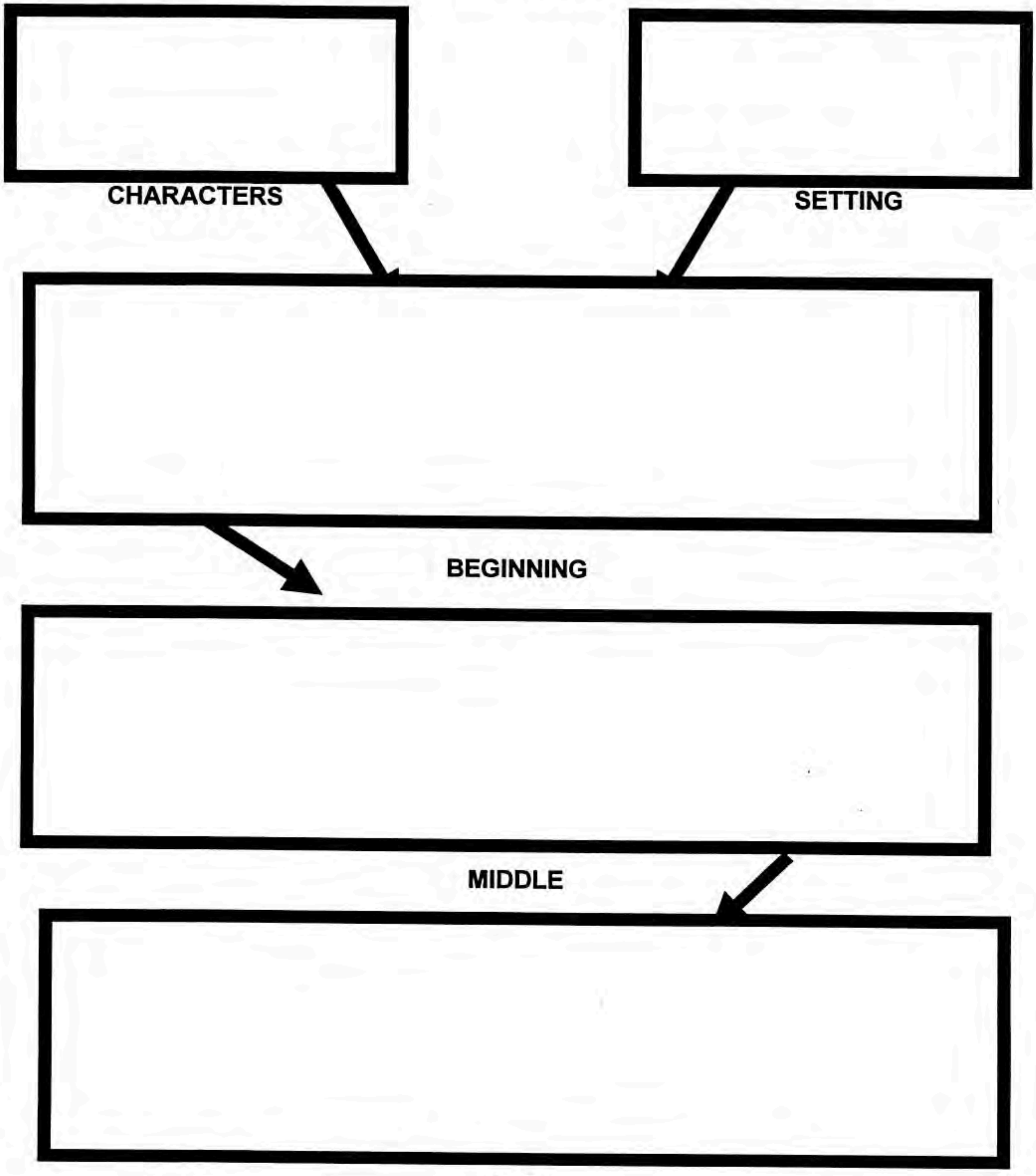
1. If the clothes dryer needs 4.86 kilowatts of electricity per hour to function properly, how many pounds of coal are necessary for the clothes dryer to run for four hours?

2. If the washing machine needs 0.51 kilowatts of electricity per hour to function properly, how many pounds of coal are necessary for the washing machine to run for two hours?

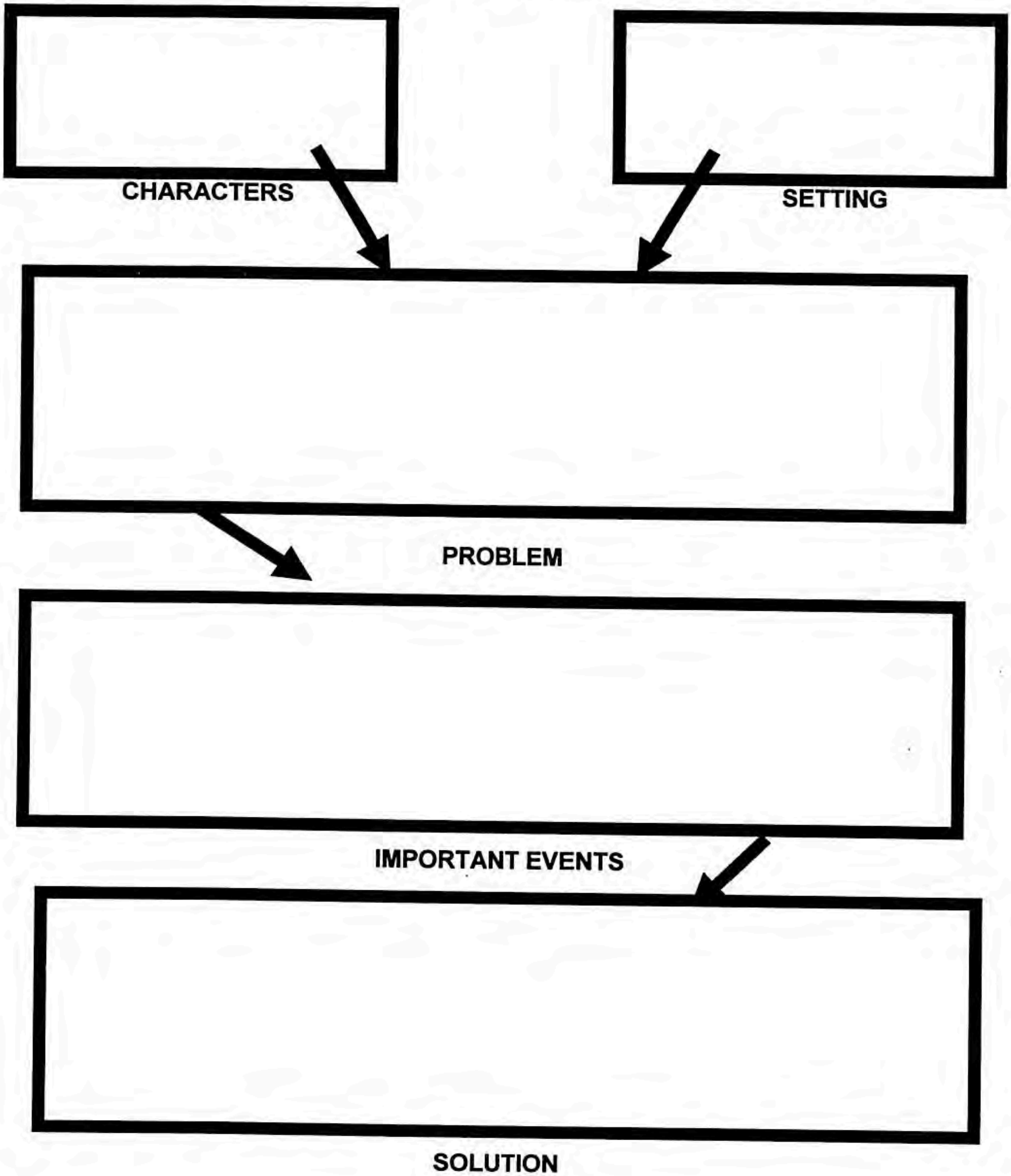
3. If the television needs 0.14 kilowatts of electricity per hour to function properly, how many pounds of coal are necessary for the television to run for three hours?

4. If the stovetop needs 12.2 kilowatts of electricity per hour to function properly, how many pounds of coal are necessary for the stovetop to run for three hours?

Student Activity Page D: *"Creative Coal" Story Map* ***(Grades K-2)***



Student Activity Page E: *"Creative Coal" Story Map (Grades 3-4)*



Lesson

Reclamation: Our Productive Resources at Work

OVERVIEW

In this lesson, students will examine the ways in which mined land can be restored and determine the costs and benefits of particular choices. Using age-appropriate productive resources, students will simulate the extraction of coal from sandy land and identify the best way to reclaim the land depending on particular facts about the land and its surroundings. Students will gain a better understanding of how coal mining companies make a profit or experience a loss and the trade-offs involved in mining coal and reclaiming the land.

MATERIALS

- Chart paper
- Markers
- Six Rubbermaid shoe box containers filled with sand and coal pieces
- One copy of Teacher Resource Page A: *The Prices of Productive Resources* (cut apart)
- One copy of Teacher Resource Page B: *Coal Currency* per team (cut apart)
- One copy of Teacher Resource Page C: *Reclamation Scenarios K-2* (2 pages) (one scenario per group)
- One copy of Teacher Resource Page D: *Reclamation Riddle (3-4)* (per group)
- One copy of Teacher Resource Page E: *Reclamation Scenarios (K-2) – Answer Key*
- Teacher Resource Page F: *Our Productive Resources at Work – Possible Answers*
- Teacher Resource Page G: *A Sandy Situation – Answer Key*
- One transparency of Student Activity Page A: *Our Productive Resources at Work in the Coal Mines*
- One copy of Student Activity Page A: *Our Productive Resources at Work in the Coal Mines* per group
- One copy of Student Activity Page B: *A Sandy Situation* per group
- One copy of Student Activity Page C: *Persuasive Writing Outline*
- Plastic spoons
- Craft sticks
- Paper clips
- Toothpicks
- Construction paper
- Scissors
- Pencils
- Glue
- Reclamation materials (construction paper, toothpicks, craft sticks, rocks, scissors, glue, felt, etc.)
- Overhead projector

APPROXIMATE TIME REQUIRED
- Three forty-five minute class periods will be needed to complete the lesson.

VOCABULARY
- Benefits
- Capital
- Coal
- Conservation
- Costs
- Labor
- Loss
- Natural resources
- Opportunity cost
- Productive resources
- Profit
- Reclamation
- Revenue
- Trade-offs

OBJECTIVES
After completing this lesson, students will be able to:
- illustrate ways in which mined land can be restored or reclaimed.
- identify reasons for reclaiming mined land in particular ways.
- describe the costs and benefits of making particular reclamation choices.
- classify productive resources as natural, human, or capital.
- explain the difference between profit and loss.
- compute profits and losses.
- develop persuasive writing pieces.

ENGLISH LANGUAGE ARTS STANDARDS
3.C.1a; 3.C.2a; 4.A.1a; 4.B.1b; 4.B.2b

MATH STANDARDS
6.B.1; 6.B.2; 6.C.1a; 6.C.2a; 7.A.1c; 7.A.2b; 10.A.1b; 10.A.2c

SCIENCE STANDARDS
11.B.1a; 11.B.2a; 11.B.2b; 12.B.1a; 12.E.1c

SOCIAL SCIENCE STANDARDS
15.B.1; 15.B.2a; 15.B.2c; 15.C.1a; 15.C.1b; 15.C.2a

PROCEDURE

1. Introduce the lesson by asking students to raise their hands if they can answer "yes" to the following questions: Have you ever had to clean up your room at home? Have you ever been asked by a teacher to clean your desk or table at school? Have you ever been asked by a lunch supervisor to pick up your garbage from the lunch table? Have you ever had to put toys back in their place at a friend's house? (Most of the students will answer "yes" to at least some of the questions.)
2. Discuss with the class why it is important to clean up certain areas after making a mess or put things back neatly after using them.
3. List student answers on large chart paper at the front of the room.
4. Explain to students that it takes a great deal of planning and money to mine for coal in Illinois, and once the coal has been extracted, the land needs to be put back neatly or made into something better. Introduce the terms *reclamation* and *conservation* here.
5. Through a discussion, compare the reasons for cleaning up after oneself, which are listed on the chart paper, with reasons for land reclamation. (Many similarities should appear.)
6. Explain to the students that in any situation, three types of resources are used to produce goods or services. The same is true in the coal-mining industry – productive resources are used to mine for the coal.
7. Break students into cooperative teams of four, and pass out one copy of Student Activity Page A: *Our Productive Resources at Work in the Coal Mines.* In addition, use a transparency of the activity page, which has a three-column chart with the headings: Natural Resources, Capital Resources, and Human Resources.
8. Ask students to discuss in their groups what is meant by each of the three headings. Once students share their ideas, explain that natural resources are things that come from nature, capital resources are tools that are used over and over again, and human resources are people who work.
9. After watching the film entitled *Kids, Coal, and the Environment*, reading a number of coal-related books, and visiting the http://illinoisbiz.biz/dceo/Bureaus/Coal/Virtual+Tour/ website, instructs groups to list different examples of resources that are used in order to gather coal from the earth on Student Activity Page A: *Our Productive Resources at Work in the Coal Mines.* Remind them to place the resources underneath the proper headings.
10. As students share their ideas, list them on the transparency. Make any column corrections as needed for better student understanding.
11. Next, explain to the students that each group is going to pretend it is a coal-mining company that will be digging for coal in a sandy area. Just as coal companies use a number of tools and machines to find, dig for, and gather the coal, so must the student teams. Each team must plan ahead by deciding on which productive resources it will use to make the most money as a company. In other words, the teams would like to make the greatest profit and not experience a loss.
12. Pass out one copy of Student Activity Page B: *A Sandy Situation* per team and $20.00 in play money (use Teacher Resource Page B: *Coal Currency*). Go through each step of the planning sheet explaining carefully what is meant.

Overall, tell the students that each coal-mining company will begin their planning with $20.00 in play money. They need to pay for the land that will be mined, in addition to the capital resources they choose to use (costs). Be sure to tell students that bare hands are not allowed in the digging or gathering of the coal, just as coal miners, nowadays, do not use their own bare hands to extract and gather coal. Heavy machinery and highly technical tools are the resources that they use. After going over these rules, explain that the objective is to mine the most coal (revenue) from a sandy area in a certain amount of time and make the greatest profit in the end.

13. After passing out a Rubbermaid shoebox filled with sand and small pieces of coal hidden beneath it to each team, lead them to a table that has the possible productive resources for sale. Copy Teacher Resource Page A: *The Prices of Productive Resources,* and cut the price tags apart to label the resources.
14. Allow teams time to decide which capital resources they'd like to buy and fill in Student Activity Page B: *A Sandy Situation* accordingly. (Lower grades: this sheet should be done aloud as a whole class.)
15. Once students have gathered their capital resources, give each team five minutes to mine their coal from the shoebox. (Remind the students, once again, that bare hands are not allowed to be used as digging tools.) Once the time is up, have each group compute their profits or losses on the activity page.
16. Lead a discussion about why some teams profited, while others experienced a loss. Be sure to talk about the choices that were made and the trade-offs and opportunity costs (the next best alternative given up when a choice is made) that were experienced.
17. Bring the students' attention back to the chart that was made regarding the need to clean up after oneself from the beginning of the lesson. Ask the students if they feel their work is done after mining the coal. (Students should remember that the land needs to be cleaned up or changed into something better now through land reclamation.)
18. For younger students, pass out one scenario from Teacher Resource Page C: *Reclamation Scenarios* to each group. Instruct each team to read the scenario and decide on the best way to reclaim the land. For older students, pass out one copy of Teacher Resource Page D: *Reclamation Riddle* to each group. Assign each team a different group in the community to represent environmental advocates, farmers, construction company, wildlife activists, mining company, village hall, or average tax-paying citizens and instruct the groups to determine the best way to reclaim the land based on the interests of their particular community group.
19. Review the definition of productive resources and instruct the students to use any classroom productive resources to reclaim the sandy mining site in their Rubbermaid shoeboxes. Have a variety of materials available for their use on a separate table in the classroom (i.e. construction paper, toothpicks, craft sticks, rocks, scissors, glue, felt, etc.)
20. Allow teams approximately twenty minutes to complete the reclamation. Once all teams have completed the process, ask them to share their work with the class. Ask the other students if they can tell what type of reclamation took place.

21. When all teams have shared, discuss the costs (penalties that result from an action or activity) and benefits (rewards gained from an action or activity) of choosing specific types of reclamation.
22. Using Student Activity Page C: *Persuasive Writing Outline,* review the components of a persuasive writing piece.
23. Instruct individual students to write persuasive sentences or a persuasive paragraph/essay about why the type of reclamation their team chose was best in that particular situation.
24. Once outlines are completed, students should complete final drafts to be shared and hung outside the classroom alongside their reclaimed mining areas in the shoeboxes.

DEBRIEFING QUESTIONS

1. What are some ways cleaning up your room and reclaiming mined land are similar? (Answers will vary but may include: things must be put back in their place; neat, useful areas benefit more people; it's only fair to those around you; someone could get hurt if things aren't put back or cleaned up correctly, etc.)
2. What are the three productive resources used to produce goods and services? (Answer: natural, capital, and human resources)
3. What are some examples of each productive resource needed to mine for coal? (Answers will vary but may include: N – water, land, limestone, etc.; C – bulldozers, shovels, drills, etc.; H – engineers, geologists, miners, etc.)
4. Why is it important that coal-mining companies plan carefully and make good choices before beginning the mining process? (Answers will vary but may include: they can predict a profit or loss; they can choose what is appropriate for the specific land to be mined; etc.)
5. What was the trade-offs and costs and benefits of making the decision you did in the reclamation activity? (Answers will vary depending upon the reclamation scenario. Example for Scenario #1: Costs of building a park instead of reclaiming the land as farmland might include that there would be fewer farming jobs available and no opportunity to grow crops. Benefits of building the park versus farmland might include the opportunity for more citizens to utilize the land and accommodate the growing population of young people. The trade-offs might include trading jobs for recreation and trading crops for open land.)
6. Who might be affected by choices made in the reclamation process? (Answers will vary but may include: the community, wildlife, farmers, construction companies, mining companies, etc.)

GLOSSARY

- Benefits – rewards gained from an action or activity
- Capital – resources used over and over again to produce goods and services
- Coal – natural dark brown to black material used as a fuel, formed from fossilized plants and consisting of carbon
- Conservation – the protection or saving of something from loss or damage
- Costs – penalties that result from an action or activity
- Labor – human resources that produce work

- Loss – the condition of losing money from an investment
- Natural resources - "gifts of nature" that are present without human intervention; resources that occur naturally that can be used to produce goods and services
- Opportunity cost – the highest-valued alternative given up when a choice is made
- Productive resources – natural, capital, and human resources used to produce goods and services
- Profit – income received from an investment
- Reclamation – restoring land to the way it was or better
- Revenue – the amount producers receive when consumers buy a producer's product
- Trade-off – giving up some of one thing to gain some of another thing

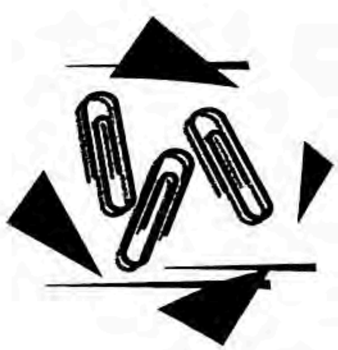
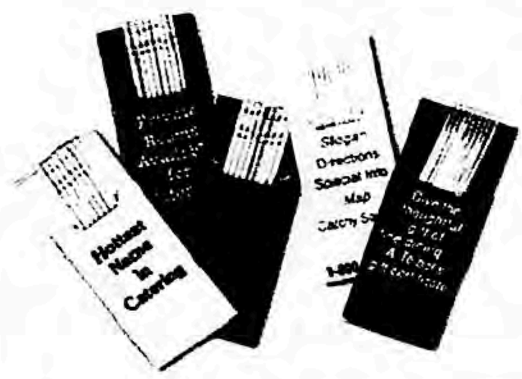
EXTENSION ACTIVITIES
- Read through the picture book entitled *In Coal Country* by Judith Hendershot. Identify the different productive resources used throughout the story.
- Design a poster showing at least two possible choices for reclamation.
- Folding a sheet of paper into thirds, draw and label an example of each productive resource needed to mine or reclaim land. (Include one natural, one capital, and one human resource.)
- Complete an additional *"Sandy Situation"* sheet making different choices, and compute the profit or loss.
- Role play a short skit in which coal miners are getting ready to reclaim land into something with which the community is or is not happy.
- Write a poem about the importance of reclaiming land correctly.

ADDITIONAL RESOURCES
- www.imcc.isa.us
- http://www.illinoisbiz.biz/dceo/Bureaus/Coal/Virtual+Tour/

CREDITS
- http://www.teachcoal.org/

TEACHER RESOURCE PAGES
- Teacher Resource Page A: *The Prices of Productive Resources*
- Teacher Resource Page B: *Coal Currency*
- Teacher Resource Page C: *Reclamation Scenarios (K-2)* (2 pages)
- Teacher Resource Page D: *Reclamation Riddle (3-4)*
- Teacher Resource Page E: *Reclamation Scenarios (K-2)* – Answer Key
- Teacher Resource Page F: *Our Productive Resources at Work in the Coal Mines – Possible Answers*
- Teacher Resource Page G: *A Sandy Situation – Answer Key*

STUDENT ACTIVITY PAGES
- Student Activity Page A: *Our Productive Resources at Work in the Coal Mines*
- Student Activity Page B: *A Sandy Situation*
- Student Activity Page C: *Persuasive Writing Outline*

PLASTIC SPOONS ***$5.00 each*** 	**CRAFT STICKS** ***$3.00 each***
PAPER CLIPS ***$2.00 each*** 	**TOOTHPICKS** ***$1.00 each*** 

Teacher Resource Page B: *Coal Currency*

5 5

Coal  Currency

$5.00

5 5

1 1

Coal  Currency

$1.00

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5 5

Coal  Currency

$5.00

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Teacher Resource Page C: *Reclamation Scenarios (K-2)* Page 1

1. This mine used to have farmland above it. The farmer's major crops were corn and soybeans. However, the farmer was not having very good luck with his crops the last few years because the land was not very fertile. The town surrounding the coal mine has many children, who love to run and play, and don't have a lot of space.

   How should this land be reclaimed?

   a) a golf course b) a park c) farmland d) a bank

   ____

2. This mine used to have a beautiful forest above it. The trees had grown to be very large and provided a nice, shady area for picnickers and hikers. The people of the community loved the forest preserve since the rest of their town was made up of shopping malls and golf courses.

   How should this land be reclaimed?

   a) a golf course b) farmland c) a shopping mall d) a forest

   ____

3. This mine used to have wetlands above it. It was meant to be a place for wildlife to gather. However, the town grew so much that people would tramp through these wetlands in order to get from one person's house to the next. The people of the town began to move elsewhere because there were no houses available to them.

   How should this land be reclaimed?

   a) a housing development b) a forest c) a hospital d) farmland

   ____

Teacher Resource Page C: *Reclamation Scenarios (K-2)* Page 2

4. This mine used to have flat, fertile land above it that was simply an open area. No trees grew there, but the soil was very good. The people of the town grow corn, but were really hoping to grow soybeans as well. They are spending a lot of money buying their soybeans elsewhere, and would save a lot if they could grow them themselves.

How should this land be reclaimed?

a) a golf course b) a school c) farmland d) wetlands

____

5. This mine used to have pretty, rolling green grass above it. Trees were planted throughout the area, as well. The people who live in the area are mostly adults who are quite active. They enjoy all kinds of sports that take place outdoors. They have a walking trail near their houses, but nothing else.

How should this land be reclaimed?

a) farmland b) a golf course c) a school d) open space

____

6. This mine used to have lots of animals roaming around. They loved to run across the land and swim in its shallow water. Now, the animals have run away and do not have a place to live. They are starting to get on the townspeople's nerves.

How should this land be reclaimed?

a) a housing development b) a school c) farmland d) a wildlife habitat

____

Teacher Resource Page D: *Reclamation Riddle (3-4)*

This mine used to have fertile land that was used for planting corn and soybean crops. Although the population of the town is changing from rural farmers to more urban workers traveling to the city for work, there are still families that depend on the corn and soybean crops for their income.

Pretend that your student group represents the members of one of the community groups that your teacher has assigned to you. Determine the best way the group you are representing would choose to reclaim the land based on the group's particular interests. Be sure to fill in the section labeled ***REASONS*** *with at least five good reasons for choosing the reclamation process that you did.*

Community Groups:
- **Farmers**
- **Wildlife Activists**
- **Village Hall**
- **Environmental Advocates**
- **Construction Company**
- **Mining Company**
- **Average Tax-Paying Citizens**

How should this land be reclaimed?

____

REASONS

1. ____
____
2. ____
____
3. ____
____
4. ____
____
5. ____
____

Teacher Resource Page E: *Reclamation Scenarios (K-2) – Answer Key*

1) b – a park
2) d – a forest
3) a – a housing development
4) c – farmland
5) b – a golf course
6) d – a wildlife habitat

Teacher Resource Page F: *Our Productive Resources at Work in the Coal Mines –Possible Answers*

Natural Resources 	***Capital Resources*** 	***Human Resources*** 
water	bulldozers	engineers
land	shovels	miners
limestone	drills	geologists
	computers	safety directors
		transportation operators

Teacher Resource Page G: *A Sandy Situation – Answer Key*

Beginning amount of money (company had saved for project) **$ 20.00**

Cost of land to be mined $ 5.00 (A)

Choose the capital resources you would like to buy in order to mine the greatest amount of coal and list the amount spent on each line.

Plastic spoon = $5.00 each (1=$5.00; 2= $10.00; 3= $15.00)
$10.00 (B)

Popsicle stick = $3.00 each (1= $3.00; 2= $6.00; 3= $9.00)
______(C)

Paper clip = $2.00 each (1= $2.00; 2= $4.00; 3= $6.00) $ 2.00 (D)

Toothpick = $1.00 each (1= $1.00; 2= $2.00; 3= $3.00) $ 1.00 (E)

ADD (A)+(B)+(C)+(D)+(E) = *COSTS* = $18.00 (F)

Mine the sandy area for coal, and list how many pieces you found on this line: 10
If each piece of coal is worth $3.00, how much money would you earn for the number of pieces you found?
***REVENUE* = $30.00 (G)**

If you are able to SUBTRACT (F) from (G), you have made a *PROFIT*.

$ 30.00 (G) *REVENUE*
− $ 18.00 (F) *COSTS*
$ 12.00 = *PROFIT!*

If you are unable to SUBTRACT (F) from (G), but can SUBTRACT (G) from (F), you have experienced a *LOSS*.

$____________ (F) *COSTS*
− $____________ (G) *REVENUE*
$____________ = *LOSS*

Student Activity Page A: *Our Productive Resources at Work in the Coal Mines*

Natural Resources	*Capital Resources*	*Human Resources*
		

Student Activity Page B: *A Sandy Situation*

Beginning amount of money (company had saved for project) **$ 20.00**

Cost of land to be mined 5.00 (A)

Choose the capital resources you would like to buy in order to mine the greatest amount of coal and list the amount spent on each line.

Plastic spoon	= $5.00 each (1=$5.00; 2= $10.00; 3= $15.00)	______	(B)
Popsicle stick	= $3.00 each (1= $3.00; 2= $6.00; 3= $9.00)	______	(C)
Paper clip	= $2.00 each (1= $2.00; 2= $4.00; 3= $6.00)	______	(D)
Toothpick	= $1.00 each (1= $1.00; 2= $2.00; 3= $3.00)	______	(E)

ADD (A)+(B)+(C)+(D)+(E) = ***COSTS =*** ______ **(F)**

Mine the sandy area for coal, and list how many pieces you found on this line: ______.
If each piece of coal is worth $3.00, how much money would you earn for the number of pieces you found?

REVENUE = ______ **(G)**

If you are able to SUBTRACT (F) from (G), you have made a *PROFIT*.

$ ____________ **(G) *REVENUE***

- $ ____________ **(F) *COSTS***

$ ____________ **= *PROFIT***

If you are unable to SUBTRACT (F) from (G), but can SUBTRACT (G) from (F), you have experienced a *LOSS*.

$____________ **(F) *COSTS***

- $____________ **(G) *REVENUE***

$____________ **= *LOSS***

Student Activity Page C: *Persuasive Writing Outline*

INTRODUCTORY SENTENCE
(Write about what it is you believe in so strongly.)

BODY OF PARAGRAPH
(List from one to three reasons why you feel the way you do.)

CONCLUDING SENTENCE
(Restate your strong belief in different words.)

Lesson

To Surface Mine or Underground Mine? That is the Question!

OVERVIEW

In this lesson, students will examine the economic steps required in making a wise decision. They will formulate problems, evaluate criteria, and make decisions about everyday choices, as well as mining choices. After making decisions, students will identify trade-offs and opportunity costs that accompany their decisions. Students will read coal-related material and gain a better understanding of both surface and underground mining.

MATERIALS

- One bag of Hershey's chocolates (unwrapped)
- One bag of Nestle's chocolates (unwrapped)
- One bag of Russell Stover chocolates (unwrapped)
- Alternative treats in case of food allergies such as 3 brands of graham crackers, animal crackers, or vanilla wafers
- One copy of Teacher Resource Page A: *Decision-Making Grid – Possible Answers (Chocolate)*
- One copy of Teacher Resource Page B: *Decision-Making Grid – Possible Answers (Coal)*
- One copy of Student Activity Page A: *PACED – The Way to Make a Good Decision* per student
- Two copies of Student Activity Page B: *Decision-Making Grid* per student
- One transparency of Student Activity Page A: *PACED – The Way to Make a Good Decision*
- One transparency of Student Activity Page B: *Decision-Making Grid*
- One copy of Student Activity Page C: *Coal Mining: Underground vs. Surface* per student
- Chart paper
- Markers
- Student writing journals
- Paper to make books
- Crayons, pencils, and markers
- Coal mining resource books or Internet
- Overhead projector

APPROXIMATE TIME REQUIRED

- Two forty-five minute class periods are required to complete the lesson.

VOCABULARY

- Alternative
- Coal seam
- Criteria
- Decision
- Evaluate
- Opportunity cost
- Surface mining
- Trade-offs
- Underground mining

OBJECTIVES

After completing this lesson, students will be able to:

- read for understanding.
- describe examples of decisions people must make.
- explain the importance of understanding choices before making decisions.
- define a problem.
- identify criteria important to solving the problem.
- evaluate criteria using mathematical operations.
- effectively apply the PACED decision-making model to a choice situation.
- develop stories based on factual information learned.

ENGLISH LANGUAGE ARTS STANDARDS

1.C.1e; 1.C.2e; 3.C.1a; 3.C.2a; 3.C.1b; 3.C.2b; 4.A.1c; 4.A.2c; 4.A.1d; 4.B.1b; 4.B.2b; 5.A.1a; 5.C.1a; 5.C.2a

MATH STANDARDS

6.A.1a; 6.A.2; 6.B.1; 6.B.2; 6.C.1a; 6.C.2a; 6.C.1b; 6.C.2b; 10.A.1a; 10.A.2a; 10.A.1b; 10.A.2c; 10.B.1b; 10.B.2b; 10.B.1c; 10.B.2d

SCIENCE STANDARDS

11.A.1b; 11.A.2a; 11.A.2b; 11.A.1d; 11.A.2c; 11.A.1e; 11.A.2d; 11.A.1f; 11.A.2e; 12.E.1c; 13.A.2b; 13.A.2c; 13.B.2f

SOCIAL SCIENCE STANDARDS

15.B.1; 15.B.2a; 15.B.2c; 15.C.1b

PROCEDURE

1. Introduce the lesson by asking the class what types of choices or decisions they had already made that day, whether before school or during school. (Answers will vary but may include: what clothes to wear; how to wear their hair; what to eat for breakfast; who to sit with on the bus; which pencil to use; to raise a hand or not, etc.)
2. Explain to the students that while people make decisions everyday of their lives, some decisions are bigger than others, or require more careful thought.

3. Ask students if they can think of some decisions their parents or other adults have had to make that may have been very big decisions. (Answers will vary but may include: which house to buy; which car to buy; how much money to spend at the grocery store; how much money to spend on school clothes/supplies; which college a child might attend; what type of punishment to give; what type of reward to give; whether or not to let a child go on a vacation with friends, etc.)
4. Discuss the importance of knowing your choices and thinking about what is important to you before making any decision.
5. Tell the students that you are going to have a small treat for them because of a job well done in class in the recent past, but you are unsure of what type of treat to serve. (Before deciding on the type of treat to serve, be sure student food allergies are taken into consideration. Possible treats might include chocolate, graham crackers, animal crackers, or vanilla wafers.) Let them know that you have narrowed down the treat to three types of chocolate candy (or other type of treat). You need their help in deciding which type of chocolate should be served. (The students should, now, be quite excited about making a decision!)
6. Explain to the class that there are five very simple, yet important, steps to making a decision. In order to remember these steps, you'd like them to remember the word "PACED." Hand out one Student Activity Page A: *PACED – The Way to Make a Good Decision* to each student. Place a transparency of the activity page on the overhead projector as well.
7. Go through the steps, explaining what each means. (P-Problem; A-Alternatives; C-Criteria; E-Evaluate; D-Decision)
8. Next, hand out one copy of Student Activity Page B: *Decision-Making Grid* to each student. Again, place a transparency of this activity page on the projector in order to complete parts together.
9. Tell students that they will be taking a taste-test in order to help them decide which brand of chocolate they like best and, therefore, which type should be served as their treat. Identify this as the *problem*.
10. Without telling them the actual brand-names (this could cause biased decisions) tell the students that they will be calling the three *alternatives* A, B, and C. Fill these in on the transparency, while the students fill in their own grids.
11. Next, ask the students to brainstorm the important things they look for in a piece of chocolate (or other treat you choose to serve), introducing the word *criteria*. (Some ideas might include: sweet; soft; large size, etc.) Fill in their criteria on the transparency for them to copy onto their grids once again.
12. Explain that the next step is to *evaluate*. This means that they need to test or find the worth of each piece of chocolate using some type of rating scale. Draw the following rating scale on the board: 5 = Great!; 4 = Good; 3 = Okay; 2 = Not so good; 1 = Yuck!
13. Tell the students that they will taste one piece of chocolate at a time, and will need to rate it based on each of the criterion listed on their grids.
14. Do an example together on the transparency to ensure student understanding.
15. Begin passing out chocolate A, waiting until most students are finished, then B, and so on.

16. Once the majority of the children have completed their evaluations, ask them how this helps them make a *decision*. (Most students will see that they need to add each type of chocolate's ratings in order to make a good decision.)
17. Instruct the students to complete the addition and circle the greatest number or highest rating total. Have them draw a square around the second place "winner", introducing the term *opportunity cost* as the next best alternative given up when a choice is made. (See Teacher Resource Page A: Decision-Making Grid – Possible Answers (Chocolate).
18. Compare answers when finished, gaining an understanding for the most popular chocolate. Tell the students the real brand-names of the chocolates and that they have helped you decide which type of chocolate to serve as their treat the next day.
19. Ask students what other types of people need to make choices. Encourage them to think about different jobs or careers that need to make decisions.
20. Explain to the class that coal mining companies need to make decisions everyday regarding mining locations, mining tools, types of mining, style of mine, whether or not to mine a certain area, etc.
21. One of the biggest decisions has to do with the use of surface mining versus underground mining or not to mine a specific area at all, and many factors or criteria are important to consider.
22. Distribute one copy of Activity Page C: *Coal Mining: Underground vs. Surface* to each student. Read the explanations of each type of mining aloud, while students follow along.
23. Discuss with the students some of the reasons for using one type of mining over another. By reading Activity Page C, visiting the website www.illinoiscoal.biz, and reading other coal-related books, students will find many criteria for choosing one mining method over another. (Some ideas: location of the coal; location of the mine; budget (money); availability of machinery, etc.) List these things on a chart to be used again later in the lesson.
24. Tell the class that their help is needed in making a decision about which type of mining to use in order to gather coal from a mine in a nearby town (depending on the location of the school) or not to mine this particular land at all. Explain that this particular mining company usually employs a large number of people and has been in business for a long time. They are a well known and trusted company that has a great deal of experience in both types of mining. They are confused about which type of mining to use or if they should mine this area at all because the location of this particular coal seam is not very close to the surface of the earth, but not deep in the layers of the earth either.
25. Ask the students how they might go about helping make the decision. (Most students will answer using PACED and a decision-making grid.)
26. Again, pass out one copy of Student Activity Page B: *Decision-Making Grid* to each student, while using a transparency on the overhead projector.
27. Ask students to name the P-Problem that the coal company is having. (Which type of mining should be used in a particular mine?)
28. Next, ask students what the A-Alternatives are. (Surface mining, underground mining, and not to mine at all at this location)

29. Gather ideas from the students regarding different C-Criteria that need to be E-Evaluated. (Some criteria might include: jobs for a number of people; advanced technology used; requires advanced planning; cost of reclamation, etc.) Fill in the grid with these criteria.
30. Remind the students that in order to E-Evaluate the criteria, they need to use a rating system of some sort. Recap the method used to evaluate in the chocolate taste test: using the numbers 1 through 5. Introduce other possible methods such as using pluses and minuses, etc.
31. Allow time for the students to evaluate the criteria reminding them about the company that will be completing the mining. (See Teacher Resource Page B: Decision-Making Grid – Possible Answers (Coal).
32. Once students have completed the decision-making grid, compare decisions and discuss the trade-offs and opportunity cost of choosing a particular type of mining or no mining at all.
33. Share with the class the picture book entitled *In Coal Country* by Judith Hendershot, which is a book about life in an Ohio coal-mining town in the 1930's.
34. Discuss the importance of the first-person narration as well as the detailed illustrations.
35. Instruct students to design their own picture books describing the life of a coal miner taking part in either an underground or surface-mining project. (Younger students may complete the book using pictures only, while older students should be challenged to include a narration of the story along with illustrations.)
36. Students may use Student Activity Page C: *Coal Mining: Surface vs. Underground* as well as the websites listed under additional resources.
37. Students should be given time to share their picture books with the class in an "Author's Chair", answering questions about their stories when they are finished.

DEBRIEFING QUESTIONS

1. What are some decisions you make day-to-day? (Answers will vary but may include: what clothes to wear; what to eat for breakfast; whether or not to raise a hand; who to sit with on the bus, etc.)
2. Why is it important to keep the PACED economic decision-making grid in mind when making a big decision? (Answers will vary but may include: it encourages you to think carefully about your choices and reasons for choosing the things you do.)
3. Why might one person's decision differ from another's in the same situation? (Answers will vary but may include: different people have different values, tastes, etc.; people have special criteria, etc.)
4. What is one of the simplest ways to decide whether surface mining or underground mining should be used? (Answers will vary but may include: the location of the coal seam – if it's deep in the layers of the earth, underground mining should be used; if it is close to the surface, surface mining should be used.)
5. Why might a large, wealthy company choose underground mining over surface mining if the location of the coal seam was uncertain? (Answers will vary but may include: it may have the money to operate advanced machinery; it may want to employ more people, etc.)

6. What was your opportunity cost when using the decision-making grid to make your mining decision? (Answers will vary based on the decision.)

GLOSSARY

- Alternative – a choice between two or more things
- Coal seam – a bed or large deposit of coal
- Criteria – a standard on which a judgment or decision is based
- Decision – a conclusion made after consideration
- Evaluate – to find or determine the worth of something
- Opportunity cost – the highest-valued alternative given up when a choice is made
- Surface mining – mining the coal that lies near the surface of the earth
- Trade-off – giving up some of one thing to gain some of another thing
- Underground mining – mining the coal that is deep in the layers of the earth

EXTENSION ACTIVITIES

- Folding a sheet of paper in half, draw a picture of both an underground mine and a surface mine, including as many details as possible.
- Design a taste-test of interest to classmates, asking the class to use decision-making grids to help them make a wise decision.
- Make a list of all of the choices or decisions you need to make in the next week.
- Write a letter to your parents explaining the PACED decision-making process step-by-step.
- Research the two different types of underground mining and decide which type would best be used in a certain situation.
- Visit the website: www.illinoiscoal.biz and read more about the three types of underground mines: slope, drift, and shaft. Make a model of your favorite.
- Role-play a debate between two coal mining companies that feel differently about which type of mining should be used in a particular situation.

ADDITIONAL RESOURCES

- http://www.illinoisbiz.biz/dceo/Bureaus/Coal/Virtual+Tour/

CREDITS

- http://www.teachcoal.org/

TEACHER RESOURCE PAGES

- Teacher Resource Page A: *Decision-Making Grid – Possible Answers (Chocolate)*
- Teacher Resource Page B: *Decision-Making Grid – Possible Answers (Coal)*

STUDENT ACTIVITY PAGES

- Student Activity Page A: *PACED – The Way to Make A Good Decision*
- Student Activity Page B: *Decision-Making Grid*
- Student Activity Page C: *Coal Mining: Surface vs. Underground*

Teacher Resource Page A: ***Decision-Making Grid – Possible Answers (Chocolate)***

	CRITERIA				
ALTERNATIVES	sweet	big	soft	easy to chew	**TOTALS**
A	4	5	1	2	13
B	2	1	4	4	11
C	5	3	2	2	12

Teacher Resource Page B: ***Decision-Making Grid – Possible Answers (Coal)***

	CRITERIA				
ALTERNATIVES	cheap	many jobs	advanced technology	low reclamation cost	**TOTALS**
Surface Mining	3	3	3	4	13
Underground Mining	2	5	4	3	14

Economic Decision-Making Steps

Remember the word PACED when you need to make a wise decision.

P = Problem (What is the problem I have to solve?)

A = Alternatives (What are the different items from which I have to choose?)

C = Criteria (What are the important things I look for in the items? What makes them so good?)

E = Evaluate (Look closely at each item and give each a "grade.")

D = Decision (Add up the "grades" or scores to see which choice would be best.)

5 = Great!
4 = Good
3 = Okay
2 = Not so good
1 = Yuck

Student Activity Page B: *Decision-Making Grid*

	CRITERIA				
ALTERNATIVES					TOTALS

Surface Mining

Surface mining is the most commonly used method of mining. Surface mines produce more than half of the coal in the United States. Generally, surface mining is used when a coal seam is found no more than 150 feet beneath the earth's surface. It involves the loosening of overburden (soil and rocks) above the seam of coal through blasting. Giant power shovels then scoop up the overburden until the coal deposit can be seen. Next, smaller shovels scoop coal and load it into trucks. These trucks transport the coal to a preparation plant where the coal is crushed, sized, and washed so it can be shipped by truck, railroad, or barge to the end user.

Underground Mining

Underground mining is used when coal is found deep in the layers of the earth. In an underground mine only some of the coal is removed. The coal that remains helps support the mine roof. Underground mines look like a system of tunnels. The tunnels are used for traveling throughout the mine, moving coal from place to place and allowing air to circulate in the mine. Conveyor belts are used to transport the coal from the mine to the surface of the earth. When this type of mining is used, mining engineers must develop careful plans to tunnel beneath the earth's crust. Underground mining is very tricky. It requires a great deal of advanced equipment to produce the coal safely and economically.

Tie In - Rocks and Minerals

CORRESPONDING STANDARDS

- Illinois Science State Goal 12
  - A. Know and apply concepts that explain how living things function, adapt and change.
  - B. Know and apply concepts that describe how living things interact with each other and with their environment.
  - C. Know and apply concepts that describe properties of matter and energy and the interactions between them.
  - E. Know and apply concepts that describe the features and processes of the Earth and its resources.
- Illinois Social Science State Goal 15
  - A. Understand how different systems operate in the exchange, production, distribution and consumption of goods and services.

DID YOU KNOW?

- Coal was formed from natural matter – from plants that lived 300 million years ago.
- Coal began its formation from plants grown in swampy areas that died and fell, forming separate layers. The combination of time, heat and pressure forced oxygen and hydrogen out of the plants leaving behind carbon deposits in the form of coal.
- Plants receive energy from the sun, which helps in growth and reproduction. When they die, energy is released into organisms that eat the plants. When plants do not decompose completely, the energy becomes trapped. Therefore, coal contains energy that can be released.
- Coal is considered a "fossil fuel" because it was transformed from fossil plant material into burnable carbon which is used primarily in the production of electricity.
- Coal changes states by being placed in a boiler at a power plant. The boiler burns the coal, changing the chemical energy to heat energy. This energy is transferred to water (liquid), and the water changes to steam (gas). Steam turns the blades of a turbine, which runs the generator and produces electricity.
- Four types of coal exist, including lignite, subbituminous, bituminous and anthracite.
- Lignite is brownish-black in color and is considered the "youngest" type of coal, with the lowest heating value.
- Subbituminous is a dull black coal with a higher heating value than lignite.
- Bituminous is a soft black coal, sometimes appearing layered, with a higher heating value than subbituminous coal.
- Anthracite is a hard, shiny black coal having the highest heating value.
- Fossils or impressions of early plants are often found in coal.
- Bituminous coal is the most plentiful coal mined in Illinois.
- The mining of coal produces both goods and services. Some products of coal such as coal tar, coal gas, chemicals and coke are used as fuel to produce goods. Some coal byproducts such as fly ash and bottom ash are used as ingredients in goods. Coal itself is used as a fuel to produce the service of electric power.

- The United States has the world's largest supply of coal – enough for another 300 years at the present rate of use.

QUESTIONS/ISSUES

- What are some examples of how electricity is used in your home? (Answers will vary but may include: television, microwave, hairdryer, refrigerator, computer, etc.)
- How might you and your family be affected if coal became scarce and was not readily available? (Answers will vary but may include: no electricity, therefore no heat, computers, or microwave ovens; alternative sources of energy would have to be discovered and used; need to conserve energy/electricity.)
- In what ways are geologists in the coal industry able to identify the type or rank of coal? (Answers will vary but may include: using color, luster, layering, hardness, texture, and its ability to burn.)
- How does coal become electricity? (Answer: From dead plants to energy; from energy to the boiler; from the boiler to the generator; from the generator to electricity.)
- What are some coal products that are used as fuel in the production of goods used in our homes and businesses? (Answers will vary but may include: coal tar, coke, chemicals, coal gas.) Coal byproducts that are used as ingredients? (Answer: fly ash, bottom ash.)
- How do time, heat and pressure affect the development of coal? (Answers will vary but may include: Coal began its formation from plants grown in swampy areas that in time died and fell, forming separate layers. The combination of time, heat and pressure forced oxygen and hydrogen out of the plants leaving behind rich carbon deposits in the form of coal.)
- Why might the cost of anthracite exceed the cost of bituminous coal in Illinois? (Answers will vary but may include: Anthracite coal is not found in Illinois. There is more of a demand for anthracite due to its high heating value. Bituminous coal provides less heating value. Bituminous coal is in Illinois.)

EXTENSIONS/CONNECTIONS

- Observe sample pieces of the four types of coal, and record characteristics in a table. Identify each sample of coal based on your observations.
- Make a "Who Am I?" flip-book that describes the four types of coal using pictures and factual clues. *(Lower grades: include pictures and/or important words.)*
- Trace an outline of a tree, adding leaves with pictures or words of goods and services that use coal in their production process or use coal byproducts as ingredients.
- Create original fossils using plant leaves, clay and plaster.
- Make a poster of different goods and services that use coal in their production.
- Create a picture timeline describing the formation of coal. *(Lower grades: sequence pre-made information cards.)*
- Draw a flow chart explaining the process of coal becoming electricity. *(Lower grades: cut-out and organize pre-made picture cards.)*
- Write a short story from a piece of coal's point-of-view traveling from the coal mine to the power line.
- Write an expository essay describing the process of coal becoming electricity.

Tie In - The Environment

CORRESPONDING STANDARDS

- Illinois Science State Goal 11
  - A. Know and apply the concepts, principles and processes of scientific inquiry.
  - B. Know and apply the concepts, principles and processes of technological design.
- Illinois Science State Goal 12
  - A. Know and apply concepts that describe how living things interact with each other and their environment.
  - B. Know and apply concepts that describe properties of matter and energy and the interactions between them.
  - E. Know and apply concepts that describe the features and processes of the Earth and its resources.
- Illinois Science State Goal 13
  - B. Know and apply concepts that describe the interaction between science, technology and society.
- Illinois Social Science State Goal 15
  - B. Understand that scarcity necessitates choices by consumers.
  - C. Understand that scarcity necessitates choices by producers.
  - D. Understand trade as an exchange of goods and services.

DID YOU KNOW?

- Before the late 1960's and early 1970's, coal-mining companies were not overly concerned with how the land would be used after coal was taken out of the ground.
- Federal environmental laws were passed in the 1970's that affect the mining industry. State and local laws have been enforced, as well, to aid in the recovery and environmentally sound development of mined land.
- Reclamation is the process of returning mined land to productive and beneficial use.
- Reclaimed mining sites can be developed into a number of environmentally safe zones such as recreational parks, wildlife habitats, agricultural areas, forests, etc., depending upon the supply of resources and the demand from the public.
- There are three main phases to mining reclamation: pre-mining, mining, and post-mining.
- During pre-mining, many questions must be answered regarding the possibility and value of mining the area, the environmental and economic impacts of the mine, and the types of reclamation actions that will take place after mining operations stop.
- Throughout mining, other concerns must be addressed such as waste storage, water management, air quality, wildlife habitat protection, and ongoing reclamation.
- During post-mining, these steps must be completed in order to ensure that the environment is disturbed as little as possible: leveling rocks and soil to re-shape the land, replacing subsoil and topsoil, replacing or introducing vegetation, monitoring the production of vegetation, sealing mine openings, and removing roads.
- Modern technologies have greatly changed the mining reclamation process, as well as the ways in which productive resources are used.

- Whether or not to mine a particular area is a big decision that must include local citizens, the mining company, recreational use representatives, local government, state and federal government, and more.

QUESTIONS/ISSUES

- Why was it necessary for the government to create laws regarding mining reclamation? (Answers will vary but may include: In the past mining often left pits or cliffs that were ugly, dangerous, and unproductive. Air and water pollution were heightened. Wildlife became endangered.)
- Why might some mines be best reclaimed as farming areas, while other mines might better be reclaimed for recreational areas? (Answers will vary but may include: The choice of reclamation depends upon the location, size and type of mine being reclaimed, and previous land use. One particular area might not include fertile land for agriculture, whereas it might be more suitable for rolling grassy land for bike paths and parks.)
- If you were the president of a coal-mining company, what are some positive reasons you would give for mining a particular area of land in Illinois? (Answers will vary but may include: coal is needed to produce energy, mining in Illinois will cost less money than gathering coal from other states, mining will provide needed jobs, etc.)
- If you were an environmental representative, what are some potential problems you foresee in mining a particular area of land in Illinois? (Answers will vary but may include: wildlife might be put in danger, water and air might be contaminated, etc.)
- If you were a federal government representative, what might your reaction be to a potential mining site in Illinois? (Answers will vary but may include: If reclamation laws are followed, including the three mining phases, mining the area most likely will benefit the public.)
- What are some modern technologies that have a positive effect on reclamation? How is each example helpful? (Answers will vary but may include: satellite imaging, computer /virtual simulations and modeling. Before investing the labor and resources, each can be used to predict which type of reclamation is most beneficial.)

EXTENSIONS/CONNECTIONS

- Discuss the similarities between mining reclamation and picking up toys or cleaning up one's room. Touch on who is affected by your choices.
- Using a Venn diagram, compare and contrast the way land looked after mining before 1970 and the way it looks today after mining is completed.
- Role-play a public hearing on a proposed mining operation near the community.
- Draw a three-part timetable illustrating the three phases of reclamation.
- Design a poster showing at least two possible choices for reclamation.
- Folding a sheet of paper into thirds, draw and label an example of each productive resource needed to mine or reclaim land. (Include one human, one natural, and one capital resource.)
- Write a thank you letter or post card from an animal's point-of-view to a mining company that has reclaimed land in an environmentally sound way.
- Given a model of a mining site and information about the land and its surroundings, predict the best way to reclaim the land, giving examples of the productive resources that would be involved in the reclamation.

Tie In - Technology and Types of Mining

CORRESPONDING STANDARDS

- Illinois Science State Goal 11
  - B. Know and apply the concepts, principles and processes of technological design.
- Illinois Science State Goal 12
  - B. Know and apply concepts that describe how living things interact with each other and with their environment.
  - D. Know and apply concepts that describe force and motion and the principles that explain them.
  - E. Know and apply concepts that describe the features and processes of the Earth and its resources.
- Illinois Science State Goal 13
  - B. Know and apply concepts that describe the interaction between science, technology and society.
- Illinois Social Science State Goal 15
  - B. Understand that scarcity necessitates choices by consumers.
  - C. Understand that scarcity necessitates choices by producers.

DID YOU KNOW?

- Coal is mined by both surface mining and underground mining.
- Surface mining is used when a coal seam is located close to the surface (no more than 150 feet down), while underground mining is used when the coal lies in deeper layers.
- Surface mines produce more than half of the coal mined in the United States, while the majority of mines in Illinois are underground mines.
- Three things happen in order to uncover the coal in a surface mine: removing topsoil, blasting overburden (rocks and soil), and scooping up the overburden until the coal deposit is exposed.
- After the coal has been exposed, coal is scooped into trucks that transport the coal to a preparation plant where the coal is crushed, sized, and washed. This is all done in preparation for a shipment to the end user or consumer.
- There are three different examples of underground mines: slope, drift, and shaft.
- A slope mine is used when coal is fairly close to the surface, but too deep to use surface mining. A tunnel is dug which slants down from the surface to the seam.
- A drift mine is used when the mine is located on the side of a hill or mountain. Passages are dug parallel to the coal seam.
- The most common mine is the shaft mine, in which miners remove the coal by drilling a hole, or shaft, in the ground until they reach the layer of coal. From there, they dig tunnels in the coal seam, allowing coal movement and air circulation.
- In Illinois, two types of underground mining are used: room and pillar and longwall.
- Room and pillar mining leaves blocks of coal in the mine to support the roof. Continuous miner machines move up and down cutting 18 to 20 foot wide tunnels.
- In longwall mining the roof is allowed to collapse in a planned sequence. More coal is mined using this method since the machine cuts 750 to 1,000 foot wide tunnels.
- Both types of underground mining incorporate the use of a conveyor belt to transport the coal from the mine to the surface.

- Before the early 1900's, miners used more modest capital resources (tools/machinery) to gather the coal. Sledgehammers and pick-axes were used until mechanical saws and bulldozers were invented. Large conveyors replaced mules in hauling coal out of the mines.
- Prior to the development of lighting systems that were explosion-proof, miners were taking greater risks each day in the mines.
- Before battery-powered lamps were attached to hardhats, candles were used.
- Until the Davy safety lamp was invented to detect methane gas in coal mines, miners may have been exposed to poisonous and flammable gas.
- Both safety and productivity were enhanced due to the many technological advances in mining.

QUESTIONS/ISSUES

- Why might surface mining be chosen over underground mining of a certain area? (Answers will vary but may include: The coal seam is within 150 feet of the surface.)
- By choosing to use room and pillar mining, what might be the opportunity cost (the next best alternative that is forgone when a choice is made)? (Answers will vary but may include: longwall mining, more coal removal, greater profit, etc.)
- By choosing to use longwall mining, what might be the opportunity cost (the next best alternative)? (Answers will vary but may include: lower capital costs (tools/machinery), safety of a roof, geology of land, subsidence costs, etc.)
- What are some benefits of using advanced technologies in mining? (Answers will vary but may include: increased safety, faster extraction, greater amounts of coal removal, etc.) Costs? (Answers will vary but may include: different job opportunities requiring higher education, higher labor/capital costs, etc.)
- What are some different types of transportation used to haul coal from the mining site to the consumer? (Answers will vary but may include: truck, railroad, barge, etc.)

EXTENSIONS/CONNECTIONS

- Make a model of one of the three types of underground mines.
- Make a picture booklet comparing the tools used long ago in mining with the tools used today. Include brief descriptions of each below the drawings.
- Interview an adult worker to find out the kinds of technology used in his/her job. Record the ways in which new technology has affected production and the job.
- Read the story entitled *Mama Is a Miner* by George Ella Lyon and discuss the interdependence of the coal mine workers.
- Think about the ways technology is used in your everyday life. Using a T-chart, list the positive aspects and the negative aspects.
- Given a coal mine scenario, weigh the costs and benefits of using a particular type of mining. After completing a decision-making grid, describe the best choice including reasons.

Tie In - Illinois History

CORRESPONDING STANDARDS

- Illinois Science State Goal 11
  - B. Know and apply the concepts, principles and processes of technological design.
- Illinois Science State Goal 12
  - D. Know and apply concepts that describe force and motion and the principles that explain them.
  - E. Know and apply concepts that describe the features and processes of the Earth and its resources.
- Illinois Science State Goal 13
  - B. Know and apply concepts that describe the interaction between science, technology and society.
- Illinois Social Science State Goal 15
  - A. Understand how different economic systems operate in the exchange, production, distribution and consumption of goods and services.
  - E. Understand the impact of government policies and decisions on production and consumption in the economy.

DID YOU KNOW?

- In 1673 coal was discovered along the Illinois River by Marquette and Joliet.
- The first mine in Illinois began in the early 1800's in the state's county of Jackson on the banks of the Big Muddy River.
- Illinois coal was first used by railroads to power their steam engines.
- Coal actually was one of the motivating factors of the Industrial Revolution.
- In the late 1800's coal mining was difficult and included hazards such as lack of ventilation, explosions, and mine collapse.
- During the early 1900's, a number of mining inventions were designed to increase productivity while decreasing injuries and deaths.
- In 2008, Illinois ranked eighth among coal producing states, and coal was mined in 11 Illinois counties.
- Although coal has been mined in many areas of Illinois, the majority of active coal mines are found in the southern part of the state.
- A number of towns and cities grew in Illinois due to the occupational opportunities offered by coal mining companies.
- In 2008, coal mining in Illinois employed over 3,400 miners as well as created over 20,000 related job positions.
- The technology used in Illinois mining has changed drastically over the course of time, moving from simple shovels and picks to complex computerized machinery.
- 3,700 Illinois miners produced as much coal in 1999 as 15,000 miners produced in 1954 and 41,000 miners produced in 1927.
- Through the Illinois Department of Commerce and Economic Opportunity's Office of Coal Development, the state of Illinois sponsors the largest state-funded coal research and development program in the United States, aiding in research on coal extraction, preparation and use.

- In the late 1960's and early 1970's laws regarding health and safety, as well as clean air, were passed.
- Through the use of clean-coal technologies, such as coal combustion processes, flue gas cleaning, and recycling of combustion byproducts (using byproducts as ingredients), Illinois coal is being utilized while reducing the impact to our environment.

QUESTIONS/ISSUES

- How many years has it been since Marquette and Joliet discovered coal along the Illinois River? (Answer: Subtract 1673 from the current year to find the number of years.)
- What types of jobs or careers do you suppose the Illinois coal mining industry offers in order to produce coal goods and services? (Answers will vary but may include: miners; computer programmers, machinery operators, safety specialists, engineers, scientists, etc.)
- What are some possible consequences of unsafe mines and mining practices? (Answers will vary but may include: miners were injured or killed, less production, less profit, etc.)
- If you were a coal mine supervisor, what rules would you remind your workers about before entering a mine? (Answers will vary but may include: wearing hard hat with lamp, wearing steel-toed boots, carrying self-rescuer and safety belt, making sure someone knows you are entering the coal mine, etc.)
- Why might fewer miners be needed today to produce the same amount of coal as in 1927? (Answers will vary but may include: improved technology, increased expertise, different capital resources (tools) needed, etc.)
- Why do you think people flocked to cities or towns with active coal mines? (Answers will vary but may include: job opportunities, money, etc.)
- What might have happened in Illinois if the mining industry did not move forward in its use of technology? (Answers will vary but may include: loss of money from the consumers, loss of lives, environmental problems, etc.)
- It is important that Illinois support coal research and development? How is that similar to the importance of continuing your education in school? (Answers will vary but may include: increased knowledge, preparation for the future, etc.)

EXTENSIONS/CONNECTIONS

- Using a map of Illinois, identify the Illinois River by tracing over its path with a red crayon. In addition, color each of the 11 counties within Illinois where coal is mined.
- List the 11 coal-producing counties in Illinois in alphabetical order.
- Using the *Coal Industry in Illinois* map, measure the distance between your own county and the greatest coal-producing Illinois county.
- Design a *Want Ad* for a particular career in mining. Advertise the skills this producer of coal products needs. *(Lower grades: draw a picture including needed supplies.)*
- Make a flow chart incorporating all of the consumers of coal beginning inside the mine and ending in our homes. *(Lower grades: order pre-made cards.)*
- Create a bar graph comparing the 9 top ranking coal-producing states.
- Generate a timeline by sequencing important Illinois coal events. *(Lower grades: sequence pre-made cards.)*
- After researching a particular capital resource (tool) used to mine coal, design a plan to make it even better, more efficient, and safer. Create a model of the new invention demonstrating how it functions.

Tie In - Social Studies and Money-Making Coal

CORRESPONDING STANDARDS

- Illinois Science State Goal 13
    B. Know and apply concepts that describe the interaction between science, technology and society.
- Illinois Social Science State Goal 15
    A. Understand how different economic systems operate in the exchange, production, distribution and consumption of goods and services.
    B. Understand that scarcity necessitates choices by consumers.
    C. Understand that scarcity necessitates choices by producers.
    D. Understand trade as an exchange of goods and services.

DID YOU KNOW?

- Coal has helped the United States become the economic leader it is today, since it boasts the world's largest supply of this fuel.
- Coal has played a major role in our country's electricity generation. We use it to make us more productive, entertain us, and keep us safe in our homes.
- Although some states along the east coast import coal from foreign countries, Illinois does not have the need to import due to the fact that coal underlies 65% of the state.
- The cost of generating electricity with coal is about half the cost of using other fossil fuels. In 2004, the cost of electricity from coal was about $1.36 per one million Btu's (British thermal units), compared to oil at $4.29 per one million Btu's. *
- In addition to using Illinois coal to produce electricity and other important goods for our state, Illinois sells its coal to other states to make a profit.
- Canada, Japan, and Italy import a great deal of American coal due to the scarcity of coal in their countries.
- In 2003, 24 million tons of coal was used by the iron and steel industries. In order to be utilized by these industries coal must be heated to a very high temperature without being burned. The coal transforms into coke, which is mixed with iron ore and limestone in a blast furnace, beginning the steel making process.
- Products and byproducts of coal are used as ingredients or as fuel in producing other popular goods which are bought and sold.
- Coal mining provides hundreds of thousands of jobs a year to hard-working people. In a few areas in Illinois, direct mining jobs and their spin-off jobs can account for as much as 50 percent of the total county employment.
- Depending upon the type of job and qualifications, beginning salaries range from $35,000 to $60,000 annually, in addition to complete health care coverage.
- Computerized machinery has increased productivity of coal mining while lowering the cost of operation because it takes less time to complete a job using advanced technologies.

* http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html

QUESTIONS/ISSUES

- What are some ways coal is used in your home? (Answers will vary but may include: coal produces electricity which, in turn, allows us to use the television, computer, air conditioning, refrigerator, hair dryer, etc.; electricity runs the furnace which heats our homes.)
- What are some reasons coal is less expensive if bought right here in the United States? (Answers will vary but may include: lower transportation costs, greater supply, etc.)
- Using 2004 statistics, what is the difference between the price per million Btu's of coal compared with the price per million Btu's of oil? (Answer: \$2.53-\$1.22= \$1.31)
- What do you suppose might happen to the economy of Illinois if coal was not produced here, or there was a scarcity of coal in Illinois? (Answers will vary but may include: economy would weaken due to fewer jobs, higher costs of transportation, higher costs of products, etc.)
- What are some potential problems for the coal industry and the economy with new laws regarding clean coal? (Answers will vary but may include: it will be more difficult to pass environmental tests, cost of electricity will be higher, etc.)
- Why is coal-mining so important to many Southern Illinois towns? (Answers will vary but may include: coal is an abundant resource, it provides jobs, and sales taxes contribute to schools/roads, etc.)

EXTENSIONS/CONNECTIONS

- Create an art gallery of at least three hand-drawn pictures of different ways the production of coal earns money for the state of Illinois.
- Using a map of the world, color in the locations of the countries that import the most coal from the United States.
- For each letter of your first name, challenge yourself to think of things in your home that function because of electricity. (Example: TOM – T-toaster; O-oven; M-mixer)
- Write a class thank you letter to a coal mining company in your area expressing your gratitude for their hard work in gathering coal to be used for electricity in your home. Be sure to include the heading, date, greeting, body, closing, and your signature.
- Using a short, teacher-generated story about how coal is mined in Illinois, color code the productive resources (natural-red; capital-blue; human-green) mentioned throughout the tale.
- Using the different annual salaries of specific coal-mining jobs, compare the wages earned using greater than (>), less than (<), or equal to (=) signs.
- Make predictions and take actual measurements (weight, length, volume) of various pieces of coal.
- Sort various pieces of coal based on specific characteristics (size, geometric shape, color, luster, etc.)
- Make an acrostic poem using the word coal and related words or phrases. (Example: C-clean-coal technology; O-operations throughout Illinois; A-abundant; L-long-lasting)
- Role play a scenario where a coal mine is closing in a small town. Both the mother and the father in a family work in that mine.
- Allow students to bring in old toys and trinkets no longer needed/wanted from home to sell for play money at a school store. Discuss the similarities of this type of voluntary exchange to that of coal.

Tie In - Reading and Writing about Coal-Related Careers

CORRESPONDING STANDARDS

- Illinois Science State Goal 12
  - A. Know and apply concepts that explain how living things function, adapt and change.
  - B. Know and apply concepts that describe how living things interact with each other and with their environment.
- Illinois Science State Goal 13
  - A. Know and apply the accepted practices of science.
  - B. Know and apply concepts that describe the interaction between science, technology and society.
- Illinois Social Science State Goal 15
  - A. Understand how different economic systems operate in the exchange, production, distribution and consumption of goods and services.
  - D. Understand trade as an exchange of goods and services.
  - E. Understand the impact of government policies and decisions on production and consumption in the economy.

DID YOU KNOW?

- In 2003, a bill was passed that offered $300 million to help build coal power plants in Illinois. The push to do this came from a need to utilize clean coal technologies, better the state's economy, and create new jobs.
- Total mining employment in the United States in 2008 was 81,278.*
- Different coal-related jobs require special skills and experience. Some important skills necessary for the majority of mine-related jobs include creative thinking, good communication skills, problem solving, computer literacy, and decision making.
- School subjects such as math, science, and physics are helpful in preparing students interested in coal mine-related careers.
- Depending upon the type of job and qualifications, beginning salaries range from $35,000 to $60,000 annually, in addition to complete health care coverage.
- The coal industry in Illinois employs a great number of people in the areas of construction, power plant management, and coal mining. Jobs are made available during pre-mining planning, mining, and post-mining clean-up and reclamation.
- Drill rig operators actually drill holes in the Earth to obtain coal samples.
- Coal petrologists analyze the coal in a laboratory to determine the type of coal.
- Surveyors and mapping specialists determine the uses of the coal deposit.
- Mining engineers supervise the development and operation of mines.
- Coal miners dig coal from the earth and prepare it for use by consumers.
- Environmental specialists use their skills and knowledge to lessen coal-related hazards to the land and the atmosphere.
- Directors of safety work to protect the health of miners and ensure that coal mines meet safety requirements.
- Power plant supervisors oversee the timely/correct use of coal in creating energy.
- Transportation operators control vehicles that carry coal from the producers to the consumers.

* http://www.nma

- Trade analysts work with foreign countries in determining the price and quantity of coal supplied to them.
- Countries such as Canada, Japan, and Italy buy coal from the United States.
- Careers in coal mining are specialized, yet interdependent. Although jobs require unique skills, the end product of energy requires all workers to complete jobs well.

QUESTIONS/ISSUES
- What types of jobs are available in the coal mining industry? (Answers will vary but may include: surveyor, coal miner, environmental specialist, and transportation operator.)
- In what ways do you think math and science are used in coal-related careers? (Answers will vary but may include: problem solving, figuring area of coal deposits, weighing coal, developing machinery, analyzing rock and mineral samples.)
- If a miner makes $40,000 in one year, how much will he/she make in 4 years? (Answer: $160,000)
- If a person was interested in transporting coal and enjoyed traveling, which coal-related job might be best for him/her? (Answers will vary but may include: transportation operator, trade analyst.)
- If a person was interested in working beneath the earth and enjoyed dark places, which coal-related career might be best for him/her? (Answers will vary but may include: mining engineer, coal miner.)
- If a person was concerned about keeping the Earth clean and pollution-free, which coal-related job might be best for him/her? (Answers will vary but may include: environmental specialist, environmental engineer, etc.)
- Why is it important that people get some type of "reward" or salary for a job well done? (Answers will vary but may include: Incentives encourage people to work harder and complete work well.)
- Why might other countries be interested in purchasing coal from Illinois? (Answers will vary but may include: their countries do not produce coal, Illinois coal is less expensive.)

EXTENSIONS/CONNECTIONS
- Read *Mama is a Miner* by George Ella Lyon, and list all of the different coal-related jobs on an outline of a coal miner.
- Make an ABC book about coal mining displaying one word or picture related to coal for each letter of the alphabet.
- Create an illustration of a properly dressed coal miner.
- Discuss the types of chores/jobs you do in your house and the reward you get for your work. Design a pictograph of the jobs completed by students in class.
- Design questions about coal careers using each of the six "WH" question words (Who? What? Where? When? Why? How?) Quiz a partner.
- Using a map of the world, locate all of the countries that import coal from the United States. Draw lines connecting each country with the U.S. comparing the distances.
- Write a letter to a person holding a particular coal-mining position you admire. Ask questions about his/her job and compliment him/her on an admirable career.
- Research a particular coal-related job, and dress as that typical worker while giving a brief explanation of the skills necessary to carry out the job.
- Assign small groups of students particular jobs coal miners must do in order to gather coal from a coal mine. Discuss the importance of working interdependently.

K – 4 GLOSSARY

Alternative – a choice between two or more things

Benefits – rewards gained from an action or activity

Capital – resources used over and over again to produce goods and services

Coal – natural dark brown to black material used as a fuel, formed from fossilized plants and consisting of carbon

Coal seam – a bed or large deposit of coal

Conservation – the protection or saving of something from loss or damage

Costs – penalties that result from an action or activity

Criteria – a standard on which a judgment or decision is based

Decision – a conclusion made after consideration

Electricity – electric current used or regarded as a source of power

Evaluate – to find or determine the worth of something

Generate – to produce as a result of a chemical or physical process

Goods – material things that produce satisfaction

Kilowatt – a unit of power equal to 1,000 watts

Labor – human resources that produce work

Loss – the condition of losing money from an investment

Natural resources - "gifts of nature" that are present without human intervention; resources that occur naturally that can be used to produce goods and services

Opportunity cost – the highest-valued alternative given up when a choice is made

Produce – to make

Productive resources – natural, capital, and human resources used to produce goods and services

Profit – income received from an investment

Reclamation – restoring land to the way it was or better

Revenue – the amount producers receive when consumers buy the producer's product

Services – actions that are done for you that provide satisfaction

Surface mining – mining the coal that lies near the surface of the earth

Trade-off – giving up some of one thing to gain some of another thing

Underground mining – mining the coal that is deep in the layers of the earth

FROM THE COAL MINES
TO THE POWER LINES

Teacher's Curriculum Guide
Grades 5-8

PREPARED BY

ILLINOIS DEPARTMENT OF COMMERCE AND ECONOMIC OPPORTUNITY
OFFICE OF COAL DEVELOPMENT

AND

ILLINOIS COUNCIL ON ECONOMIC EDUCATION

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Illinois Department of Commerce and Economic Opportunity
Office of Coal Development

"From the Coal Mines to the Power Lines" Teachers Guide has been developed to give teachers sufficient information to incorporate coal education into their curriculum. Bituminous coal, Illinois' most abundant natural resource, underlies 37,000 square miles of Illinois, about 65 percent of the state's surface. Since the Illinois coal industry contributes nearly $1 billion to the Illinois economy annually and 49 percent of the electricity used in Illinois is generated from coal, it is important for teachers to provide a sound and meaningful understanding of coal and energy issues to their students. By including coal education in their curriculum, teachers will bring to their students and communities an awareness of our state's greatest natural resource and the positive role coal plays in our day-to-day lives and the economy of the state.

"From the Coal Mines to the Power Lines" addresses a variety of topics and skills in science, social studies, math, language arts and economics. Although the guide is divided into grade level sections of K-4, 5-8 and 9-12, the lessons and tie-ins can be used interchangeably with minor adjustments by the teacher. A matrix is included to show the correlation of the lessons and tie-ins to the Illinois State Learning Standards. A CD-ROM accompanies each of the three grade level sections. Each CD-ROM displays a PowerPoint Presentation that is designed to be a teaching tool for the instructor complementing the series by adding depth and understanding to the concepts and vocabulary inherent to the lessons and tie-ins that comprise the written portion of the curriculum. The presentations highlight glossaries of terms through the use of captions, questions, photos, clip art, descriptions, and music.

"From the Coal Mines to the Power Lines" will give teachers the knowledge, skills, and tools necessary to provide their students a sound and meaningful understanding of coal in Illinois. The curriculum covers the rich history of coal and coal mining, its role in the Illinois economy as well as its significance to the state's energy profile and the impact of clean coal technology on the environment.

For more information on Illinois coal, contact the Office of Coal Development at:

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NOTE

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Copies of the coal curriculum may be obtained from:

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Illinois Council on
[redacted]

The EconomicsAmerica School Program

About the Illinois Council on Economic Education

The Illinois Council on Economic Education supports this curriculum through *curriculum consulting* and *professional development* programs for schools/teachers. A comprehensive set of *curriculum materials* to supplement the economics in "From the Coal Mines to the Power Lines," and to further address Illinois Learning Standards in economics, language arts, math and other areas, is available through the Council and its affiliated Centers for Economic Education around the state. In addition, ICEE offers **The Stock Market Game™** for students in grades 4-12; the **Economics Poster Contest** for students in grades 1-8, and the **Economics Challenge** for high school students.

For more assistance in teaching personal finance and economic education topics to your students, contact the Council at:

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Tie In - Mine Safety and Ventilation **103**

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Tie In - Geology/Earth History **109**

Lesson

Density

OVERVIEW

In this lesson, students will examine the formation of coal and environmental factors that established different ranks of coal. Students will measure density of different coal types to determine if there is a relation between coal rank and density.

MATERIALS

- Anthracite sample
- Balance
- Beaker
- Bituminous sample
- Lignite sample
- Pencil
- Water
- Safety goggles
- One copy of Teacher Resource Page A: *Coal Worksheet – Answer Key*
- One copy of Student Activity Page A: *Coal Fact Sheet* per student (2 pages)
- One copy of Student Activity Page B: *Coal Density Data Table* per student
- One copy of Student Activity Page C: *Coal Worksheet* per student

APPROXIMATE TIME REQUIRED

- Two forty-five minute periods are required to complete this lesson.

VOCABULARY

- Anthracite
- Bituminous
- Btu
- Carbon
- Clean coal technologies
- Coal
- Demand
- Density
- Displacement
- Fossil fuel
- Lignite
- Mass
- Matter
- Peat
- Pennsylvanian Period
- Physical characteristics

- Subbituminous
- Sulfur
- Volume

OBJECTIVES
After completing this lesson, students will be able to:
- calculate the density of different ranks of coal.
- practice measurement techniques by finding mass and volume of rock samples.
- review information regarding coal formation, economics and use.
- discuss issues related to the use of coal as a fossil fuel.

ENGLISH LANGUAGE ARTS STANDARDS
1.A.2b; 1.A.3b; 1.B.2a; 1.B.2b; 1.C.2a; 1.C.2d; 1.C.2f; 1.C.3a; 1.C.3d; 1.C.3f; 2.B.2a; 2.B.3a; 3.A.2; 3.B.3a

MATH STANDARDS
6.A.2; 6.A.3; 6.B.2; 6.B.3a; 6.B.3b; 6.C.2a; 6.C.2b; 6.C.3a; 6.C.3b; 6.D.2; 6.D.3; 7.A.2a; 7.A.2b; 7.A.3a; 7.A.3b; 7.B.3; 8.A.2b; 8.A.3a; 8.A.3b; 8.C.2; 8.C.3; 8.D.2; 8.D.3a; 8.D.3b; 10.A.2a; 10.A.2c; 10.A.3a; 10.C.2b; 10.C.2c; 10.c.3b

SCIENCE STANDARDS
11.A.2b; 11.A.2d; 11.A.2e; 11.A.3a; 11.A.3c; 11.A.3f; 11.A.3g; 12.C.2a; 12.C.2b; 12.C.3a; 12.C.3b; 13.A.2a; 13.A.2b; 13.A.2c; 13.B.2a; 13.B.2b; 13.B.2c; 13.B.2e; 13.B.2f; 13.B.3a; 13.B.3c; 13.B.3d; 13.B.3e; 13.B.3f

SOCIAL STUDIES STANDARDS
15.A.2a; 15.B.2a; 15.B.2c; 15.B.3b; 15.C.2b; 15.D.3b; 15.E.3a; 15.E.3b

PROCEDURE
Period 1:
1. Gather materials: safety goggles, anthracite, bituminous and lignite samples, pencil, Student Activity Page B: *Coal Density Data Table*, balance, and beaker filled with water.
2. Examine each sample of coal and describe its physical characteristics on the data table.
3. Predict the order of coal from highest to lowest density.
4. Mass each sample of coal and record it on the data table.
5. Find the volume of each piece of coal. (Take the beaker with water and note original volume of water. Add coal then note volume after the addition of the coal sample. Subtract the original volume from the final volume to get the volume of the coal sample). Record the volume of coal sample on the data table.
6. Calculate the density of each coal sample using the formula for density (density equals mass divided by volume): $D = M / V$
7. Record density of each sample on the data table.
8. Compare individual results to that of the entire class. Determine possible reasons for any differences in the outcomes of the density tests.

Period 2:

1. Review data from Period 1, as a large group.
2. Read Student Activity Page A: *Coal Fact Sheet* individually.
3. Break into dyads to discuss and answer questions on the Student Activity Page C: *Coal Worksheet*.
4. Reconvene into a large group to discuss questions and responses. (Use Teacher Resource Page A: *Coal Worksheet – Answer Key* as a guide.)

DEBRIEFING QUESTIONS

(see Teacher Resource Page A: *Coal Worksheet – Answer Key*)

1. Name three different types of coal.
2. What factors determine the rank of coal?
3. Which rank has the highest density? The lowest? Explain.
4. What issues affect the use of coal as a fossil fuel?
5. Which coal has the highest Btu value? Explain.

GLOSSARY

- Anthracite – hard coal with the highest carbon content and low volatile matter (high heat producer with little flame and smoke)
- Bituminous – coal that is between anthracite and lignite in hardness and heat value; the most common type of coal
- Btu – British thermal unit: a unit of heat required to raise the temperature of one pound of water 1 degree Fahrenheit
- Carbon – a very common nonmetallic element which occurs in combination with other elements in all plants and animals; coal is mainly composed of uncrystallized carbon
- Clean coal technologies – processes that are designed to use coal in ways that minimize harm to the environment
- Coal – a black or brownish-black rock that is made up of fossilized plants that were alive about 300 million years ago
- Demand – the amount of a good or service that people are willing to purchase at a specific price at a specific time
- Density – the relation of an object's mass to its volume (D = M / V)
- Displacement – the change in position of an object in a space
- Fossil fuel – a fuel that is made from the remains of plants and/or animals
- Lignite – coal that is soft and brownish-black with the lowest heating value
- Mass – a measure of the quantity of matter a body contains
- Matter – anything that takes up space and has mass
- Peat – a brown, crumbly, lightweight and spongy material; it is the first stage of coal formation
- Pennsylvanian Period – the sixth period of the Paleozoic Era; it is characterized by coal, oil, and gas deposits and cyclic sedimentation
- Physical characteristics – characteristics relating to the size, shape and general state of a substance

- Subbituminous coal – a coal intermediate between lignite and bituminous with a heat value ranging from 8,300 to 11,500 Btu/lb.
- Sulfur – a light-yellow, highly flammable nonmetallic element that exists in several forms and burns in the air with a blue flame and a stifling odor
- Volume – the amount of space occupied by a body as measured in three dimensions, expressed in cubic units

EXTENSION ACTIVITIES

- Compare physical characteristics of other sedimentary rock with that of coal.
- Calculate the densities of various samples of sedimentary rock. Rank your samples. How do they compare to coal? Are they less dense? More dense? How can you explain the differences?
- Investigate different methods of clean coal technology.
- Design a prototype of an existing clean coal technology.
- Formulate and present an idea for another method of cleaning coal.
- Compare and contrast the use of coal as a fossil fuel in a short essay.
- Research the amount of coal necessary to provide electricity for various daily activities.
- Project demand for coal for a four-person family for one year.

ADDITIONAL RESOURCES

- Illinois Council on Economic Education – http://www.econed-il.org/
- Illinois Department of Commerce and Economic Opportunity – http://www.illinoisbiz.biz/dceo/Bureaus/Coal/
- Illinois Department of Natural Resources – http://dnr.state.il.us/mines/
- Illinois State Geological Survey – http://www.isgs.uiuc.edu/research/coal/illinois-coal.shtml
- Coal Education – http://www.coaleducation.org/
- Coal Chemical Structure – http://www.ems.psu.edu/~radovic/coal_structure.html
- Glossary of Coal Terms – http://www.coaleducation.org/glossary.htm
- Energy Information Administration – http://www.eia.doe.gov/fuelcoal.html
- Illinois Clean Coal Institute – http://www.icci.org/
- U.S. Department of Energy/Fossil Energy – http://www.fe.doe.gov/

CREDITS

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- Miller, Roger L. (2001). Economics Today. Boston: Addison Wesley.

TEACHER RESOURCE PAGE

- Teacher Resource Page A: *Coal Worksheet – Answer Key*

STUDENT ACTIVITY PAGES

- Student Activity Page A: *Coal Fact Sheet* (2 pages)
- Student Activity Page B: *Coal Density Data Table*
- Student Activity Page C: *Coal Worksheet*

Teacher Resource Page A: *Coal Worksheet – Answer Key*

1. Name three different types of coal. (Answer: anthracite, bituminous, lignite)
2. Describe the formation of coal in Illinois. (Answer: Coal was formed during the Pennsylvanian Period, which was about 325-285 million years ago. The Pennsylvanian Period had an environment that alternated between terrestrial and marine. The primary source of carbon for the coal formed during the Pennsylvanian Period is from the group of plants called Lycophytes (club mosses and scale trees). Other important plants of coal swamp forests include: Pteridopsida (ferns) and Sphenophyta (herb-like spore plants related to modern horsetail and Equisetum). Formation of coal begins in peat bogs or wet soggy areas with low amounts of oxygen where decaying plants form layers. The rate of plant debris accumulation must surpass the rate of plant decay in order for coal to form.
3. What factors determine the rank of coal? (Answer: Coal is ranked according to its hardness, moisture, gas content and volatility. Carbon content increases as water and gas levels decrease.)
4. What is the rank of coal, from highest to lowest density? Explain. (Answer: Coal rank from highest to lowest density is anthracite, bituminous, subbituminious, lignite. Anthracite has the lowest amount of water and gas and therefore, the highest carbon content.)
5. Which coal has the highest Btu value? Explain. (Answer: Anthracite has the highest Btu value because it is the densest and has the highest carbon content and the least amount of gas and water.)
6. If you were the manager of an Illinois power plant, what issues might affect your decision when purchasing coal to fuel your plant? (Answers will vary but may include: supply of coal, cost of coal, transportation costs and times, Btu values, costs of cleaning coal, regulations concerning pollution from the burning of coal to produce steam for electricity, previous experience with mining companies.)
7. As an Illinois citizen, what benefits do you reap with regard to coal mining and coal as a fossil fuel? (Answers will vary but may include: money circulating through the Illinois economy, reclaimed areas are often returned to higher levels of use, many reclaimed areas are returned as recreational areas, low-cost fossil fuel for electricity, jobs for Illinois workers.)

Student Activity Page A: *Coal Fact Sheet* (Page 1)

- The plants that make up the coal seams in Illinois were alive during the Pennsylvanian Period, which was about 325-285 million years ago.
- The Pennsylvanian Period had an environment that alternated between terrestrial and marine.
- A group of plants called the Lycophytes (club mosses and scale trees) were the primary source of carbon for the coal formed during the Pennsylvanian Period.
- Other important plants of the coal swamp forests include: Pteridopsida (ferns) and Sphenophyta (the herb-like spore plants related to the modern horsetail, Equisetum).
- The formation of coal begins in peat bogs, wet soggy areas with low amounts of oxygen, where decaying plants form layers.
- Patterns in coal layers, due to climatic changes, are called cyclotherms.
- The rate of plant debris accumulation must exceed the rate of plant decay in order for coal to be formed.
- Dead plants from the Pennsylvanian Period + geothermal heat + pressure of overlying rocks + time (in millions of years) = coal.
- The carbon content of coal increases as the water and gas levels decrease.
- One foot of coal comes from approximately 10 feet of peat.
- The four main types of coal are lignite, subbituminous, bituminous and anthracite.
- The differences in coal quality or coal types are due to the changes in the environment where the coal was formed.
- Lignite and bituminous coal are considered to be sedimentary rock.
- Bituminous coal is the most common and most widely used coal in the United States. It is soft and has intermediate carbon content.
- Anthracite is considered to be metamorphic rock and could eventually become graphite.
- The sulfur in Illinois' bituminous coal is due to large amounts of sulfate ions contained in the seawater that once covered Illinois.
- The sulfates infiltrated into the peat over time and are the cause of high sulfur content in Illinois coal.
- If there was spillover from a freshwater source, it formed shale. The shale protected the peat from the saltwater. The result is coal that is low in sulfur content.
- Coal was discovered in Illinois about 300 years ago.
- Coal mining in Illinois began about 200 years ago.
- Ninety percent of Illinois coal comes from the Springfield (No. 5) and Herrin (No. 6) seams.
- The thickest coal seams in Illinois are between 6 and 8 feet thick.
- Coal lies beneath approximately 37,000 square miles of Illinois – about 65% of Illinois' land surface.
- In 2008, coal was mined in about 11 counties in Illinois.
- The coal industry contributes $1 billion to the Illinois economy annually.
- Nearly 90% of Illinois coal is purchased by the electric utility industry.
- Many of the byproducts from burning coal for electricity are sold for use in the construction industry.

Student Activity Page A: *Coal Fact Sheet* (Page 2)

- Over two-thirds (of the coal mined in Illinois) are sold to out-of-state electric utilities.
- The top five utility users of Illinois coal in 2007 were: Tennessee Valley Authority, Northern Indiana Public Inc., Tampa Electric Company, Duke Energy of Indiana, and Dayton Power & Light.
- In 2008, nearly 33 million tons of coal was mined in Illinois alone.
- Illinois' coal reserves contain more energy than the oil reserves of Saudi Arabia and Kuwait.
- Illinois has the largest amount of bituminous coal in the U.S.
- Much of Illinois coal is high in sulfer content, which can cause high levels of pollution when burned.
- The government regulates the amount of pollution that may be produced by burning coal.
- Some western states have subbituminous coal, which is not high in sulfur.
- New technologies, though costly, can clean coal so that regulations may be met.
- Lignite has the lowest content of carbon and therefore the lowest value for heating.
- Bituminous coal is the most common coal and the most widely used coal in the United States. It is soft and has intermediate carbon content.
- Anthracite is the hardest type of coal. It has the highest heating value because it is almost pure carbon.
- Coal is a fossil fuel because it is made of plants that were once living.
- Coal is non-renewable because once it is used up, it cannot be replaced.

Student Activity Page B: ***Coal Density Data Table***

Which coal do you predict will have the highest density? The lowest? Explain the reasoning behind your predictions.

	Physical Characteristics	Mass	Volume	Density
Lignite				
Bituminous				
Anthracite				
Other Samples of Sedimentary Rock				

Student Activity Page C: *Coal Worksheet*

1. Name three different types of coal.

2. Describe the formation of coal in Illinois.

3. What factors determine the rank of coal?

4. What is the rank of coal, from highest to lowest density? Explain.

5. Which type of coal has the highest Btu value? Explain.

6. If you were the manager of an Illinois power plant, what issues might affect your decision when purchasing coal to fuel your plant?

7. As an Illinois citizen, what benefits do you reap in regards to coal mining and coal as a fossil fuel?

Lesson

The Demand for Coal

OVERVIEW

In this lesson, students will be introduced to the economic Law of Demand, which states that as price increases, the quantity demanded decreases. They will examine the five factors that can cause changes in demand and consider how they influence the demand for coal in certain situations. After students read various articles dealing with price and demand for coal, they will learn to create a demand schedule and line graph representing a demand curve for coal. We are all consumers of electricity, and thus, we indirectly affect the demand for coal as we make choices about using electricity. Each ton of coal consumed at an electric power plant produces about 2,000 KW of electricity. One pound of coal supplies enough electricity to light ten 100-watt bulbs for about an hour.

MATERIALS

- Chart paper
- Markers
- Pencils
- Colored pencils
- Bag of *M&M* candies
- One transparency of Teacher Resource Page A: *When is Candy in High Demand?*
- One transparency of Teacher Resource Page C: *Average Mine Price of U.S. Coal 1990-2004*
- One transparency of Teacher Resource Page D: *Friendly Factors Influencing Demand*
- One transparency of Teacher Resource Page E: *Increase, Decrease, and Why?*
- One transparency of Student Activity Page A: *A Candy Curve*
- One copy of Teacher Resource Page B: *Coal Prices* from the website: http://www.eia.doe.gov/neic/infosheets/coalprice.htm per student
- One copy Teacher Resource Page F: *Coal Demand* (2 pages) from the following website: http://www.eia.doe.gov/neic/infosheets/coaldemand.htm per student
- One copy of Teacher Resource Page G: *When is Candy in High Demand? – Possible Answers*
- One copy of Teacher Resource Page H: *Increase, Decrease, and Why? – Possible Answers*
- One copy of Teacher Resource Page I: *A Candy Curve – Possible Answers*
- One copy of Teacher Resource Page J: *When is Coal in High Demand? – Possible Demand Schedule*
- One copy of Teacher Resource Page K: *A Coal Curve – Possible Answers*
- One copy of Teacher Resource Page L: *Shifting Situations – Answer Key* (2 pages)
- Two copies of Student Activity Page A: *A Candy Curve* per student
- One copy of Student Activity Page B: *When is Coal in High Demand?* per pair of students

- One copy of Student Activity Page C: *Shifting Situations* (2 pages) per student
- Computers with Internet access
- If using variation in procedural step #3: 1 brown paper bag for each student, and play money (coins, one dollar bills, five dollar bills)
- Overhead projector

APPROXIMATE TIME REQUIRED
- Three forty minute class periods are required to complete this lesson.

VOCABULARY
- Average mine price
- Clean coal technologies
- Coal
- Complementary goods
- Consumers
- Decrease
- Demand
- Demand curve
- Demand schedule
- Income
- Increase
- Inverse relationship
- Law of demand
- Market price
- Preferences
- Services
- Short ton
- Spot market price
- Substitute goods
- Sulfur

OBJECTIVES
After completing this lesson, students will be able to:
- read age appropriate material with fluency.
- explain the economic Law of Demand.
- identify the five factors that can cause a change in demand.
- describe the reasons the factors work as they do.
- navigate through websites appropriate to the lesson.
- use information to form predictions.
- collect and record data accurately.
- interpret and report results.
- generate a demand schedule.
- create hand-drawn and computer-generated line graphs.
- compose writings using personal and critical points of view.

- recognize the relationship among coal mining, technological development and ecosystem impact.

ENGLISH LANGUAGE ARTS STANDARDS
1.B.3d; 1.C.3a; 1.C.3d; 2.B.3a; 3.A.3; 3.C.3a; 5.C.3b

MATH STANDARDS
8.B.3; 8.C.3; 10.A.3a; 10.A.3c

SCIENCE STANDARDS
11.A.3c; 11.A.3f; 13.B.3d

SOCIAL SCIENCE STANDARDS
15.A.3a; 15.B.2a; 15.B.2b; 15.B.2c; 15.B.3b; 15.C.2a; 15.C.2b

PROCEDURE

1. Introduce the lesson by displaying a bag of *M&M* candies for the class to see.
2. Place a transparency of Teacher Resource Page A: *When is Candy in High Demand?* on the overhead projector.
3. Ask the students how many of them would be willing and able to buy the bag of candy if it were priced at $.10. Tally student responses on the chart. (Note: If the concept of "being willing and able to buy" presents an uncomfortable situation for some students, this step can be modified using the following variation:
   a. Prepare a paper bag with play money inside for each student.
   b. The amounts inside the bags need to vary. About 1/3 of the bags should contain $2.00 or less, about 1/3 should contain between $3.00 and $5.00, and about 1/3 should contain between $6.00 and $8.00. Demand is created by consumers' willingness and ability to buy. In the real world, all consumers are not on a level playing field, which is why the use of varying amounts of play money is essential if this variation is applied. The more even the distribution here, the more likely it is for the final graph to generate points that are easily connected.
   c. Put all bags on display on a table. All bags should be folded at the top to conceal their contents.
   d. Instruct the students (individually), by calling names randomly drawn from a hat, to pick up a bag. Ask them not to open their bags until all bags have been chosen.
   e. After all bags have been selected, tell the students that the money inside the bags is being used to simulate how consumers in society have varying amounts of money that are available and can be used to purchase goods and services. Highlight the fact that the bags were distributed randomly if complaints are heard from those with less money.
   f. Proceed with procedural step #4.
4. Next, poll the students to see how many would be willing and able to buy the bag of candy if the price were raised to $.50. (Remind the students that they may raise their hands more than once. Even if they raised their hands in positive response to

the first question, they may also raise their hands for this one if they would pay the higher price.)

5. Continue asking questions regarding buyers of the bag of candy according to the overhead chart, recording student answers appropriately.
6. Once the chart is complete, ask students what they notice about the number of students willing and able to purchase the bag of candy as the price increases. (Answers will vary but may include: the number of buyers decreased as the price increased; the quantity demanded went down as the price went up, etc.)
7. Explain that the completed chart represents a demand schedule for the bag of candy and that this information embodies the economic Law of Demand, which states that as price increases, the quantity demanded decreases. Write the law in large letters on the board.
8. Pass out one copy of Student Activity Page A: *A Candy Curve* to each student and display a copy of the page as a transparency on the overhead projector. Review the components of a line graph focusing on which axis on a graph is the x-axis and which is the y-axis. Label the x-axis "Quantity Demanded" numbering by five's beginning with 0 and ending with 30 (depending on the number of students in your class). Explain to students that this represents the number of students willing and able to buy the candy. Allow students to label their own graphs appropriately copying from the transparency.
9. Next, identify the y-axis as the "Price" axis, and demonstrate how to number the axis by fifty-cent increments beginning with 0 and ending with $7.00. Explain to the students that this represents the price of the bag of candy at different periods of time. Allow students to label their own graphs appropriately copying from the transparency.
10. Instruct the students to plot the points using the results recorded on the chart on Teacher Resource Page A: *When is Candy in High Demand?* Explain that each combination of "price per bag" and "quantity demanded" represents a pair of coordinates that in turn gets plotted as a point on the graph. Plot each of the five points on the transparency, referring back to the coordinates from the chart. Allow students to plot each of the five points in the appropriate places on their own graphs, asking them to check for accuracy using the transparency.
11. Tell the class that this line graph represents a demand curve. Although you used the example of candy in class, this is similar to what the demand curve would look like in any situation. Review with the class the Law of Demand mentioned in procedure #7.
12. Instruct students to read Teacher Resource Page B: *Coal Prices* from the website: http://www.eia.doe.gov/neic/infosheets/coalprice.htm.
13. When students finish reading, review the table that shows the prices of coal per short ton from 1990-2004 by displaying a transparency of Teacher Resource Page C: *Average Mine Price of U.S. Coal 1990-2004* on the overhead projector.
14. Using the prices included in the website chart, instruct pairs of students to create a demand schedule (similar to the one used with the candy) by predicting what the quantity of coal demanded might be (using million short tons) based on the Law of Demand. Allow students to fill in Student Activity Page B: *When is Coal in High Demand?* (Although the coal prices on the chart are shown from greatest to least,

be sure students list the prices from the lowest to the highest on their demand schedule in order to create the correct demand curve later in the lesson.)

15. Once students complete their demand schedules in partners, have them share their predictions with the class.
16. Next, distribute another copy of Student Activity Page A: *A Candy Curve* to each pair of students replacing the word *Candy* with the word *Coal*.
17. Instruct partners to use colored pencils to help create a line graph using their demand schedule information in order to show the demand curve once again.
18. After the groups complete their curves, discuss the similarities among the curves and the reasons for the curves appearing the way they do. (Law of Demand: as price increases, the quantity demanded decreases.)
19. Give students time to read the article entitled "Coal Demand" from the following website: http://www.eia.doe.gov/neic/infosheets/coaldemand.htm. Note: The average mine price and delivered price are two different terms. The delivered price includes the transportation costs. The last sentence of the 2nd paragraph in the article talks about the average price for coal delivered and the chart at the end of the page lists the average mine price of U.S. coal by year. This could be misinterpreted: in 2000 there was a huge jump in coal prices compared to 1999 prices listed on the chart. Use caution when drawing conclusions using these prices.
20. Once students complete their reading ask them to help you list causes for changes in demand for coal. (Examples: the economy – consumers have less money; petroleum is cheaper, natural gas prices are higher, consumers prefer natural gas over coal due to environmental regulations that favor natural gas and low sulfur coal, etc.) List these ideas on large chart paper.
21. Explain that their answers are correct and that there actually is an economic set of five factors that can cause changes in demand. Display a transparency of Teacher Resource Page D: *Friendly Factors Influencing Demand*. Be sure to go over the specific meanings of each factor before beginning the next section of the lesson. (Income of consumers=an increase or decrease in wages of buyers; number of consumers=an increase or decrease in the population buying the product; price of substitutes=an increase or decrease in the price of a replacement good; price of complements=an increase or decrease in the price of accompanying goods; tastes/preferences=a change in buyers' preferences.)
22. After explaining the five factors that influence demand, ask students to use the information given in the scenarios to try and determine if there would be an increase or decrease in quantity demanded of the products listed on the transparency of: Teacher Resource Page E: *Increase, Decrease, and Why?* In addition, ask students to explain their thinking orally. List the responses on the transparency as well as some possible reasons why.
23. Once students seem to have a good understanding of the factors and reasons for an increase or decrease in demand, distribute one copy of Student Activity Page C: *Shifting Situations* to each student.
24. Instruct students to indicate an increase or decrease in demand for coal in each scenario as well as explain in three to five sentences the factor that influenced the shift including specific reasons.

25. When all students have completed the assignment, allow time for sharing and comparing of answers.

DEBRIEFING QUESTIONS

1. What is the Law of Demand? Describe at least 3 examples of how/when it works. (Answer: As price increases, the quantity demanded decreases.)
2. What are the five factors that can cause a change in demand? List at least one scenario for each factor. (Answer: income of consumers, number of consumers, price of substitutes, price of complements, tastes/preferences.)
3. What are three reasons the quantity of coal demanded has gone up over the past 10 years? (Answer: price has decreased; clean coal technologies have been used which affect the tastes/preferences of the EPA and citizens; price of substitutes has fluctuated.)
4. There is an inverse relationship between price and quantity demanded of a good or service. Explain an inverse relationship. (Answer: When one value increases, the other decreases.)

GLOSSARY

- Average mine price – the ratio of the total value of the coal produced at the mine to the total production tonnage
- Clean coal technologies – processes that are designed to use coal in ways that minimize harm to the environment
- Coal – natural dark brown to black material used as fuel, formed from fossilized plants and consisting of carbon
- Complementary goods – goods which often accompany or are used with another good
- Consumers – people who buy and use goods and services
- Decrease – to become less or grow smaller
- Demand – the relationship between alternative prices and the quantities of a product that consumers are willing and able to buy
- Demand curve – a graphical representation of the demand schedule; a negatively sloped line showing the inverse relationship between the price and the quantity demanded (all other things being equal)
- Demand schedule – a schedule of how much of a good or service people will purchase at any price during a specified time period, all other things being constant
- Goods – material things that produce satisfaction
- Income – the benefits received (usually measured by money) for engaging in productive labor
- Increase – to become greater or larger
- Inverse relationship – condition that exists between two variables showing that when the value of one variable increases, the other decreases, and vice versa
- Law of demand – when price increases, the quantity demanded decreases; when price decreases, the quantity demanded increases
- Market price – the price where the quantity demanded of a good or service equals the quantity supplied of that good or service

- Preference – one's specific choice or selection; an individual's likes or tastes
- Services – actions that are done for you that provide satisfaction
- Short ton – a unit of weight equal to 2,000 pounds
- Spot market price – the price for a one-time open market transaction for immediate delivery of a specific quantity of product at a specific location where the commodity is purchased "on the spot" at current market rates
- Substitute goods – goods which can replace another good

EXTENSION ACTIVITIES

- After reading the article entitled "Coal Demand" from the following website: http://www.eia.doe.gov/neic/infosheets/coaldemand.htm, generate a line graph from the information displayed on the bar graph.
- Convert your hand-made line graph representing price and quantity demanded of coal into a computer-generated graph.
- Using information about coal and clean coal technologies researched through Internet resources, create an advertisement persuading consumers of electricity to buy coal instead of natural gas or petroleum.
- Describe at least two other situations where an inverse relationship is experienced or represented.
- Prepare a demand schedule for a good that is important to you. Remember to include an increase in price and appropriate quantities demanded at each price. Create a line graph displaying the information.
- Choose one good that is popular to students your age, and create a T-chart providing examples of how each of the five factors affects an increase in demand for the product.

ADDITIONAL RESOURCES

- http://www.eia.doe.gov/neic/infosheets/coaldemand.htm
- http://www.illinoisbiz.biz/dceo/Bureaus/Coal/virtual+Tour/
- http://illinisbiz.biz/dceo/Bureaus/Coal/Kids+Site/
- http://www.econed-il.org/
- http://nces.ed.gov/nceskids/graphing/
- http://eiadoe.gov/cneaf/coal/page/gloss.html

CREDITS

- *Economics Today* Roger LeRoy Miller - Addison Wesley Longman, 2001
- http://www.teachcoal.org
- http://nces.ed.gov/nceskids/graphing/
- http://www.eia.doe.gov/neic/infosheets/coaldemand.htm

TEACHER RESOURCE PAGES

- Teacher Resource Page A: *When is Candy in High Demand?*
- Teacher Resource Page B: *Coal Prices*
- Teacher Resource Page C: *Average Mine Price of U.S. Coal 1990-1999*
- Teacher Resource Page D: *Friendly Factors Influencing Demand*

- Teacher Resource Page E: *Increase, Decrease, and Why?*
- Teacher Resource Page F: *Coal Demand* (2 pages)
- Teacher Resource Page G: *When is Candy in High Demand? Possible Answers*
- Teacher Resource Page H: *Increase, Decrease, and Why? Possible Answers*
- Teacher Resource Page I: *A Candy Curve – Possible Answers*
- Teacher Resource Page J: *When is Coal in High Demand? – Possible Demand Schedule*
- Teacher Resource Page K: *A Coal Curve – Possible Answers*
- Teacher Resource Page L: *Shifting Situations – Answer Key* (2 pages)

STUDENT ACTIVITY PAGES
- Student Activity Page A: *A Candy Curve*
- Student Activity Page B: *When is Coal in High Demand?*
- Student Activity Page C: *Shifting Situations* (2 pages)

Teacher Resource Page A: ***When is Candy in High Demand?***

Price per bag	Quantity Demanded
10 cents	
50 cents	
$1.00	
$3.00	
$5.00	
$7.00	

Teacher Resource Page B: *Coal Prices*

In the early 1900s, coal was the Nation's major fuel source, supplying almost 90 percent of its energy needs. Later, coal's importance declined, mainly because petroleum and natural gas were cleaner, more cost effective, and more efficient. However, at the present time, coal is the primary source used for electricity generation because it is now far cheaper than other fossil fuels, and because it is also more abundant in the United States than any other fossil fuel. In 2000, coal receipts by the electric power industry totaled a record 983 million short tons. Of the total coal consumed in the United States (1,080 million short tons in 2000), 91 percent was used for generating electricity -- accounting for over half of the total electricity produced.

During the early 1970s, natural gas was the least expensive fuel used to generate electricity. In 1970 electric utilities paid on the average, about 28 cents per million Btu for natural gas, 31 cents per million Btu for coal, and 42 cents per million Btu for petroleum. Since 1976, however, coal has been the least expensive fossil fuel used to generate electricity. In 1999, on a dollars-per-million-Btu basis, natural gas was the most expensive fossil fuel ($2.59), petroleum was second ($2.56), and coal was least expensive ($1.22). Although these figures show that the cost of generating electricity from coal has increased significantly, it is still lower than the cost of generating electricity from either natural gas or petroleum. The average price for coal delivered to electric utilities was $24.28 per short ton in 2000, with the spot-market price being only slightly higher at $24.85.

The average coal export price for 2000 was $34.90 per short ton compared to the price for 2004 was $54.11 per short ton. Coal exports in 2000 totaled 58 million short tons and 48 million short tons in 2004, far below the 1996 high of over 90 million short tons. The total coal imports for 2000 rose to an annual level of 12.5 million short tons, an increase from the 1999 level of 9 million short tons. In 2004, imports increased to 27 million short tons. The average coal import price for 2000 was $30.10 per short ton and $37.52 per short ton in 2004, down from the high of $34.32 per short ton in 1997.

Another important use of coal is to produce coke, which is used in smelting iron ore to make steel. The average price paid for the special type of coal used to make coke generally declined in the early 1980s. From 1993 to 2000, it decreased from $47.44 per short ton to $44.45 per short ton.

The average mine price per short ton of coal in 1999 was $16.63. This was a drop of almost $1 (6 percent) from 1998 and the 17th straight year of decline. Because coal is so abundant, and as long as it remains relatively low priced, power plants will continue to use it rather than the two other major fossil fuels--petroleum and natural gas--to generate electricity.

More information on this subject can be found in the following EIA publications: Electric Power Monthly, Coal Industry Annual, Quarterly Coal Report, Annual Energy Review, and Cost and Quality of Fuels for Electric Utility Plants

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Teacher Resource Page C: *Average Mine Price of U.S. Coal 1990-1999*

Average Mine Price of U.S. Coal 1990-1999	
Year	**Dollars per Short Ton**
1990	21.76
1991	21.49
1992	21.03
1993	19.85
1994	19.41
1995	18.83
1996	18.50
1997	18.14
1998	17.67
1999	16.63
Source: Energy Information Administration, Coal Industry Annual 1999	

FRIENDLY FACTORS THAT CAN CAUSE A CHANGE IN DEMAND

1. Income of consumers
   * Have the wages of the buyers increased or decreased?

2. Number of consumers
   * Has there been a growth or decline in the population buying the product?

3. Price of substitutes
   * Has the price of a substitute good (something to be bought in place of the primary good) gone up or down?

4. Price of complements
   * Has the price of a good that accompanies the primary good gone up or down?

5. Tastes/preferences
   * Have the tastes or preferences of the consumers changed?

Teacher Resource Page E: *Increase, Decrease, and Why?*

Read the scenarios below and decide whether each represents an increase or decrease in the demand for the goods mentioned. Then explain what factor has influenced the change in demand and why.

Scenario #1:

The town of Brunsville, known for its delicious sweet corn, is bursting at the seams ever since a new development of over 3,000 homes has been built. In addition, the sweet corn industry there has had a wonderful year yielding the most delicious and plentiful crops.

Does this scenario represent an increase or decrease in demand for sweet corn?
____

Which factor affected the change in demand and why? ____________________

Scenario #2:

Wrigley Field, the baseball stadium in which the Chicago Cubs play, has been selling hot dogs like crazy during a very exciting season for the Cubs. Suddenly, the price of hamburgers decreased due to the cost of beef decreasing.

Does this scenario represent an increase or decrease in demand for hot dogs?
____

Which factor affected the change in demand and why? ____________________

Teacher Resource Page F: *Coal Demand (Page 1)*

During 2000, 1.08 billion short tons of coal were consumed in the United States. The greatest demand for coal was by electricity generating plants that burn coal to produce electricity. Some 982.6 million short tons, 91.0 percent of the total, were used by the electric power sector to produce more than half (51.8 percent) of all electricity generated. Each ton of coal consumed at an electric power plant produces about 2,000 kilowatt-hours of electricity. A pound of coal supplies enough electricity to light ten 100-watt bulbs for about an hour.

The second largest sector of coal demand was for industrial use, which amounted to 65.52 million short tons in 2000. Some industries that used coal included cement, chemicals, paper, and primary metals. Cement plants use about a ton of coal for each 3.5 tons of cement produced. Small amounts of coal are also used to manufacture a number of everyday products, such as photographic film base, carbon and graphite electrodes, varnishes, perfumes, dyes, plastics, paints and inks.

United States coal imports totaled 12.5 million short tons in 2000, a 37.7 percent increase from 1999 imports. Imports represented less than 1 percent of U.S. coal consumption and were equivalent to about 26 percent of U.S. coal exports. The increase in imports in 2000 was attributable to increased demand for low-sulfur coal. The average price of all coal imported into the United States fell by 2.2 percent, to $30.10 per short ton in 2000 from the 1999 price of $30.77.

Colombia remained the largest supplier of U.S. imports, with 7.6 million short tons. Venezuela followed with 2.0 million short tons and Canada with 1.9 million short tons. Although imports consisted primarily of steam coal bought by a few East Coast power plants, coal from Canada was largely metallurgical coal used by coke plants in Illinois, Indiana, and Michigan.

Coal exports account for a small segment of the U.S. coal industry, and remained unchanged from 1999. Metallurgical coal exports increased in 2000 by 2.2 percent, regaining some of the loss experienced in 1999. The market for U.S. steam coal exports dropped somewhat in 2000. Total steam coal exports were down (by 2.6 percent) to a level of 25.7 million short tons, down from 26.3 million short tons in 1999. 2004 exports were down as well to 15 million short tons. Canada represented the largest steam coal export market for the United States, accounting for 58.1 percent of all steam coal exports in 2000, despite the 4.1 percent drop from the 1999 level.

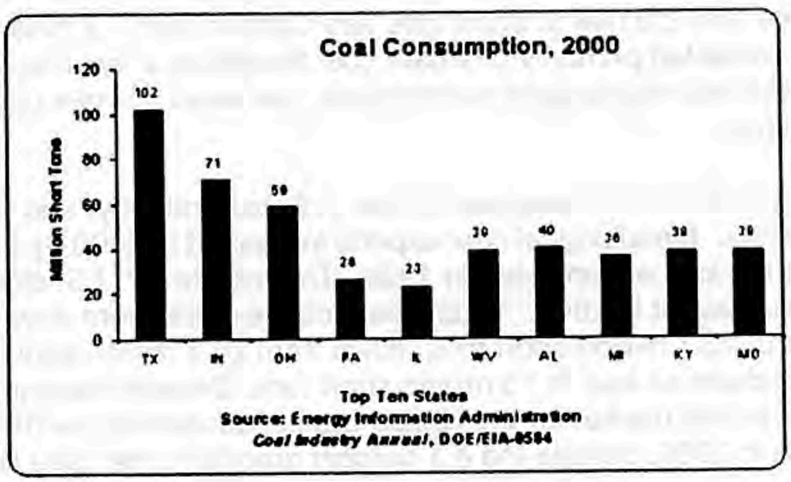
In 2004, coke plants consumed 22.5 million short tons of coal. In 2000, 28.9 million short tons of coal were consumed by coke plants (an increase of 3 percent over 1999), and residential/commercial consumption declined to 4.1 million short tons, down from 4.9 million short tons in 1999. other industrial use of coal (largely in the food, paper, chemical, nonmetallic mineral products and primary metal manufacturing industries) fell slightly to 65.2 million short tons in 2000, continuing its downward trend in recent years.

Teacher Resource Page F: *Coal Demand (Page 2)*

Competition from natural gas has gradually been diminishing coal use in the manufacturing industry. Coal is converted into coke through a process known as "carbonization." Coke is then used in smelting iron ore to produce steel. Both the number of coke plants and the amount of coal carbonized have declined since 1973. There are currently about half as many coke plants as there were a decade ago.

Coal stocks at the end of 2000 totaled 140.1 million short tons, a drop of 43.4 million short tons. Stocks held by coal producers and distributors fell by 7.6 million short tons, a decrease of 19.2 percent. Industrial users, including coke plants, held a total of 6.1 million short tons, a decrease of 1.4 million short tons. Coal stocks in the electric power sector declined by 34.4 million short tons in 2000, helping to keep production levels down. The colder than normal weather in many parts of the country combined with the tight coal market at the end of the year, kept inventories at levels well below historical levels.

Texas led all States in coal consumption in 2000, using 102 million short tons. Indiana and Ohio were second and third, respectively. These three States accounted for over 21 percent of the total U.S. coal consumption for the year. North Dakota, which ranked tenth in coal use, is the site of one coal gasification plant that uses 6.3 million tons of lignite per year to produce about 54 billion cubic feet per year of synthetic natural gas.



More information on this subject can be found in the following EIA publications: <u>Coal Industry Annual 2000 Executive Summary</u>, <u>Quarterly Coal Report</u> and <u>Monthly Energy Review</u>.

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Teacher Resource Page G: ***When is Candy in High Demand?***
Possible Answers

Price per bag	Quantity Demanded
10 cents	25 students
50 cents	23 students
$1.00	20 students
$3.00	16 students
$5.00	10 students
$7.00	3 students

Teacher Resource Page H: *Increase, Decrease, and Why?*
Possible Answers

Scenario #1:

The town of Brunsville, known for its delicious sweet corn, is bursting at the seams ever since a new development of over 3,000 homes has been built. In addition, the sweet corn industry there has had a wonderful year yielding the most delicious and plentiful crops.

Does this scenario represent an increase or decrease in demand for sweet corn?

INCREASE

Which factor affected the change in demand and why?

The number of consumers affected the increase in demand for sweet corn because the population of Brunsville increased. Not only did the population increase in the town, but the local farmers had one of the best years ever for delicious and plentiful sweet corn crops. Therefore, it only makes sense that the demand for sweet corn by the consumers in Brunsville would increase.

The amount of sweet corn grown does not affect demand. It could affect quantity demanded if the price decreases because of the increased supply.

Scenario #2:

Wrigley Field, the baseball stadium in which the Chicago Cubs play, had been selling hot dogs like crazy during a very exciting season for the Cubs. Suddenly, the price of hamburgers decreased due to the cost of beef decreasing.

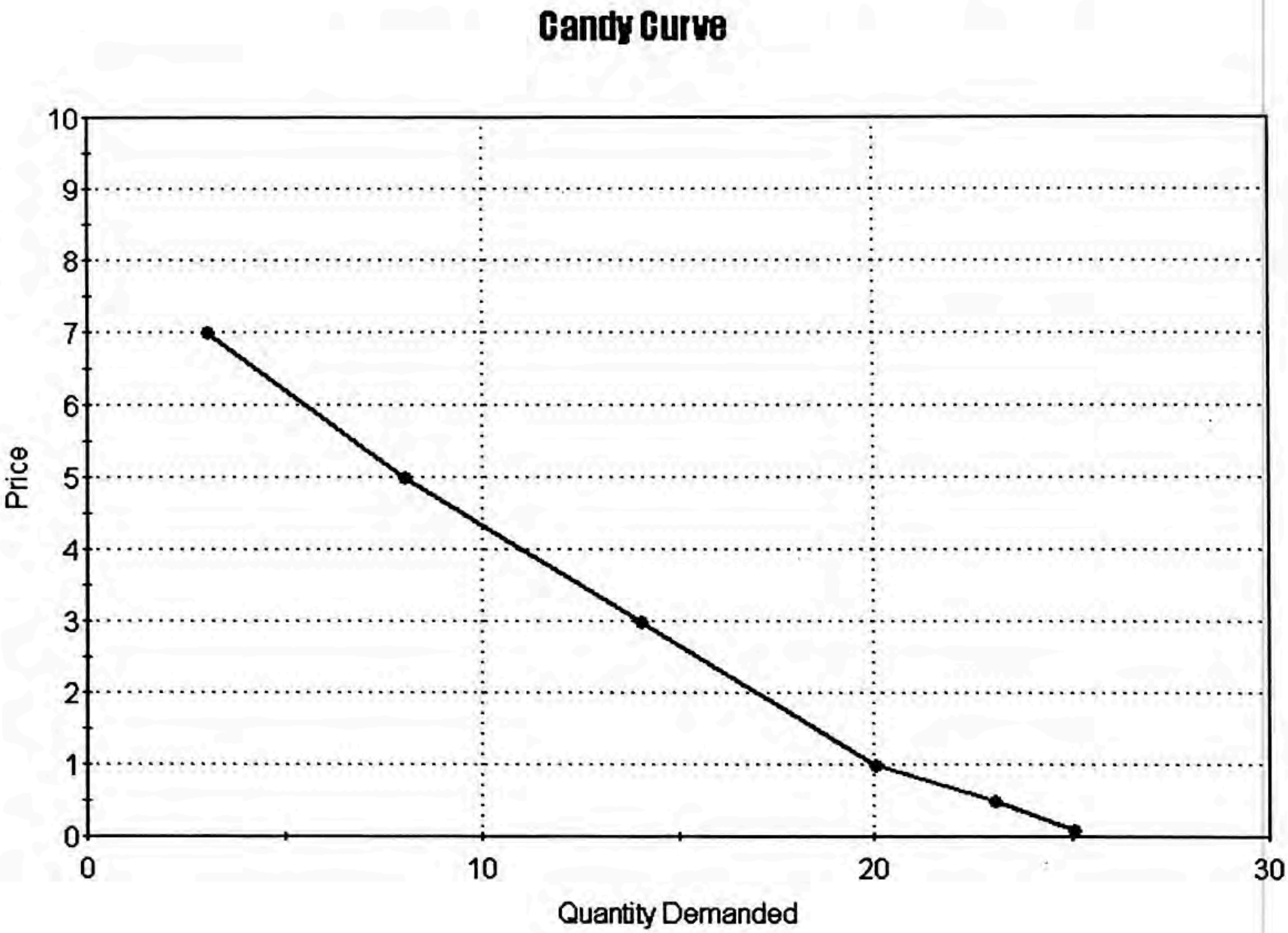
Does this scenario represent an increase or decrease in demand for hot dogs?

DECREASE

Which factor affected the change in demand and why?

The decrease in demand for hot dogs at Wrigley Field was most likely caused by the decreasing price of substitutes. Since the cost of an alternative meat decreased, people were more likely to buy the less expensive meal. In the end, the demand for hot dogs would have decreased, while the quantity demanded of hamburgers may have increased.

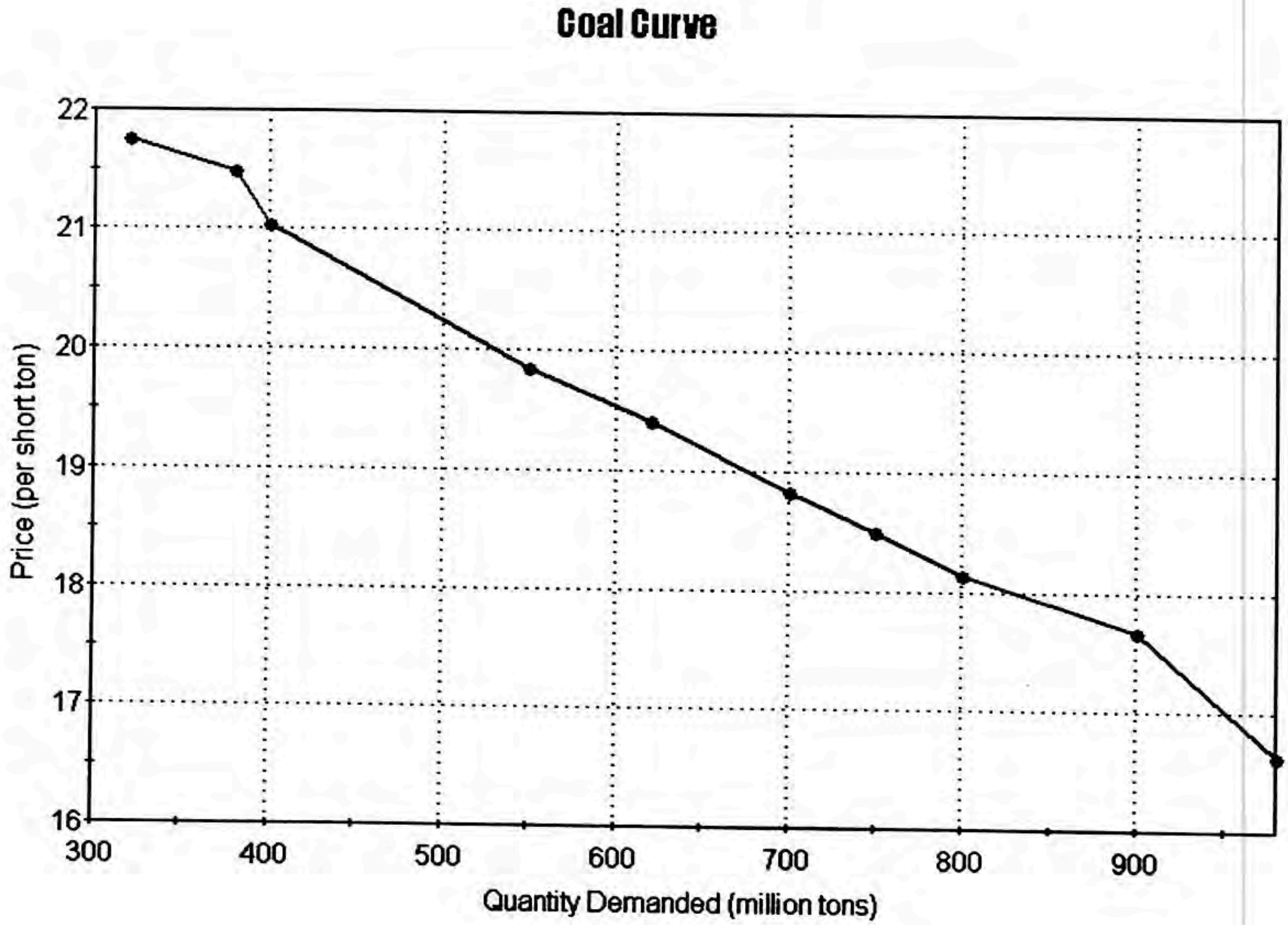
Teacher Resource Page I: *A Candy Curve – Possible Answers*



Teacher Resource Page J: ***When is Coal in High Demand?***
Possible Demand Schedule

Price per short ton	Quantity Demanded
$21.76	781.0 million
$21.49	783.9 million
$21.03	795.1 million
$19.85	831.6 million
$19.41	838.4 million
$18.83	850.2 million
$18.50	896.9 million
$18.14	921.4 million
$17.67	936.6 million
$16.63	940.9 million

Teacher Resource Page K: ***A Coal Curve – Possible Answers***



Teacher Resource Page L: *Shifting Situations – Answer Key (Page 1)*

Read the scenarios below and decide whether each represents an increase or decrease in the demand for ***coal***. Then explain what factor has influenced the change in demand and why.

Scenario #1:

In the area known as Little Egypt, Illinois, power plants (consumers of coal) had been doing extremely well during years of economic growth. However, the power plants recently began experiencing a long period of economic uncertainty along with the rest of the country.

Does this scenario represent an increase or decrease in demand for coal? **DECREASE**

Which factor affected the change in demand and why? **Decrease in income of consumers…students would need to know that incomes had decreased because of a slowing economy and loss of jobs – not explained in the paragraph**

Scenario #2:

Over 5,000 new homes were built in the Illinois town of Galatia. Therefore, the population has increased significantly. With so many people living there, the need for electricity is great.

Does this scenario represent an increase or decrease in demand for coal? **INCREASE**

Which factor affected the change in demand and why? **Increase in number of consumers…**

Scenario #3:

Although coal has been the major resource used in powering electricity, natural gas can also be used in the production of electricity. The price of natural gas has increased in Illinois since September 11, 2001.

Does this scenario represent an increase or decrease in demand for coal? **INCREASE**

Which factor affected the change in demand and why? **Increase in price of substitute…**

Teacher Resource Page L: *Shifting Situations – Answer Key (Page 2)*

Scenario #4:

In the past, the sulfur content of Illinois coal exceeded environmental regulations of the Clean Air Act, which caused coal consumers (the producers of electricity) to buy coal elsewhere. However, due to clean coal technologies used in Illinois, its coal has become cleaner to burn than ever before. People are very aware of the sulfur content in coal and are beginning to see the environmental value of clean coal technologies.

Does this scenario represent an increase or decrease in demand for coal? **INCREASE**

Which factor affected the change in demand and why? **Change in taste/preference...**

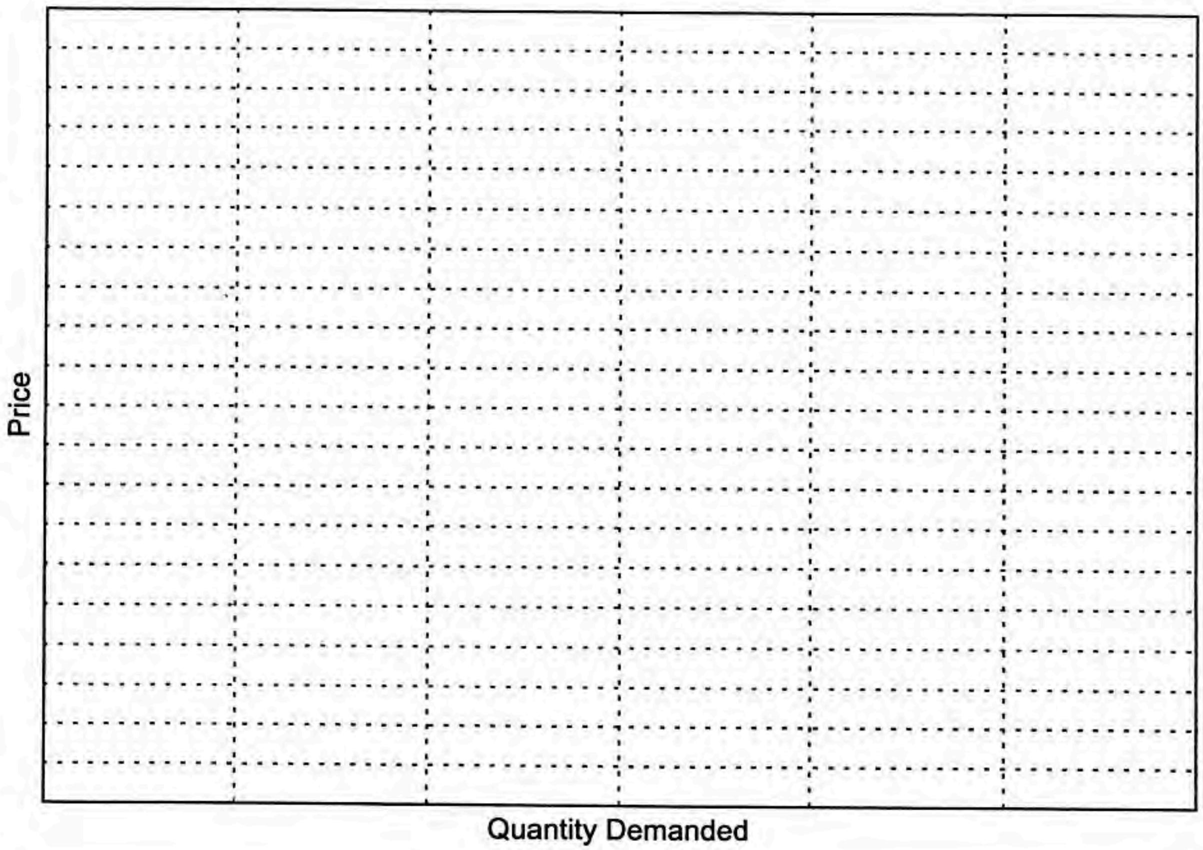
Scenario #5:

The cost of scrubbers has gone down drastically. Coal could not be processed efficiently and used to produce electricity if it weren't for this important machine.

Does this scenario represent an increase or decrease in demand for coal? **INCREASE**

Which factor affected the change in demand and why? **Decrease in price of complementary goods...**

Student Activity Page A: *A Candy Curve*



Student Activity Page B: ***When is Coal in High Demand?***

Price per short ton	Quantity Demanded

Student Activity Page C: *Shifting Situations (Page 1)*

Read the scenarios below and decide whether each represents an increase or decrease in the demand for ***coal***. Then explain what factor has influenced the change in demand and why.

Scenario #1:

In the area known as Little Egypt, Illinois, power plants (consumers of coal) had been doing extremely well during years of economic growth. However, the power plants recently began experiencing a long period of economic uncertainty along with the rest of the country.

Does this scenario represent an increase or decrease in demand for coal?

____

Which factor affected the change in demand and why? ______________

____

____

____

____

Scenario #2:

Over 5,000 new homes were built in the Illinois town of Galatia. Therefore, the population has increased significantly. With so many people living there, the need for electricity is great.

Does this scenario represent an increase or decrease in demand for coal?

____

Which factor affected the change in demand and why? ______________

____

____

____

____

Scenario #3:

Although coal has been the major resource used in powering electricity, natural gas can also be used in the production of electricity. The price of natural gas has increased in Illinois since September 11, 2001.

Student Activity Page C: *Shifting Situations* (Page 2)

Does this scenario represent an <u>increase</u> or <u>decrease</u> in demand for coal?

____

Which factor affected the change in demand and why? ______________

____

____

____

____

____

Scenario #4:

In the past, the sulfur content of Illinois coal exceeded environmental regulations of the Clean Air Act, which caused coal consumers (the producers of electricity) to buy coal elsewhere. However, due to clean coal technologies used in Illinois, its coal has become cleaner to burn than ever before. People are very aware of the sulfur content in coal and are beginning to see the environmental value of clean coal technologies.

Does this scenario represent an <u>increase</u> or <u>decrease</u> in demand for coal?

____

Which factor affected the change in demand and why? ______________

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Scenario #5:

The cost of scrubbers has gone down drastically. Coal could not be processed efficiently and used to produce electricity if it weren't for this important machine.

Does this scenario represent an <u>increase</u> or <u>decrease</u> in demand for coal?

____

Which factor affected the change in demand and why? ______________

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Lesson

Discover the Power of Illinois Coal: Persuasive Essays

OVERVIEW

In this lesson, students will examine the costs and benefits of using Illinois coal. They will research many aspects of Illinois coal. Students will identify both negative and positive externalities associated with mining coal in Illinois. In addition, they will write persuasive essays convincing consumers to choose Illinois coal over other coal and alternate resources.

MATERIALS

- Computers with Internet access
- Access to a library
- Overhead projector
- Vis-à-Vis markers
- One transparency of Teacher Resource Page A: *A Coal Call for Help*
- One transparency of Teacher Resource Page B: *Coal Idea Web*
- One copy of Teacher Resource Page C: *Coal Research Websites* per student
- One copy of Teacher Resource Page D: *Persuasive Writing Scoring Rubric* per student (optional)
- One copy of Student Activity Page A: *Knowledge is Power – KWL Chart* per group
- One copy of Student Activity Page B: *Coal Conditions Research Records* per group (9 pages)
- One copy of Student Activity Page C: *Externalities Research Chart* per group
- Pencils

APPROXIMATE TIME REQUIRED

- Seven forty-five minute class periods are required to complete the lesson.

VOCABULARY

- Advantage
- Alternative
- Anthracite
- Bituminous coal
- Btu
- Coal
- Coal Seam
- Disadvantage
- Externality
- Lignite
- Negative
- Opportunity Cost

- Persuasive essay
- Positive
- Subbituminous coal

OBJECTIVES
After completing this lesson, students will be able to:
- identify the costs and benefits associated with the use of Illinois coal.
- research a topic using the Internet and print resources.
- make informed decisions.
- interpret graphs and charts.
- identify positive and negative externalities.
- write persuasive essays.

ENGLISH LANGUAGE ARTS STANDARDS
1.B.3a; 1.B.3b; 1.B.3d; 1.C.3a; 1.C.3d; 1.C.3f; 3.A.3; 3.B.3a; 3.B.3b; 3.C.3a; 4.B.3a; 4.B.3b; 5.A.3b; 5.B.3a; 5.B.3b; 5.C.3a

MATH STANDARDS
10.A.3a; 10.A.3c; 10.B.3

SCIENCE STANDARDS
11.A.3a; 11.A.3c; 11.A.3f; 12.C.3a; 12.E.3b; 13.B.3a; 13.B.3c; 13.B.3d; 13.B.3e

SOCIAL STUDIES STANDARDS
15.B.2a; 15.B.3b; 15.C.3; 15.D.2a; 15.E.2a

PROCEDURE
1. Inform the students that you have received a letter from the Office of Coal Development in Springfield, Illinois, asking for their help in spreading the word about the usefulness of Illinois coal.
2. Share with the students the letter contained on Teacher Resource Page A: *A Coal Call for Help*.
3. After reading the letter aloud, explain in detail to the students that they have been asked by the Office of Coal Development and other coal-related agencies in Illinois to research and share information with coal consumers regarding the positive aspects of using Illinois coal. Further explain that the students have been asked to develop persuasive essays when they have completed their research.
4. Using a transparency of Teacher Resource Page B: *Coal Idea Web*, ask students to brainstorm everything they know about coal and its uses. Encourage students to think about things they've learned in the past, as well as facts provided by the letter from the Office of Coal Development. Add these ideas to the web as students share them.
5. After completing the web, ask students to define the word *persuade*. Answers will vary but might include: to convince, to cause someone to do something, to change a person's mind, etc.

6. Remind them that the Office of Coal Development is asking that the students persuade the public to purchase and utilize Illinois coal in place of other resources and instead of other states' or countries' coal.
7. Tell the students that through their research they will most likely find that a number of citizens and businesses are affected by the use of Illinois coal, although they might not be using coal themselves. Some things will be affected in positive ways, while others might be negatively affected. These are called *externalities* and are defined as costs or benefits that result when the consumption or production of a good or service affects people who are not directly involved.
8. In order to ensure the students' understanding of externalities, provide the following examples: POSITIVE: Your neighbors own an apple tree that they must water, fertilize and prune; however, some of the apples fall into your yard for you to enjoy. You don't pay for or care for the tree, but you gain something positive from it anyway. NEGATIVE: Factories and businesses in your city contaminate the air with harmful pollutants that you breathe in each day. You don't work at the factory or pollute yourself, but your health gains something negative from pollution anyway.
9. Now ask the students the following question: *What are some positive and negative externalities the students have experienced in school, at home, or in their neighborhoods?* (Negative externalities might include: getting recess taken away because other students disrupted the class, inability to concentrate when another sibling is playing music too loudly, inability to sleep due to a loud party. Positive externalities might include: receiving a treat from the teacher because another student completed a group assignment on time, playing a certain video game because a sibling received it as a birthday gift, playing at a park in your neighborhood because other homeowners petitioned for a recreation area.)
10. Following the discussion regarding externalities, break the students up into pairs and assign each group of two students a specific Illinois coal topic to research. Do this by handing out the corresponding topics from Student Activity Page B: *Coal Conditions Research Records.* There are nine different topics in all.
11. Before allowing students to begin researching their topics, assign the completion of the **K** (know) and **W** (want to know) sections of Student Activity Page A: *Knowledge is Power – KWL Chart.* Remind students to focus on what they already know about coal with respect to their specific research topic.
12. Once students have recorded answers in the **K** and **W** sections on their KWL charts, introduce the students to the Internet websites listed on Teacher Resource Page C: *Coal Research Websites* to aid in their research. Note: Make a point to check the websites that are listed, making sure that the sites are current. Periodically, updates for this Teacher Resource Page C: *Coal Research Websites* will be made available.
13. Distribute a copy of Student Activity Page C: *Externalities Research Chart* to each group. Explain to the students that while they are conducting their research, they should be paying particular attention to examples of positive and negative externalities that are associated with their research topic. Students should be instructed to complete the chart with as many examples as they can find while researching their topic.

14. In addition to the websites, allow students to find current books and magazine articles to assist them in their research.
15. Allow students 2-3 class periods to complete their research, answering the questions they listed on their KWL charts. Additional information should be recorded on Student Activity Page B: *Coal Conditions Research Records.*
16. Students should be prepared to debrief the information they found through creative presentations. Instruct students to begin their presentations by distributing a handout entitled "Did You Know ". This handout should summarize the important information recorded on the following:
    - Student Activity Page A: *Knowledge is Power – KWL Chart*
    - Student Activity Page B: *Coal Conditions Research Records*
    - Student Activity Page C: *Externalities Research Chart*
17. Once all students have shared the information gained about their topics, ask them to write a persuasive essay. Be sure to remind them of the specific components of persuasive essays at their corresponding grade levels and the need for focus, organization, elaboration and mechanics. Some specific requirements might include:
    - an attention-grabbing introductory paragraph complete with a topic sentence;
    - two or three complete paragraphs focusing on two or three assigned topics regarding Illinois coal; and
    - a clinching concluding paragraph complete with a closing statement.

    See Teacher Resource Page D: *Persuasive Writing Scoring Rubric.* If appropriate, distribute this scoring rubric to each student. Use this rubric as a guide for evaluating students' essays.
18. Once students complete their rough drafts, allow them time to peer-edit each other's work and make appropriate corrections.
19. Encourage students to enter their essays in the Coal Art and Essay Calendar Contest.

DEBRIEFING QUESTIONS

1. How does coal mining in Illinois affect the Illinois economy? (Answers will vary but may include: coal mining provides both mining jobs and spin-off jobs (i.e. jobs in transporting coal, jobs in construction relative to roads built to access mines), coal mining in Illinois keeps the cost of coal low to Illinois power plants and industrial users that use Illinois coal (consumers of Illinois), sales tax paid on Illinois coal sold in Illinois.
2. What are some of the advantages to burning Illinois coal for electricity usage? (Answers will vary but may include: cleanliness of coal through clean coal technologies, location, cost, revenue for state, readily available electricity, etc.)
3. What are some alternatives to using coal to produce energy such as electricity? (Answers will vary but may include: biomass, geothermal, hydropower, natural gas, petroleum, propane, solar, nuclear, wind, etc.)
4. What other states compete with Illinois in their production and sale of coal? (Possible answers: Wyoming, Kentucky, West Virginia, Pennsylvania, Texas.)
5. What are some positive and negative externalities associated with the use of Illinois coal? (Positive: greater revenues for Illinois citizens, job opportunities, reliable,

affordable fuel, energy security, electricity etc. Negative: pollution, costly technology, increased traffic and noise caused by transporting coal, dust and noise near mines, etc.)

GLOSSARY

- Advantage – a benefit or gain
- Alternative – a choice between two or more things
- Anthracite – hard coal with the highest carbon content and low volatile matter (high heat producer with little flame and smoke)
- Bituminous coal – coal that is between anthracite and lignite in hardness and heat value; the most common coal type
- Btu – British thermal unit: a unit of heat required to raise the temperature of one pound of water one degree Fahrenheit
- Coal – natural dark brown to black material used as a fuel, formed from fossilized plants and consisting of carbon
- Coal seam – a bed or large deposit of coal
- Disadvantage – a loss; an unfavorable or inferior condition
- Externality – cost or benefit that results when the consumption or production of a good or service affects people who are not directly involved
- Lignite – coal that is soft and brownish
- Negative – opposite of positive, lacking the qualities of being positive
- Opportunity cost – the highest valued alternative given up when a choice is made
- Persuasive essay – a written series of paragraphs having the power to convince
- Positive – affirmative, good, just
- Subbituminous coal – a coal intermediate between lignite and bituminous with a heat value ranging from 8,300 to 11,500 Btu/lb.

EXTENSION ACTIVITIES

- Prepare a speech stating the positive and negative externalities of coal usage in a certain area of Illinois.
- Visit the website: http://www.coaleducation.org/lessons/lesson.htm to find out which other states in the United States produce coal. Choose another state to research and compare that state's coal with Illinois' coal using a Venn diagram.
- Watch the movie entitled *October Sky* and identify the important events that took place throughout the story. Then role-play those events, challenging fellow classmates to identify the positive and negative externalities that were associated with those events.
- Research the amount of coal produced in Illinois over the past ten years, and create a graph of your findings. (Possible graphs might include: bar, line, etc.)
- Write an advertising campaign promoting Illinois coal using facts from research.
- What are the advantages and disadvantages of states relying on one source for all their electrical needs? Research how different states generate electricity and compare the energy costs per kilowatt.

ADDITIONAL RESOURCES

- http://illinoisbiz.biz/dceo/Bureaus/Coal/Kids+Site/
- http://www.icci.org/coalfacts.pdf
- http://www.crc.siu.edu/
- http://www.coaleducation.org/lessons/lesson.htm
- http://www.eia.doe.gov/fuelcoal.html

CREDITS

- http://www.icci.org/coalfacts.pdf
- http://www.coaleducation.org/lessons/lesson.htm
- http://www.crc.siu.edu/
- http://illinoisbiz.biz/dceo/Bureaus/Coal/Kids+Site/

TEACHER RESOURCE PAGES

- Teacher Resource Page A: *A Coal Call for Help*
- Teacher Resource Page B: *Coal Idea Web*
- Teacher Resource Page C: *Coal Research Websites*
- Teacher Resource Page D: *Persuasive Writing Scoring Rubric*

STUDENT ACTIVITY PAGES

- Student Activity Page A: *Knowledge is Power – KWL Chart*
- Student Activity Page B: *Coal Conditions Research Records (9 pages)*
- Student Activity Page C: *Externalities Research Chart*

Teacher Resource Page A: *A Coal Call for Help*

Dear Students:

As you may be aware, coal is a very useful and abundant resource in the United States. Its primary use is in the production of electricity. Each day, every American uses about 20 pounds of coal in the form of increasingly clean coal-based electricity.

Illinois boasts the world's largest supply of bituminous coal. In fact, coal underlies 37,000 square miles of Illinois, which is about 65% of the state's surface. Illinois' coal reserves contain more Btus than the oil reserves of Saudi Arabia and Kuwait. As you can see, it seems wise that consumers should choose Illinois coal over the coal produced in other states and countries. This is an important issue for our office, and for our state!

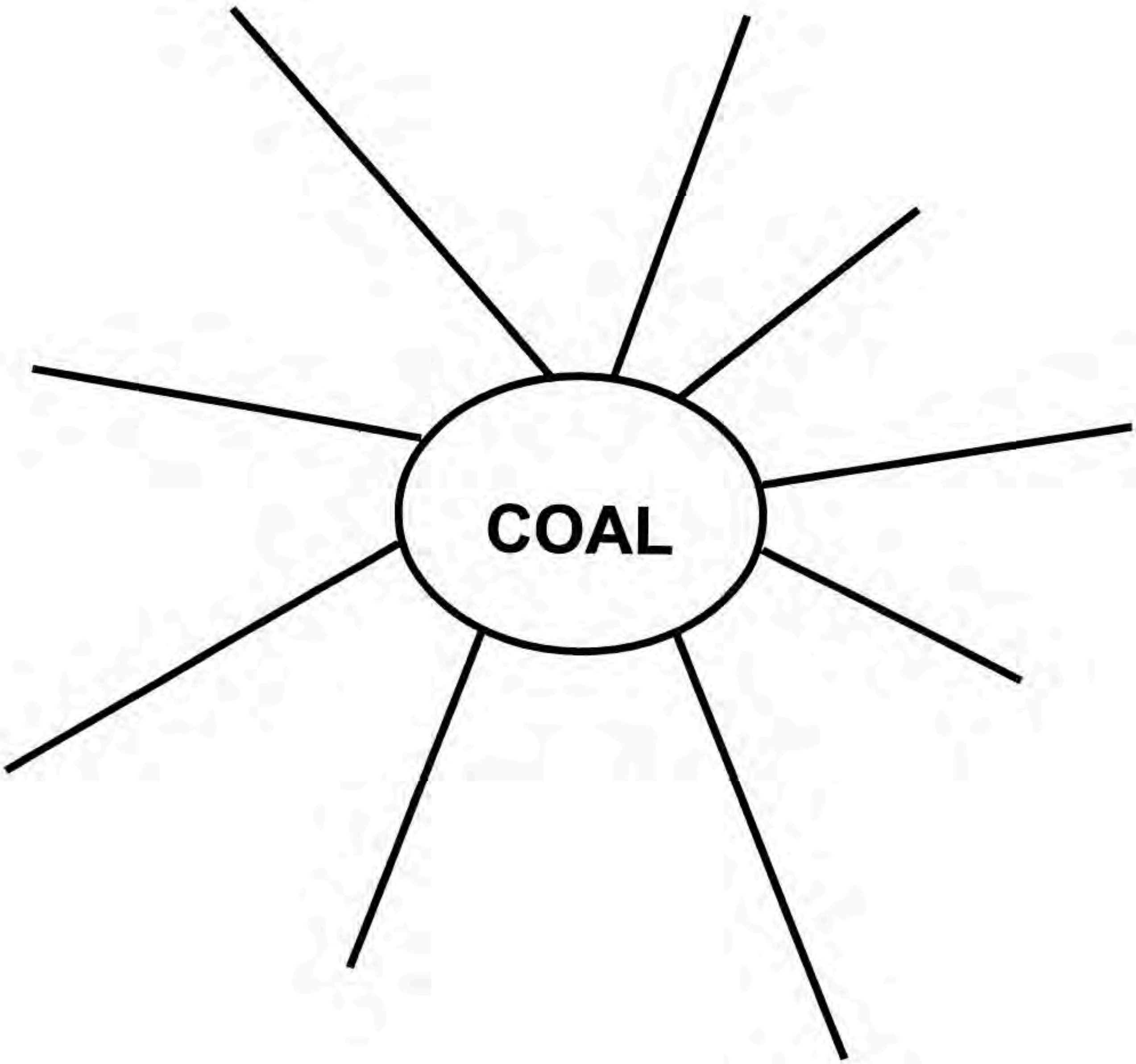
We would like to appoint your class to serve on a task force to investigate the positive and negative externalities associated with the use of Illinois coal. We are asking that you, the students and citizens of Illinois, inform and convince the public and coal consumers that using our own state's coal in an environmentally friendly way will benefit the entire state.

We, the members of the Office of Coal Development, are convinced that you can help spread the word about the power of Illinois coal. Thank you, in advance, for your hard work and cooperation in this matter.

Sincerely,

Office of Coal Development
Springfield, Illinois

Teacher Resource Page B: *Coal Idea Web*



Teacher Resource Page C: *Coal Research Websites*

- http://www.illinoisbiz.biz/dceo/Bureaus/Coal/Kids+Site/
- http://www.illinoisbiz.biz/dceo/Bureaus/Coal/Publications/3-industry+Reports.htm
- http://www.siu.edu/~coalctr/page43.html
- http://www.coaleducation.org/lessons/lesson.htm
- http://www.eia.doe.gov/fuelcoal.html
- http://www.eia.doe.gov/kids/energyfacts/sources/non-renewable/nonrenewable.html
- http://www.eia.doe.gov/neic/qickstats.html
- http://www.fe.gov/
- http://www.illinoisbiz.biz/dceo/Bureaus/Coal/Virtual-Tour/
- http://www.illinoiscoal.biz

Teacher Resource Page D: *Persuasive Writing Scoring Rubric*

	Focus	Support	Organization	Conventions
6	*Introduction explains topic sentence and/or previews main ideas *Supporting details reinforce the topic or position throughout essay *Closing refocuses reader on topic *Closing statement is creative and leaves the reader thinking	*<u>All</u> main ideas have specific facts/examples *<u>All</u> examples are elaborated with details and explanations *<u>All</u> main points are restated in a variety of interesting ways *Appropriate and creative word choice is apparent	*Introductory and closing paragraphs are well-developed *Main ideas are developed in individual paragraphs *Natural transitions between and within paragraphs are used appropriately	*Paper includes standard: - capitalization - punctuation - grammar - spelling - paragraph indentation
4	*Topic is mentioned but not explained *Supporting details drift off position slightly *Paper has an ending, but does not refocus the reader on the topic	* <u>Some</u> main ideas have specific facts/examples *<u>Some</u> supporting details are general *<u>Some</u> main ideas are restated *Word choice needs to be more exact for meaning	*Opening and closing paragraphs are evident *<u>Not all</u> main ideas are developed within individual paragraphs *<u>Some</u> transitions are used between or within paragraphs	*Paper includes <u>limited</u> errors in: - capitalization - punctuation - grammar - spelling - paragraph indentation
2	*Topic or position are not explained in first paragraph *Paper drifts off topic completely *Paper ends, but has no closing statement *Type of essay is incorrect	*Facts/examples are unrelated to topic or main idea *Examples repeat or are unclear *More main ideas are needed to explain the topic *Word choice is too simple for the topic	*Main ideas are not separated into paragraphs *Over-usage or under-usage of transitions is evident	*Paper includes <u>many</u> errors in: - capitalization - punctuation - grammar - spelling - paragraph indentation

Student Activity Page A: ***Knowledge is Power – KWL Chart***

Research Topic #: ____ Research Topic Title: ____________________

K (What do I already **know** about Illinois coal?)	**W** (What do I **want** to know about Illinois coal?)	**L** (What have I **learned** about Illinois coal?)

Student Activity Page B: *Coal Conditions Research Records*
(Page 1 of 9)

Topic #1:

Coal Mining History from 1900 to 1950:

Resources used:

Student Activity Page B: ***Coal Conditions Research Records***
(Page 2 of 9)

Topic #2:

Uses of Illinois Coal from 1900 to 1950:

Resources used:

Student Activity Page B: *Coal Conditions Research Records*
(Page 3 of 9)

Topic #3:

Coal Mining History from 1951 to Present:

Resources used:

Student Activity Page B: *Coal Conditions Research Records*
(Page 4 of 9)

Topic #4:

Uses of Illinois Coal from 1951 to Present:

Resources used:

Student Activity Page B: *Coal Conditions Research Records*
(Page 5 of 9)

Topic #5:

Clean Coal Technologies Involving Combustion, Post-Combustion and By-Products:

Resources used:

Student Activity Page B: ***Coal Conditions Research Records***
(Page 6 of 9)

Topic #6:

Location and Rank of Coal in the US: How Does Illinois Coal Measure Up?

Resources used:

Student Activity Page B: *Coal Conditions Research Records*
(Page 7 of 9)

Topic #7:

Current Jobs In and Related to the Coal Industry:

Resources used:

Student Activity Page B: ***Coal Conditions Research Records***
(Page 8 of 9)

Topic #8:

Mining Technology: From Locating the Coal through Mining the Coal:

Resources used:

Student Activity Page B: *Coal Conditions Research Records*
(Page 9 of 9)

Topic #9:

Clean Coal Technology: From Coal Washing and Sorting to Combustion:

Resources used:

Student Activity Page C: *Externalities Research Chart*

Research Topic #: _____	
Research Topic Title: ____________________	
Examples of Positive Externalities Associate with Topic	Examples of Negative Externalities Associated with Topic

Tie In - Economics

CORRESPONDING STANDARDS

- Illinois English Language Arts Goal 3
  - B. Compose well-organized and coherent writing for specific purposes and audiences.
  - C. Communicate ideas in writing to accomplish a variety of purposes.
- Illinois English Language Arts Goal 5
  - C. Apply acquired information, concepts and ideas to communicate in a variety of formats.
- Illinois Social Science Goal 15
  - A. Understand how different economic systems operate in the exchange, production, distribution and consumption of goods and services.
  - B. Understand that scarcity necessitates choices by consumers.
  - C. Understand that scarcity necessitates choices by producers.
  - D. Understand trade as an exchange of goods or services.
  - E. Understand the impact of government policies and decisions on production and consumption in the economy.

DID YOU KNOW?

- Illinois' coal reserves contain more energy than the oil reserves of Saudi Arabia and Kuwait.
- The coal industry contributes nearly $1 billion to the Illinois economy annually.
- More than 90% of Illinois coal is purchased by the electric utility industry. Over two thirds are sold to out-of-state electric utilities.
- Illinois has the largest amount of bituminous coal in the U.S.
- The top 5 utility users of Illinois coal in 2008 were: Tennessee Valley Authority, Northern Indiana Public Service, Tampa Electric Company, Duke Energy of Indiana, and Dayton Power & Light company.
- In 2008, 18 Illinois mines employed over 3,400 miners and generated about 20,000 spin-off jobs.
- Hardhats, safety glasses, cap lamps, dust respirators and self-rescuers (gas masks) are examples of equipment that miners wear for safety purposes.
- The typical coal miner earns $64,000 per year including overtime.
- 3,700 Illinois miners produced as much coal in 1999 as 15,000 miners produced in 1954, and 41,000 miners produced in 1927.
- Continuous miner machines for room and pillar mining and longwall machines for longwall mining allow underground coal to be extracted quickly and efficiently.
- Land reclamation laws ensure that mined land is returned to some useful purpose.
- In 1995, Illinois exported 2.7 million tons of coal.
- Much of Illinois coal is high in sulfur content, which causes sulfur dioxide emissions when burned.
- The government limits the amount of pollution that may be produced by burning coal.

- Some Western states have subbituminous coal, which is not high in sulfur.
- New technologies, though costly, can clean coal emissions so that regulations may be met.
- Many of the byproducts from burning coal for electricity are sold for use in the construction industry.
- Miners, foreman, safety inspectors, truck drivers, barge/boat captains, heavy equipment operators, chemists, surveyors, secretaries, and engineers are just a few of the jobs connected to the coal mining industry.

QUESTIONS/ISSUES

- What factors affect the cost of coal? (Answers will vary but may include: sulfur content, transportation costs, production costs.)
- How does coal mining impact Illinois' economy? (Answers will vary but may include: contributes $1 billion annually to the Illinois economy, directly provides over 3,400 jobs in Illinois, spin-off jobs needed to support the mining of coal can reach 20,000 people.)
- How does coal connect to electricity? (Answer: Water is heated by burning coal. The steam produced rotates turbines, changing the heat energy into mechanical energy. The spinning turbine powers the generator. Magnets inside the generator spin inside a wire coil, changing mechanical energy into electricity.)
- How can coal byproducts be used? (Answers will vary but may include: bottom ash for roofing materials, fly ash for cement, gypsum for fertilizer and wallboard.)
- How has technology had a positive effect on the production of coal in Illinois? (Answers will vary but may include: increased coal extraction, fewer people do greater amounts of work, an adequate supply of coal is maintained to meet the consumer demands, newer safety equipment, improved working conditions.)
- If you were an Illinois government official, which issues would you need to consider concerning coal mining in your state? (Answers will vary but may include: generation of new jobs, public health and safety, workers' health and safety, pollution, economic gain, local ecology, energy production and consumption.)

EXTENSIONS/CONNECTIONS

- Research the different jobs and spin-off jobs that coal mining creates.
- Compare the advantages and disadvantages of Illinois coal in an essay.
- Formulate a marketing plan to persuade consumers to buy Illinois coal.
- Draw a map of Illinois indicating which counties contain coal.
- Research miners' wages over the past 100 years and graph the data.
- Create a crossword puzzle using facts on coal.
- Graph a demand schedule, explaining how price will cause movement along the demand curve.
- Find at least 5 different coal mines that have been reclaimed. Plot the land reclamation areas on a map and indicate what purpose they serve today.

Tie In - Careers

CORRESPONDING STANDARDS

- Illinois Science Goal 13
  - B. Know and apply concepts that describe the interaction between science, technology and society consumption in the economy.
- Illinois Social Science Goal 15
  - A. Understand how different economic systems operate in the exchange, production, distribution and consumption of goods and services.
  - D. Understand trade as an exchange of goods or services.
  - E. Understand the impact of government policies and decisions of production and consumption in the economy.

DID YOU KNOW?

- The coal industry contributes nearly $1 billion to the Illinois economy annually.
- In 2008, 18 Illinois mines employed over 3,400 miners, and generated roughly 20,000 spin-off jobs.
- Spin-off jobs are jobs that support the mining of coal or the use of coal products. Spin-off jobs include those that generate electricity from coal, transport coal by truck, barge, or train, and market coal locally and internationally.
- The typical coal miner earns $64,000 per year including overtime.
- The coal industry is an equipment-intensive industry where machinists, electricians and mechanics are in high demand.
- Land reclamation laws ensure that mined land is returned to some useful purpose. Reclamation planning, development and implementation require the employment of people with backgrounds in geology, chemistry, soil science, biology, botany and earth science.
- Many of the byproducts from burning coal for electricity are sold for use in the construction industry.
- In 2000, approximately 24% of coal miners were union members. In 2004, less than 20% of coal miners were union members.
- United Mine Workers of America (UMWA) is the primary union representing coal miners. The United Steelworkers of America and the International Union of Operating Engineers are examples of other unions that represent coal miners.
- According to NetCent Communications, the 2002-2003 Occupational Outlook continuous mining machine operators earn approximately $16.16 per hour. Mining and geological engineers and safety engineers earn approximately $29.23 per hour. Explosives workers, ordinance handling experts and blasters make $16.08 per hour. Excavating and loading machine and dragline operators earn $16.05 each hour.
- A mining engineer must know about: geological engineering, mechanical engineering, civil engineering, surveying engineering, electrical engineering, industrial engineering, safety engineering, HVAC (Heating/Ventilation/Air Conditioning) engineering, metallurgical engineering and environmental engineering.

QUESTIONS/ISSUES

- How does coal affect the Illinois economy? (Answers will vary but may include: contributes $1 billion annually, 18 Illinois mines employed over 3,400 miners in 2008, up to 20,000 spin-off jobs generated.)
- What are some of the jobs that are created as a direct result of coal mining? (Answers will vary but may include: coal miners, geologists, electricians, heavy equipment operators, chemists, accountants, mechanics, mining engineers, managers, foremen, truck drivers, drillers, roof bolters, safety specialists, emergency medical technicians, mine rescue specialists, ventilation technicians, surveying engineers, botanists, ecologists, preparation engineers, ship/barge captains, agronomists, federal and state mine inspectors, computer aided designers, surveyors, welders, tool and die makers, lab technicians, certified blasters, industrial hygienists, railroad engineers.)
- Name as many spin-off jobs created as a result of coal or coal mining as possible. (Answers will vary but may include: pharmacists, bankers, construction workers, recreational leaders, storekeepers, artisans, industrialists, agriculturalists, state employees, conservationists, biologists, lawyers, power plant operators.)
- How does the mining of Illinois coal for international trade affect the job market? (Answers will vary but may include: same jobs as domestic plus international market managers to price, market and sell on international market; senior international analyst to identify potential international customers, translators, dock workers, ship captains, crane operators.)

EXTENSIONS/CONNECTIONS

- Use the Internet to research spin-off jobs created by the mining of coal in Illinois.
- Diagram the flow of coal from the earth to a specific use in your community.
- Design a brochure for a coal-related career.
- Find all of the local businesses in your community that are in some way connected to coal.
- Participate in a mock interview for a coal-related career.
- Videotape a documentary of coal-related careers.
- Shadow a person who works in the coal industry or who holds a coal-related job.
- Plan a career day for your school highlighting those jobs which are connected to the coal industry.
- Interview a coal miner.
- Compare and contrast the job of a coal miner from the past with that of the present.
- Choose a coal related career and research all of the education classes necessary for that job.
- Create a graph comparing the average salaries (by decade) of coal miners for the last 100 years.
- Analyze a coal-related occupation and identify how the worker's decisions might be influenced by science and/or technology.

Tie In - Botany

CORRESPONDING STANDARDS

- Illinois Science Goal 12
  - A. Know and apply concepts that explain how living things function, adapt and change.
  - B. Know and apply concepts that describe how living things interact with each other and with their environment.
  - C. Know and apply concepts that describe properties of matter and energy and the interactions between them.
  - E. Know and apply concepts that describe the features and processes of the Earth and its resources.
- Illinois Science Goal 13
  - B. Know and apply concepts that describe the interaction between science, technology and society.
- Illinois Social Science Goal 15
  - A. Understand how different economic systems operate in the exchange, production, distribution and consumption of goods and services.

DID YOU KNOW?

- The four main types of coal are lignite, subbituminous, bituminous and anthracite.
- One reason for differences in coal quality or coal types is due to the changes that occur in the environment while the coal is being formed.
- Lignite has the lowest content of carbon and therefore the lowest heating value.
- Bituminous coal is the most common coal and the most widely used coal in the United States. It is soft and has intermediate carbon content.
- Anthracite is the hardest type of coal. It has the highest heating value because it is almost pure carbon.
- Illinois has the largest amount of bituminous coal in the U.S.
- Seawater, containing sulfate ions, once covered Illinois.
- Much of Illinois coal is high in sulfur content, which releases SO_2 when burned.
- The government regulates the amount of pollution that may be produced by burning coal.
- Land reclamation laws ensure that mined land is returned to a useful purpose.
- The primary source of carbon for the coal formed during the Pennsylvanian Period is the group of plants called the Lycophytes (club mosses and scale trees).
- Other important plants of the coal swamp forests include: Pteridopsida (ferns) and Sphenophyta (the herb-like spore plants related to the modern horsetail, Equisetum).
- The formation of coal begins in peat bogs, wet soggy areas with low amounts of oxygen, where decaying plants form layers.
- The rate of plant debris accumulation must exceed the rate of plant decay in order for coal to be formed.
- The carbon content of coal increases as the water and gas levels decrease.

- Dead plants from the Pennsylvanian Period + geothermal heat + pressure of overlying rocks + time (in millions of years) = coal.
- One foot of coal comes from approximately 10 feet of peat.

QUESTIONS/ISSUES

- When were the plants that make up Illinois coal alive? (Answer: They were alive during the Pennsylvanian Period (Carboniferous), or 325-285 million years ago.)
- Why might a farmer allow a mining company to surface mine his land? (Answers will vary but may include: governmental regulations require mining companies to return the land to pre-mining condition, a mining company would pay a farmer for sub-surface mineral rights or even buy or lease the land from the farmer, agricultural production could resume after mining has ceased.)
- Why does Illinois' bituminous coal contain large amounts of sulfur? (Answer: Due to sulfate ions contained in seawater once covering Illinois, sulfates infiltrated into the peat over time.)
- Illinois has the largest supply of bituminous coal. What does this tell us about the environment of Illinois 300 million years ago? (Answer: During the Pennsylvanian Period the environment alternated between terrestrial and marine, with warm, humid climates; flora included extensive jungle-like forests and swamps.)
- How do we solve the pollution problems caused by the burning of bituminous coal with high sulfur content, like that found in Illinois? (Answer: The EPA regulates the amount of pollutants that can be released. Clean coal technologies remove pollutants, bringing the power plants within governmental regulations.)
- Surface mining decimates the flora in the mining area. How can we ensure that the plants and our environment are not destroyed forever? (Answers will vary but may include: laws hold mining companies to stringent guidelines, mined land must be returned to the same quality or higher, many mining sites are reclaimed as natural areas.)
- How does coal get its energy? (Answer: Coal is a fossil fuel, which was formed from organic matter that captured energy from the sun through photosynthesis. Partial decomposition of the plants that make up coal ensures that some energy remains. Energy cannot be created or destroyed. It changes forms and moves through the environment.)

EXTENSIONS/CONNECTIONS

- Diagram the life cycle of a plant.
- Calculate (in tons) the amount of plant matter necessary to create a cubic foot of coal.
- Make a timeline of events during the Pennsylvanian Period.
- Sketch and label plants of the Illinois coal swamps.
- Research the pre-mining agricultural production of a particular coal site and compare it to the post-mining production.
- Evaluate the impact of coal mining in Illinois in regards to economics and the environment.
- Develop a model that depicts the formation of coal.

Tie In - Mine Safety and Ventilation

CORRESPONDING STANDARDS

- Illinois Mathematics Goal 7
  - A. Measure and compare quantities using appropriate units, instruments and methods.
  - E. Select and use appropriate technology, instruments and formulas to solve problems, interpret results and communicate findings.
- Illinois Science Goal 13
  - A. Know and apply the accepted practices of science.
  - B. Know and apply concepts that describe the interaction between science, technology and society.
- Illinois Social Science Goal 15
  - E. Understand the impact of government policies and decisions on production and consumption in the economy.

DID YOU KNOW?

- In 2008, 18 Illinois mines employed over 3,400 miners and generated about 20,000 spin-off jobs.
- Mining jobs that directly relate to safety include: mine rescue specialists, rock mechanic engineers, ventilation engineers, safety inspectors and emergency medical technicians.
- Each underground miner puts on a hardhat, steel-toed boots, safety glasses, a cap lamp and a self-rescuer (gas mask) as part of his or her daily uniform for underground mining.
- The safety equipment worn by underground miners will help them stay alive should they find themselves in a dangerous situation.
- The self-contained, self-rescuer (SCSR) provides the miner with approximately 1 hour of breathable air under heavy activity and up to four hours under resting conditions.
- From 1900 – 1940, approximately 8,500 people were killed working in U.S. mines.
- From 1941 – 2000, the total number of mining fatalities was 1,436.
- The huge reduction in mining tragedies can be accredited to safety regulations and new safety technologies.
- Many of the injuries sustained in mines today are due to roof falls or hauling accidents.
- Methane gas (CH4) is emitted from coal. Methane gas replaces oxygen and can cause suffocation if breathed in high quantities. It will explode at concentrations between 5%-15%.
- If the methane gasses in an underground mine combust, the blast kicks up coal dust which causes an even larger explosion.
- In underground mines, pulverized limestone is sprayed over exposed coal to reduce the risk of coal dust combustion.

- Ventilation systems are used to reduce or dilute the dangerous gasses, both natural and mechanically derived, that are present in underground mines.
- By withdrawing air, the fans create a difference in pressure, causing fresh air from another opening to rush into the mines.
- Curtains and metal or block stoppings are used to route the fresh air through the mines.
- Roof bolts are long bolts or pieces of steel rebar that are glued into the ceiling of an underground mine as secondary roof support.
- Roof bolts help to stabilize the roof of the mine, reducing the chance of a cave-in.
- Lamination is a type of roof bolting that provides support by binding several shallow strata together.
- Suspension is a type of roof bolting that ties the lower stratum of the roof to a stronger strata that is located just above it.
- The Federal Mine Safety and Health Administration (MSHA) and Illinois Office of Mines and Minerals today routinely inspect mines.
- MSHA holds the industry to regulations that are even more rigorous than those of the Occupational Safety and Health Administration (OSHA).
- In 1981, a law was passed requiring all mines to have a mine rescue team in place.
- The mine rescue teams are composed of miners who volunteer to take extra classes and training to prepare for emergency situations.
- The main goals of the mine rescue teams are to rescue any miners and to return the mine back to "safe" status.

QUESTIONS/ISSUES

- How can the mining industry continue to reduce accidents and/or deaths? (Answers will vary but may include: make miners aware of safety precautions and dangerous situations, implement advancements in safety equipment, have effective rescue plans, training, communication and properly ventilate mines.)
- What are some of the challenges that a ventilation engineer must face when designing a ventilation plan for a mine? (Answers will vary but may include: develop ventilation pathways to ensure miners have fresh air, situate curtains to direct the flow of air, designate areas reserved as "fresh air rooms" for use in emergency situations, cope with continuous changes in ventilation rates as the mining moves further from the airway.)
- What gas poses the most danger to the miners? How is exposure avoided? (Answer: Methane gas is naturally emitted from coal. Mines are ventilated to dilute and remove harmful gasses. Answer: Miners wear a SCSR during emergencies.)
- A mine has an arched entryway (radius of 7.5 feet, height of 15 feet, and width of 15 feet.) Use the equation [$A = Pi \times r^2/2 + W \times H$] to compute the area of the opening. (Answer: 313.36 ft^2)
- Why is methane gas like a fuse in an underground mine? (Answer: Methane ignition can kick up coal dust, triggering an even larger explosion.)

EXTENSIONS/CONNECTIONS

- Graph coal industry fatalities by decade.
- Interview a safety inspector. Define areas in which safety can be further improved.
- Write an essay explaining the economic impact of improved safety in the mines.
- Compare the safety equipment of today with that of a miner in the 1800's.
- Investigate the courses of study needed to perform a specific job related to mine safety or ventilation.
- Use simple geometric equations to figure and find the area of coverage needed for fresh air ventilation.
- Create a model of an underground room and pillar mine, demonstrating a possible ventilation strategy.
- Make a poster to increase awareness of safety issues for miners.

Tie In - Environmental Issues

CORRESPONDING STANDARDS

- Illinois English Language Arts Goal 3
  - B. Compose well-organized and coherent writing for specific purposes and audiences.
  - C. Communicate ideas in writing to accomplish a variety of purposes.
- Illinois Science Goal 12
  - B. Know and apply concepts that describe how living things interact with each other and with their environment.
  - C. Know and apply concepts that describe the features and processes of the Earth and its resources.
- Illinois Science Goal 13
  - B. Know and apply concepts that describe the interaction between science, technology and society.
- Illinois Social Science Goal 15
  - B. Understand that scarcity necessitates choices by consumers.
  - C. Understand that scarcity necessitates choices by producers.

DID YOU KNOW?

- Ecology is the study of biotic (living) and abiotic (non-living) things and their interactions.
- Subsidence is the settling of the land after underground mining has occurred.
- Continuous miner machines (for room and pillar mining) and longwall machines (for longwall mining) allow underground coal to be extracted quickly, but may cause subsidence.
- Land reclamation laws ensure that mined land is returned to a useful purpose.
- Reclaimed mine lands are used for many different purposes including: cropland, recreation sites, natural areas, community developments, forests, pastures, and even developed water areas. Reclaimed areas can create spin-off jobs.
- Mining companies must purchase bonds to ensure that they restore the land to at least its original condition.
- In 1995, Illinois exported 2.7 million tons of coal.
- Much of Illinois coal is high in sulfur content, which causes sulfur dioxide emissions when burned.
- The government regulates the amount of pollution that may be produced by burning coal.
- New technologies, though costly, can clean coal and emissions so that regulations may be met.
- Many of the byproducts from burning coal for electricity are sold for use in the construction industry.
- Mining companies employ many people to help ensure that the mine is reclaimed properly. These jobs may include: environmental engineers, environmental technicians, botanists and ecologists.

QUESTIONS/ISSUES

- Why did the demand for Illinois coal exports experience a drastic drop from 1995 to 2004? (Answer: Stringent regulations designed to limit pollution required coal to be cleaned. Coal cleaning technologies are very costly. Consumers of Illinois coal were able to find less expensive substitutes such as coal with lower sulfur content from other countries or states that could be used at lower prices. Consumers switched to these substitutes, resulting in an overall decrease in demand in the market for Illinois coal.)
- What emissions are introduced to the environment when coal is burned? (Answers will vary but may include: particulate matter (PM_2) and released gasses including nitrogen oxides (NO_x), sulfer dioxide (SO_2), mercury (Hg) emissions, and carbon dioxide (CO_2))
- How do clean coal technologies reduce the impact of coal on the environment? (Answer: Various technologies including flue gas desulfurization (scrubbers), low NO_x burners, atmospheric circulating fluidized bed combustion, gasification, and sedimentation ponds, reduce the amount of pollution caused by burning coal. This allows us to benefit from the use of coal as a natural resource, while limiting the negative effects on the environment.)
- What effect does surface mining have on the surrounding ecology? Explain. (Answer: While surface mining can destroy the local environment, reclamation laws ensure that mined areas are restored to useful purposes. Crop land that is mined must meet or exceed production rates for three consecutive years after reclamation before the bond will be released.)
- What happened to the land that was mined before all of the reclamation regulations were put into effect? (Answer: Federal coal taxes generated 35 cents for each ton of coal sold from surface mines and 15 cents for each ton of coal sold from underground mines. Money was then pooled and old sites were reclaimed.)

EXTENSIONS/CONNECTIONS

- Evaluate the current pollutant emissions laws for the burning of coal.
- Compare former surface mining sites before reclamation laws were enacted to current reclaimed surface mining sites.
- Visit a reclaimed mine and share your experience with others.
- Create a chart showing the impact of clean coal technologies on the reduction of pollutants into the environment.
- Create a television ad that highlights the economic importance of reclaimed areas.
- Research the agricultural production of a particular coal site before mining began.
- Evaluate the impact of coal mining in Illinois with regard to economics and the environment.
- Research different types of clean coal technology.
- Choose one method of cleaning coal and create a model that simulates it.
- Write a persuasive essay on the economic importance of mining coal in Illinois.

Tie In - Geology/Earth History

CORRESPONDING STANDARDS

- Illinois Science Goal 12
  - C. Know and apply concepts that describe properties of matter and energy and the interactions between them.
  - E. Know and apply concepts that describe the features and processes of the Earth and its resources.
- Illinois Science Goal 13
  - B. Know and apply concepts that describe the interaction between science, technology and society.
- Illinois Social Science Goal 15
  - D. Understand trade as an exchange of goods or services.
  - E. Understand the impact of government policies and decisions on production and consumption in the economy.

DID YOU KNOW?

- Coal is a fossil fuel because it contains energy from plants that were once living.
- Coal is nonrenewable: once it is used up, it cannot be replaced.
- The four main types of coal are lignite, subbituminous, bituminous and anthracite.
- The reason for differences in coal quality or coal types is due to the changes that occur in the environment while the coal is being formed.
- Lignite has the lowest content of carbon and the lowest value for heating.
- Bituminous coal is the most common coal and it is mined in Illinois. It has intermediate carbon content.
- Anthracite is the hardest type of coal. It has the highest heating value because it is almost pure carbon.
- Lignite, subbituminous and bituminous coal are considered to be sedimentary rock.
- Anthracite is considered to be metamorphic rock and could eventually become graphite.
- The formation of coal begins in peat bogs, wet soggy areas with low amounts of oxygen, where decaying plants form layers.
- Patterns in coal layers, due to changes in depositional environments, are called cyclotherms.
- The rate of plant debris accumulation must surpass the rate of plant decay in order for coal to be formed.
- The carbon content of coal increases as the water and gas levels decrease.
- One foot of coal comes from approximately 10 feet of peat.
- The plants that make up the coal seams in Illinois were alive during the Pennsylvanian Period, which was about 325-285 million years ago.
- The Pennsylvanian Period had an environment that alternated between terrestrial and marine.
- The sulfur in Illinois bituminous coal is due to large amounts of sulfate ions contained in the seawater that once covered Illinois.

- If there was spillover from a freshwater source, shale was formed. The shale protected the peat from the saltwater. The result is coal which is low in sulfur content.
- Coal mining in Illinois began about 200 years ago.
- 90% of Illinois coal comes from the Springfield (No. 5) and Herrin (No. 6) seams.
- The thickest coal seams in Illinois are between 6 and 8 feet thick.
- Coal lies beneath approximately 37,000 square miles of Illinois – about 65% of Illinois' land surface.
- Coal is mined in about 11 counties in Illinois.
- Illinois has the largest concentration of bituminous coal in the United States.
- In 2008, nearly 33 million tons of coal was mined in Illinois alone.

QUESTIONS/ISSUES

- What is the Illinois Basin? (Answer: Coal deposits in Illinois, Indiana and the western Kentucky area were created by rifting during the Ordovician and Cambrian periods.)
- How is coal formed? (Answer: It begins in peat bogs where decaying plants form layers. The accumulation of plant debris surpasses rate of decay. Heat and pressure form plant material into coal over time.)
- Why do different types of coal have different energy values? (Answer: The more water and gas that is contained in a piece of coal, the lower the Btu, or heat value. Lignite has lowest value, subbituminous has low value, bituminous has medium value, and anthracite has the highest value.)
- How is coal classified as a natural resource? (Answer: It is a nonrenewable fossil fuel, created by plants that were once alive, and it cannot be replaced once it is used.)
- What are some advantages of using coal as a fuel source? (Answers will vary but may include: readily available, abundant, relatively inexpensive, boosts the region's economy; reduction in pollution due to technology, etc.)
- What factors might a mining company consider before making a decision to mine a particular site? (Answers will vary but may include: thickness, depth and quality of coal, proximity to market, geologic conditions of the area for stability purposes, etc.)

EXTENSIONS/CONNECTIONS

- Create a key to identify the different types of coal.
- Make a map of Illinois depicting the location of coal within the state. Label the Herrin and Springfield coal seams.
- Diagram the process of coal formation.
- Plot the Earth's history on a timeline, highlighting the Pennsylvanian Period.
- Construct a model to show how the cyclothemic pattern formed coal in the Illinois Basin.
- Conduct research to find out if any areas in your community have been undermined.
- Compare density of each coal grade with other types of sedimentary rock.

5-8 GLOSSARY

Alternative – a choice between two or more things

Anthracite – hard coal with the highest carbon content and low volatile matter (high heat producer with little flame and smoke)

Average mine price – the ratio of the total value of the coal produced at the mine to the total production tonnage

Bituminous – coal that is between anthracite and lignite in hardness and heat value; the most common type of coal

Btu – British thermal unit: a unit of heat required to raise the temperature of one pound of water 1 degree Fahrenheit

Carbon – a very common nonmetallic element which occurs in combination with other elements in all plants and animals; coal is mainly composed of uncrystallized carbon

Clean coal technologies – processes that are designed to use coal in ways that minimize harm to the environment

Coal – a black or brownish-black rock that is made up of fossilized plants that were alive about 300 million years ago

Coal seam – a bed or large deposit of coal

Complementary goods – goods which often accompany or are used with another good

Consumers – people who buy and use goods and services

Decrease – to become less or grow smaller

Demand – the amount of a good or service that people are willing to purchase at a specific price at a specific time

Demand curve – a graphical representation of the demand schedule; a negatively sloped line showing the inverse relationship between the price and the quantity demanded (all other things being equal)

Demand schedule – a schedule of how much of a good or service people will purchase at any price during a specified time period, all other things being constant

Density – the relation of an object's mass to its volume (D = M / V)

Disadvantage – a loss; an unfavorable or inferior condition

Displacement – the change in position of an object in a space

Externality – cost or benefit that results when the consumption or production of a good or service affects people who are not directly involved

Fossil fuel – a fuel that is made from the remains of plants and/or animals

Goods – material things that produce satisfaction

Income – the benefits received (usually measured by money) for engaging in productive labor

Increase – to become greater or larger

Inverse relationship – condition that exists between two variables showing that when the value of one variable increases, the other decreases, and vice versa

Law of demand – when price increases, the quantity demanded decreases; when price decreases, the quantity demanded increases

Lignite – coal that is soft and brownish-black with the lowest heating value

Market price – the price where the quantity demanded of a good or service equals the quantity supplied of that good or service

Mass – a measure of the quantity of matter a body contains

Matter – anything that takes up space and has mass

Negative – opposite of positive, lacking the qualities of being positive

Opportunity cost – the highest valued alternative given up when a choice is made

Peat – a brown, crumbly, lightweight and spongy material; it is the first stage of coal formation

Pennsylvanian Period – the sixth period of the Paleozoic Era; it is characterized by coal, oil, and gas deposits and cyclic sedimentation

Persuasive essay – a written series of paragraphs having the power to convince

Physical characteristics – characteristics relating to the size, shape and general state of a substance

Positive – affirmative, good, just

Preference – one's specific choice or selection; an individual's likes or tastes

Services – actions that are done for you that provide satisfaction

Short ton – a unit of weight equal to 2,000 pounds

Spot market price – the price for a one-time open market transaction for immediate delivery of a specific quantity of product at a specific location where the commodity is purchased "on the spot" at current market rates

Subbituminous coal – a coal intermediate between lignite and bituminous with a heat value ranging from 8,300 to 11,500 Btu/lb.

Substitute goods – goods which can replace another good

Sulfur – a light-yellow, highly flammable nonmetallic element that exists in several forms and burns in the air with a blue flame and a stifling odor

Volume – the amount of space occupied by a body as measured in three dimensions, expressed in cubic units

FROM THE COAL MINES TO THE POWER LINES

Teacher's Curriculum Guide
Grades 9 - 12

PREPARED BY

ILLINOIS DEPARTMENT OF COMMERCE AND ECONOMIC OPPORTUNITY
OFFICE OF COAL DEVELOPMENT

AND

ILLINOIS COUNCIL ON ECONOMIC EDUCATION

MAY 2004

Illinois Department of Commerce and Economic Opportunity
Office of Coal Development

"From the Coal Mines to the Power Lines" Teachers Guide has been developed to give teachers sufficient information to incorporate coal education into their curriculum. Bituminous coal, Illinois' most abundant natural resource, underlies 37,000 square miles of Illinois, about 65 percent of the state's surface. Since the Illinois coal industry contributes nearly $1 billion to the Illinois economy annually and 49 percent of the electricity used in Illinois is generated from coal, it is important for teachers to provide a sound and meaningful understanding of coal and energy issues to their students. By including coal education in their curriculum, teachers will bring to their students and communities an awareness of our state's greatest natural resource and the positive role coal plays in our day-to-day lives and the economy of the state.

"From the Coal Mines to the Power Lines" addresses a variety of topics and skills in science, social studies, math, language arts and economics. Although the guide is divided into grade level sections of K-4, 5-8 and 9-12, the lessons and tie-ins can be used interchangeably with minor adjustments by the teacher. A matrix is included to show the correlation of the lessons and tie-ins to the Illinois State Learning Standards. A CD-ROM accompanies each of the three grade level sections. Each CD-ROM displays a PowerPoint Presentation that is designed to be a teaching tool for the instructor complementing the series by adding depth and understanding to the concepts and vocabulary inherent to the lessons and tie-ins that comprise the written portion of the curriculum. The presentations highlight glossaries of terms through the use of captions, questions, photos, clip art, descriptions, and music.

"From the Coal Mines to the Power Lines" will give teachers the knowledge, skills, and tools necessary to provide their students a sound and meaningful understanding of coal in Illinois. The curriculum covers the rich history of coal and coal mining, its role in the Illinois economy as well as its significance to the state's energy profile and the impact of clean coal technology on the environment.

For more information on Illinois coal, contact the Office of Coal Development at:

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NOTE

This manual is being provided free of charge by the Illinois Department of Commerce and Economic Opportunity Office of Coal Development as a public service to education. As such, it is being provided on the basis that the Department of Commerce and Economic Opportunity Office of Coal Development has no legal liability and disclaims all legal liability for all claims arising from the use of this manual and the activities contained in it. Responsibility for the use of any of this information is assumed by the local district/institution.

Copies of the coal curriculum may be obtained from:

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Illinois Council on
[redacted]

The EconomicsAmerica School Program

About the Illinois Council on Economic Education

The Illinois Council on Economic Education supports this curriculum through *curriculum consulting* and *professional development* programs for schools/teachers. A comprehensive set of *curriculum materials* to supplement the economics in "From the Coal Mines to the Power Lines," and to further address Illinois Learning Standards in economics, language arts, math and other areas, is available through the Council and its affiliated Centers for Economic Education around the state. In addition, ICEE offers **The Stock Market Game™** for students in grades 4-12; the **Economics Poster Contest** for students in grades 1-8, and the **Economics Challenge** for high school students.

For more assistance in teaching personal finance and economic education topics to your students, contact the Council at:

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Lesson

Can My Company Make a Profit in the Development of a New Coal Mine?

OVERVIEW

In this lesson, students will have the opportunity to explore a variety of criteria associated with the exploration and development of a surface coal mine. Through the process of examining factors such as land costs, exploration fees, thickness and area of coal reserves, coal impurities, and other criteria, students will understand the decisions that go into the comparison of risk to reward in determining whether or not a surface coal mine might be profitable. Students will gain experience in using a number of perimeter combinations to maximize the area of the mine. They will also plot drill site data to determine the most profitable mine location and calculate approximate tons of coal present.

MATERIALS

- Graphing calculators (Optional: 1 per group of 3-4 students)
- Graph paper (1cm or ½ inch grids preferable) two sheets per student
- Markers or colored pencils (two different colors per student)
- One copy of Student Activity Page A: *Coal Exploration and Mine Development – Activity #1* per student
- One copy of Student Activity Page B: *Drill Hole Data Sheet* per student
- One copy of Student Activity Page C: *Maximizing Area – Activity #2* per student
- One copy of Student Activity Page D: *Determining the Time Required for a Mine to Show a Profit – Activity #3* per student
- One copy of Teacher Resource Page A: *Drill Hole Data Sheet* (Answer Key)
- One copy of Teacher Resource Page C: *Maximizing Area – Activity #2* (Answer Key)
- One transparency of Teacher Resource Page B: *Kickapoo Creek Mining Company: Prospect Map #1*
- One transparency of Teacher Resource Page D: *Coal Reserve Map for Illinois*
- Paper clips, straws or coffee stirrers (24 per student group)
- Overhead projector

APPROXIMATE TIME REQUIRED

- Three fifty-minute class periods are required to complete this lesson.

VOCABULARY

- Area (of quadrilaterals such as rectangles)
- Coal reserves
- Coal seam
- Entrepreneur

- Interburden
- Isopach map
- Overburden
- Perimeter
- Reclamation
- Scarcity
- Start-up costs
- Stripping ratio
- Trade-offs

OBJECTIVES

After completing this lesson, the student will be able to:

- calculate the perimeter and area of rectangles and squares.
- understand how to maximize the area of rectangles of varying dimensions given a predetermined perimeter.
- represent and organize data by creating lists, tables and graphs.
- construct models to show the impact that changing the dimensions of a predetermined perimeter have on area.
- calculate stripping ratios for various test drill holes.
- construct a graph of locations and drill site data to determine the optimal locations for mining.
- list and discuss the factors that determine the potential for profit and loss in mining a particular coal seam.
- determine how much time is required for a coal mining project to become profitable using supplied expense and revenue information.
- demonstrate an understanding of relevant vocabulary.
- demonstrate the ability to enter lists or data sets and create the resulting graph if graphing calculators are available and depending on the model of the calculator.
- make predictions using available data.

MATH STANDARDS

6.A.4; 7.A.4b; 7.C.5b; 9.A.5; 9.C.5b

SCIENCE STANDARDS

11.A.4c; 11.B.4c; 12.E.4b; 13.A.4c

SOCIAL SCIENCE STANDARDS

15.C.4a; 15.D.5a

PROCEDURE

1. Initiate a discussion about the factors that entrepreneurs must consider when considering the start up of a new business. How would you research successes and problems of similar businesses? What are the start-up costs? What are the costs of production? What are ongoing costs? How do you "get the word out" about the product or service?

2. Use the website http://illinoisbiz.biz/dceo/Bureaus/Coal/Kids+Site to give an overview of surface mining for coal. This could be done by teams on computers or by projecting the information for the class to see and discuss. Ideas of processes and the scope of such a project can be realized in a few minutes. If computer access is not available to the class, the teacher can produce handouts that give an excellent overview. Use the coal reserve map on a transparency of Teacher Resource Page D: *Coal Reserve Map for Illinois* to discuss locations of nearest coal deposits.
3. Ask the class to brainstorm the factors that would determine profitability of a surface coal mine. These might include: land lease or purchase costs, depth of coal, thickness of coal seam, surface features, heat values, coal impurities such as sulfur content, reclamation costs, labor (union vs. nonunion), permit and application fees, and pending regulations/legislation that might impact future costs. It would be important to be able to predict the total amount of coal reserves anticipated as well as the expected selling price of the coal.
4. Challenge the students to speculate about what potential investors would want to know before giving the "green light" to the project. This should eventually come down to a way to calculate the amount by which expected revenues will exceed anticipated expenses.
5. Explain that of the previous criteria, the seam thickness and the distance from the surface are most important. Extend the information from the website in procedure #2 by discussing the terms in the glossary. For surface mines, profitability is related to the *stripping ratio,* which mathematically relates the ratio of the cubic yards *of overburden* (soil and rock overlying the coal seam) to tons of coal available. For most surface mines, a stripping ratio of less than 25:1 is desirable. In other words, for every 25 cubic yards of overburden removed, at least one ton of coal needs to be mined. Of course, if the sulfur and impurity contents are too high, the location may not be suitable. <u>Note</u>: Explain that there may be a second seam of coal that may be removed and any rock between the two coal seams would be called *interburden.*
6. Divide the class into groups of 3 or 4 and distribute copies of Student Activity Page A: *Coal Exploration and Mine Development – Activity #1,* Student Activity Page B: *Drill Hole Data Sheet, and* graph paper to each student. Students will play the role of geologists who are extracting drilling samples at various test sites on a prospective mine site. Following the directions given, they will plot the location and record the stripping ratio, depth, and thickness to determine the optimal location for the mine as well as the approximate amount of coal available. Instruct students to compare their results with the other students in their group. The map showing the coal thickness trends is known as an *isopach* map. At this point, discuss that on real samples, geological information on carbon content, heat values, impurities, etc., would be necessary before actually considering the area. We will make an assumption that all of these factors are within accepted ranges.
7. Discuss the results obtained by the students, using Teacher Resource Page A: *Drill Hole Data Sheet (Answer Key)* as a guide. Display an overhead transparency of a completed prospect map as shown in Teacher Resource Page B: *Kickapoo Creek Mining Company: Prospect Map #1*. Have students explain how they chose the best extension of the graph beyond the data points (extrapolation). Ask for some

tonnage calculations. Why would they vary? (Answers will vary but may include: selection of map extension, counting area of grids in acres, decision to label every other graph grid, etc.).

8. One of the most critical factors in designing the mine "layout" is related to maximizing the area by using particular dimensional and resulting perimeter values. In other words, by using the test site drilling data, how can you maximize the area of a particular perimeter? Begin by reviewing the concepts of perimeter (the sum of the lengths of all the sides) and area (the product of the length and width) of squares and rectangle. Have the class brainstorm about practical applications in their lives. (Answers will vary but might include: purchasing carpeting, floor and ceiling tile, baseboard, dry wall, paint, fence, designing ponds, etc.). Demonstrate the calculations using the room dimensions and have students compute perimeter and area of their desk tops. Discuss results.
9. Divide the class again into groups of 3 or 4 and distribute Student Activity Page C: *Maximizing Area - Activity #2* to each student. Explain that two famous coal geologists have come up with a game. Each group will be given 24 congruent pieces (example: paper clips, coffee stirrers, straws, etc.) The goal is to arrange the pieces in every possible way to make a rectangle and to determine which dimensions also create the greatest area. Have students individually enter the various dimensions in the table and graph them as ordered pairs. Discuss the results using Teacher Resource Page C: *Maximizing Area – Activity #2 (Answer Key)*. (The 6 by 6 square would have the greatest area). What shape does the graph of length and width combinations take? (Answer: a parabola)
10. Distribute copies of Student Activity Page D: *Determining the Time Required for a Mine to Show a Profit – Activity #3* to each student. Allow students to work in teams of 3 or 4 and use the information provided to calculate the time required for a mine to show a profit.

    - Depending upon the math background of each student you may need to guide them in the setup of the equation in part A below. Review the calculations and discuss the factors that may really change these projections.

- *Let D stand for the variable representing the time for profitability.*
- *Set-up an equation where Start-up Costs plus daily operating expenses are equal to the revenue generated from selling coal.*
- *The variable D may be found by equating the accumulating daily and start-up expenses (left side of the equation) to the accumulating revenue (right side of the equation). The day that they are equal (show by D) is the day the mine should begin to turn a profit.*

The time for profitability (D days) is found by using the following formula:

Calculate the days required for start-up costs + the total daily expenses to equal total income *in that same number of days.* Number of Days (D) to profit x daily expense + start-up costs = D x Daily tons of coal x price per ton.

In this example:

A. (D x \$10,000 / day + \$7,000,000) = (1000 tons/day x D x \$25/ton)

D X \$10,000/day + \$7,000,000 = \$25,000/day x D

- (Divide both sides by \$)
- D x 10,000/day + 7,000,000 = 25,000/day x D
- (Multiply both sides by day)
- D x 10,000 + 7,000,000 = 25,000 x D
- 10,000D + 7,000,000 = 25,000D
- (Subtract 10,000D from both sides)
- 7,000,000 = 15,000 D
- (Divide both sides by 15,000)
- 467 days = D

Answer: *467 Days or 1.27 Years to profitability*

B. Factors that may alter projections include: labor costs, interest rates, strikes, safety shutdowns, clean air legislation, cost of gasoline and maintenance, disposal fees, taxes, contracts, and transportation costs.

C. After profitability in 1.27 years, each year would bring a profit of revenues less expenses.

   a. This is calculated by:

      1000 tons/day x 365 days x \$25/ton) - (365 days x \$10,000/day

      Show here: \$9,125,000-\$365,000 = \$5,475,000 per year.

Hypothetically, this would yield a profit of \$5,475,000 total (annually), or \$273,750 each if split equally among 20 investors.

DEBRIEFING QUESTIONS

1. In Student Activity Page A: *Coal Exploration and Mine Development – Activity #1*, what would a drilling sample look like when it is brought above ground? Have students research this. (Answer: The sample would be a core that would be as long as needed to capture the geologic nature of the particular drill hole. It would show the layers of topsoil, clay, rock, coal, etc., that are present at the site of the sample.)
2. In Student Activity Page A: *Coal Exploration and Mine Development – Activity #1* how would geologists analyze the sample for chemical content? (Answers will vary but may include: conduct analyses including destructive distillation, heat content tests, moisture content, ash, sulfur, etc.)
3. Ask the class why Student Activity Page C: *Maximizing Area – Activity #2* would be of interest to the coal mine investors. (Answer: The miners would want to be able to mine the greatest possible area while creating as small of a perimeter as possible in order to minimize costs.)
4. What types of other cost-saving actions could the investors consider? (Answers will vary but may include: non-union labor, used equipment, leasing rather than purchasing, etc.)

5. What effect could additional clean coal legislation have on the financial projections? (Answer: The costs of producing cleaner coal could diminish profit potential.)
6. How could the coal be mined if a major seam was discovered deeper than the current surface equipment could mine? (Answers will vary but may include: consider an underground mine or develop new methods.)
7. Is it possible that reclaimed land could be more valuable if left in lakes and wetlands than if returned to farmland? Support your argument. (Answer: Recent land auctions of reclaimed surface mines that are left as recreational areas may show a higher selling price than cropland.)

GLOSSARY

- Area (of quadrilaterals such as rectangles) – the measure, in square units, of the interior region of a 2-dimensional figure in square units; for a rectangle it is calculated by multiplying the length and the width
- Coal reserves – the amount of mineable coal in a particular region
- Coal seam – a "bed" or stratum of coal, usually a large deposit of coal
- Entrepreneur – a person who assumes the risk of organizing productive resources to produce goods and services
- Interburden – the amount of rock between two seams of coal
- Isopach map – a map that shows the coal thickness trends as revealed in drilling samples
- Overburden – the amount of rock and soil above the coal seam
- Perimeter – the distance around a figure. In rectangles, $P = 2L + 2W$
- Reclamation – the restoration of land and environmental values to a mine site after the coal is extracted. The process commonly includes "recontouring" or reshaping the land to its approximate original appearance, restoring topsoil, and planting native grasses and ground covers
- Scarcity – the condition of not being able to have all the goods and services we want; the basic economic problem that occurs because economic wants are greater than the resources available to satisfy those wants
- Start-up costs – expenses associated with the establishment of a new business These may include things such as land and building costs, permit fees, etc.
- Stripping ratio – a number that mathematically relates the ratio of the cubic yards *of overburden* (soil and rock overlying the coal seam) to tons of coal available
- Trade-offs – giving up some of one thing to get some of another thing

EXTENSION ACTIVITIES

- Contact a surface mine in the area to arrange a field trip, or invite a mine owner to the class to discuss costs that impact a mining operation.
- Historically, what has the economic impact been in areas after the coal mines have closed?
- Recent research has shown that there is a link between coal emissions and the absorption of heavy metals like mercury by fish such as tuna. Why could this pose a health risk? Investigate this topic and share the information with the class.

- What are the long-term economic impacts of surface mines that were not fully reclaimed? Consider possible environmental and safety hazards associated with the closed mine area. Also, speculate on the lost revenues associated with lost crop productivity.
- Investigate the concept of purchasing bonding for a surface coal mine project. What is bonding? What are typical costs of bonding per acre? What happens if a bond is defaulted?
- Use the list or table function on graphing calculators to create the graph in Student Activity Page C: *Maximizing Area – Activity #2.*
- Write an algebraic equation for each graph. Since Perimeter (24) = 2l + 2w, l = w (24-2w) / 2, or y = x(24-2x) / 2.
- Contact the Illinois Office of Coal Development in Springfield at (217) 782-6370 for more information.

ADDITIONAL RESOURCES:

- http://illinoisbiz.biz/dceo/Bureaus/Coal/Kids+Site
- www.osmre.gov
- www.nma.org
- www.smenet.org
- www.dnr.state.il.us/mines
- http://www.isgs.uiuc.edu/research/coal/illinois-coal.shtml
- http://www.isgs.uiuc.edu/
- http://www.eia.doe.gov/

CREDITS

Student Activity Page A: *Coal Exploration and Mine Development – Activity #1* is a modified version of a draft activity that was authored by Janis and Colin Tregworthy and provided by the Illinois State Geological Survey.

TEACHER RESOURCE PAGES

- Teacher Resource Page A: *Drill Hole Data Sheet (Answer Key)*
- Teacher Resource Page B: *Kickapoo Creek Mining Company: Prospect Map #1*
- Teacher Resource Page C: *Maximizing Area – Activity #2 (Answer Key)*
- Teacher Resource Page D: *Coal Reserve Map for Illinois*

STUDENT ACTIVITY PAGES

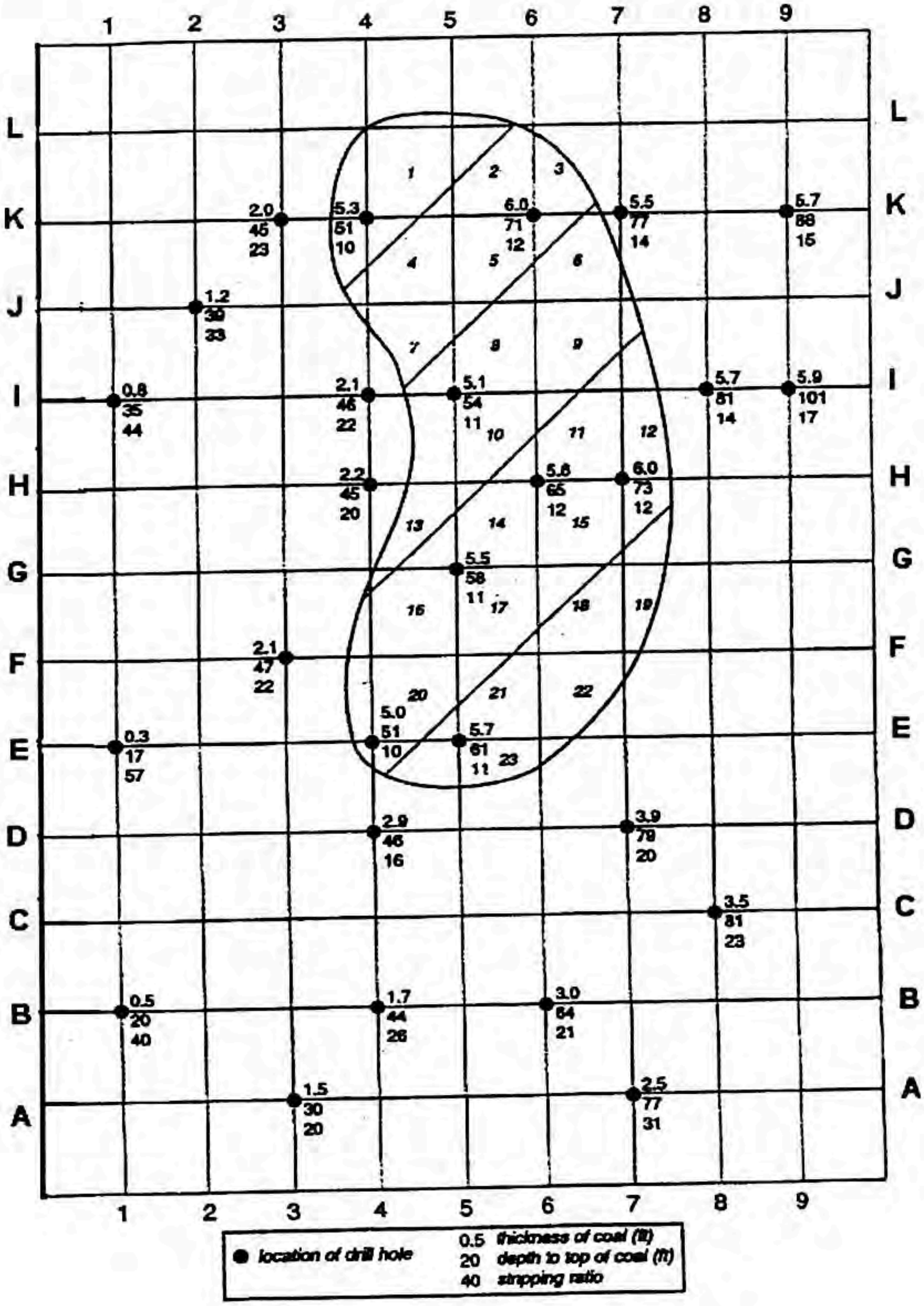
- Student Activity Page A: *Coal Exploration and Mine Development – Activity #1*
- Student Activity Page B: *Drill Hole Data Sheet*
- Student Activity Page C: *Maximizing Area – Activity #2*
- Student Activity Page D: *Determining the Time Required for a Mine to Show a Profit – Activity #3*

Teacher Resource Page A: *Drill Hole Data Sheet* (Answer Key)

KICKAPOO CREEK MINING COMPANY

B1	.5	20	40:1 or 40
E1	.3	17	57
I 1	.8	35	44
J2	1.2	39	33
A3	1.5	30	20
F3	2.1	47	22
K3	2.0	45	23
B4	1.7	44	26
D4	2.9	46	16
E4	5.0	51	10
H4	2.2	45	20
I 4	2.1	46	22
K4	5.3	51	10
E5	5.7	61	11
G5	5.5	58	11
I 5	5.1	54	11
B6	3.0	64	21
H6	5.6	65	12
K6	6.0	71	12
A7	2.5	77	31
D7	3.9	79	20
H7	6.0	73	12
K7	5.5	77	14
C8	3.5	81	23
I 8	5.7	81	14
I 9	5.9	101	17
K9	5.7	88	15

Teacher Resource Page B: *Kickapoo Creek Mining Company: Prospect Map #1*



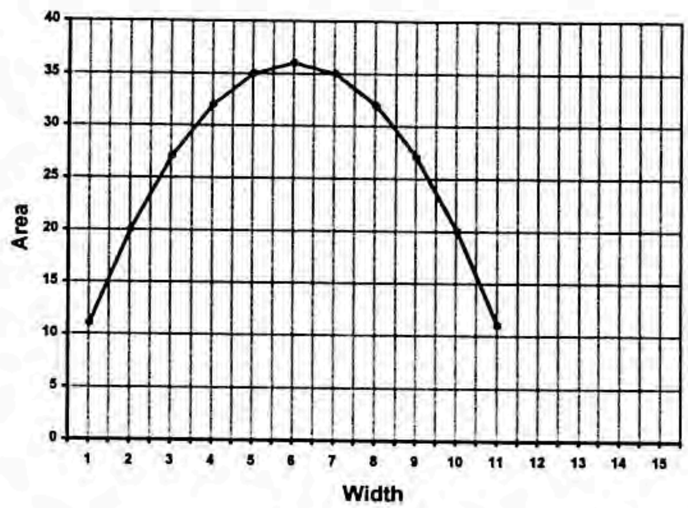
Teacher Resource Page C: *Maximizing Area – Activity* #2 (Answer Key)

Introduction

- Using all 24 pieces that are supplied to you, arrange them to create rectangles of different lengths and widths. In each case, the total perimeter would be 24, but the areas might be different.
- Fill in the table below using the various combinations that you have discovered.

Width	Length	Area
1	11	11
2	10	20
3	9	27
4	8	32
5	7	35
6	6	36
7	5	35
8	4	32
9	3	27
10	2	20
11	1	11

1. Use a piece of graph paper with Width on the X axis and Area on the Y axis and graph the ordered pairs for (width, area).



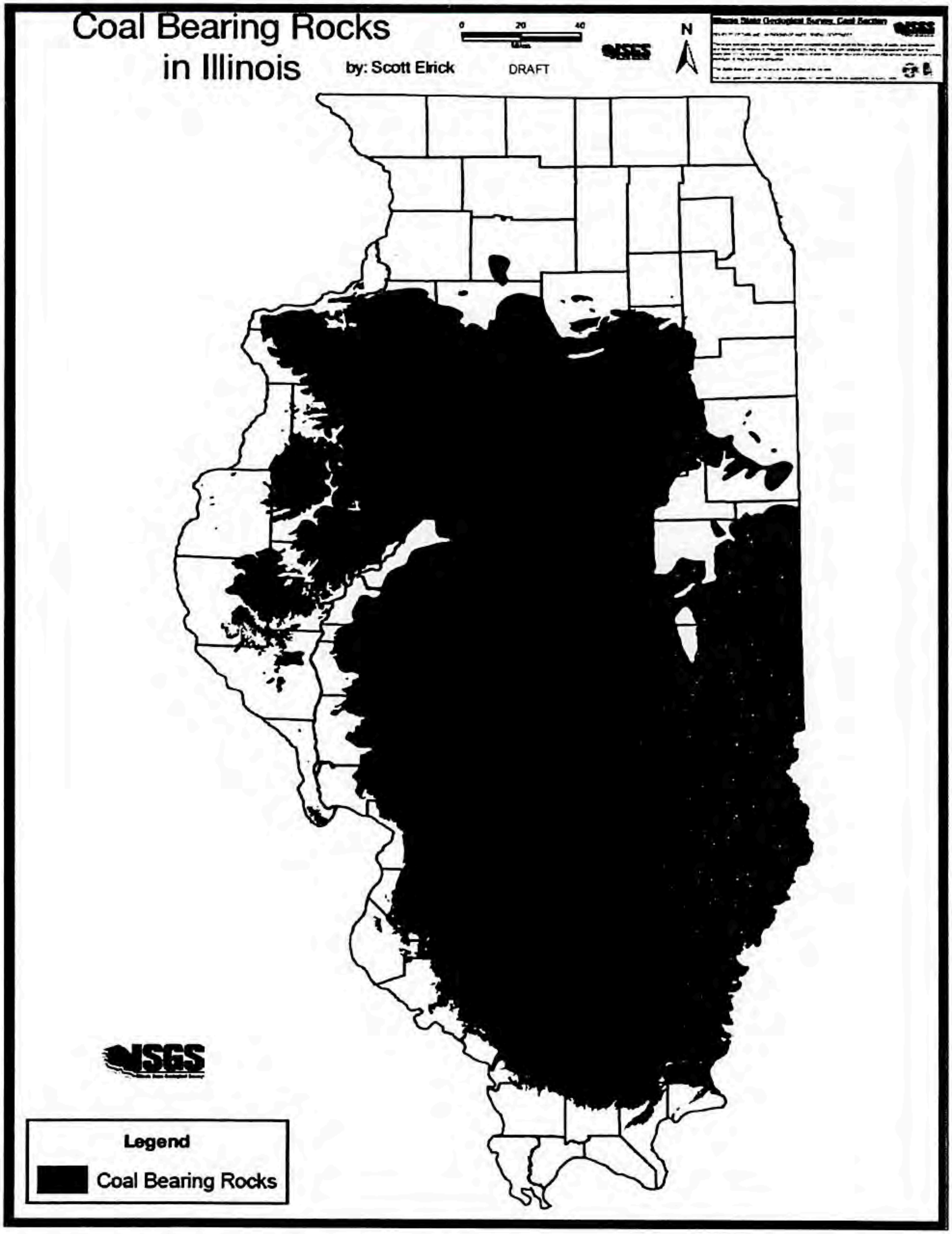
2. What dimensions allow for the greatest area? (Answer: 6 by 6)

3. What shape do these dimensions represent? (Answer: A square)

4. What formula could be used to calculate the length once the width and perimeter is known? (Answer: P-2w)/2 = L)

5. Why would this type of information be important to the mine investors? (Answer: It would be important to have the largest area of coal seam, but have options as to how the mining perimeter would be established.)

Teacher Resource Page D: ***Coal Reserve Map for Illinois***



Student Activity Page A: ***Coal Exploration and Mine Development – Activity #1***

In this activity, you are geologists working for the Kickapoo Creek Mining Company. Your company is considering opening a surface mine on a particular plot of land, which means that (1) they will remove all of the *overburden* (material above the coal), (2) then remove the coal and sell it, and (3) finally reclaim the area by returning all of the overburden back into the mine in the reverse order that they removed it, and restore the surface to the condition it was in before they started. Your company only has equipment that can surface mine to a depth of 75 feet, and to insure profitability they want a *stripping ratio* of no more than 15:1. The stripping ratio is the ratio of the thickness of the overburden (also the depth of the coal) to the coal thickness.

When prospecting for coal, geologists drill holes down into the ground, sometimes several hundred feet deep to determine the presence of coal and the thickness of any existing seam. We will assume that you have already conducted the drilling and that you have recorded your information on the "Drill Hole Data Sheet." Following the steps below, calculate stripping ratios, plot the data on the graph paper, outline the area of the proposed surface mine, and calculate the number of tons of coal present.

PROCEDURE

1. Using the data sheet, calculate the stripping ratio for each hole and record the value to the nearest whole number. EXAMPLE: 20:0.5 = 40

2. On your graph paper, label the X (horizontal) axis with the numbers 1-9 and label the Y (vertical) axis with the letters A-L. Depending on the size of the graph grids, you may want to label every 2^{nd} grid. Plot the holes on the map.

3. Next to each drill hole on the map, write 3 pieces of data: thickness of the coal, depth of the coal, and stripping ratio. Record thickness data on top, then depth data, then stripping ratio on the bottom.

4. Take a colored pencil or sharp marker and circle all depths less than 75 ft.

5. Take a different colored pencil or marker and circle all stripping ratios that are 15:1 or less.

6. Construct a line that extends beyond all of the points that are at depths of less than 75 feet AND have stripping ratios of 15:1 or less. They would be circled with 2 colors. YOU WILL HAVE TO ESTIMATE HOW FAR BEYOND THE POINTS TO EXTEND THE FIGURE. The area inside the figure would be the best prospect for the new mine!

7. Let's assume that every grid (square) on your graph represents one acre of land. Count how many squares (acres) there are. Use an average thickness of coal by averaging the thickest and thinnest coal in the area, and calculate the tons of coal present by:

   Tons of coal = thickness (ft) x area (acres) x tonnage (1800 tons/acre-ft.)

Student Activity Page B: ***Drill Hole Data Sheet***

KICKAPOO CREEK MINING COMPANY

B1	.5	20	40:1 or 40
E1	.3	17	
I 1	.8	35	
J2	1.2	39	
A3	1.5	30	
F3	2.1	47	
K3	2.0	45	
B4	1.7	44	
D4	2.9	46	
E4	5.0	51	
H4	2.2	45	
I 4	2.1	46	
K4	5.3	51	
E5	5.7	61	
G5	5.5	58	
I 5	5.1	54	
B6	3.0	64	
H6	5.6	65	
K6	6.0	71	
A7	2.5	77	
D7	3.9	79	
H7	6.0	73	
K7	5.5	77	
C8	3.5	81	
I 8	5.7	81	
I 9	5.9	101	
K9	5.7	88	

Student Activity Page C: *Maximizing Area – Activity #2*

Introduction:

- Using all 24 pieces that are supplied to you, arrange them to create rectangles of different lengths and widths. In each case, the total perimeter would be 24, but the areas might be different.
- Fill in the table below using the various combinations that you have discovered.

Width	Length	Area

1. Use a piece of graph paper with Width on the X axis and Area on the Y axis, and graph the ordered pairs for (width, area).
2. What dimensions allow for the greatest area?
3. What shape do these dimensions represent?
4. What formula could be used to calculate the length once the width and perimeter is known?
5. Why would this type of information be important to the mine investors?

Student Activity Page D:
Determining the Time Required for a Mine to Show a Profit
Activity #3

A group of eight investors has analyzed the results of the geological drilling and chemical tests done as part of coal mine exploration, and the results are favorable for a mining operation. Now they are interested in determining how much time it would take to make a profit and how much yearly income they could realize from this endeavor. Based upon their previous coal mining experience and information obtained from accountants, engineers, geologists and others, they have made projections of revenues and expenses.

Average Projected start-up costs: $7,000,000
- Drilling and testing
- Land lease and/or purchase
- Bonding
- Equipment
- Building and site construction
- Permits and fees
- Preparation of forms, financial data, and applications
- Other expenses

Average Daily Costs: $10,000
- Labor costs (20 employees)
- Maintenance
- Fuel
- Coal Cleaning
- Equipment
- Utilities
- Other Expenses

Average Daily Production: 1,000 Tons

Average Price of Coal: $25/ton

A. Using the information provided, work with your partners to propose a way to determine how long it would take to realize a profit. Show your calculations.
B. Brainstorm with your partners the factors that may alter your projections. Record those factors.
C. Assuming all factors hold constant, once profitability has been achieved, what yearly profit could be expected? If 20 investors were to receive equal amounts, how much would they each earn?

Lesson

Illinois History: The Role of the Illinois Coal Industry in Illinois Economics

OVERVIEW

Coal is a significant part of the Illinois economy as it has been for a century and a half. But the presence of coal in the economy of many areas of the state may not be so obvious to the students who do not live in communities with active coal mines. The search for coal, by studying what is underground and looking for it in the economy, past and present, provides a variety of research activities to satisfy the different interests and skills in a typical classroom. The search will provide significant insight into how communities function. Some possible leads to follow in the search for coal include the geology of the area, local economic history, the heating of homes, the production of electricity, heavy industry, and the transportation of commodities on rail, water, and highway. The concepts of spin-off jobs and byproducts will also help students see the broad impact of coal in the state's economy. Each student or student group can choose a narrow area of research and report on it. On the basis of information collected by the class, students will be able to do a number of follow-up steps requiring analysis and decision-making.

MATERIALS

- One copy of Student Activity Page A: *Coal Checklist – Is There Coal In My Community's Past?* per student
- One copy of Student Activity Page B: *Preliminary Notes Guide – Is There Coal in My Community's Past?* per student (3 pages)
- One copy of Student Activity Page C: *Guidelines for Essay Topics and Displays* per student (3 pages)
- One copy of Student Activity Page D: *Social Science Rubric* per student
- Research material options: books, magazines, Internet, newspapers covering coal topics

APPROXIMATE TIME REQUIRED

- Six forty-five to fifty-minute class periods are required to complete this lesson.

VOCABULARY

- Byproducts
- Coal seam
- Collective bargaining
- Command economy
- Demand
- Externality
- Geology
- Human resources

- Law of diminishing returns
- Mixed market economy
- Resources
- Shaft mine
- Spin-off jobs
- Supply
- Surface mining

OBJECTIVES

After completing this lesson, students will be able to:

- provide a description of the level of availability of coal in the area, if any, and explain why it is present or not.
- provide examples of the role of coal in the local economy in the past.
- outline changes in coal mining and/or the uses of coal over time.
- present information concerning coal in the community's past orally and visually.
- write an essay showing an understanding of an economic, social, governmental, or environmental issue involving coal.
- develop a display to illustrate a topic that complements his/her essay.

MATH STANDARDS

6.A.4; 6.A.5; 6.B.4; 6.B.5; 6.C.4; 6.C.5; 7.A.4a; 7.A.4b; 7.B.4; 7.B.5; 7.C.4a; 7.C.5a

SCIENCE STANDARDS

11.A.4a; 11.A.4c; 11.A.4f; 11.A.5a; 12.E.4a; 12.E.4b; 12.E.5

SOCIAL SCIENCE STANDARDS

15.A.4a; 15.A.5a; 15.A.5b; 15.B.4b; 15.C.4a; 15.C.4b; 15.C.5c; 15.E.4a; 15.E.4b; 15.E.5b

PROCEDURE

1. Initiate a discussion about the presence of coal in the state of Illinois. Take the opportunity to introduce that the students will be working on research projects that have some connection to the coal mine industry.
2. Distribute Student Activity Page A: *Coal Checklist – Is There Coal In My Community's Past?* to each student and review the importance of initial note-taking when beginning a research project. Review the directions on Student Activity Page A, taking all questions. Review the proper way to cite sources.
3. Allow the students a minimum of one class period and one evening to complete Student Activity Page A. *Coal Checklist – Is There Coal in My Community's Past?* It is likely that many of the questions can be answered by talking to parents, contacting local businesses and people knowledgeable of local history, and/or reviewing library and Internet sources on the local area.
4. When Student Activity Page A: *Coal Checklist – Is There Coal in My Community's Past?* is complete, review the information together in class and resolve any disagreements over answers. "Maybe," "possibly," or other such words can be good answers also if a clear yes or no is not possible. NOTE: If all the answers are no,

then discuss with the students about how the study of the topic will need to focus on a regional or statewide basis. Allow students some time to share information about sources used and recommendations that they would make.

5. Distribute Student Activity Page B: *Preliminary Notes Guide – Is There Coal in My Community's Past?* to each student. Remind students to utilize the information they gathered on Student Activity Page A: *Coal Checklist – Is There Coal in My Community's Past?* to complete Student Activity Page B. Encourage students to have at least 4 or 5 items circled when finished, labeling those in which they might be interested.
6. Distribute Student Activity Page C: *Guidelines for Essay Topics and Displays* to each student. Point out that there are several choices that they will be making concerning an essay topic as well as a display that will be created to accompany the essay. Remind students that with each checkpoint with this activity page, you will be asking them to defend their choices. Teacher approval of topics is mandatory.
7. Allow students sufficient time to complete Student Activity Page C: *Guidelines for Essay Topics and Displays.* Students may find the need to explore the many possibilities for obtaining materials (outside school) before committing to a display.
8. Discuss essay guidelines with the students. The essay should be at least two typed pages but no more than three pages in length. Distribute Student Activity Page D: *SOCIAL SCIENCE RUBRIC* to each student, to be used as a guide. Inform the students that you will be using the rubric to grade their work.
9. Proper research practices are important. Discuss the following thoroughly: Information from research of other individuals or groups must be used to support a position and those sources should be cited in a bibliography or works cited page. That information need not be taken as completely factual and may be contrasted against other sources as the writer sees fit. The students will need to take a position in the essay on the topic involved and support that position with information available from the collective research. Explain to students that not all of the research work will be completed in class, and that it is important to complete portions of the essay as homework. The display should be constructed outside of class and brought to school on the due date.
10. Time permitting, when student essays and displays are complete, allow students to share their displays, noting how the features of the display connect to the essay.
11. Lead a final debriefing discussion of thoughts and rationales. See the Debriefing Questions section for a guide.

DEBRIEFING QUESTIONS

1. What methods are used to determine whether coal exists below the surface of a given area? (Answers will vary but may include: core drilling, computer mapping, human experience.)
2. How has coal been used in this community at different times in its history? (Answers will vary but may include: trains and manufacturing, heating homes, producing electricity, jobs.)
3. How has coal mining changed due to advances in technology for coal production? Technology for mine safety? (Answers will vary but may include: The use of

mechanized machinery, robotics, lasers and computers has increased efficiency, productivity and safety.)

4. Describe the impact of coal mining either locally, regionally, or statewide. (Answers will vary but may include: mining jobs, spin-off jobs (transportation of coal, generation of electricity) support the economy by using local services, paying taxes, environmental impacts, etc.)
5. Describe a controversial issue involving coal and provide one of the positions some people take on the issue. (Answers will vary but may include: clean air – clean coal technologies allow the safe burning of coal to produce affordable electricity, land reclamation – the land is returned to its original condition or better.)
6. Illinois past, present and future relies on coal in varying degrees. Discuss how this has changed over the years and predict what changes we might expect in the future. (Answers will vary but may include: the changes in mine employment, location of mining in the state, size of the mines, methods of mining, annual production, CAAA impact on fuel switching, impact of mercury regulations as related to national security issues and homegrown energy.)

GLOSSARY

- Byproduct – anything produced in the course of making something else
- Coal seam – a "bed" or stratum of coal, usually a large deposit of coal
- Collective bargaining – negotiations with management by a union to prepare a labor contract
- Command economy – a system in which the basic economic questions of what, how, and who are answered by the government
- Demand – the quantities of a good or service that consumers are willing to and able to buy at different possible prices
- Externality – the effect of economic activity that fall outside the market
- Geology – the science that deals with the history, origin, and structure of the earth
- Human resources – labor or the physical and mental efforts people use to create goods and services
- Law of diminishing returns – as more and more variable resources are added to a fixed amount of other resources, the additional or marginal amount produced eventually diminishes
- Mixed market economy – an economic system in which the basic economic questions are answered by a mixture of market, command, and traditional approaches
- Resources – the basic elements used to create goods and services commonly called land, labor, and capital
- Shaft mine – an underground mine where the mine opening is a deep hole with an elevator that carries miners and materials to the coal seam
- Spin-off jobs – jobs created by coal mining operations that are outside the coal mine industry such as transportation jobs
- Supply – the various amounts of something a producer is willing and able to sell at different possible prices
- Surface mining – the process of extracting coal that lies near the surface by removing the layer of rock and soil that covers the coal seam

EXTENSION ACTIVITIES

- After reviewing local history concerning coal and filling gaps that may exist, put together a narrative history of the role of coal in the area's history.
- Make presentations to local authorities or civic groups on coal issues with which they are now familiar.
- Research family or community history's involvement in coal industry.
- Develop a concept map of the future based on what they have learned about the economic importance of coal in Illinois' past.
- Collect primary sources such as letters, newspaper articles, interview narratives, etc. associated with the coal industry in the area and assemble them for a display in the local library.

ADDITIONAL RESOURCES

- http://www.kentlaw.edu/
- http://www.msha.gov/
- http://www.coalcity.lib.il.us/coalmining/index.html
- http://www.piperspages.com/
- http://www.lib.niu.edu/ipo/ihylistyrs.html
- http://illinoisbiz.biz/dceo/Bureaus/Coal/Publications/
- http://www.dnr.state.il.us/mines/

CREDITS

- The Social Science Rubric is the work of Lawrence W. McBride, Frederick D. Drake, and Marcel Lewinski from Illinois State University and John C. Craig from the Illinois State Board of Education.
- Illinois Dept. of Natural Resources, Office of Mines and Minerals

STUDENT ACTIVITY PAGES

- Student Activity Page A: *Coal Checklist – Is There Coal in My Community's Past?*
- Student Activity Page B: *Preliminary Notes Guide – Is There Coal in My Community's Past?* (3 pages)
- Student Activity Page C: *Guidelines for Essay Topics and Displays* (3 pages)
- Student Activity Page D: *Social Science Rubric*

Student Activity Page A: ***Coal Checklist – Is There Coal in My Community's Past?***

The four checklist questions below will help assess the area in which you are living, with regard to the present or past availability and/or use of coal. Each answer of "Yes" or "No" should be verified by at least two sources, and those sources should be listed accordingly. Possible sources include: testimonials, interviews, books, newspapers, magazines, Internet, etc. After answering the four checklist questions here, proceed to each of the corresponding sections on Student Activity Page B: *Preliminary Notes Guide – Is There Coal in My Community's Past?*

A. Is there coal underground in the area? Yes No

Sources used to verify answer: 1. ______________________________

2. ______________________________

B. Has there been coal mining in the area? Yes No

Sources used to verify answer: 1. ______________________________

2. ______________________________

C. Is there mine reclamation that has or should take place? Yes No

Sources used to verify answer: 1. ______________________________

2. ______________________________

D. Are there businesses in the area (including the utility that produces electricity for the local area) that have used coal?

Yes No

Sources used to verify answer: 1. ______________________________

2. ______________________________

Student Activity Page B: *Preliminary Notes Guide – Is There Coal in My Community's Past? (Page 1)*

Use the completed Student Activity Page A: *Coal Checklist – Is There Coal in My Community's Past?* Each of the coal checklist questions corresponds to a set of questions/ statements that you will find on this activity page. Answer as many of the questions below as possible, using the information gathered during your initial search for the coal checklist. Circle as many of the questions that interest you. Be selective. When complete, this activity page will provide you with preliminary notes to help guide your research.

A. Is there coal underground in the area? Yes No

If yes, respond to the following:

1. How is it known that there is coal?
2. How and when was the coal formed?
3. What is known about the coal?
4. What might explain any unique characteristics of coal in the area?
5. What are the potential uses for the coal?
6. How is the land being used other than coal mining?
7. How much energy does the coal underground contain?
8. How much soil, rock, etc. would have to be moved to reach the coal?
9. What factors explain why some or all of the coal is not being mined?
10. What technology is used to determine the location and depth of coal?

If no, respond to the following:

1. How is it known that there is no coal underground where you live?
2. If any coal has been transported into the area, where did it originate and how is it used?
3. What is the impact on the local economy due to the lack of coal in the area?
4. What professions are involved in locating underground coal seams?
5. How would having a source of coal nearby affect your daily life?
6. How would having a source of coal nearby affect your community?

B. Has there been coal mining in the area? Yes No

If yes, respond to the following:

1. How much coal was mined in the past?
2. How much coal is remaining?
3. What impact has geography or geology had on the local mining industry?
4. What evidence of past mining can be seen in the area?

Student Activity Page B: *Preliminary Notes Guide – Is There Coal in My Community's Past? (Page 2)*

5. What method(s) of mining have been used and why?
6. How many people were/are employed by the mines?
7. What safety improvements have been made in the mines?
8. What, if any, long-term effects did the miners suffer?
9. What are the histories of mining pioneers?
10. What other career opportunities are available due to the mining?
11. How has government (specify local, state, or federal) played a role in the local mining operations?
12. What evidence is there that child labor was or was not used in local mines?
13. What mining, if any, is taking place now?
14. When and how did the current mining operations start?
15. What is the environmental impact of current mining?
16. How has technology changed how coal has been mined?
17. What spin-off jobs from coal are in the area?

<u>If no, respond to the following:</u>

1. Are there people in the area that know a coal miner?
2. What jobs are characteristic of the area in which you live?
3. Are there jobs that are dictated by the natural resources in the area?
4. How do you feel about children being allowed to work as coal miners at the turn of the 20th Century?
5. How has the national coal economy impacted the local economy?
6. Would you consider becoming a coal miner?
7. How do you think towns near coal mines differ from yours?

C. Is there mine reclamation that has or should take place? Yes No

<u>If yes, respond to the following:</u>

1. What is the history of local mine reclamation?
2. What is the revenue source for mine reclamation?
3. How is a mine reclamation plan developed?
4. What reclamation plans have been used or could be used?
5. What is the environmental impact of former mines and/or reclamation sites?
6. What is the impact of former mines and/or reclamation sites on the lives of the people in the area?
7. What involvement does government (specify local, state, or federal) play in area reclamation projects?
8. How can community members participate in reclaiming old mine sites?

Student Activity Page B: ***Preliminary Notes Guide – Is There Coal in My Community's Past? (Page 3)***

If no, respond to the following:

1. What do reclamation and conservation have in common?
2. What might an area look like that has been mined but not reclaimed?
3. Why should all people be concerned about reclamation, regardless of where they live?
4. What are the steps in developing a mine reclamation plan?
5. What is the environmental impact of former mines and/or reclamation sites?
6. What involvement does government (specify local, state, or federal) play in area reclamation projects?
7. How can community members participate in reclaiming old mine sites?

D. Are there businesses in the area (including the utility that produces electricity for the local area) that have used coal?

Yes No

If yes, respond to the following:

1. How do the local businesses and/or utilities reduce air pollution?
2. What other businesses, either past or present, benefit from coal mining other than the coal mining companies?
3. What railroads and other means of transportation were created in part to transport coal?
4. What has been the financial impact of coal mining in the area?
5. What was the impact of immigrants on local mining operations?

If no, respond to the following:

1. Is coal shipped through the area?
2. What fuel sources are used for electricity generation in the area?
3. What are the pros and cons of producing electricity with coal versus other sources of energy?

Student Activity Page C: ***Guidelines for Essay Topics and Displays (Page 1)***

Selecting the correct topic for your essay and display is very important. Choose a topic that interests you and one that can be supported by research you gather and explore.

1. Review the answers and items you circled on Student Activity Page B: *Preliminary Notes Guide – Is There Coal in My Community's Past?*

2. Review the following topics list carefully.

   TOPICS LIST
   1. What role should government play in helping the Illinois coal industry mine and sell more coal? Why?
   2. What does government do about mines that closed before laws required reclamation? Do you approve of that role of government? Why or why not?
   3. What are the pros and cons of a new mining operation in the area? For you, do the benefits outweigh the costs? Why?
   4. Are wages in the mining industry impacted by supply and demand? Why or why not?
   5. Should the government have been involved in mine safety or should that have remained an issue between the union and management? Why or why not?
   6. For any industry, who bears or should bear the cost of worker safety and why? The owner through higher investment or less profit, the government and taxpayer, the consumer through higher prices, the workers through lower wages, or some combination?
   7. Using the concept of diminishing returns, the safer and cleaner a work environment is, the greater the cost of making the environment even safer and cleaner. The cost of a totally safe and clean environment, if it were possible, would be astronomical. How should the line be drawn as to when a work environment is safe enough and clean enough?
   8. Should it be legal for an individual to take the job of a person who is on strike? Why or why not? Should the law enforcement protect the strikebreaker? Why or why not?
   9. Should the consumers of electricity be required to pay more for electricity to pay for clean coal technologies so Illinois coal can be used instead of out of state coal? Why or why not?
   10. Unions helped win higher wages and better safety standards for miners which led to more mechanization of mines and fewer mining jobs. Should unions have accepted lower wages and safety standards in order to keep more of their members working? Why or why not?
   11. Other than land set aside for parks and such, should the government have a role in deciding if land is used for a farm, housing development, factory, or mine, or should the free market decide what would be the most profitable use of land? What are the benefits and costs of each approach?
   12. How might the Illinois coal mining industry be different, if the U.S. had a command economy rather than a mixed market economy? Why?

Student Activity Page C: ***Guidelines for Essay Topics and Displays (Page 2)***

13. Based on what you know of the geology of the area, is your community making the best use of the resources present? Why or why not? What are the benefits and costs of fully utilizing the resources available?
14. Among the human resources that helped Illinois develop its coal resources were thousands of immigrants. What are benefits and costs of such immigration to the state? Legal immigration into the U.S. has since been significantly restricted. Do you support such restrictions? Why or why not?

3. Select three topics that you are considering for your essay and record them below, in order of preference:

   a. ____
   ____
   ____

   b. ____
   ____
   ____

   c. ____
   ____
   ____

4. Decide on your essay topic and have it approved by the teacher. Be ready to support your reasoning and defend your topic choice, using your notes.

5. Think about the display that you will create to accompany your essay. Decide <u>what</u> the display will feature as well as <u>how</u> the display will be presented. Select an idea as well as a display model. The display idea and model should compliment your essay topic. See the idea list for suggestions.

WHAT WILL THE DISPLAY FEATURE? – IDEA LIST

1. A historic mine
2. A reclamation project
3. The stages of surface mining – include surveying, bonding, first cut through reclamation
4. A comparison of shaft mining with surface mining
5. Local trends in coal mining or coal usage in the local area
6. Advantages and disadvantages of mining methods: long wall, room and pillar, surface mining
7. Historic location and types of mines and reclamation projects

Student Activity Page C: ***Guidelines for Essay Topics and Displays (Page 3)***

8. Coal seam – coal formation and location in Illinois
9. Air movement in a mine
10. Technology used in coal mining
11. Mine safety
12. Natural dangers in a mine and methods for eliminating or minimizing dangers
13. Local mine disaster
14. Mine owners, miners, and families
15. Coal fired electric generation

HOW WILL THE DISPLAY BE PRESENTED? – IDEA LIST

Chronologically ordered maps with legends
Power Point Presentation
Skit
3-D Construction
Time Line
Mock Interview
Flow Chart

6. Record your decisions about your display below and have them approved by the teacher. Be ready to support your reasoning and defend your display choices.

   My display will feature: ______________________________

   I will create: ______________________________________

   The display and essay are due on: ______________________

Student Activity Page D: *Social Science Rubric*

Points Awarded *	KNOWLEDGE *Knowledge of evidence from the social sciences: Facts/supporting details; themes/issues; and concepts/ideas.*	REASONING *Reasoning: Analysis, evaluation, and synthesis of evidence.*	COMMUNICATION *Communication: Demonstrates knowledge and reasoning through oral, written, visual, dramatic, or mixed media presentation.*
4	• Key concepts/themes/issues/ideas are thoroughly identified, defined and described. • Has little or no factual inaccuracies.	• Identifies and logically organizes almost all relevant evidence. • Uses appropriate and comprehensive critical thinking skills and habits of mind to analyze, evaluate, and synthesize evidence. • Reaches informed conclusions based on the evidence.	• Almost all ideas in the presentation are expressed in a way that provides evidence of the student's knowledge and reasoning processes. • The presentation is well focused with a well-defined thesis. • Presentation shows substantial evidence of organization. • Presentation shows attention to the details of specific performance conventions.
3	• Key concepts/themes/issues/ ideas are identified, defined, and described. • May have a major factual inaccuracy, but most information is correct.	• Identifies and organizes most of the relevant evidence. • Uses partial critical thinking skills and habits of mind to analyze, evaluate, and synthesize evidence. • Reaches informed conclusions based on the evidence.	• Most ideas in the presentation are expressed in a way that provides evidence of the student's knowledge and reasoning processes. • The presentation demonstrates a focus and thesis with several narrative gaps. • Presentation demonstrates adequate evidence of organization. • Presentation has mistakes in attention to the details of specific performance conventions.
2	• Some key concepts/themes/issues/ ideas are identified, defined, and described. • Has some correct and some incorrect information.	• Identifies some relevant evidence and omits most of the other evidence. • Uses unclear, inappropriate, or incomplete critical thinking skills and habits of mind to analyze, evaluate, and synthesize evidence. • Reaches incomplete or inaccurate conclusions based on the evidence.	• Some ideas in the presentation are expressed in a way that provides evidence of the student's knowledge and reasoning processes. • The presentation demonstrates an inadequate focus and thesis. • Presentation demonstrates inadequate evidence of organization. • Presentation has insufficient attention to the details of specific performance conventions.
1	• Few or no key concepts/themes/ issues/ideas are identified, defined, and described. • Few or no facts/supporting details included. • Information is largely inaccurate, absent or irrelevant.	• Important evidence relevant to the problem is not identified. • Critical thinking skills and habits of mind are absent. • Conclusions are lacking or unclear.	• Expression of almost all ideas in the presentation is unclear. • The presentation demonstrates little focus and lacks a thesis. • Presentation demonstrates little or no evidence of organization. • Presentation has multiple mistakes in attention to details of specific performance conventions.
Total Score			

*** Grading Scale:**

______ Exceeds Standard (total points 11 - 12)   _____ Meets Standard (total points 8 - 10)
______ Approaches Standard (total points 5 – 7)   _____ Begins Standard or absent (total points 1 - 4)

Source: Illinois State Board of Education (http://www.isbe.state.il.us/ils/socsciassess/SOCIAL%20SCIENCE%20RUBRIC.pdf)

Lesson

Coal, Clean Air and the Economy

OVERVIEW

The future of the U.S. coal industry is closely connected to the public policies affecting energy, the economy, and the environment. Clean air legislation has had a dramatic impact on both the environment and the Illinois economy over the past decade. After the 1990 Clean Air Act Amendments prompted utilities to switch from high-sulfur Illinois coal to low-sulfur western coal, a significant portion of Illinois coal production and sales were lost. Illinois coal production decreased from 61.6 million tons in 1990 to nearly 33 million tons in 2008. Through extensive use of on-line research, this lesson examines the legislation that impacts the use of coal, the misconceptions of the "Greenhouse Effect," the economic and natural security consequences of using coal, and techniques like carbon sequestration. To diminish the environmental impact of power plant emissions, everyone must reduce use, increase efficiency and examine and implement clean coal technologies such as circulating fluidized bed boilers, scrubbers, etc.

MATERIALS

- Internet access for the class or enough copies of the resources listed at each URL to match the numbers of students in each group
- One copy of Student Activity Page A: *Illinois Coal Fact Sheet* (2 pages) per student (See www.illinoisbiz.biz/dceo/Bureaus/Coal/Publications/ for recent updates.)
- One copy of Student Activity Page B: *Forces Shaping Future U.S. Coal Production and Use* (http://pubs.usgs.gov/fs/fs158-00/) per student
- One copy of Student Activity Page C: *Analysis of Fuel Costs for Electric Generation* (Note: This can be used as an overhead transparency, or given to each student.)
- One copy of Student Activity Page D: *Coal, Clean Air and the Environment – Activity Directions* per student
- One copy of Teacher Resource Page A: *Jigsaw Cooperative Learning Technique Overview*
- One copy of Teacher Resource Page B: *Analysis of Fuel Costs for Electric Generation – Answer Key*
- One copy of Teacher Resource Page C: *Coal, Clean Air, and the Economy – Assessment* per student (optional)
- One copy of Teacher Resource Page D: Coal*, Clean Air, and the Economy – Assessment Key (2 pages)*
- Overhead projector
- Vis-a-Vis colored transparency markers (optional)

APPROXIMATE TIME REQUIRED

- Five forty-five to fifty-minute class periods are required to complete this lesson.

VOCABULARY
- Anthropogenic
- Avoided emission
- Balance of payments
- Bioaccumulate
- Btu
- Carbon sequestration
- Clean Air Act Amendments of 1990
- Clear Skies Initiative
- Expected returns
- Greenhouse Effect
- Kyoto Accord
- Law of demand
- Productive resources

OBJECTIVES
After completing this lesson, students will be able to:
- give a general overview of the content and economic impact of the *Clean Air Act Amendments of 1990,* the *Clear Skies Initiative (2002),* and the *Kyoto Accord.*
- interpret a graph of fluctuations in the cost of coal, oil, and natural gas to make predictions about power generation in the future.
- demonstrate an understanding of the economic importance of Illinois coal in terms of employment and creation of "spin-off" jobs.
- discuss the Greenhouse Effect and the misconceptions about this topic.
- explain the concept of the *carbon sequestration program* and the economic impact on the consumer.
- discuss the concerns in the data surrounding *Global Climate Change.*
- use the Internet and other sources to collect and interpret relevant information related to air quality and emissions from coal-fired power plants.
- demonstrate an understanding of the importance of coal in national security and energy independence of the U.S.
- participate in a jigsaw cooperative learning activity to become an "expert" in one area of coal knowledge (optional).

SCIENCE STANDARDS
- 11.A.4c; 11.A.4d; 11.B.4c; 12.C.5a; 13.A.4c

SOCIAL SCIENCE STANDARDS
- 15.A.5a; 15.C.4a; 15.D.5a; 15.E.4c

PROCEDURE

This lesson is designed to integrate the environmental, economic and national security aspects of relying upon coal as one of our nation's primary energy sources. The format for instructional delivery can be modified (depending upon availability of on-line resources) to use a traditional teacher-centered approach, a class research approach, or a "Jigsaw" cooperative learning approach. The approach recommended is:

1. Introduce the topic by brainstorming what students know about coal as an energy source and problems associated with using coal.
2. Allow 1 day for your introduction (including discussion of handouts listed earlier), 2 days for Internet research, group planning of project and your facilitation and 1 ½ - 2 days for presentations. The assessment provided with this lesson may be used as a "take-home" or in-class tool, or the group presentations may serve as the assessment. Note that you may wish to allow several days or even a week for the presentations to be finalized. Much of this may be done "out of class," and instructors may wish to return to their regular curriculum during this time until the presentations are scheduled.
3. Distribute copies of Student Activity Page A: *Illinois Coal Fact Sheet* http://www.illinoisbiz.biz/dceo/Bureaus/Coal/Publications/3-Industry+Reports.htm and discuss.
4. Distribute copies of Student Activity Page B: *Forces Shaping Future U.S. Coal Production and Use* (http://pubs.usgs.gov/fs/fs158-00/) and discuss. Define Btus and emphasize the graphs to show the sulfur variation with geographic location. Focus upon the last passage concerning coal's future.
5. Distribute copies of Student Activity Page C: *Coal, Clean Air and the Environment - Activity Directions* and discuss the project guidelines.
6. Assign research topics to groups of 3-5 students (or use optional Jigsaw cooperative learning activity using Teacher Resource Page A: *Jigsaw Cooperative Learning Technique Overview.* Student groups should be selected so that the ability levels of groups are equal, based upon past grades. Provide at least one class period for on-line research, or use as an out-of-class activity. Students should use the URLs provided, and may use other resources as they wish. It is recommended that the teacher go through each of these sources. Please note that the total content for the URLs listed will be approximately equal for each group. Student groups should become "experts" on the topic and develop a 15-20 minute group presentation to make to the entire class. The key components of their research must emphasize the relevant parts of the information listed in the *objectives section*. Your role will be as teacher-facilitator ("guide on the side") and to assist on content issues. The group topics (at a minimum) are:
   - ***"Coal, Jobs, and National Security"*** (Include balance of payments, expected returns, law of demand, and economic resources as part of the vocabulary).
     http://www.nationalcoalcouncil.org/Documents/SECURE.pdf
     http://www.illinoisbiz.biz/dceo/Bureaus/Coal/Publications/

- **"Greenhouse Effect and Global Climate Changes"**
  http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html
  http://yosemite.epa.gov/oar/globalwarming.nsf/content/ClimateAtmosphericChangeFuture.html
  http://www.ems.psu.edu/~fraser/Bad/BadGreenhouse.html
- **"Clean Air Legislation: 1990 Clean Air Act; Clear Skies Initiative (2002), and Kyoto Accord."**
  http://www.epa.gov/oar/caa/overview.txt
  http://www.epa.gov/air/clearskies/fact2003.html
- **"Carbon Sequestration"** (In addition to the objectives related to this concept, discuss the terms avoided emission, anthropogenic and bioaccumulate, and *FutureGen Initiative*. Also include the possible economic consequences of carbon sequestration).
  http://www.netl.doe.gov/

7. Conclude the activity by brainstorming to determine how attitudes have changed about coal and stress the role of coal as our nation's largest source of energy, and the direct and indirect economic contributions. The direct contributions would include the value of the coal production in coal sales and employment. The indirect contribution would include supporting a standard of living, especially in the generation of cheap electricity, as well as all of the "spin-off" jobs created in regions where coal mines are operating.
8. Distribute Student Activity Page D: *Analysis of Fuel Costs for Electric Generation* and/or display on an overhead projector. Have the students complete the answers. Discuss the answers using Teacher Resource Page B: *Analysis of Fuel Costs for Electric Generation – Answer Key.*
9. The assessment provided with this lesson, Teacher Resource Page C: *Coal, Clean Air, and the Economy – Assessment*, may be used as a "take-home" or in-class tool, or the group presentations may serve as the assessment.

DEBRIEFING QUESTIONS

1. Analyze (and draw conclusions about) the quote from Massoud Rostam-Abadi of the Illinois State Geological Society that "coal is too valuable to burn." (Answers will vary but may include: Chemicals produced from coal are more valuable than burning coal in low efficient boilers. An analogy would be using a steer for just hamburger instead of cutting out the sirloins, T-bones, and rib eyes first. Acetic acid, acetic anhydride, carbolic acid and hydrogen can be produced from coal through gasification.)
2. Why is the "Greenhouse Effect" not as negative as most people believe? (Answer: Without the Greenhouse Effect, it is probable that life on earth as we know it could not exist. The radiation of heat that has been absorbed from the atmosphere is responsible for much of the beneficial warming that the earth receives.)
3. Why is the concept of global warming so complicated to address? (Answer: There are numerous and variable sources of carbon dioxide and particulate matter besides power plants. These sources include industries, automobiles, volcanoes, and the

burning of forests. Much attention is given to power plants because they are big, visible and stationary.)

4. What factors may limit the success of carbon sequestration? (Answer should include: Availability of suitable geologic formations, length of time required for adequate research, public perception, storage capacity, and pipeline infrastructure.)

GLOSSARY

- Anthropogenic – caused by human activity
- Avoided emission – power plant emissions that are eliminated as the result of an emission reduction project
- Balance of payments – the record of all transactions (in goods, services, physical and financial assets) between individuals, firms and governments of one country with those in all other countries in a given year, expressed in monetary terms. Any transaction that causes money to flow into a country is a credit to its BOP account, and any transaction that causes money to flow out is a debit
- Bioaccumulate – to accumulate in a biological system; the uptake over time of toxic substances (such as mercury) that can stay in a biological system
- Btu – British thermal unit; the amount of heat required to raise the temperature of one pound of water 1 degree Fahrenheit. It is often used to describe the heat value of fuels and heating and cooling system capacities
- Carbon sequestration – the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere. Research in carbon storage includes ocean storage, mineral storage, geologic storage and plant uptake. Usually, carbon sequestration refers to the sequestration of carbon dioxide.
- Clean Air Act Amendments of 1990 – a comprehensive set of amendments to the 1970 Clean Air Act to address significant air pollution in our cities. The 1990 amendments broaden and strengthen the original law to address specific problems such as acid depostition, urban smog, hazardous air pollutants, and stratospheric ozone depletion
- Clear Skies Initiative – a program that would dramatically reduce power plant emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), and mercury by setting a national cap on each pollutant
- Expected returns – the amount of financial gain to be predicted from a particular action or investment
- Greenhouse Effect – the trapping of some solar radiation by a planet's atmosphere, increasing the temperature on and near the surface
- Kyoto Accord – an international treaty proposing binding targets for the reduction of greenhouse gases emissions, which are generally believed to aggravate global warming
- Law of demand – holding everything else constant, when price increases, the quantity people are willing and able to buy decreases; when price decreases, the quantity people are willing and able to buy increases
- Productive resources – all natural resources (from nature), human resources (skills and knowledge of people), and capital resources (tools and machines) used in the production of goods and services

EXTENSION ACTIVITIES

- Add additional related topics to the group research:
  - the U.S. position on the Kyoto Accord
  - the possible bioaccumulation of substances such as mercury in the food chain
  - acid rain and the steps being taken to control sulfur and nitrogen emissions from power plants.
- Organize a debate focusing upon the positive and negative consequences of relying upon coal as a primary energy source for the United States.
- Work with the chemistry teacher to arrange a demonstration of the byproducts of the destructive distillation of coal.
- Assign a paper defending the statement that coal is essential for the national security and economic independence of the U.S.
- Research the value-added products that are derived from coal. These would include products including coal tar, hydrogen, acetic acid, acetic anhydride, coke, carbolic acid, etc.
- Have students analyze and discuss the following statement: "If we were to move away from using coal as a primary energy source, what would be some of the "trade-offs" that we would face?"
- Investigate base load power plants, intermediate load power plants, and peaker plants

ADDITIONAL RESOURCES

- http://epa.gov
- http://illinoiscoal.biz
- http://www.illinoisbiz.biz/dceo/Bureaus/Coal/Publications/
- http://www.eia.doe.gov/
- http://www.ceednet.org
- http://www.balancedenergy.org
- Lomborg, Bjorn (2001) The Skeptical Environmentalist. New York. Cambridge University Press.

CREDITS

- *Illinois Coal Facts* (Office of Coal Development)
- *Forces Shaping U.S. Coal Production and Use* (U.S. Geological Survey)
- *Jigsaw Classroom (http://www.jigsaw.org/overview.htm)*
- Graph: "Fluctuations in the Price of Coal, Oil, and Natural Gas." RDI Fossil-Fuel Receipts at Steam-Electric Utility Plants through February 2003; Energy Information Administration, May 2003 Short Term Energy Outlook and Peabody Estimates March – May 2003.

TEACHER RESOURCE PAGES

- Teacher Resource Page A: *Jigsaw Cooperative Learning Technique Overview*
- Teacher Resource Page B: *Analysis of Fuel Costs for Electric Generation – Answer Key*
- Teacher Resource Page C: *Coal, Clean Air, and the Economy – Assessment Key*

- Teacher Resource Page C: *Coal, Clean Air, and the Economy – Assessment Key* (2 pages)

STUDENT ACTIVITY PAGES

- Student Activity Page A: *Illinois Coal Fact Sheet* http://www.illinoisbiz.biz/dceo/Bureaus/Coal/Publications/
- Student Activity Page B: *Forces Shaping Future U.S. Coal Production and Use* (http://pubs.usgs.gov/fs/fs158-00/)
- Student Activity Page C: *Coal, Clean Air and the Environment – Activity Directions* (2 pages)
- Student Activity Page D: *Analysis of Fuel Costs for Electric Generation*

Teacher Resource Page A: ***Jigsaw Cooperative Learning Technique Overview***

The jigsaw classroom is a specific cooperative learning technique. As in a jigsaw puzzle, each piece (each student's part) is essential for the completion and full understanding of the final product. If each student's part is essential, then each student is essential; and that is precisely what makes this strategy so effective.

Here is how it works: The students in an ecology, environment, or economics class, for example, are divided into small groups of five or six students. Suppose their task is to learn about coal, clean air and the economy. In one jigsaw group, "Linda" is responsible for researching the Greenhouse Effect and global climate change. Another member of the group, "Nancy", is assigned to cover legislation impacting clean air. "John" is assigned coal's role in maintaining national security and energy independence, and "Chuck" researches carbon sequestration. Eventually each student will come back to her or his jigsaw group and will try to present a well-organized report to the group. The situation is specifically structured so that the only access any member has to the other five assignments is by listening closely to the information of the person reporting.

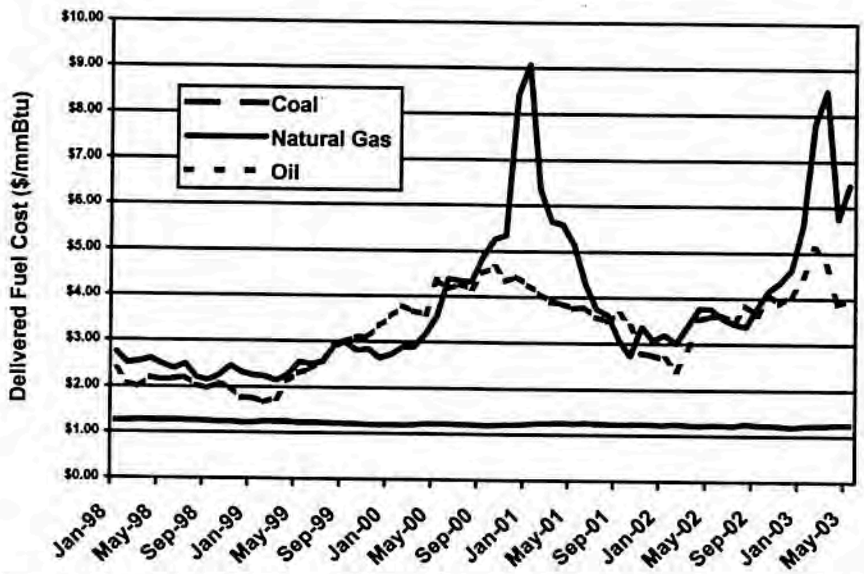
To increase the chances that each report will be accurate, the students doing the research do not immediately take it back to their jigsaw group. Instead, they meet first with students who have the identical assignment (one from each jigsaw group). For example, students meet as a team of specialists, gathering information, becoming experts on their topic, and rehearsing their presentations. We call this the "expert" group. It is particularly useful for students who might have initial difficulty learning or organizing their part of the assignment, because it allows them to hear and rehearse with other "experts."

Once each presenter is up to speed, the jigsaw groups reconvene in their initial heterogeneous configuration. The Greenhouse Effect and global climate change expert in each group teaches the other group members about the information gained from his/her research. Each student in each group educates the whole group about his/her topic from *Coal, Clean Air and the Economy.*

What is the benefit of the jigsaw classroom? First and foremost, it is a remarkably efficient way to learn the material. But even more important, the jigsaw process encourages listening, engagement, and empathy by giving each member of the group an essential part to play in the academic activity. Group members must work together as a team to accomplish a common goal; each person depends on all the others. No student can succeed completely unless everyone works well together as a team.

Teacher Resource Page B: *Analysis of Fuel Costs for Electric Generation – Answer Key*

Figure 1. Delivery Cost of Coal, Oil and Natural Gas, 1998-2003



Source: RDI Fossil-Fuel Receipts at Steam-Electric Utility Plants through February 2003; Energy Information Administration, May 2003 Short Term Energy Outlook and Peabody estimates March – May 2003.

1. Examine the delivery costs of various fuels from Figure 1.
   a. Which fuel has been the most stable in price? (Answer: *Coal)*
   b. Which fuel has seen the greatest price fluctuation? (Answer: *Natural gas)*
   c. What might be the causes of these trends? (Answer: *There is a fairly abundant and constant supply of domestic coal, but natural gas is subject to pressures internationally as well as fluctuating demand due to changes in weather patterns. Gas wells have a short life. Exploration and developing new wells aren't keeping up with demand.)*
2. What types of pressures could make the costs of these fuels escalate? (Answer: *Available supplies, severity of heating and cooling seasons, wars, economic downturns, clean air legislation.).*
3. In January of 2001, the cost of natural gas was about how many times greater than the cost of coal with the same heating value? (Answer: *approximately 8-9 times.*)
4. The economic well-being of the U.S. is substantially dependent upon the electricity produced from coal-fired power plants. How would our way of life (standard of living) be affected if, because of more stringent air quality controls or other factors, the price of coal doubled? (*Answers will vary but may include ideas like decreased use of air conditioning, appliances, and less disposable income since more dollars are going to utilities. This could lead to a long-term economic downturn.*)

Teacher Resource Page C: *Coal, Clean Air, and the Economy – Assessment*

1. How is it possible, as stated on the "Illinois Coal Fact Sheet," that every American uses about 20 pounds of coal?

2. How are the enormous reserves of Illinois coal linked to national security and the Illinois economy? As part of your explanation, include a discussion of productive resources and the law of demand.

3. Discuss the content of the Clean Air Act of 1990, the Clear Skies Initiative and the Kyoto Accord. In your answer, explain the terms anthropogenic and bioaccumulate.

4. Explain the concept of carbon sequestration and how it might impact the cost of coal.

5. Emphasizing sound economic and/or environmental arguments, defend or refute the following statements:
   - The Greenhouse Effect has a devastatingly harmful impact on the earth.
   - The evidence is clear that the combustion of fossil fuels has led to global warming and climate changes.

Teacher Resource Page C: Coal, Clean Air, and the Economy – Assessment Key

(Page 1)

1. How is it possible, as stated on the "Illinois Coal Fact Sheet," that every American uses about 20 pounds of coal? (Answer: On the average, this is the amount obtained on a daily basis by dividing the total weight of coal used (primarily in electricity production) by the population of the United States.)

2. How are the enormous reserves of Illinois coal linked to national security and the Illinois economy? As part of your explanation, include a discussion of productive resources and the law of demand. (Answer: As a nation, we have a variety of critical resources, including coal, natural gas, forests, and even the educational level of our population. The U.S. coal reserves have been predicted to be enough for more than a 250-year supply at current rates of usage. Coal at a reasonable cost is essential to provide the low cost electricity that powers our nation and our economy. Since coal is an abundant domestic resource, it is buffered against the vagaries of imported oil, and since great quantities are stored at power plants, there is a buffer in case of supply interruptions. As the price of imported fuels increase, demand for them may diminish while the demand for coal could increase.

3. Discuss the content of the Clean Air Act of 1990, the Clear Skies Initiative and the Kyoto Accord. In your answer, explain the terms anthropogenic and bioaccumulate. (Answer: Generally, these are initiatives that reduce the amount of power plant emissions that are allowable over a period of time. The Clean Air Act of 1990 focuses upon acid rain and how much of a pollutant can be in the air anywhere in the U.S. Individual states must have state implementation plans (SIPs) and flexible economic incentives (i.e. credits that can be used or traded to other utilities). The Clear Skies Initiative is a mandatory program that would dramatically reduce and cap emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_X), and mercury from electric power generation to approximately 70% below 2000 levels. The Kyoto Accord is an international treaty whereby countries agree to reduce the amount of greenhouse gases, mainly carbon dioxide, they emit if their neighbors do likewise. It is a very complex agreement that allows trading pollution credits. In these initiatives, there is a great deal of concern that anthropogenic (human caused) power plant emissions can cause toxic materials like mercury to bioaccumulate in the food chain through species like tuna and cause health risks to humans).

4. Explain the concept of carbon sequestration and how it might impact the cost of coal. (Answer: Carbon sequestration is the capture and storage of carbon dioxide that would otherwise be emitted to the atmosphere. The carbon dioxide can be captured at the point of emission, or it can be removed from the air. The captured gases can be stored in underground reservoirs, dissolved in deep oceans, converted to rock-like solid materials, or absorbed by trees, grasses, soils, or algae. Because there are significant expenses in adding carbon dioxide sequestration to "avoid emissions", this initiative could substantially increase the cost of electricity generated from coal and have a negative impact on the economy.

Teacher Resource Page C: *Coal, Clean Air, and the Economy – Assessment Key*
(Page 2)

5. Emphasizing sound economic and/or environmental arguments defend or refute the following statements:

- The Greenhouse Effect has a devastatingly harmful impact on the earth. (Answer: Not true. Life as we know it is related to this effect. In the absence of an atmosphere, the earth would average about 30 Celsius degrees (about 50 Fahrenheit degrees) lower than it does at present. Daytime and nighttime temperature ranges would be too great for normal plant growth. Life, as we now know it, could not exist.)

- The evidence is clear that the combustion of fossil fuels has lead to global warming and climate changes. (Answer: The evidence is very mixed and does not give a clear answer. Global warming is also complex due to natural phenomenon such as volcanoes and forest fires.)

Student Activity Page A: *Illinois Coal Fact Sheet* – Page 1

ILLINOIS COAL FACT SHEET
CURRENT MARKETS FOR ILLINOIS COAL

- Nearly thirty-three million tons of Illinois coal was mined in 2008. [1]
- In 2008, the average open market sales price was $33.60/short ton.[2]
- 49 percent of the electricity used in Illinois and 49.7 percent of the electricity used in the U.S. is generated from coal.[3]
- More than 90 percent of Illinois coal produced was purchased by the electric utility industry in 2008. Industrial and commercial users account for the remaining percent.[3]
- More than 80 percent of Illinois coal is sold to out-of-state utilities.[4]
- The top 5 utility users of Illinois coal in 2007 were: Tennessee Valley Authority, Northern Indiana Public, Inc., Tampa Electric Company, Duke Energy of Indiana, and Dayton Power & Light Company.[4]
- Illinois utilities and industrial facilities used 5.6 million tons of Illinois coal in 2007.[4]

Source: 1 Energy Information Administration. http://www.eia.doe.gov/cneaf/coal/quarterly/html/t2p01p1.pdf
2 Energy Information Administration, State Energy Profiles;
http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=IL
3 EIA, Electricity Infocard;
http://www.eia.doe.gov/bookshelf/brochures/electricityinfocard/elecinfocard2006/elecinfocard.html
4 Platts Energy Advantage. Coal Transactions Analyzer: 1. McGraw-Hill Co. Inc. accessed 17 March 2008.

CLEAN-COAL TECHNOLOGIES

The Office of Coal Development oversees the largest state-sponsored coal research and development program in the United States. Laboratory-scale research projects initiate and advance technologies in the areas of coal combustion systems, coal residuals management and coal preparation. Development projects include technology maturation, technology transfer and commercialization projects.

- The Midwest Geological Sequestration Consortium, the Illinois State Geological Survey and Archer Daniels Midland Company (ADM) are conducting a large-scale carbon dioxide sequestration demonstration project in the Mt. Simon Sandstone. The project will involve the capture and storage of 1 million tons of carbon dioxide from ADM's ethanol plant in Decatur, Illinois.
- Southern Illinois University in Carbondale developed and successfully tested an engineered, composite wooden element and wooden wedges that overcome most of the disadvantages of conventional cribs in underground mines. It was demonstrated that these crib supports and wedges are a viable primary support for mining areas, including longwall development entries. A new project will assist with commercial production of cribs in southern Illinois with appropriate quality controls.
- Southern Illinois University is installing an *I-Lab Coal to Liquids Research Facility*. This new laboratory is needed to increase research in Fischer-Tropsch conversion for the production of transportation fuels from Illinois coal.

Researchers from Western Kentucky University are investigating the emissions of mercury from FGD scrubbers. This project will assist two utilities, who are primary users of Illinois coal within the State of Illinois, in determining the best way to meet Illinois mercury emission

Illinois' Commitment to the Coal Industry

- Since its inception in 1981, the Illinois Coal Research and Development Program has granted over $79.3 million in state, federal and private funds for basic and applied research on coal extraction, coal combustion systems, coal preparation and coal residuals management.
- The Illinois Coal Demonstration Program is helping to demonstrate and deploy clean and efficient technologies for use with Illinois coal. Illinois' commitment of over $146.3 million towards Clean-Coal Technologies has supported 31 clean coal projects within the state.
- The Illinois Coal Competitiveness Program is helping Illinois coal producers remain competitive. More than $157.6 million in state dollars have produced $1.87 billion in private infrastructure investments to coal extraction, preparation and transportation facilities across the state.

Additional Coal Facts

- Coal was first discovered in Illinois more than 300 years ago.
- Mining began in Illinois almost 200 years ago.
- Coal underlies 37,000 square miles of Illinois -- about 65 percent of the state's surface.
- Most of the coal is bituminous with high-energy values -- between 10,000 and 14,000 Btu/lb.
- Illinois' coal reserves contain more Btu's than the oil reserves of Saudi Arabia and Kuwait.
- Each day, every American uses about 20 pounds of coal in the form of inexpensive and increasingly clean, coal-based electricity.
- Recoverable coal reserves in Illinois (38 billion tons) account for almost one-eighth of the total U.S. coal reserves and one-quarter of the nation's bituminous coal reserves.
- Illinois ranked eighth among coal producing states in 2008.
- Illinois coal was mined in 11 counties in 2008.
- In 2008, 18 Illinois mines employed 3,467 miners and generated roughly 20,000 spin-off jobs.
- 20,000 acres of Illinois cropland have been surface mined and reclaimed to the original productivity.
- Nearly 18 percent of Illinois coal production was from surface mining in 2008.
- The typical coal miner earns $64,000 per year including overtime[5].
- In 1981, Illinois recorded the first fatality-free year in mining history.
- 3,700 Illinois miners produced 40 million tons of coal in 1999, as much as 15,000 miners produced in 1954 and 41,000 miners produced in 1927.

[5] Workforce West Virginia - Labor Market Data. This salary is based on miner working overtime. Hourly wage is approximately $22/hour.

For additional information contact:

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USGS
science for a changing world

Forces Shaping Future U.S. Coal Production and Use

More than half of the electricity in the United States is generated by coal-fired powerplants. U.S. coal producers sell almost 90 percent of their product for electricity generation, and so, the future of the U.S. coal industry will be determined by the future of coal-fired electricity-generation plants.

The U.S. Geological Survey (USGS) is completing a National Coal Resource Assessment (NCRA) of five major coal-producing regions of the United States (fig. 1): (1) the Appalachian Basin, (2) the Illinois Basin, (3) the Gulf Coast, (4) the Colorado Plateau, and (5) the Northern Rocky Mountains and Great Plains. The Powder River and Williston Basins are the principal producing areas of the Northern Rocky Mountains and Great Plains region.

Two principal forces that will control the size of the coal market for electric power generation are electricity-market deregulation and airborne emissions regulation.

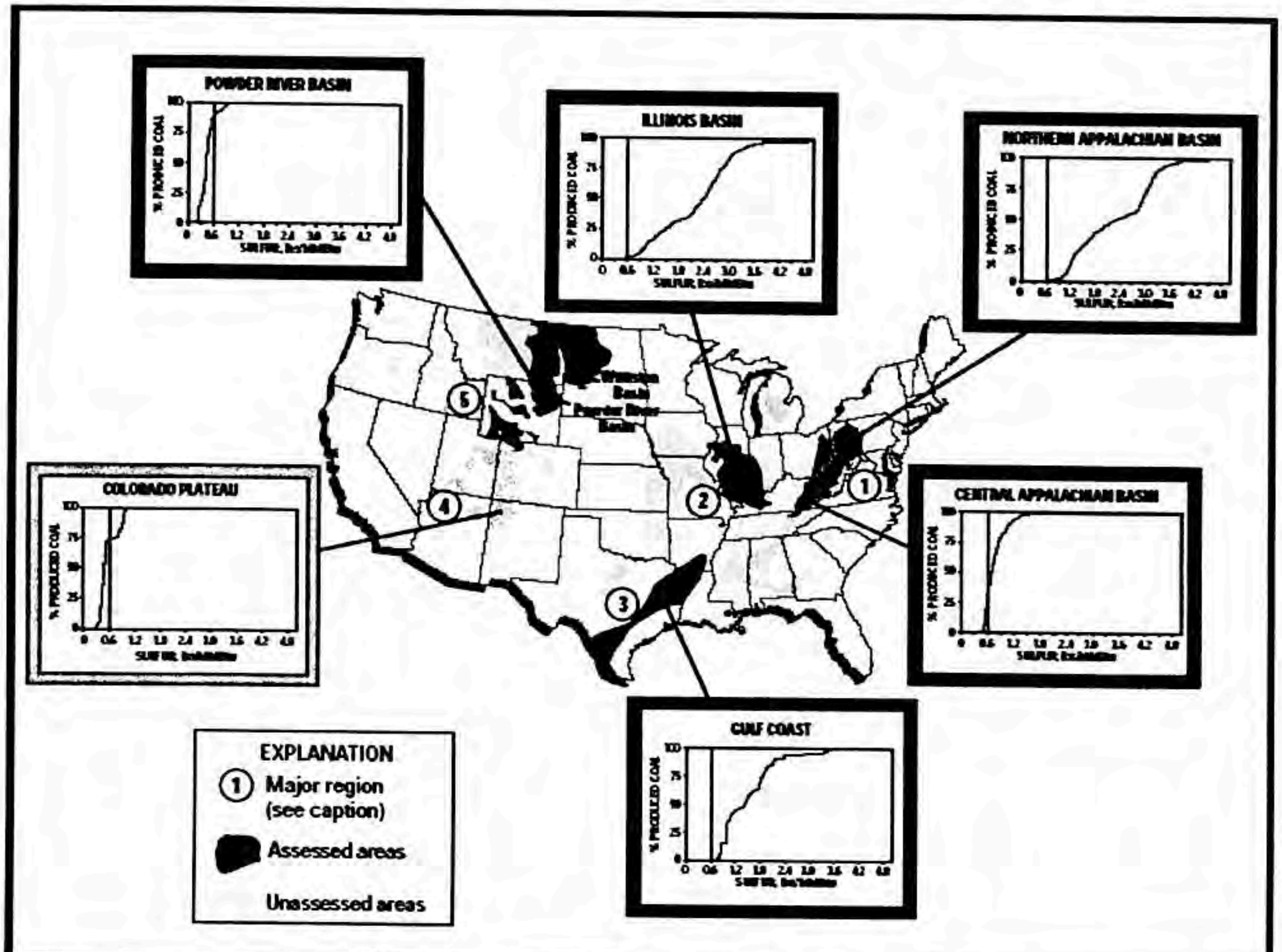

Figure 1. Coal fields of the conterminous United States. The U.S. Geological Survey is completing a National Coal Resource Assessment; colors on the map show assessed areas within five major coal-producing regions: (1) the Appalachian Basin, (2) the Illinois Basin, (3) the Gulf Coast, (4) the Colorado Plateau, and (5) the Northern Rocky Mountains and Great Plains (includes the Powder River and Williston Basins). Graphs show sulfur contents of coal delivered to powerplants in 1998 from mines in a specific area. Vertical line in each graph is the 2000 Phase II SO_2 compliance standard of the 1990 Clean Air Act Amendments. Data on sulfur contents are from the Federal Energy Regulatory Commission (available at http://www.ferc.fed.us/electric/f423/F423annual.htm). lbs/MMBtu = pounds per million British thermal units of calorific value.

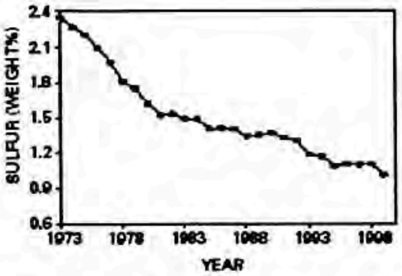

Figure 2. Sulfur content of coals used at U.S. powerplants, 1973 to 1999. Data from the Federal Energy Regulatory Commission (available at http://www.ferc.fed.us/electric/f423/F423annual.htm).

Under market deregulation, electric powerplants will no longer have captive markets but will have to compete to sell their electricity. They will have to search for the lowest cost fuel supplies. The quest to reduce fuel costs has reduced the number of operating coal mines by half since 1990, as smaller, inefficient mines have closed and larger mines have adopted new technologies to increase productivity. At the coal industry level, much of the productive capacity is now concentrated in a handful of major producers. Coal-fired plants also will compete with new, highly efficient, central gas-fired powerplants and "distributed or localized" generation systems including micro-gas-turbines and photovoltaic systems that generate electricity.

The other principal force that will shape the coal market is the need to comply with the 1990 Clean Air Act Amendments (CAAA90). The amendments set new Federal regulations on sulfur dioxide (SO_2) emissions from powerplants. Figure 2 shows declining sulfur contents of coals used by U.S. powerplants from 1973 to 1999.

Phase II of the CAAA90, implemented in January 2000, capped powerplant SO_2 emissions nationally at 8.95 million short tons per year. This cap would currently limit a plant's emissions to 1.2 pounds of SO_2 per million British thermal units (lbs SO_2/MMBtu) (or 0.6 lb sulfur/MMBtu in the coal). Each powerplant is initially allotted SO_2 emissions allowances at a rate of 1.2 lbs SO_2/MMBtu based on its fuel use during the 1985 through 1987 base period. Plants constructed after 1996 are not allotted emissions allowances. To keep emissions within the Phase II allotments, an operating coal-fired powerplant that does not currently meet the standard could retrofit with a flue-gas-desulfurization (FGD) system, switch to low-sulfur coal or another fuel, purchase additional emissions allowances, or close down. If a powerplant's emissions are below its initial allotment, it may sell or trade excess allowances. As of January 2000, there were 11.8 million short tons of SO_2 allowances available for sale to noncompliant plants; the allowances were accrued during Phase I of the CAAA90.

As of late 1999, responses to industry surveys showed that noncompliant plants anticipated the following changes to achieve compliance:

- plants representing 55 percent of productive capacity would switch to low-sulfur coal
- plants representing 35 percent would purchase SO_2 allowances and continue to use higher sulfur coal
- plants representing 10 percent (listed as undecided) would switch to another fuel, shut down boilers, or install FGD systems

The announced intentions to switch to low-sulfur coal could translate into an additional demand for 190 million short tons per year of low-sulfur subbituminous coal or 135 million short tons per year of low-sulfur bituminous coal production. Additional low-sulfur coal demand will increase as the number of stockpiled allowances available for sale to noncompliant plants shrinks.

The graphs in figure 1 show sulfur contents of produced coal transported from mines in a specific area to powerplants in 1998. The vertical line in each graph is the 2000 Phase II SO_2 emissions compliance standard. Only small amounts of the coal shipped to powerplants from the northern Appalachian Basin and the Illinois Basin met those emission limits. About 35 percent of the coal shipped from the central Appalachian Basin coal region, 75 percent of the coal shipped from the Colorado Plateau region, and 90 percent of the coal shipped from the Powder River Basin complied with the emissions standard. With coal blending, all of the coal in the Powder River Basin and the Colorado Plateau and 60 percent of the coal shipped from the central Appalachian Basin met compliance limits. Gulf Coast and Williston Basin lignite coals are used at local plants that already have FGD systems. The USGS NCRA estimates that large volumes of low-sulfur coal are in the Powder River Basin and emerging producing regions of the Colorado Plateau.

Provisions of the CAAA90 relating to fine particulates and hazardous airborne pollutants (HAP's) are still planned, and so the full effect of that act has yet to be felt. So far, the forces of deregulation and uncertainty in future emissions rules have shaped power industry responses to the CAAA90 regulations. Projections for the long-term role of coal may be uncertain, but for at least the next decade, it will continue to be the primary indigenous energy source used by the U.S. economy. Knowledge of the quantity and location of potential coal supplies is needed, and a detailed understanding of the quality of the coal will be necessary to meet future energy needs.

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Student Activity Page C: Coal, Clean Air and the Environment - Activity Directions
Page 1

OVERVIEW

The future of the U.S. coal industry is closely connected to the public policies affecting energy, the economy, and the environment. Clean air legislation has had a dramatic impact on both the environment and the Illinois economy over the past decade. After the 1990 Clean Air Act Amendments prompted utilities to switch from high-sulfur Illinois coal to low-sulfur western coal, a significant portion of Illinois coal production and sales were lost. Illinois coal production decreased from 61.6 million tons in 1990 to 33.5 million tons in 2002. Through extensive use of on-line research, this lesson examines the legislation that impacts the use of coal, the misconceptions of the "Greenhouse Effect," the economic and natural security consequences of using coal, and techniques like carbon sequestration to diminish the environmental impact of power plant emissions.

DIRECTIONS

THIS ACTIVITY WILL HAVE A VALUE OF_____ POINTS

1. You will research a specific area of the topics introduced in the overview in order to become an "expert" on a particular set of issues. In addition, review the "Illinois Coal Fact Sheet" and the article entitled "Forces Shaping Future U.S. Coal Production and Use."
2. One class period will be designated for group assignments and on-line research, and one period will be used for the discussion of the research and organization of the presentation. <u>Some preparation will need to be completed outside of class</u>. Two days will be allowed for group presentations, each of which must be 15-20 minutes.
3. Groups must use the URLs provided, as well as any other relevant sources. Each group will appoint a facilitator who will organize activities, and each group member is required to participate in at least one of the following ways:
   - Facilitator
   - Contributor to research "debriefing" (each group member does this).
   - Developer of presentation materials (i.e. overheads, powerpoint slides, posters, etc.)
   - Class presentation (1-3 members).
   - Development of a one page summary handout to distribute to the entire class.
   - Other roles as assigned by group and approved by instructor.
4. The topics and associated URLs will be assigned from the following choices:
   (Note: Each group member must review each of the sources and provide notes from at least one source, as assigned by the group facilitator.)

   - "*Coal, Jobs, and National Security*". (Include balance of payments, expected returns, law of demand, and economic resources as part of the vocabulary.)

     http://www.illinoisbiz.biz/dceo/Bureaus/Coal/Publications/ and
     http://www.nationalcoalcouncil.org/Documents/SECURE.pdf

- "Greenhouse Effect and Global Climate Changes"
  http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html
  http://yosemite.epa.gov/oar/globalwarming.nsf/content/ClimateAtmosphericChangeFuture.html
  http://www.ems.psu.edu/~fraser/Bad/BadGreenhouse.html
- *"Clean Air Legislation: 1990 Clean Air Act; Clear Skies Initiative (2002), and Kyoto Accord*."
  http://www.epa.gov/oar/caa/overview.txt
  http://www.epa.gov/air/clearskies/fact2003.html
  NOTE: This is a controversial view and should be evaluated against other information the student researches.
- *"Carbon Sequestration*" (In addition to the objectives related to this concept, discuss the terms avoided emission, anthropogenic and bioaccumulate, and *FutureGen Initiative*. Also include the possible economic consequences of carbon sequestration.)
  http://www.isgs.uiuc.edu/mgsc/resource.htm

5. In the presentations to the entire class, some form of audio visual aids must be employed. These may include overheads, powerpoint slides, posters or other techniques approved by the instructor.
6. As a bonus, each group may earn up to 10 additional points by providing a brief analysis of how home heating costs have increased due to the use of natural gas "peaker plants." This analysis would be in the form of a brief (under one page) discussion, citing sources.
7. As part of the handout to the class and the presentation, terms included in the following list that are part of the assigned research must be defined:

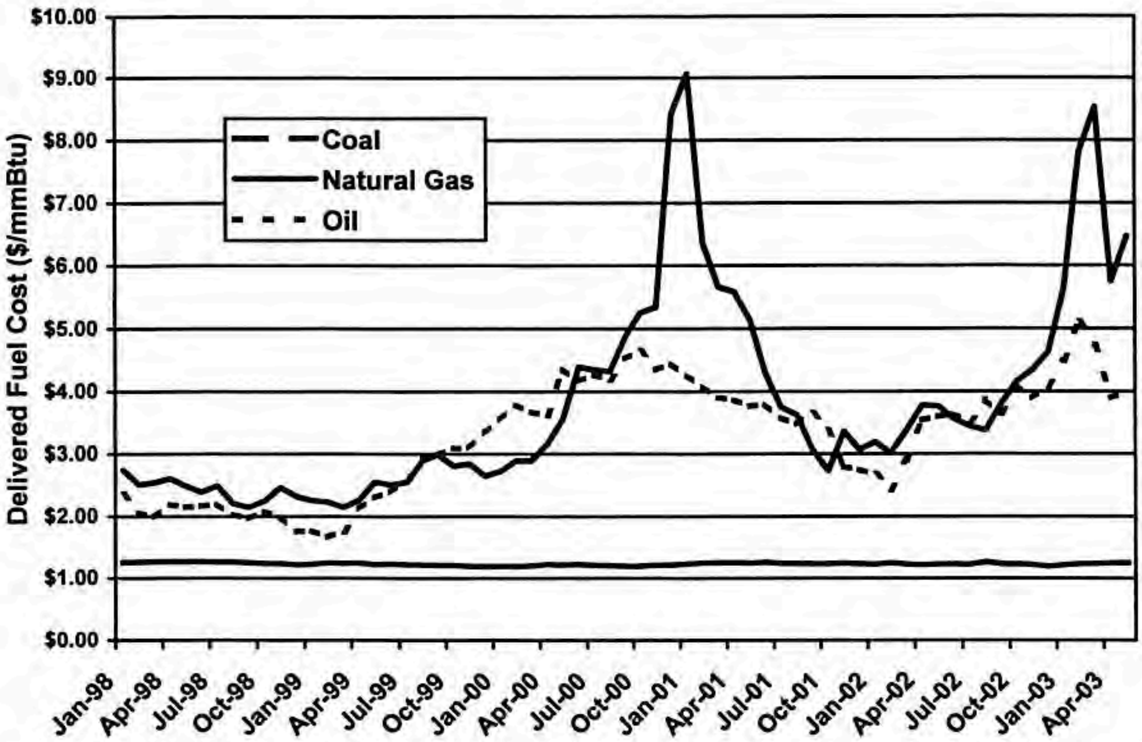
VOCABULARY

- Anthropogenic
- Avoided emission
- Balance of payments
- Bioaccumulate
- Btu
- Carbon sequestration
- Clean Air Act Amendments of 1990
- Clear Skies Initiative
- Expected returns
- Greenhouse Effect
- Kyoto Accord
- Law of demand
- Productive resources

All questions related to procedures or content of the research should be discussed with the instructor.

Student Activity Page D: ***Analysis of Fuel Costs for Electric Generation***

Figure 1. Delivery Cost of Coal, Oil and Natural Gas, 1998-2003



Source: RDI Fossil-Fuel Receipts at Steam-Electric Utility Plants through February 2003; Energy Information Administration, May 2003 Short Term Energy Outlook and Peabody estimates March – May 2003.

1. Examine the delivery costs of various fuels from Figure 1.
   A. Which fuel has been the most stable in price?
   B. Which fuel has seen the greatest price fluctuation?
   C. What might be the causes of these trends?

2. What types of pressures could make the costs of these fuels escalate?

3. In January of 2001, the cost of natural gas was about how many times greater than the cost of coal with the same heating value?

4. The economic well-being of the U.S. is substantially dependent upon the electricity produced from coal-fired power plants. How would our way of life (standard of living) be affected if, because of more stringent air quality controls or other factors, the price of coal doubled?

Student Activity Page D: Analysis of Fuel Costs for Electric Generation

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Tie In - Do the Math: Coal by the Numbers

CORRESPONDING STANDARDS

- Illinois Mathematics State Goal 6
  - C. Compute and estimate using mental mathematics, paper and pencil methods, calculators, and computers.
  - D. Solve problems using comparison of quantities, ratios, proportions and percents.
- Illinois Social Science State Goal 15
  - A. Understand that scarcity necessitates choices by consumers.
  - B. Understand that scarcity necessitates choices by producers.

DID YOU KNOW?

- Illinois' coal reserves contain more Btu's than the oil reserves of Saudi Arabia and Kuwait combined.
- U.S. coal reserves hold about 296 billion tons of recoverable coal.
- Forty-five percent of the electricity used in Illinois is generated from coal.
- Each day, every American uses about 20 pounds of coal in the form of clean coal based electricity.
- Because of Illinois diverse fuel strategy, which includes nuclear power, coal and natural gas, Illinoisans use 15 pounds of coal per day.
- The generators in American power plants turn at 3600 revolutions/minute.
- In 2008, the 18 mines in Illinois employed over 3,400 miners and created over 20,000 spin-off jobs.
- The typical coal miner earns about $64,000 each year including overtime.
- The coal industry contributes nearly $1 billion to the Illinois economy annually.
- Fatalities in the Illinois coal industry have decreased from 846 deaths in the decade of the 1940's to 12 deaths in the decade of the 1990's.
- Illinois has the largest reportable total amount of bituminous coal reserves of any state.
- Nearly 33 million tons of Illinois coal were mined in 2008.
- Coal underlies 37,000 sq. miles of Illinois - about 65% of the state's area.

QUESTIONS/ANSWERS

Using the information presented in the previous section (Coal Facts), answer the following questions:

- How many metric tons of Illinois coal are mined annually? (Answer: An English ton is 2,000 pounds; a metric ton is 1000 kg, and each kg is 2.202 pounds. Since 1000 kg is 2202 pounds, (2.202 x 1,000), an English ton is approximately 2000/2202, or, as a decimal, .908 of a metric ton. Thirty-three million English tons = .908 x 33 million English tons, or 29.964 million metric tons.)
- What is the total area of the state of Illinois? (Answer: Sixty five percent of state's surface = 37,000 square miles, so .65 S = 37,000. By division, the calculated surface area of Illinois is 56,923 square miles, or actual area = 57,918 sq. miles.)

- Why do American travelers to other countries often have to purchase special electrical adapters for appliances such as hair dryers and CD players? (Answer: In addition to having voltages that are twice as high as ours (220v to 110v), other countries often turn their generators at different speeds. This means that your North American clock will show only 50 minutes passage of time between 12:00 noon and 1:00 p.m. This difference is not so important for other motor appliances such as the fan of an electric hair dryer. In America (from Coal Facts), the generators spin at 3600 revolutions per minute. Since there are 60 seconds in a minute, by division the speed is 60 revolutions per second. This is also known a 60-hertz (hz). Converters must be employed to properly operate American appliances.)
- At what speed, in revolutions per minute, are European electrical generators spinning? (Answer: Since 50 hz = 50 revolutions per second, multiplying by 60 seconds per minute gives a spin rate of 3,000 revolutions per minute.)
- How do the coal mine fatalities in the decade of the 1990's compare to fatalities in the 1940's? (Answer: The fatalities of the 1990's were 1.41% of the fatalities of the 1940's. Expressed mathematically: 12/846, or 2/141 as a reduced fraction or .0141 as a decimal, or 1.41%.)
- Discuss why students feel that the rate has declined so dramatically. (Answers will vary but may include: instrument sensors, better safety methods and equipment, improved ventilation, etc.)
- How much coal is used by the entire population of the U.S.? Record answer in pounds and English tons. (Answer: The U.S. population is approximately 291 million people times 20 pounds per person = 5820 million pounds per day! This is equivalent to (dividing by 2000) 2.91 million English tons of coal per day for the entire country!)
- Discuss the many uses of this coal, since almost half of it generates electricity.

EXTENSIONS/CONNECTIONS

- Mathematics: Have students determine the areas of a variety of mine entrance shapes (trapezoids, rectangles, arches, etc.). A typical velocity of air movement may be as high as 300 ft. per minute. Multiply the area and velocity to calculate the quantity of air moved in cubic feet per minute.
- Economics: Discuss the need for our country to become less dependent on foreign oil reserves. How could coal play a part in this process? What types of problems would be encountered? (Answers will vary but may include: clean air legislation, producing coal byproducts that replace gasoline, etc.)
- Science: Research mine safety and show how it has changed by constructing a time line and plotting significant events related to mine safety.

Tie In - Laws Influencing the Coal Industry in Illinois

CORRESPONDING STANDARDS

- Illinois State Science Goal 12
  - E. Know and apply the concepts that describe the features and processes of the earth and its resources.
- Illinois Social Science Goal 16
  - A. Apply the skills of historical analysis and interpretation.
  - D. Understand Illinois, United States, and world social history.
  - E. Understand Illinois, United States, and world environmental history.
- Illinois Social Science Goal 17
  - C. Understand relationships between geographic factors and society.

DID YOU KNOW?

- Inspecting mines to improve mine safety started in the 1870's.
- In 1891, Congress passed the first federal statute governing mine safety. The 1891 law was relatively modest legislation that applied only to mines in U.S. territories, and, among other things, established minimum ventilation requirements at underground coal mines and prohibited operators from employing children less than 12 years of age.
- Immigrants who came to Illinois in large numbers from Europe – Irish, English, Scotch, Welsh, German, French, Belgian, Italian, Bohemians and Poles – held a majority of the coal mining jobs. In 1893, a state coal report said that nearly 80% of the miners were immigrants.
- Unions had a difficult time organizing because the men had different languages and customs, held strongly opposing religious beliefs and had national prejudices. Yet the miners banded together to improve their miserable condition. Misery was the one thing they all had in common.
- The United Mine Workers of America was formed in 1890.
- Child labor was common in Illinois mines in the early 20^{th} century.
- On November 13, 1909 in Cherry, Illinois (near Peru), a mine fire took the lives of over 250 miners in the worst mine fire disaster in Illinois history. The irony was that the mine had been declared fire-proof, and it was rated as one of the safest in the world.
- From the tragedy in Cherry, massive changes in laws occurred. It was the impetus for the first workers' compensation laws enacted in the U.S.
- In 1910, the Illinois legislature enacted strong regulations requiring mine owners to purchase and maintain fire-fighting equipment, and certification was required of miners performing certain jobs in mines.
- The Cherry mine fire was a catalyst for the creation of the U.S. Bureau of Mines in 1910.
- In 1910, following a decade in which the number of coal mine fatalities exceeded 2,000 annually, Congress established the Bureau of Mines as a new agency in the Department of the Interior. The Bureau was charged with the responsibility to

conduct research and to reduce accidents in the coal mining industry, but was given no inspection authority until 1941, when Congress empowered federal inspectors to enter mines.

- In 1911, the Illinois legislature passed the state's first liability act, allowing miners and their families to recover damages.
- Due to the loss of lives of so many young children in the Cherry disaster, Congress passed the first Federal Child labor Law on Sept. 1, 1916.
- Fatalities in the Illinois coal industry have decreased from 846 deaths in the decade of the 1940's to 12 deaths in the decade of the 1990's.
- The Federal Coal Mine Safety Act of 1952 provided for annual inspections in certain underground coal mines, and gave the Bureau limited enforcement authority, including power to issue violation notices and imminent danger withdrawal orders. The 1952 Act also authorized the assessment of civil penalties against mine operators for noncompliance with withdrawal orders or for refusing to give inspectors access to mine property, although no provision was made for monetary penalties for noncompliance with the safety provisions.
- The Federal Coal Mine Health and Safety Act of 1969, generally referred to as the Coal Act, was more comprehensive and more stringent than any previous Federal legislation governing the mining industry. The Coal Act included surface as well as underground coal mines, required two annual inspections of every surface coal mine and four at every underground coal mine, and dramatically increased federal enforcement powers in coal mines. The Coal Act also required monetary penalties for all violations, and established criminal penalties for conscious and willful violations. The safety standards for all coal mines were strengthened, and health standards were adopted. The Coal Act included specific procedures for the development of improved mandatory health and safety standards, and provided compensation for miners who were totally and permanently disabled by the progressive respiratory disease, pneumoconiosis or "black lung," caused by the inhalation of fine coal dust.
- Congress passed the Federal Mine Safety and Health Act of 1977 (Mine Act), which amended the 1969 Coal Act and consolidated all federal health and safety regulations of the mining industry. The Mine Act strengthened and expanded the rights of miners, and enhanced the protection of miners from retaliation for exercising such rights.
- Mining fatalities dropped sharply under the Mine Act from 272 in 1977 to 86 in 2000. The Mine Act also transferred responsibility for carrying out its mandates from the Department of the Interior to the Department of Labor, and named the new agency the Mine Safety and Health Administration (MSHA).
- In 1977 the Surface Coal Mining Land Conservation and Reclamation Act (P.A. 86-1475) established standards for the reclamation of surface mining sites in Illinois. According to the act, all mined lands must be restored to the optimum future productive use.
- Other legislation impacting coal mining has included a variety of air quality laws in the past 40 years. These include: The Clean Air Act of 1963, the Air Quality Act of 1967, and various Clean Air Act Amendments in 1970, 1977 and 1990.

QUESTIONS/ANSWERS

- How does the fact that mine wages were based on tonnage of coal produced account for some miners opposing safety legislation? (Answer: A safer workplace was generally understood to be a less productive workplace that would lead to diminished total production and pay. Miners were expected to do safety work on their own time. Certain dangerous shortcuts had to be eliminated.)
- What major changes have occurred over the years in coal production? (Answers will vary but may include: Safety has improved and technological advances in mining equipment have replaced people in many cases. Mine productivity has increased. Fewer workers are employed in the Illinois coal industry. Three thousand seven hundred Illinois miners produced as much coal in 1999 as 15,000 miners produced in 1954 and 41,000 miners produced in 1927.)
- Why would coal mines of the past hire children? (Answers will vary but may include: children would work more cheaply, and they could stand in places that were too small for adults. Boys were needed to help support the family and many of them dropped out of school to go to work.)
- What has been the general impact of air quality legislation on the Illinois mining industry? (Answer: The Illinois coal market has declined due to the high cost of pollution controls necessary when burning Illinois' high sulfur coal. Coal mine productivity has increased 40 percent over ten years from 1990 to 1999.)
- What positive things came out of the tragic mine fire in Cherry, Illinois? (Answers will vary but may include: improved safety, more regulatory control, fewer children in mines, benefits for families of injured and killed employees, etc.)
- Why is the Illinois coal industry a case study of the union movement in the U.S.? (Answer: Many immigrants from the British Isles were already union miners in their homelands. The miners put aside their differences and banded together to improve the situation for all miners.)

EXTENSIONS/CONNECTIONS

- Read *Trapped*, by Karen Tintori. It is the story of the 1909 Cherry Mine disaster and how the tragedy precipitated sweeping changes in child labor practices in the coal industry. It was the catalyst for the first workers' compensation laws enacted in the U.S. Write an essay about what life as a miner would have been like in the early 1900's.
- Look up the Illinois statutes covering coal mines and compare them to the construction industry.
- Research and detail the various clean air legislation acts from 1955 to the present. Discuss the role of the federal government in these legislative initiatives.
- Many communities have prominent "man-made" hills located near them. How are these hills, often rising from the flat prairie, related to the coal mining industry?
- Create a timeline tracing the history of safety initiatives in the coal mining industry.
- Watch the movie October Sky and discuss the conflicts that took place. The movie "October Sky," is the true story of Homer Hickam, a retired NASA engineer and an author. The movie takes place in 1957, in the town of Coalwood, Virginia.

Tie In - Early Coal Economics: Company Stores

CORRESPONDING STANDARDS

- Illinois Science State Goal 12
  - E. Know and apply concepts that describe the features and processes of earth and its resources.
- Illinois Social Science State Goal 15
  - A. Understand how different economic systems operate in the exchange, production, distribution, and consumption of goods and services.
- Illinois Social Science State Goal 16
  - A. Apply the skills of historical analysis and interpretation.
  - C. Understand Illinois, United States and world social history.
  - D. Understand Illinois, United States and world environmental history.
- Illinois Social Science State Goal 17
  - A. Understand relationships between geographic factors and society.

DID YOU KNOW?

- For much of Illinois history, there was so little limitation by government on free enterprise that large mining operations could be started almost anywhere once the land was purchased.
- The coal boom of the late 1860's went hand in hand with the development of an extensive railroad network that allowed coal companies to ship their products cheaply to rapidly growing industrial cities.
- Despite the difficulties and hazards, historically, the jobs in coal mining were often the first step in the American dream for many immigrants to Illinois.
- Immigrants who came to Illinois in large numbers from Europe – Irish, English, Scotch, Welsh, German, French, Belgian, Italian, Bohemians and Poles – held a majority of the coal mining jobs. In 1893 a state coal report said that nearly 80% of the miners were immigrants.
- Many coal companies issued their own money, called *scrip.*
- Scrip took various forms such as metal discs, paper bills and coupon books. It came in a variety of colors, shapes and designs.
- Scrip could be drawn as an "advance" against wages and only spent in the company store where prices might be inflated over other stores. The amount of scrip issued would be deducted from the miner's next check. Some miners never received a check since they were continually paying off their debt to the company store.
- "Hucksters" would offer cash to miners for their scrip, often at a fraction of its value.
- Sometimes the company built the entire town, and the company store was the only store in town. It stocked basic commodities such as tobacco, meat, sugar, coffee, beans, fruit, flour, canned goods, clothing, hardware and furniture.
- Scrip sometimes became the unofficial currency of the community, and it was even found in the collection plates of churches.
- During the early 1950's, changes in federal and state laws, along with the changing economic times, put an end to the issuance of scrip.

- Today, the coal industry contributes nearly $1 billion to the Illinois economy.

QUESTIONS/ANSWERS

- Consider the lyrics of this popular song of the 1950's which was popularized by "Tennessee" Ernie Ford and written by George Davis:

Sixteen Tons
Some people say a man is made outta mud
A poor man's made outta muscle and blood
Muscle and blood and skin and bones
A mind that's a-weak and a back that's strong

You load sixteen tons, what do you get?
Another day older and deeper in debt
Saint Peter don't you call me 'cause I can't go
I owe my soul to the company store

I was born one mornin' when the sun didn't shine
I picked up my shovel and I walked to the mine
I loaded sixteen tons of number nine coal
And the straw boss said "Well, a-bless my soul"

You load sixteen tons, what do you get?
Another day older and deeper in debt
Saint Peter don't you call me 'cause I can't go
I owe my soul to the company store.

- Give your thoughts about the meaning of: *"Saint Peter don't you call me 'cause I can't go, I owe my soul to the company store."* (Answer: The miners did not want to die without finding a way to first satisfy their debts.)
- What outlook on this miner's life is conveyed in the song? (Answer: Life is dismal and dark…like the inside of a coal mine.)
- What is meant by the phrase: "A mind that's a-weak and a back that's strong"? (Answer: Coal miners were hired to do heavy labor, and not to think.)
- What is "…sixteen tons of number nine coal"? (Answer: Thirty-two thousand pounds of coal from the number nine seam. Coal seams in the Illinois Basin, which includes areas of Illinois, Indiana and western Kentucky, are numbered by the geographic level where they appear.)
- How does the company store/scrip system relate to the feudal system of Europe? (Answer: In each case the miner/serf was bound, either to the company store owner or the feudal baron.)
- Why would miners resent the company store? (Answers will vary but may include: The prices were higher. Their pay was reduced. Trading was often compulsory.)
- Why would so many immigrants be employed in coal mines? (Answers will vary but may include: many of them had no other job options, they were often asked to

perform hard labor, they had mining experience in their homeland, and they were less likely to complain about the company store/scrip.)

EXTENSIONS/CONNECTIONS

- Use the Internet to increase your understanding of scrip and to investigate the various types and denominations of scrip issued by coal mining companies.
- Describe how the company store system was often a virtual monopoly in coal mining towns.
- Investigate what often happened to coal mining towns (like Cherry, Illinois) after a disaster in the mine and/or after the mine closes.
- Research how home heating sources have changed in your community. Talk to parents and grandparents to determine if they grew up in houses heated by coal. What was the routine for purchasing, storing and loading the coal into the furnace?

Tie In - Individuals and the Shaping of the Coal Industry

CORRESPONDING STANDARDS

- Illinois Social Science State Goal 14
  D. Understand the roles and influences of individuals and interest groups in the political systems of Illinois, the United States, and other nations.
- Illinois Social Science State Goal 15
  A. Understand how different economic systems operate in the exchange production, distribution, and consumption of goods and services.
  C. Understand that scarcity necessitates choices by producers.
- Illinois Social Science State Goal 16
  A. Apply the skills of historical analysis and interpretation.
  D. Understand Illinois, United States, and world social history.

DID YOU KNOW?

There are many individuals who have influenced the coal industry in various arenas.

Union Influences:

- Daniel Weaver of Belleville started the American Miner's Association, the first union of miners that was national in scope, in 1861.
- John Mitchell began working in the mines in Spring Valley in 1882 at the age of 12 and rose to be President of the United Mine Workers of America Union.
- John L. Lewis worked for the UMWA in Springfield before becoming national president from 1920 to 1960. He is buried in Springfield.
- Claude Pearcy organized the Progressive Mine Workers of America, a rival to the UMWA. That led to violence between the two unions in the 1920's and 30's.
- Vachel Davis, a miner and mine union leader, designed "The Miner", a statue that stands on the Capitol grounds in Springfield.

Political Influences:

- William Mooney came to the Braidwood mines from Scotland in 1865 and by 1874 was the first miner elected to the General Assembly.
- Alexander Bradley, "the General," was a Socialist often involved in controversies concerning mines including the "Virden Massacre" of 1898.
- Anton Cermak was a former miner from Braidwood who became mayor of Chicago in 1932.

Lobbyists:

- Mary Harris "Mother" Jones who some called the "most dangerous woman in America" due to her dedication to the labor cause is buried in Union Miner's Cemetery in Mt. Olive. It was her desire to be buried with the miners killed in the "Virden Massacre" of 1898.

- Agnes Burns Wieck became known as the "Mother Jones" of Southern Illinois for her work as a union organizer in the 1920's and 30's.

Mine Operators/Owners:

- In 1863 James Braidwood sank the first mine shaft and later claimed he built the first house and had the first child born in the town named for him.
- In the early 1900's Levi Zeigler Leiter and son Joseph used a geologist to find coal in southern Illinois and started a large, modern, high-producing mine. They created the town of Zeigler modeled after Washington, D.C.
- Mike Kelly from Ireland started selling coal in a wheelbarrow in Danville and by 1903 was the largest individual coal operator in Illinois.
- James Lester, a mine owner in Herrin, hired non-union miners during a strike and triggered the "Herrin Massacre" in 1922.

QUESTIONS/ISSUES

- How could producing and selling coal using strikebreakers during a national or regional coal strike be especially appealing to a mine owner? (Answer: A strike reduces the amount of coal in the market leading to higher coal prices.)
- Why would men like the Leiters be motivated to invest so much money in the latest technology when coal could still be mined with picks and shovels? (Answers will vary but may include: one of the following concepts - profit motive, greater productivity, and/or competition.)
- How did the laissez-faire approach by government enable mine owners to have great flexibility in the methods they used in dealing with workers, the environment, etc? (Answer: Governments typically avoided getting involved, leaving employers and employees free to act in their own best interest.)
- How did mine owners attract workers from Europe with wages that upset local union miners so much? (Answers will vary but may include: Wages in Europe were even lower so US wages were attractive compared to what workers were paid there.)
- Despite episodes of labor strife, there was also cooperation between miners and mine owners. How can that be explained economically? (Answers will vary but may include: Generally, the more coal that was mined, the more money each side made.)
- With the influx of immigrants, miners were usually plentiful. Yet at the time, economists considered them a scarce resource. Why is that? (Answer: Mine owners were forced to sacrifice higher profits to get the miners to work for them. Thus, miners who were willing to work for lower wages were scarce.)

EXTENSIONS/CONNECTIONS

- Pick a category that is of interest to you using the above list of the many individuals who have influenced the coal industry. Find at least three more individuals who could be added to that category. Add a fact sentence about each new person, including significant dates.
- Create fictional autobiographies of yourself as mine owner, miner, union leader, or their spouses or children and emphasize choices people make and why in response to events that have typically happened in the mining industry.

- Create and then conduct an interview with at least two people who are affiliated with the same union, but in different capacities. Design your questions carefully. Prepare a brief written presentation that outlines the positive and negative effects that unions may have on individual workers.
- Compile brief job descriptions and required training and education for the myriad of different jobs connected with or related to the coal industry today.
- Select an invention, safety improvement, or mining method and search for the individual(s) that developed it. A chart can be put together showing the various inventions, improvements, or methods, the person who developed it, and why the development was important.
- Research the meaning of "Boom Town". Create a series of journal entries that could have been written by an individual who experienced life in a Boom Town that was the result of a productive coal mine.

ADDITIONAL RESOURCES

- Illinois History (available online at http://www.lib.niu.edu/ipo/ihylistyrs.html)
- Journal of the Illinois State Historical Society
- Western Illinois Regional Studies

Tie In - Illinois Coal as a Topic for Discovery

CORRESPONDING STANDARDS

- Illinois Science State Goal 13
  - B. Know and apply concepts that describe the interaction between science, technology and society.
- Illinois Social Science State Goal 14
  - D. Understand the roles and influences of individuals and interest groups in the political systems of Illinois, the United States and other nations.
  - F. Understand the development of United States political ideas and traditions.
- Illinois Social Science State Goal 15
  - E. Understand the impact of government polices and decisions on production and consumption in the economy.
- Illinois Social Science State Goal 16
  - C. Understand the development of economic systems.
  - D. Understand Illinois, United States and world social history.
  - E. Understand Illinois, United States and world environmental history.
- Illinois Social Science State Goal 18
  - B. Understand the roles and interactions of individuals and groups in society.

DID YOU KNOW?

- In 1930, 185 Illinois coal mines employed 51,215 miners and produced 51,996,608 tons of coal.
- In 1940, 139 Illinois coal mines employed 26,695 miners and produced 46,071,806 tons of coal.
- In 1950, 149 Illinois coal mines employed 28,246 miners and produced 54,356,918 tons of coal.
- In 1960, 78 Illinois coal mines employed 9,772 miners and produced 43,703,382 tons of coal.
- In 1970, 64 Illinois coal mines employed 10,214 miners and produced 64,884,103 tons of coal.
- In 1980, 66 Illinois coal mines employed 18,284 miners and produced 62,542,417 tons of coal.
- In 1990, 42 Illinois coal mines employed 10,129 miners and produced 61,657,068 tons of coal.
- In 2000, 18 Illinois coal mines employed 3,461 miners and produced 33,541,271 tons of coal.
- In 2004, 18 Illinois coal mines employed 3,252 miners and produced 32,279,112 tons of coal.
- In 2008, 18 Illinois coal mines employed 3, 467 miners and produced 32,964,000 tons of coal.
- The average coal miner is 4 times more productive than his or her counterpart of 50 years ago because of the application of technology.

- In the early 20th century labor/management disputes were sometimes associated with violence and threatened the loss of coal, a vital commodity, to homes and businesses. Federal legislation requiring collective bargaining and limiting some management and labor practices have minimized violence and potential harm to the economy.
- The development of ventilation systems and safety inspections has minimized the dangers presented by methane in active coal mines.
- Coal has traditionally provided fuel for heating, fuel for producing electricity and coke for steel production.
- By 1940, oil and natural gas surpassed coal in usage.
- Between 1940 and 1970, the growth in energy consumption was sustained by increasing reliance on oil and natural gas to provide transportation, generate electricity and increase agricultural yields.
- Population growth is one important factor in determining total energy usage, but the per capita use of energy closely matches the nation's gross national product.
- In 1950, coal was selling at $28.39 per ton. It 1970, the cost was $21.68 per ton. In 1980, the cost was $51.14 per ton. In 1990, coal was $31.71 per ton, and in 2000 the cost of coal was $22.66 dollars per ton. All prices are reported in 1996 dollars.
- Underground coal mining productivity increased from 0.76 tons per miner hour in 1950 to 6.99 tons per miner hour in 2000 and 6.81 tons per miner hour in 2004.
- Coal Mine Safety and Health division of Mine Safety and Health Administration (MSHA) and inspectors from the State Office of Mines and Minerals is responsible for enforcing the Mine Act at all coal mines. This includes conducting inspections, including four complete annual inspections of underground coal mines and two complete annual inspections of surface coal mines; investigating fatal and serious nonfatal accidents; issuing citations and orders for any observed violations; and conducting safety and health conferences with mine operators on citations and orders that are issued. Specific data can be found on the MSHA website.
- For each violation cited, operators may be assessed civil money penalties. Additionally, Coal Mine Safety and Health approves roof control, ventilation, and training plans required to be submitted by mine operators, directs various mine safety and health assistance programs, and trains and certifies instructors.
- If coal mine inspectors find violations, or other conditions that pose an immediate threat to the miners' safety or health, they have the authority to issue a withdrawal order for the affected area, remove the related equipment from service, and have the miners withdrawn until the conditions are corrected.
- An EPA report on air trends and acid rain during the 20-year period from 1983-2002, released September 15, 2003, shows steady and significant air quality improvement, even as the country experiences a 164% increase in the gross domestic product, a 42% increase in energy consumption and 155% increase in vehicle miles traveled.

QUESTIONS/ISSUES

- In 2008, Illinois coal mines produced nearly 33 million tons of coal. Of that, 4.2 million tons were sold to Illinois utilities. Nearly 75 percent of the coal was sold to utilities in Florida, Indiana, Tennessee, and Ohio. Question: Why are Florida and Indiana utilities able to burn Illinois coal but Illinois uses Powder River Basin coal?

What needs to happen in Illinois to make Illinois coal use profitable for all? (Answer: Power plants in Florida and Indiana have invested in clean coal technologies that remove sulfur dioxide from the emission stream. Most Illinois utilities did not invest in clean coal technologies but chose to switch fuels.)

- How can markets for Illinois coal be expanded in such a way that air quality is protected and the competitiveness of coal to other sources of energy is not limited? (Students could research what has been improving the situation up to now. That could include research into clean coal technologies for coal.)
- How can the government deal with the negative externalities and the negative perceptions of mining and coal burning in such a way that reliable, affordable electricity is available for all people in Illinois? (Possible direction for student research could be a review of how mines and coal burning companies are taxed now, and how regulations require companies to pay for preventing some negative externalities.)
- Looking at the coal statistics from 1930 to 2000, describe the economic impact resulting from the loss of jobs. (Answers will vary but may include: Some small towns that had been dependent on the coal industry for jobs dried up. Miners looked for other work. Unemployment statistics for particular areas rose during these time periods.)
- State reasons for the decrease in employment and give explanations for the corresponding fluctuations in production. (Answers will vary but may include: Miner productivity increased due to technological advances. The Clean Air Act Amendments caused a decrease in coal use. The formation of OPEC in 1970 caused oil and natural gas consumption to fall off and coal was envisioned as a replacement. Weather patterns affected coal demand.)
- What national or worldly events were taking place between 1930 and 2000 that affected the coal industry? (Answers will vary but may include: The Great Depression, automobiles for the common people became more accessible therefore rail traffic decreased, WWII, OPEC, Oil Embargo, wars, etc.)
- How does the Mine Safety and Health Administration influence Illinois coal mines?

EXTENSIONS/CONNECTIONS

- Design an efficient, reliable, environmentally-friendly power network for a city of 200,000 people. Prepare presentations of the network designs and debate the merits of the various design suggestions.
- Draw a flow chart showing coal to electricity, including coal byproducts. Highlight one of the steps in the process. Discuss the ramifications in terms of cost and productivity if the technology in that step were no longer available or permissible. Depict projected findings on a "before" and "after" model of the flow chart.
- Research coal gasification to develop a futures wheel showing the possible chain of events that may follow further development of this technology.
- Research emission trading systems and their effect on the economy. The research can be used to develop a graphic organizer illustrating the degree to which the system follows the basic concepts of a market economy.

- Create panels to debate the pros and cons of controversial issues and how they relate to the coal industry. Issues will vary but may include: Clear Skies legislation, Kyoto Accord, health issues such as asthma and the Greenhouse Effect.

Tie In - Coal, Chemistry, and the Environment

CORRESPONDING STANDARDS

- Illinois Science State Goal 12
  - A. Know and apply concepts that explain how living things function, adapt and change.
  - B. Know and apply concepts that describe how living things interact with each other and with their environment.
  - C. Know and apply concepts that describe properties of matter and energy and interactions between them.
- Illinois Social Studies State Goal 15
  - E. Understand the impact of government policies and decisions on production and consumption in the economy.

DID YOU KNOW?

- Impurities in Illinois Basin coal, such as sulfur, chlorine, and trace amounts of heavy metals can produce acid rain and undesirable pollutants. These pollutants add significant cleaning cost to the base price of the coal.
- In 1990, Congress amended the Federal Clean Air Act to address concerns that the emissions from coal-fired power plants are dangerous to the environment and health. This led to reduced use of Illinois coal and an increased purchasing of low sulfur coal from western states such as Wyoming. However, burning western coal may produce more pollutants than burning Illinois coal in power plants equipped with scrubbers.
- When the sulfur in coal is burned, sulfur dioxide is formed in the reaction: $S + O_2 \Rightarrow SO_2$. When sulfur dioxide and different forms of nitrogen oxides (NO_X) are combined with moisture from the air, acid rain is produced. In the U.S., about 2/3 of all SO_2 and ¼ of all NOx comes from electric power generation that relies on burning fossil fuels like coal. Sunlight increases the rate of most of these reactions. The result is a mild solution of sulfuric acid and nitric acid known as acid rain.
- Acid rain causes acidification of lakes and streams and contributes to the damage of trees at high elevations. In addition, acid rain accelerates the decay of building materials and paints, including irreplaceable buildings, statues, and sculptures that are part of our nation's cultural heritage.
- Thanks to improvements in clean coal technology, air quality in Illinois is improving. A new pulverized coal boiler constructed today will control 95+% of the SO_2 emissions and 80+% of the NO_X emissions and remove almost all particulates.
- Sulfur may be decreased in coal before it is burned by separating out the heavy impurities from the coal and/or the impurities may be trapped during the combustion process or after combustion in the flue gas.
- Recent research has revealed that the emission of toxic heavy metals such as mercury (Hg) from coal-fired power plants and other sources may be absorbed into the food chain by fish such as tuna. There is current discussion about the possibility of adding warnings to cans of tuna fish about restricting consumption.

- Howard University and Fossil Fuel Sciences have worked with a collaboration of companies to develop a chemical process for removing mercury, arsenic and chromium from coal. This patented process involves such mild chemical conditions that initial cost estimates are less than $3.00 per ton of coal treated when the process is integrated with an existing coal cleaning plant.
- Bituminous coal is formed from accumulated layers of plant debris that is subjected to various forms of heat and pressure. Coal is a type of sedimentary rock that has a large range of physical and chemical properties, including heat content.
- As coal is burned in the presence of air, carbon dioxide (CO_2) is formed. CO_2 emissions can contribute to the global warming problem known as the *Greenhouse Effect*. The Greenhouse Effect is caused when gases in the atmosphere behave as a blanket and trap radiation that Earth normally reradiates into space.
- On February 14, 2002, President George W. Bush announced the *Global Climate Change Initiative (GCCI)* with the goal of significantly reducing greenhouse gas intensity in the U.S. over the next decade.
- Two general techniques are used to decrease the impact of carbon compounds on the environment: 1) capturing and sequestering greenhouse gases at the point of emission, and 2) removing them from the air through absorption by trees, grasses, soils and algae.

QUESTIONS/ANSWERS

- Why is sulfur such a problem in Illinois coal? (Answer: Illinois coal has a higher sulfur content than some other coals. Because of clean air regulations, power plants can only emit certain amounts of sulfur containing gases. Sulfur emissions contribute to acid rain effects and harm the environment, and it is very expensive to remove this impurity, which makes Illinois coal less attractive than low sulfur coal.)
- What are the two forms of sulfur that may be present in coal? (Answer: *Organic and inorganic*. Organic sulfur is bound in coal in its organic structure. It ranges from .1 percent to 5 percent by weight in Illinois. The inorganic form, pyrite, occurs in the coal in several ways such as discrete bands within the coal. The sulfur content in coal seams depends upon the types of rocks that overlie the coal seam.)
- Where did this sulfur come from? (Answer: Sulfur probably came from the seawater and sediments that originally covered the decomposing plants and peat deposits.)
- What are two methods for removing sulfur from coal, and how do they differ? (Answer: *Washing* passes coal and water through cleats inside an inclined system. The pyrite is denser and gets trapped behind cleats, while the lighter coal mixture moves across a screen that removes water, shale, fine coal and mineral impurities. *Flotation* sprays chemicals such as fuel oil or kerosene that attach to the coal particles and cause the coal to repel water. Air is bubbled into the system, and the coal is floated to the surface where it is skimmed off. Inorganics containing sulfur and other impurities are not coated with the oil and therefore do not attach to the bubbles.)
- How does the flue-gas desulfurization process work to remove SO_2 and CO_2 from emissions? Write balanced chemical equations to demonstrate the following reactions in scrubbers to remove gases: a) In dry scrubbers, limestone (calcium carbonate) is converted to calcium oxide (lime) which in turn reacts with sulfur

dioxide to form calcium sulfite; b) In wet scrubbing, limestone in water reacts with sulfur dioxide and oxygen to form hydrated calcium sulfate and carbon dioxide; c) Carbon dioxide is removed by reacting with calcium hydroxide and forming limestone and water. (Answers: a) $CaO + SO_2 \Rightarrow CaSO_3$; b) $CaCO_3 + SO_2 + 2H_2O + ½ O_2 \Rightarrow CaSO_4 + 2 H_2O + CO_2$)

- What will be the economic impact of installing more and more equipment to remove pollutants? (Answers will vary but may include: The costs may be passed on to the consumer in the form of more expensive electric rates and the increased costs of producing goods.)
- How can scientists determine if the amount of carbon dioxide in the atmosphere is changing over many centuries? (Answer: Study ice samples from glaciers to determine the amount of carbon dioxide present at various times.)
- Besides power plants, what are other sources of greenhouse gases? (Answers will vary but may include: automobiles, plant respiration, agriculture, volcanoes, forest burning, industrial plants, etc.)
- What are some potential implications of uptake of heavy metals like mercury (from power plant emissions) by fish like tuna? (Answer: Since mercury is a known carcinogen, which is especially hazardous to infants and nursing mothers, a total ban may occur, or warning labels may be required on tuna products. This could have severe economic consequences for the fishing industry and retailers.)
- Even if the United States imposes very strict emission standards for power plants, why would there still be a problem of air contamination? (Answers will vary but may include: There are other sources of air pollution, such as the emissions from autos and industry, as well as the emissions from other nations.)

EXTENSIONS/CONNECTIONS

- Conduct a class demonstration, or use a laboratory activity to show the products produced through the destructive distillation of coal. A good model activity may be found at www.coaleducation.org/lessons/sec/properties/coalderiv/coalder.htm.
- Challenge your students to discuss or debate the problems associated with removing impurities from coal.
- What are the economic consequences in Illinois if clean air regulations become more restrictive? If we are to expand our use of coal power, are we willing to pay two or three times the current rate for electricity? What impact would that have on individuals and manufacturers?
- What effect would rising oil and natural gas prices have on the use of coal?
- Have students research global climate changes and the resulting impact, and speculate on the economic consequences of carbon sequestration.
- Research different types of clean coal technology and determine which methods should be recommended to your local power plant. Support your answer with research.

9-12 GLOSSARY

Anthropogenic – caused by human activity

Area (of quadrilaterals such as rectangles) – the measure, in square units, of the interior region of a 2-dimensional figure in square units; for a rectangle it is calculated by multiplying the length and the width

Avoided emission – power plant emissions that are eliminated as the result of an emission reduction project

Balance of payments – the record of all transactions (in goods, services, physical and financial assets) between individuals, firms and governments of one country with those in all other countries in a given year, expressed in monetary terms. Any transaction that causes money to flow into a country is a credit to its BOP account, and any transaction that causes money to flow out is a debit

Bioaccumulate – to accumulate in a biological system; the uptake over time of toxic substances (such as mercury) that can stay in a biological system

Btu – British thermal unit; the amount of heat required to raise the temperature of one pound of water 1 degree Fahrenheit. It is often used to describe the heat value of fuels and heating and cooling system capacities

Byproduct – anything produced in the course of making something else

Carbon sequestration – the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere. Research in carbon storage includes ocean storage, mineral storage, geologic storage and plant uptake. Usually, carbon sequestration refers to the sequestration of carbon dioxide.

Clean Air Act Amendments of 1990 – a comprehensive set of amendments to the 1970 Clean Air Act to address significant air pollution in our cities. The 1990 amendments broaden and strengthen the original law to address specific problems such as acid depostition, urban smog, hazardous air pollutants, and stratospheric ozone depletion.

Clear Skies Initiative – a program that would dramatically reduce power plant emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), and mercury by setting a national cap on each pollutant

Coal reserves – the amount of mineable coal in a particular region

Coal seam – a "bed" or stratum of coal, usually a large deposit of coal

Collective bargaining – negotiations with management by a union to prepare a labor contract

Command economy – a system in which the basic economic questions of what, how, and who are answered by the government

Demand – the quantities of a good or service that consumers are willing to and able to buy at different possible prices

Entrepreneur – a person who assumes the risk of organizing productive resources to produce goods and services

Expected returns – the amount of financial gain to be predicted from a particular action or investment

Externality – the effect of economic activity that fall outside the market

Geology – the science that deals with the history, origin, and structure of the earth

Greenhouse Effect – the trapping of some solar radiation by a planet's atmosphere, increasing the temperature on and near the surface

Human resources – labor or the physical and mental efforts people use to create goods and services

Interburden – the amount of rock between two seams of coal

Isopach map – a map that shows the coal thickness trends as revealed in drilling samples

Kyoto Accord – an international treaty proposing binding targets for the reduction of greenhouse gases emissions, which are generally believed to aggravate global warming

Law of demand – holding everything else constant, when price increases, the quantity people are willing and able to buy decreases; when price decreases, the quantity people are willing and able to buy increases

Law of diminishing returns – as more and more variable resources are added to a fixed amount of other resources, the additional or marginal amount produced eventually diminishes

Mixed market economy – an economic system in which the basic economic questions are answered by a mixture of market, command, and traditional approaches

Overburden – the amount of rock and soil above the coal seam

Perimeter – the distance around a figure. In rectangles, P = 2L + 2W

Productive resources – all natural resources (from nature), human resources (skills and knowledge of people), and capital resources (tools and machines) used in the production of goods and services

Reclamation – the restoration of land and environmental values to a mine site after the coal is extracted. The process commonly includes "recontouring" or reshaping the land to its approximate original appearance, restoring topsoil, and planting native grasses and ground covers

Resources – the basic elements used to create goods and services commonly called land, labor, and capital

Scarcity – the condition of not being able to have all the goods and services we want; the basic economic problem that occurs because economic wants are greater than the resources available to satisfy those wants

Shaft mine – an underground mine where the mine opening is a deep hole with an elevator that carries miners and materials to the coal seam

Spin-off jobs – jobs created by coal mining operations that are outside the coal mine industry such as transportation jobs

Start-up costs – expenses associated with the establishment of a new business. These may include things such as land and building costs, permit fees, etc.

Stripping ratio – a number that mathematically relates the ratio of the cubic yards *of overburden* (soil and rock overlying the coal seam) to tons of coal available

Supply – the various amounts of something a producer is willing and able to sell at different possible prices

Surface mining – the process of extracting coal that lies near the surface by removing the layer of rock and soil that covers the coal seam

Trade-offs – giving up some of one thing to get some of another thing

Instructions for using the PowerPoint™ Presentation

This PowerPoint presentation was developed so that it will run automatically when the CD is inserted into a computer's CD-Rom drive. You do not need PowerPoint in order to view and use this presentation. A free PowerPoint viewer is included on the CD-ROM. You can also view this presentation from Internet Explorer 6.0 (or higher).

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The first time you put the CD into your computer, a **screen will come up** to install PowerPoint Viewer (see figure 1 below). The viewer will allow you to see the presentation and all of its transitions and custom animation effects. If you <u>do not</u> have PowerPoint 2003, please install this program by clicking on the "Accept" button. The program will automatically install and the PowerPoint presentation will automatically begin.

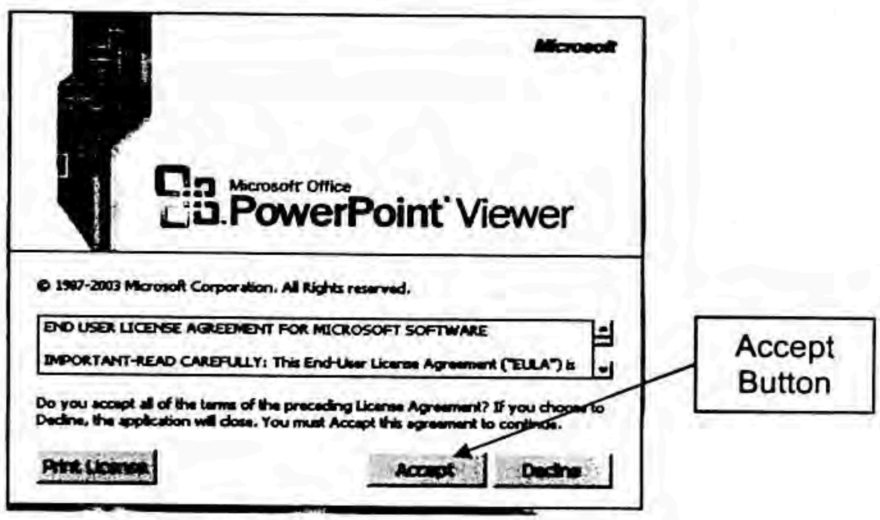

Figure 1

For your reference we are including a printout of each of the slides contained in this presentation. A brief description of the contents of the presentation and instructions for using it are included on slide # 3 of the presentation and corresponding printout.

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Open Internet Explorer.
Insert the CD into the drive.
Click on "File" then "Open" at the top of the screen.
Within the pop up menu, click on the "Browse" button.
On the bottom of this pop up window, click on "Files of Type" and click on "All Files".
From the "Look in" drop down menu, navigate to the drive containing the CD with the PowerPoint presentation. Highlight the title of the presentation and click "OK".
The presentation will automatically open and run. As this is a large file, it may take a few moments to open.

Coal: The History and The Future

Coal Publications for all Ages

Title	Author	Publisher	ISBN
In Coal Country	Judith Hendershot	Random House Children's Books	O679834796
Together in Pinecone Patch	Thomas Yezerski	Farrar, Straus Giroux Publishing	O374376476
**above books are kindergarten through fourth grade level*			
A Diamond in the Dust	Carla Johnson	Penguin Putnam	O310379504
Coal Country Christmas	Elizabeth Brown and Harvey Stevenson	Boyds Mills Press	1590780205
Coal (Rocks, Minerals, and Resources)	Ron and Adrianna Edwards, Rob McGregor	Crabtree Publishing	O778714101
Concerning Coal: An Anthology	Coal Research Center	SIU at Carbondale	N/A
Growing Up in Coal Country	Susan Bartoletti	Houghton Mifflin Co.	O395778476
Mama is a Miner	George Ella Lyon	Peter Catalanotte Illustrator	O531068536
Tales of the Mine Country	Eric McKeever	Eric McKeever Publisher	O964390507
Tell Me A Story: Memories of Early Life around the Coal Fields of IL	Coal Research Center	SIU at Carbondale	N/A
The Coal King Slaves	William Williams	Burd Street Press	1572493194
Trapped: The 1909 Cherry Mine Disaster	Karen Tintori	Atria Publishing	O743421949
**above books are fifth through eighth grade level*			
A Coal Miner's Bride	Susan Campbell Bartoletti	Scholastic Press	O439053862
Breaker	Nora Perez and N. A. Perez	Houghton Miffin Co.	O395455375
Coal: A Memoir and Critique	Duane Lockard	University of Virginia Press	O813917840
Maria Bella	Austin Goodrich	Thistlefield Studio	O966417208

ILLINOIS COAL
Discover the Power

Coal Publications Continued

Title	Author	Publisher	ISBN
Black Diamond Mines: A History of the Early Coal Mines of the Illinois River Valley	R.G. Bluemer	Grand Village Press	O967368014
Dear Mr. President: Theodore Roosevelt Letters from a Young Coal Miner	Jennifer Armstrong	Winslowhouse International	1890817279
Death Underground: The Centralia and West Frankfort Mine Disasters	Robert E. Hartley David Kenney	SIU Press	O809327066
Divided Kingdom: Work Community and the Mining Wars in the Central Illinois Coal Fields During the Great Depression	Carl D. Oblinger	Illinois State Historical Society	O912226285
Economics Today	Roger Miller	Addison Wesley Longram	O321150600
Labor, Loyalty, & Rebellion: Southwestern IL Coal Miners & World War II	Carl Weinberg	SIU Press	O809326353
Mother Jones: The Most Dangerous Woman in America	Elliot Gorn	Hill and Wang	O809070944
Mother Jones: An American Life	Elliot Gun	Farrar, Straus, and Giroux Publishing	O809070936
Mother Jones: Revolutionary Leader of Labor and Social Reform	Dorothy Wake	Xlibris Corporation	O738862452
Mother Jones: Fierce Fighter for Workers Rights	Judith Josephson	Lerner Publishing	O822549247
Southern IL Coal: A Portfolio	William Horrell and Herbert Russell	SIU Press	O809313413
The Court Martial of Mother Jones	Edwards Steel	University Press of Kentucky	O813108578
The Battle of Blair Mountain: The Story of America's Largest Labor Uprising	Robert Shogan	Westview Press	O813340969

**above books are ninth through twelfth grade and older level*

Note:
The Department of Commerce and Economic Opportunity Office Of Coal Development does not make any representation with respect to the information contained in this document. The list of coal publications is merely a list of references obtained for educational purposes.

QUESTIONS ABOUT COAL?

Listed below are resources to help you find answers to your questions by using the many sources of information on coal production and utilization.

WEB SITES:

Illinois Department of Commerce and Economic Opportunity Web Pages:
Office of Coal Development **www.illinoisbiz.biz/dceo/Bureaus/Coal/**
Coal Programs **www.illinoisbiz.biz/dceo/Bureaus/Coal/Programs/**
Coal Publications **www.illinoisbiz.biz/dceo/Bureaus/Coal/Publications/**
Virtual Coal Mine Tour **www.illinoisbiz.biz/dceo/Bureaus/Coal/Virtual+Tour/**
Coal Education **www.illinoisbiz.biz/dceo/Bureaus/Coal/Education/**
Coal Kids Site **www.illinoisbiz.biz/dceo/Bureaus/Coal/Kids+Site/**
Related Links **www.illinoisbiz.biz/dceo/Bureaus/Coal/Related+Links/**

OTHER SITES:

Illinois Dept. Of Natural Resources **www.dnr.state.il.us/mines/mst/photogallery.htm**
Illinois Dept. of Natural Resources **www.dnr.state.il.us/mines/education/kidz.htm**
Illinois State Geological Survey **www.isgs.uiuc.edu/research/coal/illinois-coal.shtml**
Coal Education **www.coaleducation.org/**
Glossary of Coal Terms **www.coaleducation.org/glossary.htm**
Mining Education **www.miningusa.com/**
Energy Information Administration **www.eia.doe.gov/fuelcoal.html**
Illinois Clean Coal Institute **www.icci.org/**
SIU Coal Research Center **www.crc.siu.edu/**
National Mining Association **www.nma.org/**
U.S. Dept. of Energy – Fossil Energy **www.fe.doe.gov/**
U.S. Office of Surface Mining Reclamation & Enforcement
www.osmre.gov/learn.htm
Mine-Engineer.com **www.mine-engineer.com/mining/coalpg.htm**
Coal Energy
www.eia.doe.gov/kids/energyfacts/sources/non-renewable/nonrenewable.html
History Matters **historymatters.gmu.edu/ Keyword: Coal (Search: GO!)**
Gasification Technologies Council **www.gasification.org/what_is_gasification/overview.aspx**

Coal City Library **www.coalcity.lib.il.us/**
History **www.kentlaw.edu//ilhs/earlyday.htm**
Mine Safety and Health Administration **www.msha.gov**
National Energy Technology Laboratory **www.netl.doe.gov/**
Online Maps **www.isgs.uiuc.edu/maps-data-pub/coal-maps.shtml**
Mining Glossary **http://www.mininglife.com/Glossary/a.asp**
American Coal Foundation **www.teachcoal.org**
Coal Prices **www.eia.doe.gov/neic/infosheets/coalprice.html**
Coal Demand **www.eia.doe.gov/neic/infosheets/coaldemand.html**
American Geological Institute **www.agiweb.org**
Earth Science World **www.earthscienceworld.org**
Coal Mining and Union Activities Project and Illinois Coal:
The Legacy of an industrial society **www.uis.edu/archives/projects.htm**

PUBLICATIONS:

American Coal Foundation
1130 Seventeenth Street, N.W., Suite 220, Washington, DC 20036-4604
202 466-8630
FAX: 202 466-8632

Illinois State Geological Survey
615 E. Peabody Dr., Champaign, IL 61820
217 333-4747

National Energy Foundation
5225 Wiley Post Way, Suite 170, Salt Lake City, UT 84116
801 539-1406
Fax: 801 539-1451

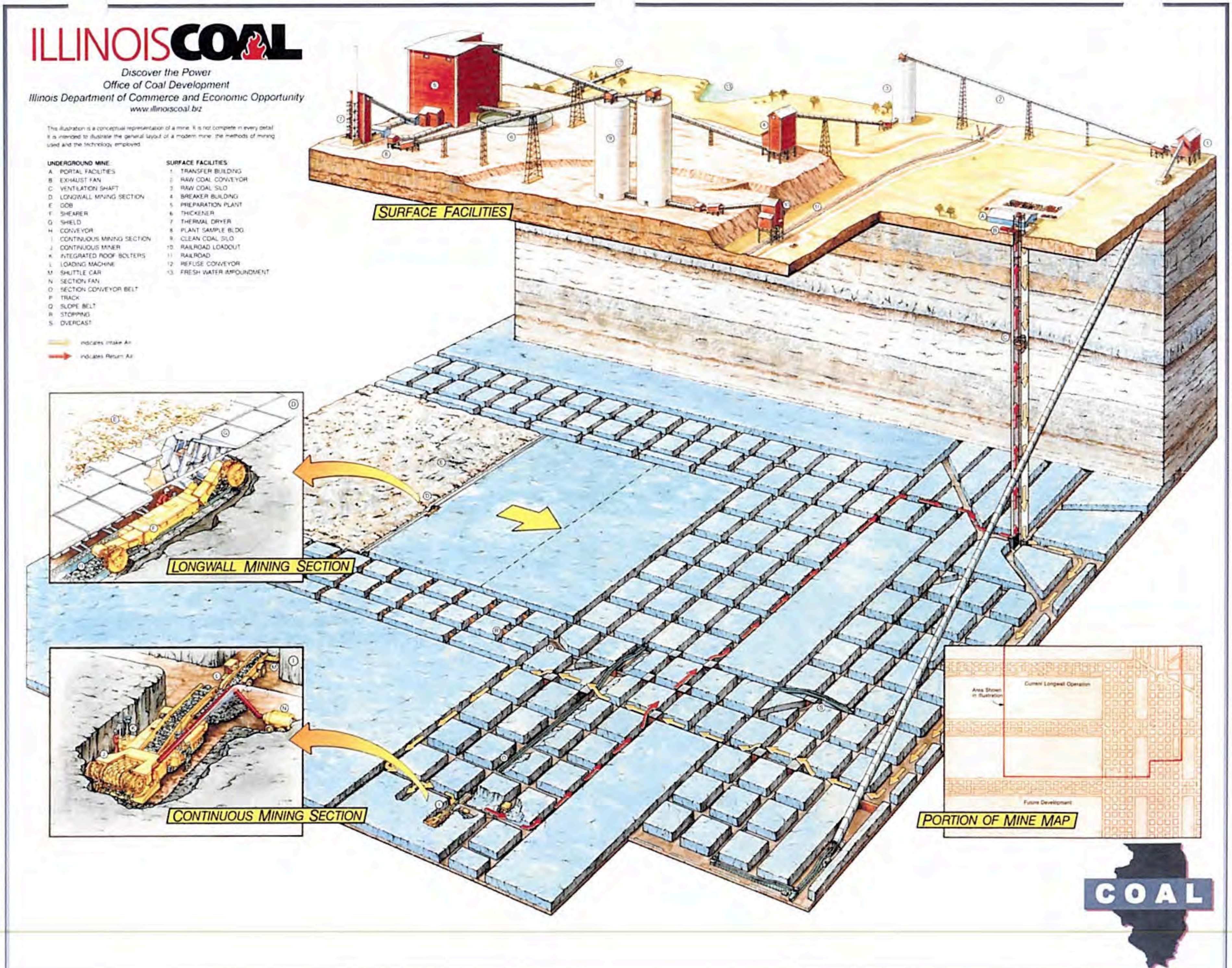
FIELD TRIPS:

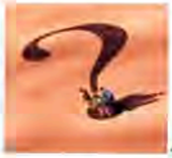
Museum of Science and Industry, The Coal Mine Exhibit
57th and Lake Shore Dr.,
Chicago, IL 60637-2093
http://www.msichicago.org/

Burpee Museum of Natural Science, Regional Geology Exhibit
737 North Main Street
Rockford, IL 61103-6971
http://www.burpee.org/

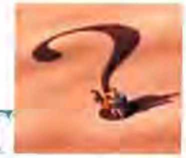
Illinois State Museum
502 S. Spring
Springfield, IL 62706
http://www.museum.state.il.us/

From the Coal Mines to the Power Lines
ILLINOIS COAL


ILLINOIS COAL
Discover the Power
Office of Coal Development
Illinois Department of Commerce and Economic Opportunity
www.illinoiscoal.biz
This illustration is a conceptual representation of a mine. It is not complete in every detail. It is intended to illustrate the general layout of a modern mine; the methods of mining used and the technology employed.
UNDERGROUND MINE:
A PORTAL FACILITIES
B EXHAUST FAN
C VENTILATION SHAFT
D LONGWALL MINING SECTION
E GOB
F SHEARER
G SHIELD
H CONVEYOR
I CONTINUOUS MINING SECTION
J CONTINUOUS MINER
K INTEGRATED ROOF BOLTERS
L LOADING MACHINE
M SHUTTLE CAR
N SECTION FAN
O SECTION CONVEYOR BELT
P TRACK
Q SLOPE BELT
R STOPPING
S OVERCAST
SURFACE FACILITIES:
1 TRANSFER BUILDING
2 RAW COAL CONVEYOR
3 RAW COAL SILO
4 BREAKER BUILDING
5 PREPARATION PLANT
6 THICKENER
7 THERMAL DRYER
8 PLANT SAMPLE BLDG
9 CLEAN COAL SILO
10 RAILROAD LOADOUT
11 RAILROAD
12 REFUSE CONVEYOR
13 FRESH WATER IMPOUNDMENT
indicates Intake Air
indicates Return Air
SURFACE FACILITIES
LONGWALL MINING SECTION
CONTINUOUS MINING SECTION
PORTION OF MINE MAP
Current Longwall Operation
Area Shown in Illustration
Future Development
COAL



ASK THE XPERTS LIST



The following list may be used by teachers and students for questions concerning coal-related issues.

Expert/Expertise	Phone	Email
Dan Barkley *Mine Subsidence & Permitting* *Engineering & Design*	217-782-4970	Dan.Barkley@illinois.gov
Francois Botha *Coal Combustion Byproducts* *Scrubber, Mercury, Flue gas*	618-985-3500	fbotha@icci.org
Scott Elrick *Coal Geology* *Resource Maps*	217-333-3222	elrick@isgs.uiuc.edu
Scott Fowler *Coal Geology*	217-558-4333	Scott.Fowler@illinois.gov
Sallie Greenberg *Geochemistry, Isotopes, Radiocarbon Dating, Carbon Sequestration, FutureGen*	217-244-4068	greenberg@isgs.uiuc.edu
Joseph Hirschi *Coal Mining* *Coal Preparation*	618-985-3500	jhirschi@icci.org
Leonard Hopkins *Environment* *Designing*	618-964-1148 ext. 443	lhopkins@sipower.org
Don McBride *Mine Safety*	618-439-9111	Don.Mcbride@illinois.gov
John Mead *Clean Coal Technology* *Environmental Laws*	618-453-7331	jmead@siu.edu
Dean Spindler *Geology* *Soils*	217-785-5195	Dean.Spindler@illinois.gov

Pat Quinn
Governor

Warren Ribley
Director

Illinois Coal Fact Sheet

Current Markets for Illinois Coal

- Nearly thirty-three million tons of Illinois coal was mined in 2008. [1]
- In 2008, the average open market sales price was $33.60/short ton.[2]
- 49 percent of the electricity used in Illinois and 49.7 percent of the electricity used in the U.S. is generated from coal.[3]
- More than 90 percent of Illinois coal produced was purchased by the electric utility industry in 2008. Industrial and commercial users account for the remaining percent.[3]
- More than 80 percent of Illinois coal is sold to out-of-state utilities.[4]
- The top 5 utility users of Illinois coal in 2007 were: Tennessee Valley Authority, Northern Indiana Public, Inc., Tampa Electric Company, Duke Energy of Indiana, and Dayton Power & Light Company.[4]
- Illinois utilities and industrial facilities used 5.6 million tons of Illinois coal in 2007.[4]

Source: 1 Energy Information Administration. http://www.eia.doe.gov/cneaf/coal/quarterly/html/t2p01p1.pdf
2 Energy Information Administration, State Energy Profiles; http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=IL
3 EIA, Electricity Infocard; http://www.eia.doe.gov/bookshelf/brochures/electricityinfocard/elecinfocard2006/elecinfocard.html
4 Platts Energy Advantage. Coal Transactions Analyzer: 1. McGraw-Hill Co. Inc. accessed 17 March 2008.

Clean-Coal Technologies

The Office of Coal Development oversees the largest state-sponsored coal research and development program in the United States. Laboratory-scale research projects initiate and advance technologies in the areas of coal combustion systems, coal residuals management and coal preparation. Development projects include technology maturation, technology transfer and commercialization projects.

- The Midwest Geological Sequestration Consortium, the Illinois State Geological Survey and Archer Daniels Midland Company (ADM) are conducting a large-scale carbon dioxide sequestration demonstration project in the Mt. Simon Sandstone. The project will involve the capture and storage of 1 million tons of carbon dioxide from ADM's ethanol plant in Decatur, Illinois.
- Southern Illinois University in Carbondale developed and successfully tested an engineered, composite wooden element and wooden wedges that overcome most of the disadvantages of conventional cribs in underground mines. It was demonstrated that these crib supports and wedges are a viable primary support for mining areas, including longwall development entries. A new project will assist with commercial production of cribs in southern Illinois with appropriate quality controls.
- Southern Illinois University is installing an *I-Lab Coal to Liquids Research Facility*. This new laboratory is needed to increase research in Fischer-Tropsch conversion for the production of transportation fuels from Illinois coal.
- Researchers from Western Kentucky University are investigating the emissions of mercury from FGD scrubbers. This project will assist two utilities, who are primary users of Illinois coal within the State of Illinois, in determining the best way to meet Illinois mercury emission limits.

Illinois' Commitment to the Coal Industry

- Since its inception in 1981, the Illinois Coal Research and Development Program has granted over \$79.3 million in state, federal and private funds for basic and applied research on coal extraction, coal combustion systems, coal preparation and coal residuals management.
- The Illinois Coal Demonstration Program is helping to demonstrate and deploy clean and efficient technologies for use with Illinois coal. Illinois' commitment of over \$146.3 million towards Clean-Coal Technologies has supported 31 clean coal projects within the state.
- The Illinois Coal Competitiveness Program is helping Illinois coal producers remain competitive. More than \$157.6 million in state dollars have produced \$1.87 billion in private infrastructure investments to coal extraction, preparation and transportation facilities across the state.

Additional Coal Facts

- Coal was first discovered in Illinois more than 300 years ago.
- Mining began in Illinois almost 200 years ago.
- Coal underlies 37,000 square miles of Illinois -- about 65 percent of the state's surface.
- Most of the coal is bituminous with high-energy values -- between 10,000 and 14,000 Btu/lb.
- Illinois' coal reserves contain more Btu's than the oil reserves of Saudi Arabia and Kuwait.
- Each day, every American uses about 20 pounds of coal in the form of inexpensive and increasingly clean, coal-based electricity.
- Recoverable coal reserves in Illinois (38 billion tons) account for almost one-eighth of the total U.S. coal reserves and one-quarter of the nation's bituminous coal reserves.
- Illinois ranked eighth among coal producing states in 2008.
- Illinois coal was mined in 11 counties in 2008.
- In 2008, 18 Illinois mines employed 3,467 miners and generated roughly 20,000 spin-off jobs.
- 20,000 acres of Illinois cropland have been surface mined and reclaimed to the original productivity.
- Nearly 18 percent of Illinois coal production was from surface mining in 2008.
- The typical coal miner earns \$64,000 per year including overtime[5].
- In 1981, Illinois recorded the first fatality-free year in mining history.
- 3,700 Illinois miners produced 40 million tons of coal in 1999, as much as 15,000 miners produced in 1954 and 41,000 miners produced in 1927.

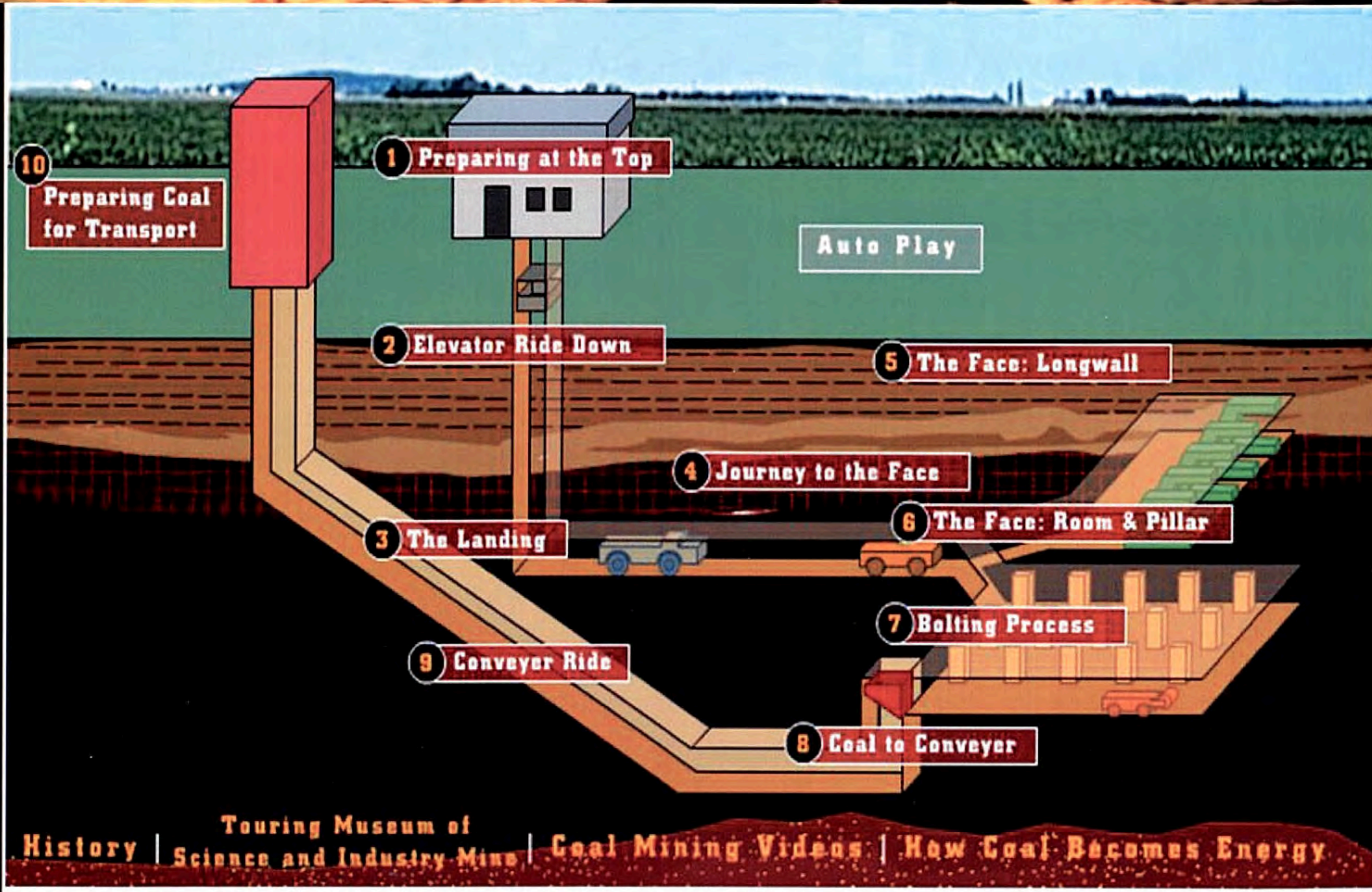
[5] Workforce West Virginia - Labor Market Data. This salary is based on miner working overtime. Hourly wage is approximately \$22/hour.

For additional information contact:

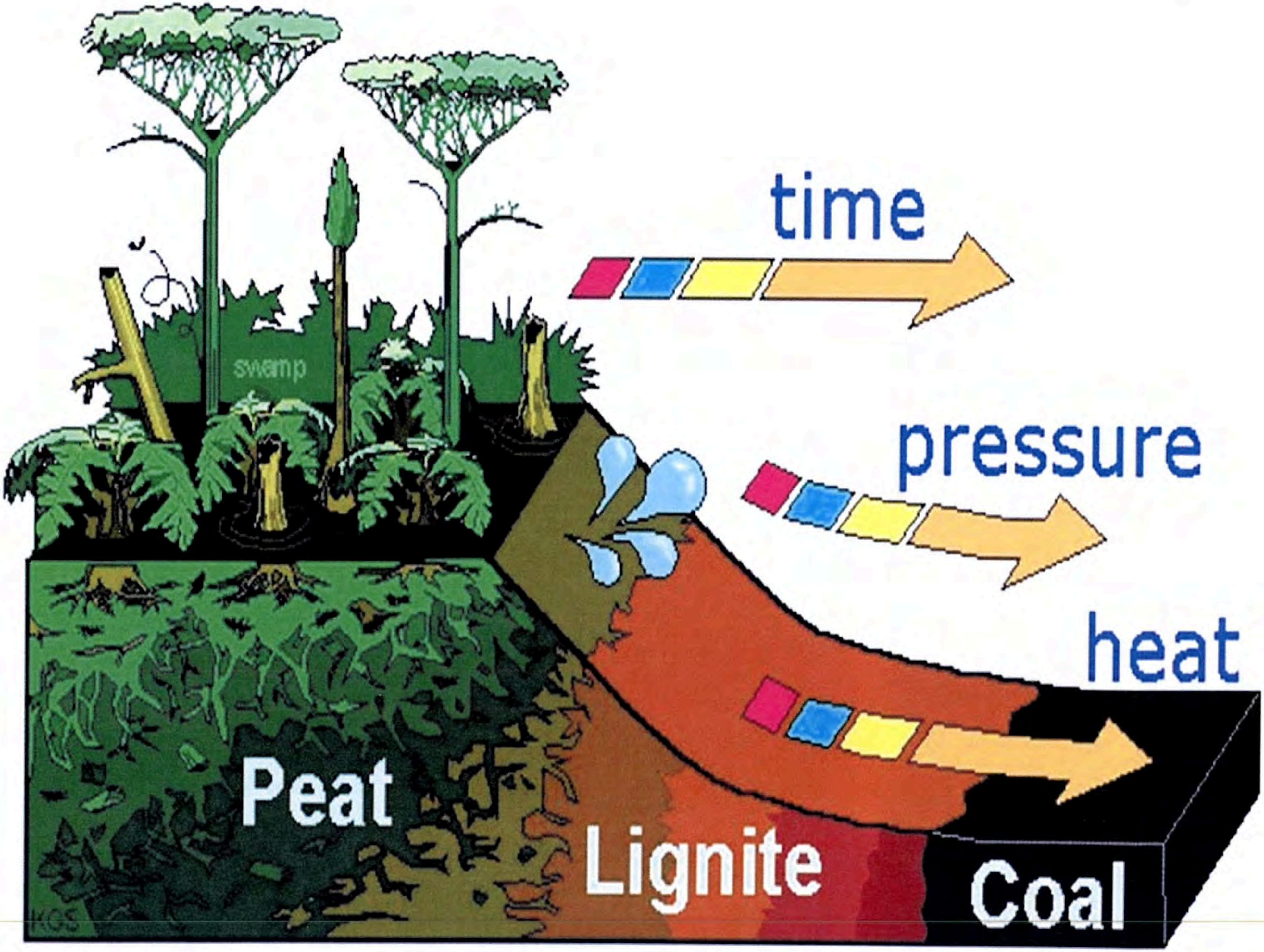
Office of Coal Development
Department of Commerce and Economic Opportunity
620 E. Adams Street
Springfield, IL 62701-1615
Phone: 217/782-6370
TDD: 800/785-6055 Fax: 217/558-2647
http://www.illinoiscoal.biz

Last updated May 2009.

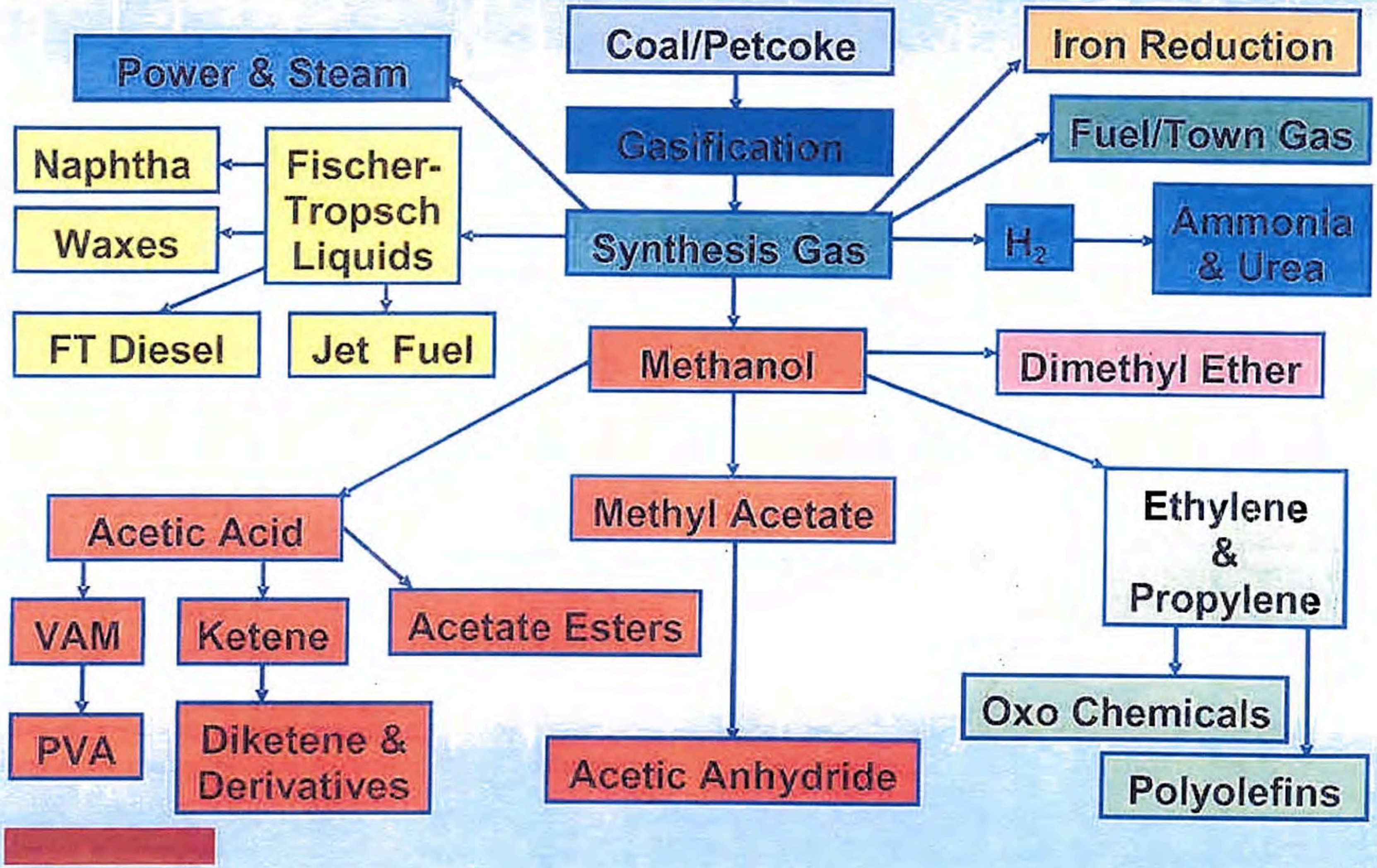
Visit the Coal Mine



http://www.illinoisbiz.biz/coal/virtualtour/index.html


swamp
time
pressure
heat
Peat
Lignite
Coal
KGS

Polygeneration Potential of Gasification



State of Illinois

Illinois Department of
Commerce and Economic Opportunity

Illinois Coal Industry Significant Dates

The following is a listing of important dates in the Illinois coal industry broken into 3 categories: Mine Disasters, Regulatory History and Landmarks in Illinois Coal Mining History. The majority of the events have a website listed which serves as a starting point for further investigation.

Mine Disasters

1883	On February 16th at Wilmington Coal Mining & Manufacturing Company, Diamond Mine, there were 69 miners that drown when mine flooded. http://coalcity.lib.il.us/coalmining/pages/diamond/disaster.html
1905	On April 3rd at Zeigler Coal Company, 47 miners were killed in an explosion and three died from asphyxiation while conducting rescue operations. http://www.zeigleril.com/pages/zighist.htm
1909	On November 13th at St. Paul Coal Company, Mine #2 (also known as the Cherry Mine Disaster), 259 miners died in the mine fire. http://www.kentlaw.edu/ilhs/cherrymi.htm
1914	On October 27th at the Franklin Coal & Coke Mine #1, 52 miners died in a gas explosion.
1932	On December 24th, Moweaqua Coal Company had 54 miners die in a gas explosion. http://www.kentlaw.edu/ilhs/moweaqua.htm
1947	On March 25th there were 111 miners that died in coal dust explosion at Centralia Coal Company #5. http://www.kentlaw.edu/ilhs/centrali.htm
1951	On December 25th in Chicago, Wilmington and Franklin Coal Company, Orient #2, 119 miners died in gas explosion. http://www.wf168.frnkln.k12.il.us/fchs/lh022.htm

Regulatory History

1883	The Bureau of Mines and Minerals was created, which had authority to inspect the state's coal mines. http://dnr.state.il.us/mines/
1890	United Mine Workers of America was formed. http://www.umwa.org/homepage.shtml
1891	Congress passed the first federal statute governing mine safety. The Federal Coal Mine Safety Act established ventilation requirements and prohibited operators from employing children less than 12 years of age. http://www.msha.gov/MSHAINFO/MSHAINF2.HTM
1910	Legislation was passed that provided for the creation of mine rescue stations. This act was in response to the mine fire at the St. Paul Coal Company, Mine #2 (Cherry Mine Disaster), that claimed the lives of 259 miners. http://www.osh.netnam.vn/html/coal_mines/mines_rescue.htm

1917 Civil Administrative Code established the Department of Mines and Minerals, which had the powers to regulate the state's growing coal industry.
http://dnr.state.il.us/mines/

1948 Following the Centralia Mine disaster, legislation was adopted that created a laboratory to analyze mine air and mine dust. The first analytical laboratory was established on the campus of the University of Illinois.
http://www.msha.gov/Accident_Prevention/ideas/airchange.htm

1962 On January 1st, the first state laws regulating reclamation at Illinois surface coal mines became in effect.
http://dnr.state.il.us/mines/education/indus3.htm

1967 Air Quality Act would improve air quality and implement emission limitations.
http://wps.prenhall.com/wps/media/objects/751/769950/Documents_Library/airquality.htm

1969 Mine Health and Safety Act creates MSHA enforcement. As a result, the safety standards for all coal mines were strengthened and health standards were adopted.
http://www.msha.gov/MSHAINFO/MSHAINF2.HTM

1970 Clean Air Act is a strict air pollution control law.
http://www.nsc.org/ehc/mobile/acback.htm

1977 Surface Mining Control and Reclamation Act protects society and environment from adverse effects of surface coal mining operations.
http://ipl.unm.edu/cwl/fedbook/smcra.html

1977 Federal Mine Safety and Health Act states all underground mines are inspected four times a year and surface mines twice annually.
http://www.dol.gov/asp/programs/guide/msha.htm

1963 Clean Air Act was considered to be the first modern environmental law enacted by Congress.
1970 It promoted the use of clean low sulfur coal by setting emission standards.
1990 http://www.ametsoc.org/sloan/cleanair/cleanairlegisl.html

1979 On July 1st, new laws were enacted providing mine subsidence insurance to homeowners providing coverage against damage from mine subsidence due to long abandoned coal mines.
http://www.imsif.com/mine.htm

Landmarks in Illinois Coal Mining History

1673 French explorers Father Jacques Marquette and Louis Joliet report seeing coal along the banks of the Illinois River near Ottawa.
http://www.eslarp.uiuc.edu/ibex/archive/vignettes/frenchconnection.htm





1810 A small drift mine along the banks of the Big Muddy River near Murphysboro recorded the first commercial sale of coal from an Illinois underground coal mine.
http://www.coaleducation.org/lessons/sec/Illinois/safil.htm

1833 The first official recording of annual coal production indicated 6,000 tons were mined.
http://www.illinoisbiz.biz/coal/pdf/EIA_State.pdf

1837 First railroad built with the purpose of shipping coal was by a company organized by Governor Reynolds and connected the mines along the bluffs of the Mississippi River in St. Clair County with a point opposite St. Louis, MO.
http://www.lib.niu.edu/ipo/ihy020444.html

1861 The American Miners Association is organized in Belleville, IL and becomes the first miner's union to extend beyond one state. The Association became inactive after 1868.
http://www.ilir.uiuc.edu/LII/history.html
http://www.ilir.uiuc.edu/lii/chronlog.html

1866 Strip mining began near Danville, Illinois, when horse-drawn plows and scrapers were used to remove overburden so the coal could be dug and hauled away in wheelbarrows and carts.
http://dnr.state.il.us/orep/c2000/assessments/vermilion/mining.htm

1870 The second bituminous coal washery (for washing and cleaning mined coal) in the United States was erected in East St. Louis.

1875 Coke replaces charcoal as the chief fuel for iron blast furnaces.

1885 The first year mechanical stripping equipment, other than horses and scoops, was used.

1887 The first underground electric mine locomotive was used in an Illinois coal mine to move loaded coal cars.

1890 United Mine Workers of America led the struggle to establish collective bargaining in American industrial life.
http://www.lib.niu.edu/ipo/ihy971218.html

1896 Steel timbering is used for the first time at the shaft mine of the Spring Valley Coal Company, where 400 feet of openings are timbered with 15-inch beams.

1898 October 12th - Battle of Virden
The Chicago-Virden Coal Company attempted to break the strike by bringing in African-American miners from Alabama. Seven miners and five coal company guards were killed and scores wounded in what is recognized as a landmark event in the history of the labor movement in the United States. As a result, October 12th was declared Miner's Day.
http://www.kentlaw.edu/ilhs/sanjuan.htm




1899	Union Miners Cemetery was constructed in Mount Olive Illinois. The local UMWA union purchased a one-acre site and the bodies of the miners killed during the Battle of Virden were moved from the town cemetery and laid to rest in the new Union Miners Cemetery. Mother Jones, the legendary UMWA organizer, and "General" Alexander Bradley, who incited Illinois miners to join a nationwide strike called by the UMWA on July 4, 1897, are buried there. http://www.kentlaw.edu/ilhs/minecem.htm
1901	Mother Jones became involved in the struggles of coal miners and became an organizer for the United Mine Workers. http://www.kentlaw.edu/ilhs/majones.htm
1911	The first state operated mine rescue stations were opened in LaSalle, Springfield and Benton.
1911	Three mine rescue railroad cars were commissioned for use at the state's three mine rescue stations. These rescue cars were furnished and equipped to respond to a mine emergency.
1912	The first self-contained breathing apparatus for mine rescue operations is used.
1913	First loading of railroad cars in a strip pit.
1920	John L. Lewis became president of the UMWA. http://www.umwa.org/history/jll1.shtml
1921	The first electrically operated coal shovel was used at the Black Servant Mine near Elkville.
1928	The Assumption Coal Company, the state's deepest underground coal mine at 1,004 feet, closes after 31 years of operations.
1936	The first trackless means of hauling coal was used in the Blue Bird Coal Company #5 mine in southern Illinois.
1936	On October 10th, a dedication to the Mother Jones monument was located in the Union Miner's Cemetery, Mt. Olive, Illinois. http://www.kentlaw.edu/ilhs/minecem.htm
1937	The shuttle car is introduced by Joy Manufacturing Company.
1938	Reclamation of surface mined lands was started on a voluntary basis by mining companies. This consisted entirely of tree planting.
1948	The continuous miner is introduced.
1955	The rail industry virtually completes its switch from coal-fired to diesel locomotives.
1961	Coal becomes the major fuel used by electric utilities to generate electricity.

dceo
Illinois Department of Commerce and Economic Opportunity
Office of Coal Development

From the Coal Mines to the Power Lines
ILLINOIS COAL
www.illinoiscoal.biz

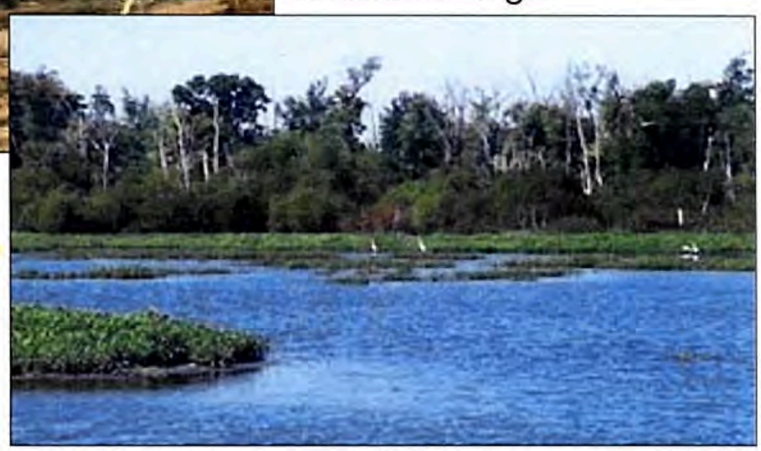
Printed by the State of Illinois 100069 10/09 500
IIOCI 0354-10

How does coal affect the environment?

Earth is a closed system. Anything that is changed on Earth causes a series of changes in the land, water and air. Forest fires, highway traffic and even parking lots cause changes in the systems on Earth. When coal seams are disturbed, changes occur in Earth's systems too.

Mining coal releases dust and gas into the air. Water is used to wash impurities from the coal. The surface of the land may be changed a lot or a little. New laws and technology help minimize effects on our environment.

Though coal mining changes the landscape, federal and state laws now require all mined land to be reclaimed. Coal companies plan the reclamation process before mining.



After reclamation the lands may be used as parks, golf courses and farmland. Some mining companies leave the land as wildlife habitat.

(See the section on Land Reclamation for more information.)

Mining companies must protect the surface water and groundwater. Water that is used in the coal washing and separating processes is cycled through sedimentation ponds.

Sedimentation ponds allow the small rock particles, or sediment, to settle to the bottom of the pond. The water is pumped back to the treatment plant and used again.

Good mining practices protect and conserve water.

Over the past several years, scientists, coal companies and others have become concerned about the air we breathe. They want to make sure that the harmful chemicals that are released into the air when coal is burned do not harm the environment.

Technologies were developed to remove these chemicals from coal before, during and after it is burned. These technologies are called **clean-coal technologies**.

Two new clean-coal technologies are **coal gasification** and **fluidized bed combustion (FBC)**. Coal gasification converts coal to gas. Fluidized Bed Combustion removes pollutants from the coal while it is being burned.

Today scientists are continuing to find ways that will enable coal to be burned cleaner. As a result, we will have a cleaner and healthier environment.

Remember

The effects of coal on our environment are minimized by:

- Land Reclamation,
- Protecting and Conserving Water and
- Clean-Coal Technologies.