

**Title:** Kentucky Coal and Our Environment

**Level:** Secondary

**Day/Time:** One class period or Homework assignment

**KERA Goals:** 1.2, 5.1, 5.3

**Background Information:**

Coal is an abundant and reliable energy resource used to generate more than 95 percent of the electricity in Kentucky. The remainder of our electricity is generated from other energy resources including nuclear energy, petroleum, hydroelectric and natural gas.

With the use of each of these energy resources comes advantages and disadvantages. The advantages of using Kentucky coal are numerous— from creating jobs for Kentucky communities to providing relatively inexpensive electricity for our homes and schools. Kentucky coal is hard at work every day and will be an important energy resource throughout the next century.

Some of the disadvantages of Kentucky coal use include its effect on our environment. Burning coal produces emission of sulfur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>) and carbon dioxide (CO<sub>2</sub>). Some scientists think that these emissions contribute to *acid rain* and *global climate change*. The good news is that we have methods to address these concerns. In Kentucky, we are changing the things that, at first, seem to be disadvantages of using Kentucky coal into advantages for Kentucky.

The first way to ensure that Kentucky coal is beneficial to all is to develop an understanding of the issues and facts concerning acid rain and global climate change. The second way is to change what might at first seem to be a disadvantage into an advantage through the use of clean coal technologies.

The emissions produced when burning coal can be removed by scrubbing, or cleaning, the air as it leaves the smokestack at the power plant. By using scrubbers or other clean coal technologies, the emissions can be reduced or eliminated.

*Acid Rain and Acid Deposition*

Our natural environment is everything that surrounds us, including air, land, water and living organisms. It provides all that is necessary to sustain life. Pollution from human activities, such as burning *fossil fuels* to generate electricity or run automobiles, can cause changes in the natural environment that may affect the overall quality of our lives.

*What is acid rain?*

*Acid rain* or *acid deposition* occurs when chemically laden emissions from electric power plants, automobiles, factories and other sources react in the atmosphere with water, oxygen and oxidants to form sulfuric and nitric acids. These compounds then fall to Earth in either

dry form (such as gas and particles) or wet form (such as rain, snow and fog).

Acid rain is mainly a problem in the northeastern part of the country where many believe it causes acidification of lakes and rivers and damage to trees at high elevations. In addition, acid rain accelerates the decay of building materials and paints, including irreplaceable buildings and statues that are part of our nation's cultural heritage. Finally, acid aerosols (tiny droplets of sulfuric acid) may pose a risk to public health.

#### *Principal causes of acid deposition*

Acid deposition is believed to be primarily caused by the combustion of fossil fuels. Sulfur dioxide (SO<sub>2</sub>) emissions from coal-burning electric power plants are the main precursor of acid rain in the United States. When coal is burned to produce power, its natural sulfur content combines with oxygen to form sulfur dioxide. The quantity of SO<sub>2</sub> formed varies with the sulfur content of the coal and other factors. Nitrogen oxide (NO<sub>x</sub>) emissions also play a role in the formation of acid rain and are formed when the nitrogen in coal, as well as nitrogen in the air, are incompletely oxidized during combustion.

Electric power plants account for about 70 percent of annual sulfur dioxide emissions and 30 percent of nitrogen oxide emissions in the United States. Certain natural events such as volcanic eruptions can emit huge amounts of acid-causing gases in a very short period of time. Automobiles and factories also emit significant amounts of acid-causing gases—especially nitrogen oxides.

#### *The National Acid Precipitation Assessment Program*

The *National Acid Precipitation Assessment Program (NAPAP)* is a federally funded research effort created by Congress in 1980 to study the causes and effects of acid deposition. While some effects of acid rain have been documented, the same number of acidic lakes exist today as did 10 years ago. A small number of lakes in the state of New York do appear to have become acidic in the last 50 years. Other bodies of water are naturally acidic as a result of acid soil and natural vegetation.

The study indicated that, at this time, no harmful effects were found on forests, crops, drinking water or to human health.

#### *Is coal contributing more SO<sub>2</sub> to the atmosphere each year?*

U. S. government data clearly indicates a decrease in both total SO<sub>2</sub> emissions and in those coming from coal-fired power plants since enactment of the Clean Air Act in 1970. This occurred while there was an increase in the use of fossil fuels, especially coal. These emissions should continue to decrease with increased use of clean coal technologies that offer new methods of using coal in an environmentally sound manner.

Today we have better technologies available to burn Kentucky coal in the United States. One way fossil-burning plants can lower emissions is to install scrubbers. *Scrubbers*

removed the sulfur from the smoke as it leave the smokestack. It is estimated that, even without additional controls mandated by the 1990 Clean Air Act Amendments, emissions would have continued to decline as old plants were retired.

### *Global Climate Change*

The slow and steady rise in Earth's atmospheric temperature over many decades is called *global climate change*. This change is believed by many to be caused by man-made emissions that result in the *greenhouse effect*. The greenhouse effect is a result of increased levels of certain *greenhouse gases* in the atmosphere. These gases trap heat that would otherwise radiate from Earth into space. As a result, the temperatures on Earth begin to warm.

The effect is similar to what happens in a garden's greenhouse. The sun shines through the glass warming the plants. These plants then warm the air. The glass in the greenhouse keeps the warm air from escaping, raising the temperature inside.

The global greenhouse effect occurs in much the same way. Greenhouse gases act like the glass in a greenhouse, allowing sunlight to enter Earth's atmosphere, but preventing the resulting heat from escaping into space. The heat, trapped by these greenhouse gases, helps to warm the Earth.

### *Greenhouse gases.*

Greenhouse gases have been present since the Earth's formation. Many occur naturally from oceans, wetlands, lakes, volcanoes, tundra and decaying tress, and other organic matter. The concern is due to the fact that the concentration of these greenhouse gases has grown rapidly during the past century.

There are 13 greenhouse gases, but only five are prevalent. They are carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>), ozone (O<sub>3</sub>) and chloroflourocarbons (CFCs). Carbon dioxide is the least efficient of the gases in trapping heat but appears in our atmosphere in the greatest volume— 50 percent, in fact. The volume of this gas has increased by 25 percent since the middle of the eighteenth century.

The principle sources of CO<sub>2</sub> include: burning of fossil fuels, deforestation and cement production. Coal accounts for one-fourth of the CO<sub>2</sub> emissions coming from fossil fuels. While fossil fuel consumption is growing worldwide, it only increased in the United State by three percent compared to China with an increase of 155 percent or India which increased by 175 percent within the last decade.

### *Central issues in the global climate change debate*

Most scientists agree that the levels of CO<sub>2</sub> in our atmosphere have increased over the past century. The debate centers around the determination of what effect it will have on our environment, if any at all. Some scientists believe global climate change is occurring, while

other do not. Will human activity, such as the use of fossil fuels, chlorofluorocarbon-based refrigerants (CFCs) in cooling systems, the venting of methane-based natural gas into the atmosphere and deforestation, accelerate the greenhouse effect?

According to some scientists, the average surface temperature of Earth has been rising over the past 100-years. Some believe that the temperature will rise from 2 degrees to 9 degrees by 2050. The result would be a change in weather patterns on Earth which would affect plant, animal and human lives. Other scientists do not believe that global warming will occur or that it has occurred at all.

NASA satellites indicate no significant change in temperature over the past 10 years. Some scientists say that global climate change is not occurring because temperatures increased in the first half of the century while CO<sub>2</sub> levels did not. Furthermore, CO<sub>2</sub> levels rose in the last half of the century while temperatures did not. They believe there is no relationship between temperature and CO<sub>2</sub> levels. Some believe the net effects could benefit the Earth while others insist that it is extremely detrimental.

There is continued debate over the effects of global climate change. If global climate change was to occur, there would be certain advantages and disadvantages. For instance, added levels of carbon dioxide in the air could cause plants to grow faster, allow for a longer growing season, produce more food and delay a future ice age.

At the same time, however, melting polar ice caps and flooding coastal areas may alter the climate and may cause changing rainfall patterns that would result in droughts and famine. There would also be further species extinction and a decline in forest growth, air quality and human health.

### *Conclusion*

It is important to understand the environmental issues of acid rain and global climate change in relation to Kentucky coal. According to the National Acid Precipitation Assessment Program, acid rain has had minimal effects on our environment. Many of the examples of acid rain were found to be a result of natural causes. Global climate change continues to be debated among scientists, so it is important to know both sides of the issue.

Coal is an important source of energy and is being used in an environmentally sound manner throughout Kentucky. Through the use of clean coal technologies, Kentucky coal can be used while limiting SO<sub>2</sub> emissions. Global climate change is a future issue that is still to be decided. The Kentucky coal industry will meet the global climate change challenge and is prepared to address any future concerns.

### **Activity: Kentucky Coal and Our Environment (Discussion worksheet)**

1. What is the environment? Give some examples of objects in your environment.

Inside:

Outside:

2. What is acid rain and where does it come from?
3. What is involved in the formation of acid deposition?
  - a.
  - b.
  - c.
4. From where do acid-causing gases come and what happen to them?
5. What are the two main contributors to precursor gases? Give two example of each:
  - a.
  - b.
6. Why is coal involved in the discussion of acid rain?
7. What is NAPAP and what does it do?
8. What is global climate change?
9. Describe the "greenhouse effect."
10. Name two greenhouse gases:
  - a.
  - b.

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