Quantified Benefits of Co-firing Biomass with Coal for Economic and Pollutant Relief
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Abstract
With the concentration of carbon dioxide and global temperatures rising together, it is well documented that greenhouse gases, most infamously carbon dioxide, have an anthropogenic source of rising concentrations known as, global warming. The main source of GHG's is combustion of fossil fuels, such as coal, in order to generate power. With a significant portion of US power generation dependent on coal, mostly from electricity generation, replacing all coal in power plants is not feasible in the short run. A faster, more reasonable goal is to fire biomass and coal together, a process known as co-firing, which can be done in different percentages of increasing biomass. To estimate the outcome of co-firing, several factors needed to be addressed: energy input and effect on the environment. Percentage of co-firing was divided into increments of 5% increases, starting with 10% and ending with 30%, and change of energy efficiency was calculated. The effects on three different types of emissions: carbon dioxide, sulfur oxide, and nitrous oxide were quantified at a 20% co-firing rate. Since the extent of emission reduction differs in biomass, we used wood as an example, leading to reductions in all emissions. The reduction of pollution and energy input change was quantified regionally and compared to plants firing coal alone. Less NOx and SOx emissions will reduce the frequency of respiratory health problems and reduce acid rain, and biomass combustion will result in less atmospheric CO2, with more CO2 absorbed into carbon reservoirs. These results show great social benefits, as well as the feasibility of co-firing biomass with coal in power generation.

Background
One tactic that requires less change in the energy sector infrastructure is co-firing biomass with coal to produce less pollutants such as carbon dioxide, sulfur oxides, and nitrous oxides. Co-firing, as the name suggests, requires energy use to produce power from coal, but with a ratio of biomass as well. Since biomass generally have less nitrogen, sulfur, and carbon, they always produce less emissions, and therefore a social benefit regarding cost and health. Though many acknowledge the fact that co-firing biomass with coal is a tactic with a huge potential to reduce pollution quantities, the national energy sector has made slow progress with co-firing due to the fact that coal is a plentiful source of efficient fuel. Coal, however, has many social costs that come from the high amount of pollutants emitted from being used that not only hurt the environment, but people as well.

Methods and Materials

Change of Energy Efficiency
With coal decreasing, biomass increased to keep total electric generation constant. Coal decreased from 0-30%, co-firing with chicken litter, refuse derived fuel, rice husk, and sawdust. (2) Average decrease of energy efficiency from 0-30% co-firings: 37%

Cost of Replacing Coal With Biomass
The cost of using coal is 95.106/MWh input. The cost of using biomass is 101.56/ MWh input. (6) Calculating the cost per MWh:

Cost of coal at 20% Co-firing rate=($/MWh Energy Input) (95.106) x (8)
2. Total cost of Biomass at 20% Co-firing rate=($/MWh Energy Input)(101.56/8)
3. Total cost at 20% co-firing = A+B

\[ \text{Cost of firing only coal}=16,425,092,565 \]
\[ \text{Total cost of co-firing}=219,621,079 \]

Difference of Pollution Quantities

Using these numbers, we quantified the pollutant difference between plants firing at only 20% coal, versus a situation with 20% coal reduction.

Pollutant Costs: CO, NOx, SOx

\[ \text{The cost of CO is 375 per metric ton} \]
\[ \text{The social costs of NOx and SOx are 67,005 and 40,008 per metric ton, respectively} \]

\[ \text{These three costs are measured in terms of damage costs per ton of pollution} \]

Pollutant Cost Savings

A) Total cost of Pollutants at 100% Coal = (NOx Costs+CO2 Costs+SOx Costs)
B) Total cost of Pollutants at 20% co-firing rate = (NOx Costs+CO2 Costs+SOx Costs) 

\[ \text{Total Amount ($ Saved from Pollutant Reduction} = A-B \]

Results

New Plant Efficiency = (Efficiency of coal)-(Efficiency of co-firing at % efficiency decrease)

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References