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NRC says long road ahead for renewable fuels to replace petroleum

By Sara Wyant

Liquid fuels from biomass and coal have the potential to reduce petroleum fuel use and CO2 emissions in the U.S. transportation sector over the next 25 years. But substantial investments in research, development, and commercial demonstration projects will be needed to produce these alternative liquid fuels in an environmentally conscious way, and at a level that could impact U.S. dependence on imported oil, according to a new report from the National Research Council.

"A lot of work remains to be done before these alternative fuels can make up a significant share of the U.S. transportation fuel market. Making the transition will require financial investments and technological developments," said Michael P. Ramage, retired executive vice president of ExxonMobil Research and Engineering Co. and chair of the committee that wrote the report. "Newer, more efficient technologies and strong policy measures will be needed to drive market penetration. These fuels will not be cost competitive at current oil prices. They could be competitive with the higher oil prices we've seen in recent years, although it will take focused research, development, and policy efforts to get there."

BIOMASS

According to the report, biofuels – primarily ethanol in the short term – should be produced from dedicated grass crops, agricultural and forestry residues, and municipal solid wastes rather than food crops such as corn grain or soybean, which can induce competition between food and fuel. The report estimates that the U.S. could produce 550 million dry tons of biomass annually by 2020. Assuming significant market penetration and construction of ethanol plants, this amount of biomass could be used to produce up to 1.6 million barrels per day of gasoline-equivalent ethanol by 2030, leading to a potential 15 percent reduction in oil use for light-duty transportation.
The net carbon impact of biomass-derived fuels can be close to zero, because biomass crops consume CO2 from the air while growing and sequester carbon in the soil, thereby offsetting the CO2 released during fuel production and combustion. If the CO2 released from the conversion process is geologically stored, then biomass-derived fuels can have negative CO2 effects, with the biomass removing more carbon from the environment than is released during the fuel's life cycle. The costs of producing biomass-derived fuels can be higher than petroleum fuels, comparable to oil prices of approximately $100 per barrel; however, if a carbon price is set high

enough, the cost of biomass-based fuels could decrease due to the potential for net negative CO2 effects, the report says.
Transitioning to biofuels involves several challenges in addition to the costs. The fuel most likely to be produced from biomass over the next decade is ethanol, which cannot be distributed in the existing petroleum gas pipeline system; ethanol distribution currently occurs via railways or barges. The need for a significantly expanded infrastructure could limit the penetration of ethanol into the U.S. transportation fuels market. In addition, the report says, the supply of biomass can vary across the country, affecting the cost of biomass-produced fuel and magnifying logistical issues of fuel production and distribution.

COAL

Coal, which can be converted into gasoline or diesel, exists in sufficient reserves in the U.S. to meet the nation's needs for more than 100 years at current rates of coal consumption, mainly for electric power. It should not be assumed, however, that there will be enough coal mined to support the demands for both electrical power and transportation fuels. Providing coal-based liquid fuel for transportation would require significant increases in coal mining activities. The U.S. transportation sector consumes 14 million barrels of oil per day. If coal mining activities in the U.S. increase by 50 percent – an additional 580 million tons of coal mined each year – up to 3 million barrels of fuel per day could be produced. To achieve this, two or three new coal-to-fuel plants would need to be built each year over the next 20 years, the report says.
Without geologic storage of the CO2 produced in the conversion process, life-time greenhouse gas emissions from coal-based fuel would be about twice that of oil. With geologic storage, CO2 emissions would be nearly equivalent to those from oil. Coal-based fuel with CO2 emissions equivalent to petroleum-based fuels will be possible by 2020 only if geologic storage of carbon dioxide is demonstrated as safe and viable in the next five to six years, says the report. To do this, several commercial-scale facilities -- demonstrating geologic carbon storage alone or in combination with the coal-to-liquid fuel technology -- should be operating by 2015. As a relatively abundant resource, coal-based fuels could be cost-competitive with gasoline at oil prices around $60 to $70 per barrel. However, if a carbon price were set, the costs of coal-based fuels could rise significantly.

COMBINED COAL-AND-BIOMASS

Although a relatively new technology, several combined coal-and-biomass demonstration plants are operating in Europe. This technology could be an important part of U.S. energy strategy, the report says, as it combines the environmental benefits of biomass with the relative abundance and lower costs of coal. According to the report, if the 550 million tons of biomass estimated to be available by 2020 were combined with coal (at a 60:40 ratio of coal energy to biomass energy), 60 billion gallons of gasoline equivalent could be produced each year, which equates to approximately 45 percent of annual U.S. gasoline usage. If CO2 produced in the conversion process is geologically stored, the greenhouse gas emissions of this combined fuel over its life cycle could be close to zero.

These combined coal-and-biomass plants are not yet available in the U.S., but if geologic carbon storage is developed by 2015, the first combination plants could be built by 2020, the report says. Assuming a 20 percent growth rate in construction, by 2035 the U.S. could produce 2.5 million barrels of gasoline equivalent per day from combined coal-and-biomass sources.

This is the first of a series of reports to be released from the National Academies' America's Energy Future project, which was undertaken to stimulate and inform a constructive national dialogue about the nation's energy future. Upcoming reports are ELECTRICITY FROM RENEWABLE RESOURCES, REALISTIC PROSPECTS FOR ENERGY EFFICIENCY IN THE UNITED STATES, and an overarching final report entitled, AMERICA'S ENERGY FUTURE: TECHNOLOGY AND TRANSFORMATION.

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Copies of LIQUID TRANSPORTATION FUELS FROM COAL AND BIOMASS: TECHNOLOGICAL STATUS, COSTS, AND ENVIRONMENTAL IMPACTS are available from the National Academies Press; tel. 202-334-3313 or 1-800-624-6242 or on the Internet at HTTP://WWW.NAP.EDU.

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