**Joint Scientific Statement**

**Jessie**

**Describe the process of coal combustion.**

- What are the products, reactants, energy released in a balanced chemical equation? How much of the reactants are necessary to produce a kilowatt-hour of electrical energy? How much of the products are made per kilowatt-hour?
- What byproducts or unconsumed reactants remain at the end of the combustion process?
- Demonstrate that mass is conserved in this process.
- Demonstrate that energy is conserved in the process.

The chemical formula for coal is as follows(Carnegie Mellon):

$C + O_2 \longrightarrow CO_2$

It takes as much energy to form a bond as it does to break a bond. Energy is conserved through this reaction because when the coal is burned the bond between the carbon breaks, resulting in the absorption of energy and when the new bonds are formed between the carbon and oxygen, energy is released. During this process no energy is gained or lost, it just changes forms. The total net energy released when the bonds break in a coal combustion is 354 kcal/mole.
It requires approximately 430.12 grams of coal to produce one kilowatt-hour. Originally coal has a heat combustion of 27.00 kJ/g (27,000 J/g) but due to the fact that there is only a 31% efficiency rate of coal power plants (EurActive), there is only a quantity of 8370 J/g.
In addition to the conservation of energy , it is also seen that mass is conserved in this process due to the fact that on both the reactant and products side, there are the same number of carbon and oxygen molecules present.

At the end of the coal combustion process, multiple byproducts remain. One byproduct is a blend of sulfur and nitrogen dioxide, which are two chemicals that contribute to producing acid rain. Burning coal to produce a source of energy creates an ash residue called Coal Combustion Byproducts (CCB). CCBs include fly ash, flue gas desulfurization, bottom ash and slag (MCR). Fly ash, also called flue-ashe, consists of tiny particles that rise with the flue gases (Consumers Energy) and are filtered so to speak through an air cleanser called an Electrostatic Precipitator. An Electrostatic Precipitator uses an electrostatic charge to pull fine matter such as dust and

ash from the flue gas rising in the power plant (Smith). These substances are eventually cleaned from the smokestacks and then transported in its dry form to landfills to reduce the risk of leakage and storage dike failure. The ashes that do not rise are referred to as bottom ashes. Bottom ashes fall into water to be cooled. These clinker (waste) clumps get crushed under water by the clinker grinders where they then fall into a trough and are turned into slag (molten bottom ash) and ejected into a sump or cesspool. The clinker is then pumped through rotary pumps into a waste yard. Though this is still a popular way of handling the bottom ash, a more modern system is used that consists of a chain conveyor that is placed under water below the furnace and collects the cooled bottom ash, removes it and puts it into storage silos. Though bottom ash is typically disposed of, it can be used as an "aggregate" in construction,cement and snow and ice traction control material (Environmental Protection Agency).

## Resources


"Analysis: Efficiency of Coal-fired Power Stations – Evolution and Prospects." *EurActiv.com*. N.p., n.d. Web. 20 Apr. 2013. <http://www.euractiv.com/energy/analysis-efficiency-coal-fired-power-stations-evolution-prospects/article-154672>.

"Boiler Slag | Coal Combustion Products Partnership | US EPA." *EPA*. Environmental Protection Agency, n.d. Web. 20 Apr. 2013. <http://www.epa.gov/osw/conserve/imr/ccps/boilslag.htm>.

"Environmental Decision Making, Science, and Technology." *Environmental Decision Making, Science, and Technology*. N.p., n.d. Web. 19 Apr. 2013. <http://telstar.ote.cmu.edu/environ/m3/s3/09fossil.shtml>.

"Coal Combustion Byproducts." *Home*. N.p., n.d. Web. 19 Apr. 2013. <http://www.consumersenergy.com/content.aspx?id=3254>.

"Coal Combustion By-products (CCB's) Include:." *Coal Combustion By-Products*. N.p., n.d. Web. 19 Apr. 2013. <http://www.mcrcc.osmre.gov/MCR/Resources/ccb/ccb-1.shtm>.

**Helen**

**What are local environmental consequences to mining of coal?**

The basic principle of coal mining is to expose it, break it up, and then haul it off to be burned. The act of exposing coal is where many of the consequences to the environment occur. There are two common ways to mine coal: underground mines and surface mines. The main issue with surface mines is the vast amount of land that they require. These vast amounts of land are often interspersed with various ecosystems and habitats. When a mine operation comes in it introduces roads, wipes out flora and fauna, and causes instability within the environment (Jacqueline Lerche). According to the Union of Concerned Scientists,

About 60% of U.S. coal is stripped from the earth in surface mines; the rest comes from underground mines. Surface coal mining may dramatically alter the landscape. Coal companies throughout Appalachia often remove entire mountain tops to expose the coal below. The wastes are generally dumped in valleys and streams...In West Virginia, more than 300,000 acres of hardwood forests (half the size of Rhode Island) and 1,000 miles of streams have been destroyed by this practice.

Underground mining, however, poses a different set of consequences to the environment. One of the more impactful problems is “mine subsidence”. Mine subsidence is the the sinking of surface ground as a result of the removal of the coal. These consequences from underground mines do not vanish when the mining operations leave, but remain for decades after. The soil becomes damaged to the point where it is near impossible to reseed (GreenPeace Web). The former environment is replaced by the mine’s “trash” such as “pits, quarries, and tailing piles” (Martha Keating).

The process of mining coal has many effects on both surface water and groundwater. A major problem with coal mining is the pollution of water with something called acid mine drainage (AMD). AMD is essentially water that is rich with metals, formed in a reaction between water and rocks that contain sulphur bearing minerals. Coal mining exposes rocks that contain pyrite, which is a sulphur bearing mineral. When water comes in contact with this pyrite, a reaction between the water, oxygen and the pyrite occurs, turning the water acidic. This acidic runoff then interacts with other metals and, because of its acidity, dissolved metals such as lead, mercury, and arsenic. This toxic water ends up contaminating both ground and surface water, eventually spreading into lakes and streams and throwing the pH off balance (World Coal Web). As a result, there has been recent concern about the mercury levels found in

fish in various lakes and reservoirs, likely caused by coal mines (Dale Rodebaugh). Along with AMD, there is also a substantial amount of waste made up of coal dust, various chemical agents used and sediments. This liquid waste, commonly known as “slurry” or “coal sludge” is either injected into vacant underground mines, leading to groundwater contamination, or it is washed away in the rain, contaminating surface water (Plundering Appalachia). Lastly, a common problem is the large quantity of water, taken from local ecosystems, that is used in the mining process. This upsets aquatic life, life on land, and diminishes the water resource for the local people (Jacqueline Lerche).

Another valid concern about the process of mining coal is the effect on air quality. 6People often talk about the $CO_2$ emissions produced in the burning and combustion of coal, but there is actually another harmful gas that is released in the mining process: methane ($CH_4$). This gas is considered a greenhouse gas, and is 23 times more harmful than $CO_2$ because it traps more heat and radiation (EPA Gov Web). It is released from the disturbed layer of rock at the mining site, as well as from the coal seam. The further down you go, the higher the methane content and so underground mines create far more methane emissions. There are, however, techniques that can be used to recover some of this methane. The recovery of this methane is important for stopping global warming because methane has a shorter life span, meaning that it causes more damage over a shorter period of time (World Coal Web). Another pollutant of the air quality is the dust that comes from coal. The coal dust is spread through the air and enters into the environment affecting plants, animals and humans. A study performed in 2001 found that there was a higher rate than normal of cardiopulmonary disease, chronic obstructive pulmonary disease, hypertension, lung disease, and kidney disease among residents who live near coal mines (GreenPeace Web).

REFERENCES:

"Coal Mining & the Environment." *World Coal Association*. N.p., n.d. Web. 24 Apr. 2013.

<http://www.worldcoal.org/coal-the-environment/coal-mining-the-environment/>.

"Cradle to Grave. Coal's Deadly Legacy." *Plundering Appalachia - The Tragedy of*

*Mountaintop-Removal Coal Mining :: The Issue*. N.p., n.d. Web. 24 Apr. 2013.

<http://www.plunderingappalachia.org/theissue.htm>.

"Environmental Impacts of Coal Power: Fuel Supply." *Union of Concerned Scientists*. N.p., n.d. Web. 24 Apr. 2013. <http://www.ucsusa.org/clean_energy/coalvswind/c02a.html>.

Lerche, Jacqueline. "Positives & Negatives of Coal Energy Sources | National Geographic." *Green Living on National Geographic*. N.p., n.d. Web. 24 Apr. 2013. <http://greenliving.nationalgeographic.com/positives-negatives-coal-energy-sources-2554.html>.

"Methane Emissions." *EPA*. Environmental Protection Agency, n.d. Web. 25 Apr. 2013. <http://epa.gov/climatechange/ghgemissions/gases/ch4.html>.

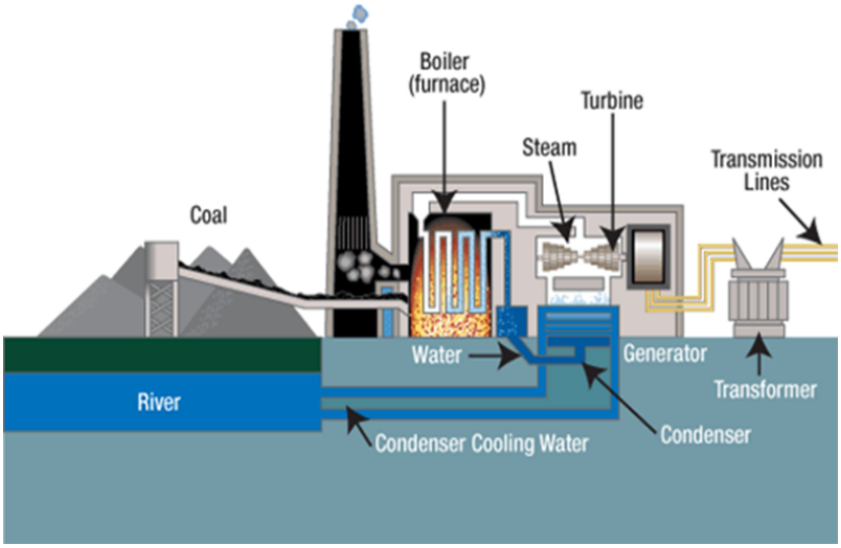
"Mining Impacts." *Greenpeace International*. N.p., 15 Apr. 2010. Web. 24 Apr. 2013. <http://www.greenpeace.org/international/en/campaigns/climate-change/coal/Mining-impacts/>.

Rodebaugh, Dale. "Mercury Danger to Undergo More Study." *The Durango Herald*. N.p., 15 Dec. 2011. Web. 24 Apr. 2013. <http://www.durangoherald.com/article/20111215/NEWS01/712159920>.

**Brittney**

**Describe the design of a coal power plant. Your description should at least include the pulveriser, furnace/boiler, turbine, generator, condenser and ash removal.**

In a coal power plant, the coal is first pulverized by crushing, impact and rubbing it to make it into a finer than face powder then transports the coal into a furnace. The heat from the coal travels to water-filled pipes which are located on the furnace walls. The furnace-boiler vaporizes the water into steam which is passed through to the turbine. The turbine shares a common shaft with the generator that produces electric energy in the form of voltage and current. The condenser is a heat exchanger, where it is liquefied in tubes by a near by a water source(EPA). After the coal is burnt, the ash from the coal is charred in boilers that generate for power generation and industrial applications(Arizona).




References:

**1.) "Coal Ash." *EPA*. Environmental Protection Agency, 30 Oct. 2012. Web. 17 Apr. 2013. <http://www.epa.gov/radiation/tenorm/coalandcoalash.html>**

**2.) "Coal-fired Power Plant ." Arizona State University . Arizona . . Web. 17 Apr. 2013. <http://holbert.faculty.asu.edu/eee463/coal.html >**

**3.)*Coal Power Plant*. N.d. Photograph. Web. <https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcRbHK3YQ4OIJOnu9NHLCiBylf**

**India Waller:**

What are the local environmental consequences associated with combusting coal?

**How is the air quality in the vicinity of the San Juan Generating Station affected by the combustion of coal?**

The main pollutants produced in the process of burning coal are carbon dioxide, sulfur dioxide, nitrogen oxide compounds and mercury. Carbon Dioxide is the most common greenhouse gas and is the leading cause of global warming. As the Union of Concerned Scientist states, "In 2011, utility coal plants in the United States emitted a total of 1.7 billion tons of CO2. A typical coal plant generates 3.5 million tons of CO2 per year"(Nydick). Sulfur dioxide is released as well when coal is burned because of the impurities found in the coal. This is a pollutant that causes acid rain which can damage crops, forest and soil. It also raises the acidity of rivers, lakes and ponds. According to the Union of Concerned Scientist, "A typical uncontrolled coal plant emits 14,100 tons of SO2 per year. A typical coal plant with emissions controls, including flue gas desulfurization (smokestack scrubbers), emits 7,000 tons of SO2 per year" (Nydick). Nitrogen oxide is also produced when coal is burned. Nitrogen is another element that is considered an impurity in the coal. This pollutant is the primary contributor to what is called smog which is basically a ground level ozone made up of chemicals and smoke. Smog can cause damage to forests and crops, in fact it is thought that because of ground level ozone $500 million dollars is lost in crop production each year (Nydick). According to the Union of Concerned Scientist, "A typical uncontrolled coal plant emits 10,300 tons of NOx per year. A typical coal plant with emissions controls, including selective catalytic reduction technology, emits 3,300 tons of NOx per year"(Environmental). Mercury is also produce in the process of burning coal. This pollutant is a toxic heavy metal that can have severe health risks and is very problematic when it enters a water supply. Also according to the Union of Concerned Scientists, " A typical uncontrolled coal plants emits approximately 170 pounds of mercury each year. Activated carbon injection technology can reduce mercury emissions by up to 90 percent when combined with baghouses. ACI technology is currently found on just 8 percent of the U.S. coal fleet" (Environmental). An active carbon injection is basically when carbon is injected into the pipes carrying the smoke from the coal combustion. Carbon has a lot of surface area which

makes it ideal for the use of removing pollutants from the smoke. Because carbon has so many nicks and crannies the pollutants get stuck in the carbon. The carbon containing the pollutants is then filtered out of the smoke emitted (Smith).

**How is the surface water quality affected by the combustion of coal?**

The two pollutants produced when coal is burned that most affect the the surrounding surface water are mercury and sulfur dioxide. The burning of coal puts pollutants in the air which are then precipitated to the lakes, rivers, ponds, etc. Sulfur dioxide increases the acidity level in surrounding water. This can create an inhospitable environment for the fish and other organisms that reside in these bodies of water. Mercury also leaches into the water supply causing high concentrations to be seen in fish and other aquatic life. In fact, "In the southwestern corner of Colorado, south and west of the San Juan Mountain range, fish from five reservoirs have been tested for mercury and all five now are listed for fish consumption advisories (McPhee, Naraguinnep, Totten, Vallecito, and Navajo Reservoirs). Across the border in northwestern New Mexico, nine water bodies have mercury consumption advisories."(Wright). In the areas stated above the fish have such high concentrations of mercury that they are unsafe to eat. In the study "Fate and Transport of Mercury in the Four Corners Region of Southern Colorado" by Mountain Studies Institute it is states, "The results of these studies indicate that mercury (Hg) flux rates are 1.6 to 3 times greater than pre-industrial periods, and that, generally when storms deposit Hg in the San Juan Mountains those storms pass over areas to the south and southwest, where many of the largest Hg emitting coal-fired power plants are located." All these pollutants being released from the power plants in our region affect the health of our region, and affect the health of the citizens. As we see in a summary done by Mountain Studies institute, "Ground-level ozone is close to exceeding the standard for human health, fish consumption advisories for mercury exist on many reservoirs, visibility often is impaired, and concentrations of nitrogen compounds in rain and snow are rising."(Nydick).

**What are the health effects of the air and water pollution from a coal fired power plant?**

Sulfur dioxide in the form of acid rain can cause health problems such as asthma and bronchitis. The acid rain itself is not dangerous, in fact you could swim in it without causing harm, it is the particles transported through the rain that is the problem. When these particles are inhaled that can cause lung and heart problems. Nitrogen oxide in ground level ozone can cause lung inflammation, including asthma, emphysema, and make people more susceptible to chronic respiratory diseases. This ozone is created when nitrogen oxide reacts with reactive organic compounds (Effects). Mercury is usually introduced to a human system through the ingestion of fish or other aquatic organisms, not through inhalation. Everyone has a certain level of mercury in their tissue. The chemical form of mercury, the dose, the age of the person exposed (the fetus is the most susceptible), the duration of exposure,the route of exposure (inhalation, ingestion, dermal contact, etc.), and the health of the person exposed are all factors considered when the Environmental Protection Agency (EPA) assesses the health risks. Methylmercury, one form of mercury, is known to damage the nervous system. A lot of the methylmercury effects are seen in the defects of babies because the mother was exposed to the toxin. These defects come in the form of damage to the nervous system and brain damage. Elemental mercury is another form of mercury that at high exposure can cause kidney problems, respiratory failure and death. This form usually enters the body through inhalation. Mercury compounds (inorganic and organic) cause issues in the gastrointestinal tract, the nervous system, and the kidneys. The mercury is absorbed when it is ingested (Effects). Statistics from the Sierra Club Adress more closely the local affect of the San Juan Generating Station "According to the San Juan Citizens Alliance, each year the plant's air pollution contributes to 33 premature deaths, 600 asthma attacks, 31 asthma-related emergency room visits, and other health impacts, at an estimated cost of more than $254 million" (Perla).

**How does the disposal of coal combustion byproducts affect the local environment?/In what manner are the coal combustion byproducts from the San Juan Generating Station disposed?**

Waste product from the burning of coal is made up of bottom ash, the pollutants taken

from the scrubbing of the fly ash, and boiler slag. The toxins extracted from the fly ash are the pollutants talked about above. If they leach from their place of disposal than they will have the negative effects d“Selenium in certain types of WMUs managing certain types of CCW may present a risk of clinical selenosis to highly exposed groundwater users or fish consumers, or a risk of adverse effects to highly exposed aquatic receptors. Arsenic in certain types of WMUs managing certain types of CCW may present lifetime cancer risks above EPA’s range of concern to highly exposed groundwater users.” discussed. The bottom ash is made up of minerals and some heavy metals such as selenium and arsenic. This waste is deposited in abandoned mines, and other area’s of land dictated as waste management units. As far as I can tell there are few restrictions on where these units can be established. There are different levels of leakage prevention, one being unlined pits, another being clay-lined pits, and another is a composite liner. The clay-lined pits do have lower risk than unlined pits but they still do not meet the standards of the Environmental Protection Agency (EPA). Here is the risk assessment done by the EPA of the two heavy metals found in coal combustion waste that offer the most concern: In this study it was concluded that more regulation must be put in place requiring higher end containing equipment such as composite liners, a high desity polyethelyne combined with either geosynthetics or natural clays, to reduce the risk associated with coal combusiton waste (Human).

"Effects of Acid Rain - Human Health." *EPA*. Environmental Protection Agency, 4 Dec. 2012. Web. 28 Apr. 2013. <http://www.epa.gov/acidrain/effects/health.html>.

"Environmental Impacts of Coal Power: Air Pollution." *Union of Concerned Scientists*. N.p., 2012. Web. 28 Apr. 2013. <http://www.ucsusa.org/clean_energy/coalvswind/c02c.html>.

"Human and Ecological Risk Assessment of Coal Combustion Waste." U. S. Environmental Protection Agency, Apr. 2010. Web. 28 Apr. 2013. <http://earthjustice.org/sites/default/files/library/reports/epa-coal-combustion-waste-risk-assessment.pdf>.

Nydick, Koren. "How's the Air Out Here? Outdoor Air Quality in the Eastern Four Corners Region." *Mountain Studies Institute*. Environmental Protection Agency, Mar. 2009. Web. 28 Apr. 2012. <http://www.mountainstudies.org/sites/default/files/pdf/education/Air_Quality_Book_2009.pdf>.

Perla, Miguel. "San Juan Generating Station California's Dirty Coal Secret." *Sierra Club*. N.p., n.d. Web. 28 Apr. 2013. <http://www.sierraclub.org/designarchive/factsheets/beyondcoal/120%20San%20Jua n/high120_SanJuanGenerating_FactSht.pdf>

Wright, Winfield G. "Sources of Atmospheric Mercury Concentrations and Wet Deposition at Molas Pass, Southwestern Colorado." *Mountain Studies Institute*. U.S. Forrest Service, 2011. Web. 28 Apr. 2013. lorado.pdf><http://www.mountainstudies.org/sites/default/files/pdf/research/mercury/Sources%20of%20Atmospheric%20Mercury%20Concentrations%20and%20Wet%20Deposition%20at%20Molas%20Pass%2C%20Southwestern%20Co

**Elizabeth**

**Describe the science involved in global climate change and how it relates to emissions from coal power plants.**

What is the greenhouse effect?

The Greenhouse effect is a process where planetary surface radiation is absorbed by the greenhouse gases in the Earth's atmosphere which is then re-radiated in all directions. In other words, when the sun radiates energy towards the Earth, the energy is re-radiated off the ground and absorbed by the greenhouse gases in the atmosphere. The way humans are altering this

process is by creating more greenhouse gases to accumulate in the atmosphere. Because of the large amount of greenhouse gases, more infrared radiation is being trapped and the Earth's atmosphere is warming because of that.

What are greenhouse gases and what about their structure makes them greenhouse gases?

Greenhouse gases are gases in the atmosphere that absorbs and emits thermal infrared radiation both from ground emissions and the Sun. Their structure allows them to absorb certain wavelengths that come through them. The sun's UV rays go right through the gases while the infrared radiation gets trapped, thus causing warmer atmospheric temperature. The reason why infrared radiation gets trapped in carbon dioxide is because of the vibrational energy the atoms give off. The vibrational energy is such that the infrared radiation gets trapped inside the carbon dioxide and it radiates onto the Earth's surface. The primary greenhouse gases are water vapor, carbon dioxide, methane, nitrous oxide and ozone. We are not too worried about water vapor because even though it is a more potent greenhouse gas, it doesn't last very long in the atmosphere. Burning fossil fuels such as coal create large amounts of greenhouse gases. Burning coal releases carbon dioxide into the Earth's atmosphere which directly affects it in the way of the greenhouse effect.

How is the combustion of fossil fuels related to global climate change?

Hydrocarbon -
A chemical compound that is made up of only carbon and hydrogen

Coal is a hydrocarbon, and the result of combusting a hydrocarbon is carbon dioxide. That carbon dioxide rises into the Earth's atmosphere and joins the other greenhouse gases, able to absorb more infrared radiation.

How do the combustion emissions of coal compare to that of natural gas and of nuclear?

Coal emissions differ from natural gas by how many pounds of $CO_2$ are being produced.
This chart below comes from http://www.eia.gov/tools/faqs/faq.cfm?id=73&t=11

This shows how many pounds of $CO_2$ are being emitted per million Btu of energy

(British thermal unit. = 1055 joules)

| | |
|---|---|
| **Coal (anthracite)** | **228.6** |
| **Coal (bituminous)** | **205.7** |
| **Coal (lignite)** | **215.4** |
| **Coal (subbituminous)** | **214.3** |
| **Diesel fuel & heating oil** | **161.3** |
| **Gasoline** | **157.2** |
| **Propane** | **139.0** |
| **Natural gas** | **117.0** |

As you can see, coal has a far higher CO2 level.

Coal emissions differ from nuclear because again, it is much filthier. Coal emissions contain carbon dioxide and emissions from nuclear power contain no carbon dioxide whatsoever. Because the way a nuclear power plant works, there are no emissions caused by the heating of the uranium rods inside the reactor.

Sources -

"Greenhouse Gas." *Wikipedia*. Wikimedia Foundation, n.d. Web. 24 Apr. 2013.

"Emissions." *EPA*. Environmental Protection Agency, n.d. Web. 24 Apr. 2013.

"The Greenhouse Effect." *National Geographic*. National Geographic, n.d. Web. 24 Apr. 2013.

Nave, R. "Greenhouse Effect." *The Greenhouse Effect*. N.p., n.d. Web. 24 Apr. 2013. <http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/grnhse.html>.

"Fossil Fuel." *ScienceDaily*. ScienceDaily, n.d. Web. 24 Apr. 2013. <http://www.sciencedaily.com/articles/f/fossil_fuel.htm>.

"Fossil Fuel." *Wikipedia*. Wikimedia Foundation, n.d. Web. 24 Apr. 2013. <http://en.wikipedia.org/wiki/Fossil_fuel>.

"Hydrocarbon." *ScienceDaily*. ScienceDaily, n.d. Web. 24 Apr. 2013. <http://www.sciencedaily.com/articles/h/hydrocarbon.htm>.

"British Thermal Unit." *Wikipedia*. Wikimedia Foundation, n.d. Web. 24 Apr. 2013. <http://en.wikipedia.org/wiki/British_thermal_unit>.

*Www.eia.gov*. U.S. Energy Information Administration, 4 Mar. 2013. Web. 24 Apr. 2013. <http://www.eia.gov/tools/faqs/faq.cfm?id=73>.

Matthews, Mike, and Demand Media. "Which One Is Better for the Environment: Coal or Nuclear? | National Geographic." *Green Living on National Geographic*. National Geographic, n.d. Web. 24 Apr. 2013.

<http://greenliving.nationalgeographic.com/one-better-environment-coal-nuclear-20469.html>.

Brian, Marshall, and Robert Lamb. "How Nuclear Power Works." *HowStuffWorks*. How Stuff Works, n.d. Web. 24 Apr. 2013. <http://www.howstuffworks.com/nuclear-power2.htm>.

"Air Emissions." *EPA*. Environmental Protection Agency, 17 Oct. 2012. Web. 24 Apr. 2013. <http://www.epa.gov/cleanenergy/energy-and-you/affect/air-emissions.html>.

.<http://en.wikipedia.org/wiki/Coal>.

(2)"Peat." *Wikipedia*. Wikimedia Foundation, 26 Apr. 2013. Web. 30 Apr. 2013. <http://en.wikipedia.org/wiki/Peat>.

(3)"Lignite." *Wikipedia*. Wikimedia Foundation, 19 Apr. 2013. Web. 30 Apr. 2013. <http://en.wikipedia.org/wiki/Lignite>.

(4) "Sub-bituminous Coal." *Wikipedia*. Wikimedia Foundation, 27 Apr. 2013. Web. 30 Apr. 2013. <http://en.wikipedia.org/wiki/Sub-bituminous_coal>.

(5) "Bituminous Coal." *Wikipedia*. Wikimedia Foundation, 27 Apr. 2013. Web. 30 Apr. 2013. <http://en.wikipedia.org/wiki/Bituminous_coal>.

(6) "Coal." *Wikipedia*. Wikimedia Foundation, 28 Apr. 2013. Web. 30 Apr. 2013. <http://en.wikipedia.org/wiki/Coal>.

**Kaylee**

·**Chemically, what is coal? Your answer should include a classification as an element, compound or mixture, the appropriate chemical formula(s) and percentages/classifications if relevant.**

(1)Coal is carbon with a mixture of hydrogen, sulfur, oxygen and nitrogen. It is black or a brownish black color. There are also different types of coal, they are, (2) Peat which is also known as turf comes from vegetation that has somewhat decayed.(3) Lignite coal is just another way to say brown coal. (4)Sub-bituminous coal is another type of that have similar properties to lignite coal and bituminous coal. (5)Bituminous coal is a black type of coal that has tar like characteristics. (6) Steam coal is a type of coal that is safe to use under steam

boilers. (7)Anthracite coal is a very hard type of coal that has close to pure carbon and does not require much of a flame and does not produce much smoke. (8) Graphite coal is considered the coal that is the highest grade.() It is the biggest source of energy that we have.

(1)"Coal."*Wikipedia*.WikimediaFoundation,9Apr.2013.Web.24Apr.2013

(7) "Anthracite." *Wikipedia*. Wikimedia Foundation, 27 Apr. 2013. Web. 30 Apr. 2013. <http://en.wikipedia.org/wiki/Anthracite>.

(8)https://en.wikipedia.org/wiki/Graphite

(9)"Coal: The Cleanest Energy Source There Is?" *Fox News*. FOX News Network, 20 Feb. 2013. Web.24Apr.2013.<http://www.foxnews.com/science/2013/02/20/coal-cleanest-energy-source-there-is/>.

· **What are the best estimates for the purely financial cost of coal generated electricity?**

o Per kilowatt-hour? Per Power Plant?

(1)Coal is an energy source that is quickly growing. Per kilowatt-hour the price of coal is estimated to be, $ 0.027 kWh. (2)It has been estimated that the cost of coal per power plant in the United States would be around 2.09 billion per million BTU. Which would be 2.08 per kilowatt hour.

(1)"Costs of Coal-fired Electricity - World Coal Association." *Costs of Coal-fired Electricity - World CoalAssociation*.N.p.,n.d.Web.24Apr.2013.<http://www.worldcoal.org/resources/ecoal-archive/ecoal-current-issue/costs-of-coal-fired-electricity/>.

(2)"Existing U.S. Coal Plants." - *SourceWatch*. N.p., n.d. Web. 24 Apr. 2013. <http://www.sourcewatch.org/index.php?title=Existing_U.S._Coal_Plants>.

**Jess**

**Describe where coal is found and how it is mined.**

Coal is mostly found and mined in North America but can also be found in the USSR, China, Asia and oceania, India, EU, Africa, and South America. Within these countries Coal is found underground but before anyone can mine a map has to be made to show how big the area is going to be for workers to mine. Then the construction workers send out surveys and start exploration drilling which shows the areas that will be developed. The mining process begins if

the area is big enough and the coal is the right quantity and all of the above is approved.

**There are several mining methods that should be addressed.**

There are several different types of mining under the topic of surface mining and underground mining. Both consist of different types of equipment and ways that are used to extract coal. Before humans had high tech equipment they used picks, shovels, and wheelbarrows. Now miners cut mining; this method uses excavators to cut away at the topsoil, removing the overburden (waste or soil), coal mining (using front and back loaders), and then transportation. While those are methods of surface mining another method type is underground mining. There are two types of underground mining one is soft rock and the other is hard rock. The difference between the two is that soft rock underground mining is for coal, oil shale, and other minerals, while hard rock mining is mostly for metals. Soft rock underground mining consists of longwall mining (gigantic blocks of coal extracted from the earth), room and pillar mining (using pillars to support rooms that are being mined), blast mining (using dynamite), shortwall mining (machines that are continuously mining), and coal skimming (using water for separating lighter coal). But the most common type of mining is open pit, also known as opencast mining, open-cut mining, and strip mining. This is where mammoth equipment dig into the earth (Figure 1) creating a man made crater with ridges along the side making it looks like a 3d topo map (Figure 2). The equipment will extract the hard rock and transport it to locations. This method has the least radiation hazard, lower than underground mining.

Figure 1

Figure 2

**What steps have coal power plants taken to reduce emissions?**

The steps that coal power plants have taken to reduce emissions are the advancement of technology which has helped mining coal industries by limiting the amount of sulfur, nitrogen, other elements, carbon dioxide, and methane in emissions. By taking control of the emissions the pollution won't have such an effect on the environment especially in developing

countries.  One way to trap carbon dioxide is to capturing the carbon dioxide from burning coal and then placing it back into the ground in gigantic holders from there the carbon dioxide can be used to maintain oil and gas extraction this is called enhanced oil recovery. Although this project will take 10 years to complete the International Energy Agency predicts the results of the project will be significant and coal will become a secondary use by 2020. Another way to delay coal emissions is to use the sunlight. Scientists have found an organic metal framework that can be used to store the gases released by the coal when the sunshines the gases are leased. When the MOF (metal organic framework) is triggered by the sun it releases the suitable amount of carbon dioxide in the atmosphere.

**References:**


("Coal is mostly found and mined in North America...")*World Coal Association* . N.p., n.d. Web. 17 Apr. 2013. <http://www.worldcoal.org/>.
<http://www.bulgacoal.com.au/EN/mining/Pages/OpenCutMining.aspx>.

**("**Soft rock underground mining consists of longwall mining..."))N.p., n.d. Web. 17 Apr. 2013. <http://en.wikipedia.org/wiki/Underground_mining_(soft_rock)>.

**("**Now miners cut mining; this method uses excavators to cut away at the topsoil...") *New South Wales Minerals council LTD*. N.p., n.d. Web. 17 Apr. 2013. <http://www.nswmin.com.au/Mining-in-NSW/About-the-Industry/How-we-mine/Mining-Methods/How-We-Mine---Mining-Methods/default.aspx>.

**("**Although this project will take 10 years to complete...")Owen, James. *Clean Coal? New Technology Buries Greenhouse Emissions*. N.p., 2 May 2006. Web. 18 Apr. 2013. <http://news.nationalgeographic.com/news/2006/05/0502_060502_coal.html>.

**("**When the MOF (metal organic framework) is triggered...")*Science Daily: Carbon Sponge Could Soak Up Coal Emissions*. N.p., n.d. Web. 21 Feb. 2013. <http://www.sciencedaily.com/releases/2013/02/130212100602.htm>.

**(“**The equipment will extract the hard rock and transport it to locations...”) *Great Mining* . N.p., n.d. Web. 24 Apr. 2013. <http://www.greatmining.com/open-pit-mining.html>.

**(“**The equipment will extract the hard rock and transport it to locations…”)*ARMZ Uranium Holding Co.*. N.p., 2013. Web. 24 Apr. 2013. <http://www.armz.ru/eng/uranium_mining/uranium_mining/open_pit_underground_mining/>

**(Figure 1)** *Marston - Mining Engineers and Consultants*. 2012. Art.

**(FIgure 2)** *SuperStock Stock Photography: Heavy equipment working at a open pit mine near Elko. Nevada, USA*. 2013 . Art.