Optimization Models in Support of Biomass Co-Firing in Coal-Fired Power Plants

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Abstract

We present an optimization model to aid with biomass co-firing decisions in coal fired power plants. Co-firing is a strategy to reduce greenhouse gas emissions at coal plants. Co-firing is a practice that impacts logistics-related costs, capital investments, plant efficiency, and tax credit collected. We present a nonlinear mixed integer programming model that captures the impact of biomass co-firing on the logistics-related costs, capital investments, plant efficiency, tax credit collected, and emission reductions. The objective is to maximize the total profits due to the production tax credit (PTC) which is equal to 2.3 cents/kwh of renewable electricity. The constraints represent the relationship between the amount of coal displaced and the amount of biomass used. These equations capture the reduced burners' efficiencies due to burning a different product with a lower heating value. In order to solve large instances of this problem we develop a linear approximation which is easier to solve. We test the performance of the models proposed on a case study developed using data from the State of Mississippi. We conducted a sensitivity analyses to evaluate the impact of biomass purchasing costs, biomass transportation costs, investment costs, and production tax credit on the cost of renewable electricity. Our results indicate that: (a) power plants would have no incentive to co-fire unless they are subsidized for their efforts; (b) tax credit schemes where the credit is a function of the amount of renewable electricity produced, or plant capacity would increase renewable electricity production.