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Biodiesel: An Industry Poised for Growth?

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Development of a domestic biofuels industry that increases production of liquid biofuels from renewable resources is a priority policy objective of the United States and a number of individual states. Biofuels are expected to reduce dependence on imported petroleum with associated political and economic vulnerability, reduce greenhouse gas emissions and other pollutants, and revitalize the economy by increasing demand and prices for agricultural products. Although most attention focuses on ethanol, interest in biodiesel is also increasing. Biodiesel is primarily produced from soybeans. However, other oilseed crops offer potential, especially in arid western regions of the US.

The purpose of this article is to compare the physical properties of biodiesel with existing petrodiesel, review key demand factors and other policies that are stimulating increased interest in biodiesel, and summarize the present economics of its production and marketing. Although both federal and state policy outlooks remain favorable, and much optimism exists among agricultural groups, present costs of producing biodiesel exceed petrodiesel by $0.20-0.50/gal.

What is Biodiesel?

The Independent Biodiesel Feasibility Group (IBFG) and www.biodiesel.org describe the physical properties and production process of biodiesel. Production dates back to the late 1970s. Biodiesel operates in diesel engines with little or no engine modification. It has superior lubricity (which reduces engine wear), higher flash point (for safer handling), and similar BTU content/performance ratings compared with petrodiesel. It has no sulfur and substantially reduced unburned hydrocarbons, carbon monoxide, and particulate matter. It is essentially free of harmful aromatics such as benzene toluene and xylene, which can be as high as 40% in petrodiesel.

The method of producing biodiesel is known as transesterification. It occurs at low temperature (<150F), is high conversion, and uses no exotic materials—far simpler and efficient compared to production of other biofuels such as ethanol. In comparison with ethanol, 1.34 BTUs of energy are produced per 1 BTU of fossil fuel used in the ethanol production process, whereas 3.2 BTUs are produced for biodiesel.

In 1993, Interchem of Overland Park, Kansas, was the sole US commercial biodiesel producer. At present, 15 companies produce biodiesel commercially in the US: three in California, two in Illinois, and one each in Arizona, Florida, Hawaii, Iowa, Kansas, Kentucky, Missouri, Nevada, North Carolina, and Ohio.

A recent $12 million factory is located in Ralston, Iowa, and is expected to produce 6 million gallons annually at a production cost of $1.50 per gallon—about $0.20-0.25 per gallon greater than petrodiesel (Figure 2). Smaller plant sizes, even tailored to an individual farm, are available (Pacific Diesel, 2002). Moreover, four additional biodiesel production facilities are planned by Archer Daniels Midland, Midland, Associated Grain Processors, Southern States Power, and United Energy. IBFG estimates current US biodiesel sales of 10 million gallons in 2001 and 18 million gallons in 2002. Several market opportunities exist for biodiesel. The National Biodiesel Board identifies three future market segments: (a) fleets regulated by statute or Energy Policy Act; (b) premium diesel; and (c) recreational marine and environmentally sensitive areas. Many look to Europe as a model for biodiesel use in the future.

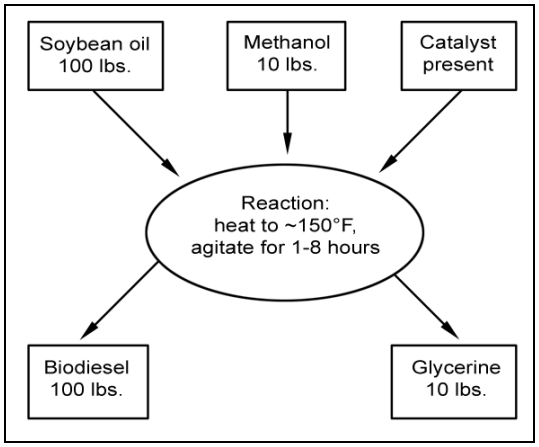

Figure 1. Biodiesel production process.

Europeans Lead Biodiesel Adoption

The European Union (EU) has chosen biodiesel as its main renewable liquid fuel. Fuel use of ethanol in the EU is much less important. Low European corn production and a high proportion of diesel engines compared to the US make biodiesel a more attractive alternative in the EU.

Average consumption of gasoline and diesel in Organization for Economic Cooperation and Development (OECD) countries was 900 million tonnes from 1996-1999 (Agriculture and Agri-food Canada, 2002). The United States accounted for the largest share (51%) followed by the European Union (26%). However, considerable differences exist between countries in their use of gasoline and diesel. In the United States and Canada, gasoline accounted for 77% and 72% of the total fuel demand in 2002, respectively. In the European Union and Japan, gasoline accounted for only 48% and 57%, respectively. If US energy policy and resulting diesel usage approaches that of the Europeans, dependence on biodiesel could increase.

Figure 2. The West Central Biodiesel Facility in Ralston, Iowa, is expected to produce 6 million gallons of biodiesel annually.

Rapeseed is the primary oil used to make European biodiesel. Biodiesel use is particularly strong in Germany, where B100 (100% biodiesel) is untaxed. Biodiesel production has expanded rapidly in the EU since 1992. An estimated 1 million metric tons (300 million gallons) was produced in 2001, requiring the use of 1.5 million hectares (3.7 million acres) of land for oilseed production. Proposals from the EU Commission called for biofuels to account for 2% of fuel use in 2005 and 5.75% by 2010. Biodiesel is expected to comprise most of the increase, given its mature processing and distribution infrastructure. The US biodiesel supporters are attempting to adopt these proposals domestically.

Why the Recent Interest in Biodiesel?

Production of biodiesel in the US is poised for growth because of increasing demand for liquid energy; recent passage of favorable federal legislation, adoption of regional subsidy programs, continuing surpluses of agricultural commodities, and rural communities seeking diversification opportunities.

Increasing Demand for Liquid Energy

The National Energy Policy Development Group, chaired by Vice President Cheney, recently reviewed the nation's energy supply and consumption needs. By 2020, US oil production will decline from 5.8 to 5.1 million barrels per day under current policy. However, oil consumption will increase to 25.8 million bpd by 2020, primarily due to growth in consumption of transportation fuels. The report notes that "growing dependence on oil imports is a serious long-term challenge.... By 2020, the oil for nearly two of every three gallons of gasoline and home heating oil could come from foreign countries." Unlike the Midwest and South, energy consumption in western states is "dominated by the transportation sector." The region is especially vulnerable to reduced availability of liquid fuels. Increased production of biodiesel could partially alleviate this increasing shortfall.

Favorable Energy Policy

The Energy Policy Act of 1992 (EPAct) was amended in 1998 to incorporate biodiesel blends as a fuel technology to aid in reducing the nation's dependence on imported petroleum and air pollution from engine emissions. Senate Energy Bill, S. 517 (2002) includes multiple provisions supporting biodiesel. The Biodiesel Excise Tax Incentive provides blenders of biodiesel with a one-cent reduction in diesel excise tax for every one percent of biodiesel made from virgin vegetable oil (up to 20% content). A Blender's Tax Credit also offers a half-cent per one percent (up to 20%) tax credit for biodiesel made from recycled oils and animal fats. The Renewable Fuels Standard specifies biodiesel as an eligible fuel and removes the 50% limit on biodiesel that was included in EPAct. Finally, the legislation requires the federal government to use biodiesel when cost competitive. Energy Bill H.R. 4 was approved in 2001 but with different biodiesel provisions. Differences between H.R. 4 and S. 517 are to be resolved in conference committee.

Adoption of Regional Support Programs

The Minnesota legislature passed legislation in the 2002 session that requires inclusion of 2% soy-based biodiesel into the majority of Minnesota's diesel sales if (a) a biodiesel production plant with 8 million gallons annual capacity is installed and (b) the federal government enacts legislation that provides a two-cent incentive for diesel fuel containing 2% biodiesel.

Neighboring North Dakota enacted a bill (House Bill 1390) directing the Legislative Council to study the potential use of biodiesel in the state. North Dakota's governor is also proposing a subsidy for biofuels production based on the prevailing joint prices of biofuels and commodity prices. Although the proposal is directed towards ethanol production, sentiment is that it could be expanded to biodiesel.

Surplus Agricultural Commodities

Agriculture and Agri-food Canada reports that if the world's 30 major economies replace just 8% of fossil fuel with biofuels, commodity prices would rise enough to solve the farm income crisis. The Upper Great Plains is especially in need of crop diversification and new markets for surplus commodities.

Table 1. Economic contribution of production plants to rural communities.

	Increased economic activity (million $)	Increased employment (000 jobs)	Plant size (million gal.)
Kansas [a]	63	248	5
Minnesota [b]	212	1128	13
North Dakota [c]	10	129	5

[a] Nelson, MARC-IV, & Leatherman, 2001.
[b] Minnesota Department of Agriculture, 2002.
[c] VanWechel, Gustafson, & Leistritz, 2002..

In North Dakota, oil crops comprise less than 22% of total crop acres. Remaining acres are planted primarily to small grains. Persistent drought and disease problems (primarily scab and orange blossom wheat midge) have resulted in significant crop losses in the region. The direct combined effects of price discounts and yield reductions from fusarium head blight for wheat and barley were estimated to be $870 million. Expanded acreage of oil crops would offer numerous crop rotational benefits that could potentially mitigate small grain disease problems. Most of the crop production is transported out of the region for processing or export. Producers in the region feel considerable opportunity exists for adding value to these commodities through processing and market development.

Rural Economic Diversification

Feasibility studies for soy-based biodiesel in Kansas, Minnesota, and North Dakota quantify the economic contribution of production plants to rural communities (Table 1). Supporters of biodiesel emphasize the value-added economic activity and increased employment created by biodiesel plants. Biodiesel plants that utilize minor oil crops as their feedstock source could yield comparable increases in economic activity.

And the Economic Feasibility Is?

Information on the economic feasibility of biodiesel is limited and unreliable. Several feasibility studies have evaluated the market potential and economic costs of producing biodiesel, all using soy

oil as the primary feedstock (Nelson, MARC-IV, & Leatherman, 2001; Minnesota Department of Agriculture, 2002; Pacific Diesel, 2002; VanWechel, Gustafson, & Leistritz, 2002; IBFG, 2002). The largest cost item of producing biodiesel is the primary oil used for processing (80-85%) followed by energy and water.

Investment costs average about $1 per gallon of plant capacity. They increase in proportion with plant capacity because the ease of production limits economies of scale. Costs of production are declining but still exceed prevailing petrodiesel market prices by $0.20-0.50 per gallon.

None of these studies address biodiesel in a comprehensive fashion. Some cost elements including land, administration, transportation, or market development were not considered. Plant performance information supporting these prior analyses is proprietary and difficult to access. Reliance on engineering data and generalities results in cost estimates that do not reflect actual operating experience. Investors contemplating construction of biodiesel facilities will require more complete information. The continued absence of such data will limit industry expansion.

Market Access will be Difficult

The wholesale market for diesel is highly concentrated in most regions. In North Dakota, four wholesale diesel suppliers service the region—Williams, Cenex, Kaneb, and Tesoro. None of them currently supply biodiesel because of the additional handling costs. Biodiesel must be segregated and handled separately because of its unique physical properties. Instead, 15 retail firms supply out-of-state produced soy-derived biodiesel, primarily to agricultural producers. Delivery is usually by semi-truck into separate biodiesel storage tanks. Local retailers then blend biodiesel for resale. Wholesale and retail demand for biodiesel derived from minor oil crops is unknown.

Potential biodiesel markets may easily be saturated. Annual diesel consumption of selected Northern Plains states is shown in Table 2. A single 12 million gallon per year biodiesel production facility could easily meet demand for the entire three-state region under Minnesota's 2% blend legislation.

Table 2. Annual 2001 diesel fuel consumption, Northern Plains states.

	Consumption (million gal)
Montana	380
North Dakota	404
South Dakota	146 (undyed, transportation only)

Conclusion

Why so much optimism about biodiesel, when production economics are not favorable and market saturation is possible? There are several reasons. First, production technology is rapidly evolving. Ethanol production has expanded rapidly through refinement of the enzyme process. Supporters of biodiesel expect similar advancements as their production equipment becomes more sophisticated and refined. Second, although market potential may be limited in the Northern Plains, other more densely populated and industrialized regions offer considerable market potential. Some consumers might pay a premium for a biofuel that is renewable, cleaner, less harmful to engines, and more desirable from a climate change perspective. Finally, future policy expectations—especially those mandating higher blend mixtures of biodiesel in liquid fuels—may overshadow marginal economics.

For More Information

A Bill to Authorize Funding the Department of Energy to Enhance Its Mission Areas Through Technology Transfer and Partnerships for Fiscal Years 2002 through 2006, and for other purposes, S.517, 107th Congress (2002).

A Bill To Enhance Energy Conservation, Research, and Development and to Provide for Security and Diversity in the Energy Supply for the American People, and for other purposes, H.R. 4, 107th Congress (2002).

ADM initiates biodiesel feasibility study. (2002, April 8). *Feedstuffs*, p.23.

AGP to Study Feasibility of Soydiesel Plant. (2002, April 15). *Feedstuffs*, p.23.

Agriculture and Agri-food Canada Strategic Policy Branch. (2002). *An economic analysis of a major bio-fuel program undertaken by OECD countries.* Ottawa, Canada: Agriculture and Agri-food Canada.

H.B. 1390, 57th North Dakota Legislative Assembly, 1st Session (1999).

Independent Biodiesel Feasibility Group. (2002). *What is biodiesel?* [unpublished paper]. Kearney, MO.

Minnesota Department of Agriculture. (2002, February). *Economic impact of soy diesel in Minnesota*. Available on the World Wide Web: http://www.mda.state.mn.us/AMS/biodiesel/ecoimpsoydiesel.pdf.

National Energy Policy Development Group. (2002). *Reliable, affordable, and environmentally sound energy for America's future*. Available on the World Wide Web: http://www.netl.doe.gov/publications/press/2001/nep/nep.html.

Nelson, R., MARC-IV Consulting, and Leatherman, J. (2001). *Kansas soybean-based biodiesel implant analysis* [unpublished paper]. Manhattan, KS: Enersol Resources.

Pacific Diesel. (2002). *Budget for 800,000 GPY biodiesel plant* [spreadsheet obtained through personal communication].

VanWechel, T., Gustafson, C.R., and Leistritz, F.L. (2002). *Economic feasibility of biodiesel production in North Dakota* (AE Report 505). Fargo, ND: North Dakota State University Agribusiness and Applied Economics.

West Central Soy. (2002). *Open House Factsheet* [unpublished pamphlet]. Ralston, IA: Author.

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