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Optimization models in support of biomass co-firing decisions in coal fired power plants

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We present an optimization model to aid with biomass co-firing decisions in coal fired power plants. Co-firing is a strategy that can be used to reduce greenhouse gas emissions at coal plants. Co-firing is a practice that also 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 of this model is to maximize the total profits. Profits are equal to the difference between the revenues generated from the tax credit and the additional logistics and investment costs. The constraints of this model 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 which has 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 in order 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 power plants would have no incentive to co-fire unless they are subsidized for their efforts. On the other side, increasing the tax credits beyond some threshold value would not necessary result in additional renewable energy produced. That means, in order to increase the renewable energy production, instead of using a "flat rate" tax credit, a better system would be to make the tax credit a function of the amount of renewable electricity produced.

Biography

Sandra D Eksioglu is an Associate Professor of Industrial Engineering at Clemson University. She received her PhD in Industrial and Systems Engineering from the University of Florida in 2002. Her research focus has been on the theory and application of operations research tools to problems that arise in the areas of transportation, logistics, and supply chain. She works on developing mathematical models and solution algorithms that help design and manage large scale and complex supply-chains. In particular, she is interested in the application of these tools to the biofuels supply chain. She received the Faculty Early Career Development (CAREER) Award from the National Science Foundation in 2011 for her work on biofuels supply chain. She has co-authored over 50 refereed journal papers and conference proceeding. She is the co-author of "Developing Spreadsheet-Based Decision Support Systems Using Excel and VBA for Excel" 2nd Ed. which is the textbook used in one of the classes she teaches. She is an active member of Institute for Operations Research and the Management Sciences (INFORMS), Institute of Industrial Engineers (IIE), and American Society for Engineering Education (ASEE).

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