Abstract

Oklahoma spends billions of dollars annually on energy consumption and markets for electricity, transportation fuels, and heating utilities are only seeing increased demand and thus increased production. These expansions are resulting in increased carbon dioxide emissions to the environment as well as higher production costs to companies and in turn, higher prices for consumers. New clean sustainable energy production facilities vastly reduce CO_2 emissions, but come at a high cost to Oklahoma's energy companies. On the other hand, existing energy production from the combustion of fossil fuels is far more inexpensive but comes with a different price of its own, environmental emissions. As the state moves farther into the 21st century, an optimum combination between increased sustainable energy production and energy production from fossil fuels must be found. Our project attempts to find this optimum as well as determine what steps should be taken to realize it. What the government needs to do to foster this sustainable energy increase, how much money it will ultimately cost, and ways to attract potential investors for this new energy are all studied in this report.

A model was created using the GAMS optimization package with the CPLEX solver. All three major energy industries were included: electric, transportation fuel, and natural gas heating. The goal of the model is to maximize the net present value of these industries while imposing constraints of required return on investment rates for potential investors, annual percent CO_2 reductions, and job salary increases. We wanted the model to meet the goals by building new wind farms and hydroelectric plants as well as biodiesel and ethanol refineries. In addition, the model is to choose where carbon capture and sequestration technology should be used and how much. Once the model was completed, numerous scenarios were run in order to determine the effect each constraint has on profitability.

A pareto-optimal surface for the net present value as a function of annual percent CO_2 reduction and job salary increase was created from the results of the various scenarios. Job creation, calculated as salaries paid to Oklahoma workers, was shown to have little effect on NPV. However, the CO_2 reduction limit was shown to have a major impact on and an inverse relationship to NPV. It was found that at higher than 2% annual CO_2 reduction, NPV begins to decrease at a faster rate. The model found that the transportation fuel and natural gas industries require little change aside from moderate refinery production increase. In order for the electric industry to meet increased future demand while achieving CO_2 reduction constraints, new clean energy production facilities are needed in the form of wind farms and hydroelectric plants. In addition, existing coal and natural gas plants must see increased carbon capture and sequestration use. Wind and hydroelectric energy sources should increase to 24% and 15% of the total electricity generation by 2030, respectively. Tax breaks of at least 10% of total profit are needed to attract potential investors for the construction of new plants. Electricity price will need to be increased to a minimum of $0.10 per kilowatt-hour to ensure investors receive a minimum return on investment of 10%.