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Evaluating Biodiesel as a Value-added Opportunity

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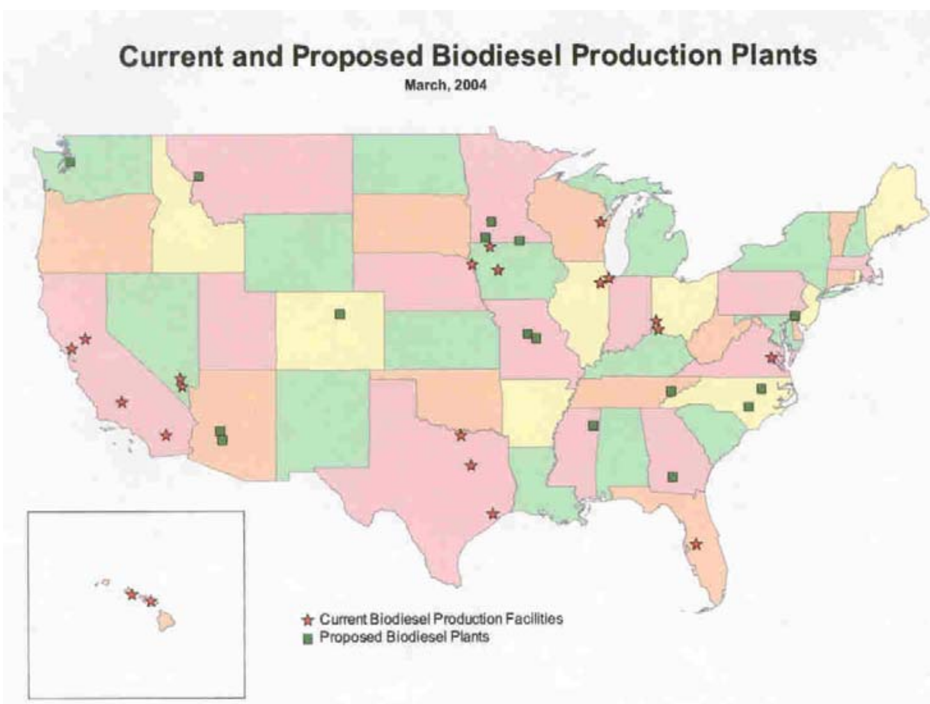
Converting animal and vegetable fats and oils to motor fuel has gained increasing interest over the past five years. There are now about 20 producers of biodiesel in the U.S. and about 17 additional companies are in some stage of development (see Figure 1). While not all of the developing companies may fully develop, it can be expected that many of these will move into production in the next 18 months. Aggregate production capacity is now estimated at approximately 50 million gallons annually.

Figure 1.



Source: National Biodiesel Board, March 2004.

Market Considerations

Several market segments for biodiesel are currently developing. Farmers have been among the first to embrace biodiesel. Producer commodity organizations and cooperatives have promoted the use of biodiesel blends in farm trucks and power equipment. A large number of rural fuel retailers now offer lower blends (B2 and B5) and many offer blends of 20% or more.

Marine engines are also a developing market segment. Biodiesel is biodegradable in a relatively short time period and has been shown to be much less harmful to fish than petroleum diesel. The danger to marine life arising from accidental fuel spills from watercraft is reduced as a result. Even the midrange biodiesel blends appear to increase the rate of which spilled petroleum degrades in marine applications.

Metropolitan Public Transit buses and school buses are both significant users of diesel fuel and represent a growing market segment for biodiesel blends. The desire to meet clean air standards and reduce carbon monoxide, hydrocarbon and particulate emissions from buses had led metro areas in many parts of the country to consider and experiment with biodiesel blends or at least consider doing so. Some school districts are also experimenting with blends as a strategy to provide healthier air and environment for students. U.S. school buses currently log approximately 4 billion miles per year and represent a significant potential market.

Large fleet operators (including the fleets operated by some U.S. Government Agencies) are also a significant potential market segment. A recent (non random) sample of 75 large fleet operators conducted for the National Biodiesel Board indicated that about 45% of the operations surveyed were currently using biodiesel blends or B100. Most (86%) of the users were using blends of B20 or more. Approximately 46% of the respondents were not currently using biodiesel, but were favorable toward the concept of a bio-based fuel. Only about 9% of survey respondents registered unfavorable responses toward the use of biodiesel.

Stationary engines used for pumping, emergency power generators and other varied applications are also a possible segment. Cleaner fuels can greatly reduce the particulates and other aspects of air quality in the immediate area where these engines are located.

Although it is now only in the early experimental stage, biodiesel blends for home heating oil show promise as a significant market segment in the future. Based on initial experience it appears that environmental benefits could be gained in the mid-Atlantic and NE regions where heating oil is used most extensively. Reduced burner problems have been observed in initial tests where blends containing biodiesel were used.

In summary the market for biodiesel is by no means fully developed yet but it has shown excellent growth over the past several years. The market consists of a number of segments and demand growth appears to be occurring in most of them. Those considering biodiesel production will need to monitor these segments and the regulatory framework surrounding them as they conduct their feasibility analysis and establish their business plans.

Manufacturing Processes and Technology Considerations

Biodiesel can be made using two different chemical processes. The most common is a methyl ester process that uses methanol along with an oil feedstock and sodium hydroxide as reactants. Most, if not all, existing commercial biodiesel plants use the methyl ester process. It has been tested and proven to be practical on a commercial scale.

Biodiesel can also be made using ethanol, an oil feedstock, and an inert catalyst to create what has been called "ethyl biodiesel". Advantages sometimes cited for ethyl biodiesel include: (1) the process does not require an alkali reagent such as sodium hydroxide (lye) and (2) it is a one step reaction that take place at room temperature without additional heat. Its disadvantages include sensitivity to water, which can cause quality problems in handling and the relatively high production cost per unit. Currently the ethanol process for producing biodiesel must be viewed as a higher risk alternative to the more established methyl ester process. At its current stage of development, the higher operating costs and quality problems are likely to be a serious drawback to the ethanol process. The final product must compete with methyl ester in the market. Significantly higher production costs could make it difficult to compete effectively.

A second major technology question is whether to build a batch or a continuous flow biodiesel plant. Most plants currently in operation are batch plants and produce discrete "runs" of product. These plants typically vent unused methanol into the air and do not recapture unused catalysts. This increases operating cost. Processing in discrete runs can at times create quality and uniformity differences in the final biodiesel product. However, batch plants have the advantage of being feasible on a smaller scale, the design has been proven to work, and there are manufacturers with components readily available.

Continuous flow plants are not nearly as common -- only one or two are in operation at this time. Some claim the continuous flow plants have several important operating cost advantages over batch plants. It is possible to reuse excess methanol that has not become part of the biodiesel and reuse catalysts. Both are typically lost in the batch plants.

The major drawback to the continuous flow process appears to be the higher initial investment required. The continuous flow process generally requires a larger scale plant (10 million gallon per year or more) thus the initial capital outlay to build a continuous flow plant is generally higher. It can be a problem for smaller start-up groups to raise the capital required for the large-scale continuous flow plants.

It is not unusual for start-up value-added firms to encounter this kind of problem. When evaluating technology and process alternatives such groups are often constrained by the amount of initial capital that can be raised. But it is important to consider not only the capital costs of building the plant but the operating costs the plant will face once it is up and running. Steering committees and their consultants typically focus more attention on evaluating the initial capital outlays required to build the plant. The focus on initial capital outlay is understandable since this is the first hurdle that must be cleared in developing the enterprise.

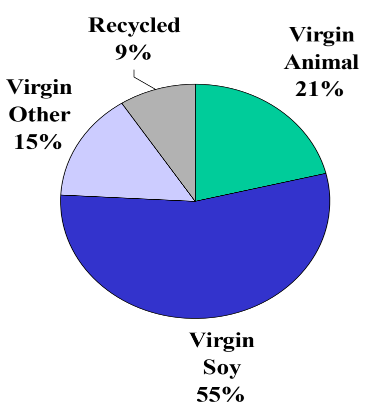
However, the longer run success of the venture is frequently more dependent on the day-in-day-out operating performance than on the size of the initial capital outlay. Low quality, variability in output quality, poor input-output yield, or high operating costs can cause the venture to under-perform or fail going forward. These factors need to be carefully considered before making a final decision on the kinds of technologies and processes that will be used.

Feedstock Considerations

Feedstock for biodiesel production can come from any of a wide variety of fat, oil or grease sources. Feedstocks are generally categorized as virgin (fats and oil that have not been previously used) or recycled (fats, oils and grease products that have been used for another purpose). Virgin feedstock may come from either plants (e.g., soy, canola, palm, corn, etc.) or animal sources. (e.g., hogs, cattle, poultry, or fish).

Annual production of animal based feedstock is estimated by the USDA NASS to exceed 7 billion pounds. For U.S. plant sourced fats and oils annual production of soy oil is estimated at approximately 18 billion pounds; with fats and oils from corn, sunflower, cottonseed and canola estimated to be approximately 5 billion pounds. While reliable data on recycled fats and oils is more difficult to obtain, it is estimated that approximately 3-4 billion pounds of feedstock could be obtained from these sources (see Figure 2). The goal of most firms who provide recycled product is to generate as little waste oil as possible since waste oil disposal represents a cost to them. Most would prefer to minimize the quantity that must be sold into the waste market and maximize the quality that is sold as part of the primary product they produce and sell.

Figure 2. Estimated Supply of Major U.S. Fats and Oils Suitable for Soy Diesel Production



Source	Billion Pounds
Virgin Animal	7
Virgin Soy	18
Virgin Other (plant based)	5
Recycled	3
Total	33

Source: NASS, USDA and Industry Estimates

Soyoil is among the lowest priced of the domestically produced (U.S.) virgin vegetable oils and is produced in the largest volume. The size and nature of the soyoil market makes it a feedstock with the best potential to expand. Soybean demand and prices may be driven by either the meal or the oil component. Either oil price increases or meal price increases can induce increased soybean production and crush and thereby cause soybean oil supply to increase. Although it is usually the meal demand that drives production and crush, oil does drive the market from time to time.

The supply of virgin animal based products and recycled products is not as likely to be increased by an increase in soydiesel demand. Both of these potential feedstocks are by-products. Their supply is largely dependent on the level of demand in another market. In the case of choice white grease and tallow, the supply will be largely determined by the demand for pork and beef. In the case of the recycled products the supply will be determined by the demand for fried food products. Increased use of these products as a biodiesel feedstock could drive up the price, but the supply response is likely to be relatively small.

Important considerations in selecting feedstocks for a biodiesel plant include: 1) per unit price (cost), (2) variability in quality and the chemical content feedstock, (3) regular availability of the feedstock, (4) flexibility to increase supply and (5) cost of transport and pretreatment. The comparison chart below shows how various feedstocks measure against these factors.

Costs per unit of feedstock are usually lowest for brown grease and yellow grease. These are typically recycled products from frying done in restaurants or food manufacturing firms. Costs for yellow grease are generally around $.10 per pound but can vary. Virgin animal fats such as choice white grease (lard), poultry fat or beef tallow are also potential feedstocks. Currently prices for these products are lower than virgin plant based products, but higher than recycled feedstocks. Virgin plant sourced feedstocks would include soy, palm, sunflower, corn, cottonseed and canola oils, as well as others. Soy and sunflower have historically had the lowest price levels with other vegetable oils being 15-25% more expensive. In the U.S. the volume of soy oil produced is much higher than the volume of other virgin plant sourced oils.

Figure 3. Soydiesel Feedstock Comparison Chart

Biodiesel Feedstock	Cost/Unit	Supply/Growth Flexibility[1]	Content/Quality Variability	Degree of Pretreatment Required
Virgin plant based feedstocks *(e.g.. soy, palm, canola, corn, cottonseed, sunflower, etc.)*	Moderate to high	Supply can be expanded	Low variability	Modest
Virgin animal based feedstocks *(e.g., lard, tallow, chicken fat, fish oil)*	Moderate	Fixed (dependent on meat, poultry, fish, demand and processing)	Low to moderate variability	Modest to high
Recycled feedstock *(e.g. yellow grease from frying or brown grease)*	Low	Fixed (dependent on restaurant, fryer activity)	High variability	High

[1] Ability to expand total supply available in response to price increases from demand shifts.

The fatty acid content and profile are important factors that must be dealt with in producing quality biodiesel. There are obvious differences between the fatty acid profile in feedstocks. These differences will need to be effectively managed if the plant is to be efficient. However, there may be less obvious variations, content and profile *within* the same feedstock types. Plant based virgin feedstocks are likely to have the least variation followed by the animal based products. Recycled feedstock such as yellow or brown grease can vary significantly from one lot to another.

While it is desirable to be able to process alternative feedstocks, managing feedstock variability is critical if consistently high quality biodiesel is to be produced and marketed. Frequently switching between feedstocks with various profiles can make this difficult to achieve. An aggressive feedstock pretreatment and blending strategy may make more sense.

The degree of pretreatment required also varies a great deal from one feedstock to another. Pretreatment requirements are typically lowest for the virgin plant based fats and oils. These feedstocks tend to have the most consistent fatty acid profiles and fewer impurities harmful to transesterification process.