Projecting the Deployement of Coal-and-biomass-to-liquids Technology Using MARKAL

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Overview

The production of liquid fuels from coal via gasification and Fischer-Tropsch (FT) synthesis, a process known as coal-to-liquids (CTL), provides a potential pathway to reduce the Nation's dependence on imported oil. With carbon acapture and storage, a CTL plant's CO_2 emissions can be limited to a level approximately equal to those of a conventional petroleum refinery. To further reduce a CTL plant's carbon footprint, biomass can be co-processed with coal, bringing the plant's overall emissions significantly below a conventional petroleum refinery. The carbon contained in the biomass is not counted as a carbon input penalty because the biomass has recently removed this carbon from the atmosphere by photosynthesis. A portion of this biomass carbon is then subsequently captured and sequestered within the CBTL facility during the conversion process. In this way a double benefit accrues to the biomass carbon. Additionally, CBTL offers another advantage - the biomass feedstocks like corn stover, prairie grasses and forest residues can be obtained from marginal lands, thus not impacting food production.

Using an energy-economic model of the U.S., this paper will examine the potential impact of CBTL technology out the year 2050. Factors examined will include deployement of CBTL technology; imports and prices of oil; CO_2 emissions levels and/or prices and other parameters as applicable. A number of scenarios will be examined which will vary the prices and availability of resources and the methods of CO_2 limitation.

Methods

The Market Allocation (MARKAL) model will be used to generate future scenario projections incorporating the CBTL technology. MARKAL is a data-driven energy-economic model, used by over 75 institutions in 37 countries. The user specifies the energy system structure, including resource supplies, energy conversion technologies, end-use energy service demands, and the technologies needed to satisfy these demands. The user must also provide data to characterize individual technologies and resources, including their fixed and variable costs, availability, performance attributes, and pollutant emissions. MARKAL then provides a least-cost combination of technologies to satisfy the given demand. Using published cost and performance data from systems studies, the CBTL technology will be charaterized within the MARKAL framework. Then, a number of scenarios will be performed to examine the impacts of the new technology under variations in carbon control regimes, and resource price and availability. Parameters such as price of energy products to consumers (electricity and liquid fuels), CO_2 emission levels and price, and imports of oil will be examined to assess the potential impact of CBTL.

Results

Initial results indicate significant entry of the technology when CO_2 limits are imposed on the system. Additionally, reductions in the price of transportation fuels and the amount of imported oil occur when CBTL is strongly deployed. High oil prices also drive significant penetration of this technology.

Conclusions

CBTL offers the potential to provide an environmentally favorable, domestically secure alternative to imported petroleum products. Unlike biofuels such as ethanol and biodiesel, CBTL-derived fuel does not have a significant impact on the overall food supply. MARKAL results indicate that this technology has the potential for to provide significant benefits to the U.S.