THE ALTERNATIVE LIQUID TRANSPORTATION FUEL SIMULATION MODEL

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Overview

High oil prices and concerns about energy security and the environment have triggered public and private interest in alternative liquid transportation fuels, including unconventional oil resources (tar sands and oil shale), natural gas and coal derived liquid fuels, and various biofuels. Many competing claims have been made regarding technical feasibility, environmental attractiveness, and economic viability of competing technologies.

Sandia's Alternative Liquid Transportation Fuels Simulation Model is a high-level analytical tool that allows a systematic, objective comparison of alternative liquid transportation fuels. The overall goal of the model is to provide policy makers, executives, and other interested stakeholders a better understanding of the trade-offs associated with a wide range of liquid fuel options. Specific options included in the model include tar sands, oil shale, Fischer-Tropsch diesel (natural gas to liquids (NGL), coal to liquids (CTL), and biomass to liquids (BTL)) and ethanol (produced from either starch (corn, sugar beets) or cellulosic biomass). Each option is compared to the existing oil option in terms of technical substitutability, economic cost, and key environmental criteria.

Each alternative fuel included in the model required a comprehensive understanding of the technical and economic characteristics for each option. For example, correctly characterizing corn-based ethanol requires capturing the life cycle energy inputs required including the energy and water used to grow, harvest, and transport the corn, and to produce and distribute the ethanol. Costs for each option are reported in terms of cost per gallon gasoline equivalent and include breakdowns of feedstock, capital, and operating and maintenance costs. The main environmental consideration in the model at present are associated emissions of carbon dioxide associated with the production and use of each liquid fuel option.

Methods

Each alternative fuel included in the model required a comprehensive understanding of the technical and economic characteristics for each option. For example, correctly characterizing corn-based ethanol requires capturing the life cycle energy inputs required including the energy and water used to grow, harvest, and transport the corn, and to produce and distribute the ethanol. Levelized costs of production are calculated for each alternative liquid fuel option. These costs include all capital, O&M, and feedstock costs associated with production of the liquid fuel. Costs also include include consideration of the construction finance costs, tax rates, and deprecation. These levelized costs are reported both in terms of cost per gallon gasoline equivalent and energy content ($/MMBtu). The model also calculates the energy balance and CO2 emissions associated with production of each fuel type. End use emissions are also calculated using assumptions about likely vehicle efficiency.

Results

Preliminary numerical results will be presented at the Houston conference. These results will show that corn based ethanol is not cost competitive at current oil prices (70 $/barrel) without federal tax subsidies or inclusion of various byproduct credits. While the economics of cellulosic based ethanol appear promising, there remains significant uncertainty about the overall feasibility and many of the economic assumptions. The economic viability of gas to liquid plants is highly sensitive to both capital and feedstock costs and does not appear to be a cost competitive option at present unless the natural gas has no other market value. Preliminary results suggest coal to liquid plants may be cost competitive with oil at current market prices unless investors require higher rates of return due to remaining uncertainties. CO2 emisisons would be significantly higher with the CTL option unless carbon capture and sequestration is included.

Conclusions

Sandia's Alternative Liquid Transportation Fuels Simulation Model is a high-level analytical tool that allows a systematic, objective comparison of alternative liquid transportation fuels. The overall goal of the model is to provide policy makers, executives, and other interested stakeholders a better understanding of the trade-offs associated with a wide range of liquid fuel options. Preliminary numerical results of the analysis will be presented at the Houston conference.

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