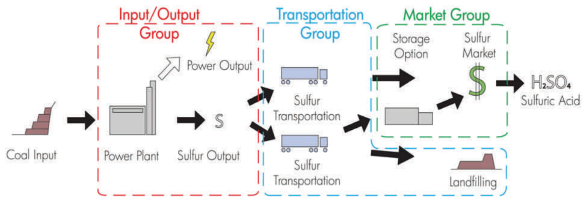
Coal Gasification Power Plant



Outputs and Inputs

The power plant produces 22,000 tons of sulfur per year from 3.4 million tons of coal. The amine process costs up to $2 million per year.

Disposal

The disposal cost would be $46 per ton. It would cost $1,022,851 to dispose of all the sulfur produced by one plant.

Transportation

The maximum truckload is 20 tons, which is shipped at a rate of $1.40 per mile. This shipping price is slightly higher because sulfur is considered a hazardous material and needs to be heated. The total cost to transport sulfur is $240,000.

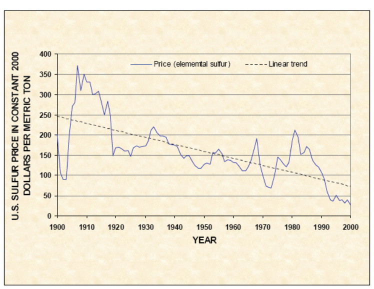


Figure G2. U.S. sulfur price, in constant 2000 dollars, 1900-2000 (data from Buckingham and Ober, 2001).

[Source: Economic Drivers of Mineral Supply
U.S. Geological Survey Open-File Report 02-335
Lorie A. Wagner, Daniel E. Sullivan, and John L. Sznopek, p. 256]

Sulfur Market

As the graph above shows, the price of sulfur has been steadily declining for decades. However, there has been a spike increase in its price recently which shows that the market can be erratic. $10 million of revenue can be made from the most recent sulfur price.

Findings

From our analysis, elemental sulfur has the potential to be cheaper or more profitable than gypsum. Also, if a coal with a higher concentration of sulfur is used, the effect of sulfur costs on the operating system could be even greater. These findings alone though do not do enough to justify one type of power plant over another.

The markets for coal power generation byproducts are highly variable and not a good source for a stable income. The sulfur and gypsum byproducts have the potential to make money for power plants, but not reliably. Byproduct markets have no base cost, since there are minimal production costs. Also the supply of the byproducts cannot be easily controlled.

Applied to the nation at large, this analysis could have very different answers. If 100 percent, or even fifty percent, of the country's coal power production were switched to gasification, the sulfur market would be flooded with more sulfur than could be sold, and the price of sulfur would drop. At the same time, gypsum prices could rise in accordance with lower gypsum production.

Our IPRO is part of a larger analysis being conducted by Sargent and Lundy. Our results cannot recommend one technology over the other, but they will be combined with others to create a more complete picture.

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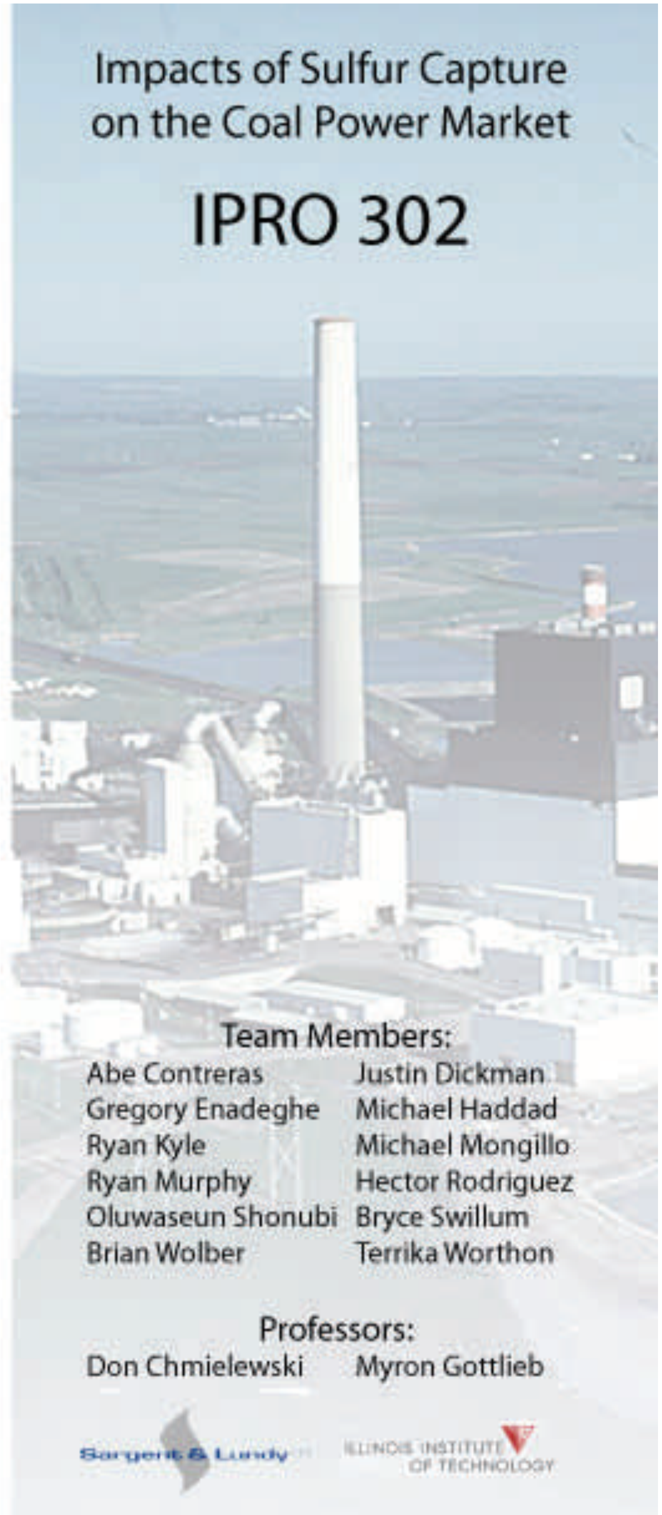

Impacts of Sulfur Capture on the Coal Power Market

IPRO 302

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Overview of Coal Power Plants

Coal is and will still be a viable fuel source for our nation's power system. Coal is abundant within the United States and can be purchased cheaply. The newest issue in coal power is the control and capture of CO_2 emissions. The Environmental Protection Agency (EPA) already has standards set up with the removal of other byproducts produced by the power plants, but may start regulating CO_2 output as well.

All coal contains sulfur that must be removed before entering the atmosphere. The current coal power plants pulverize the coal to be burned as its fuel source which needs high concentrations of oxygen. The pulverized coal power plant produce sulfur oxides (SO_2) when the coal is burned which must be collected. These are collected by submitting the SO_2 to a limestone slurry ($CaCO_3$) based in a Flue Gas Desulfurization (FGD) tower. The SO_2 and limestone react together to form large quantities of gypsum ($CaSO_4$).

A new type of power plant has come about recently that uses a gasification process to burn the coal. This is an Integrated Gasification Combined Cycle (IGCC) power plant where the coal is burned at extremely high pressures and has limited or controlled availability of oxygen. The partially burned coal turns into a gas that is fully burned later. The sulfur is removed from the gas by combining with hydrogen, which is later removed, called the Claus Process. The byproduct is in the form of elemental sulfur. This process is around 10% more efficient than the conventional coal power plant. Also, the CO_2 produced by this plant can be easily captured and stored underground if required by federal regulations in the future.

The differences between the two types of power plants are raising questions about which type will be better off in the long run. Sargent and Lundy is currently analyzing the costs and benefits of the two types of power plants in order to determine which type is more economical to build and operate. They are an energy consulting firm based in Chicago, and work with all different forms of energy production.

Methodology

Purpose

The part of Sargent and Lundy's analysis we provided was the comparison of the environmental and economic aspects of sulfur removal from the two different types of power plants. The two types of power plants each produced 600 MW of usable power.

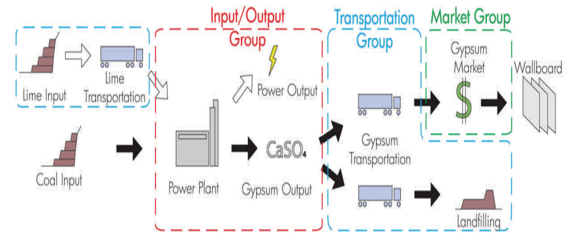
In order to complete this, we needed to develop a basic understanding of how each power plant system worked, calculate the amount of material needed and produced by each plant, and determine how to dispose of the material by either selling or land filling it.

Challenges

One issue we had when starting the IPRO was limiting the scope of our analysis. We believed we were to look at the entire system including the efficiency of removal, what types of systems used, and all the environmental aspects involved. Our sponsor, Sargent and Lundy, narrowed our scope to just the sulfur removal process.

From the many ethical issues we faced, the most important for us was making sure we used the correct information. The correct information was hard to find because different sources gave different numbers and not all the sources gave the most up to date information. We were able to overcome this issue by verifying the information with multiple sources.

Pulverized Coal Power Plant



Inputs and Outputs

The pulverized coal plant produces 46,000 tons of SO_2 per year from 3.6 million tons of coal. The SO_2 is then combined with 73,000 tons of $CaC0_3$ to produce 125,000 tons of gypsum per year. The removal system costs $6 million per year.

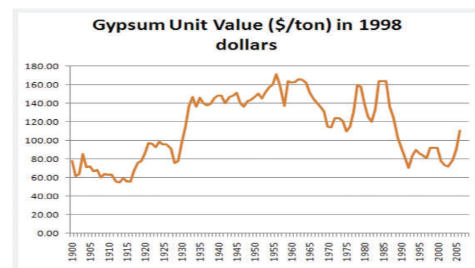
Disposal

The rate to dispose of gypsum is $20 per ton. It would cost $2,500,000 to dispose of all the gypsum produced.

Transportation

The maximum truckload is 25 tons and is currently shipped at a rate of $1.25 per mile. The total cost per year to transport the limestone to the power plant is $730,000. The total cost per year to transport the gypsum is $2,700,000 for a 430 mile trip.

Gypsum Market



As the graph above shows, the price of gypsum fluctuates greatly and does not allow for a consistent annual profit to be made. This is mostly because the price fluctuates with the housing market. From the 2007 data, $10.6 million of revenue can be made by selling all the gypsum produced.