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Biodiesel has recently experienced a major surge worldwide. A rapid expansion in production capacity is being observed not only in developed countries such as Germany, Italy, France, and the United States but also in developing countries such as Brazil, Argentina, Indonesia, and Malaysia. Interest in and expansion of the production of the renewable fuel has been fostered by mandates and financial incentives offered by governments. This interest can be mostly attributed to the commonly cited advantages of biofuels, mainly that they

- reduce the emission of gases responsible for global warming,
- promote rural development,
- contribute toward the goal of energy security,
- are renewable, and
- reduce pollution.

Another feature that proponents of biodiesel put forward is that the fuel can be used without modification in engines currently in use.

The European Union has arguably been the global leader in biodiesel production. However, as shown in Figure 1, the United States has increased its production from 2 million gallons in 2000 to an estimated 250 million gallons in 2006. While 250 million gallons is smaller than the E.U. production (Germany alone estimates its 2006 production at about 690 million gallons), it represents significant growth. The trend has recently accelerated, and production grew at a pace of 113 million gallons per year between 2004 and 2006. According to the National Biodiesel Board, there are 105 plants in operation as of early 2007 with an annual production capacity of 864 million gallons. An additional 1.7 billion gallons of capacity may come online if current plants in construction are completed.

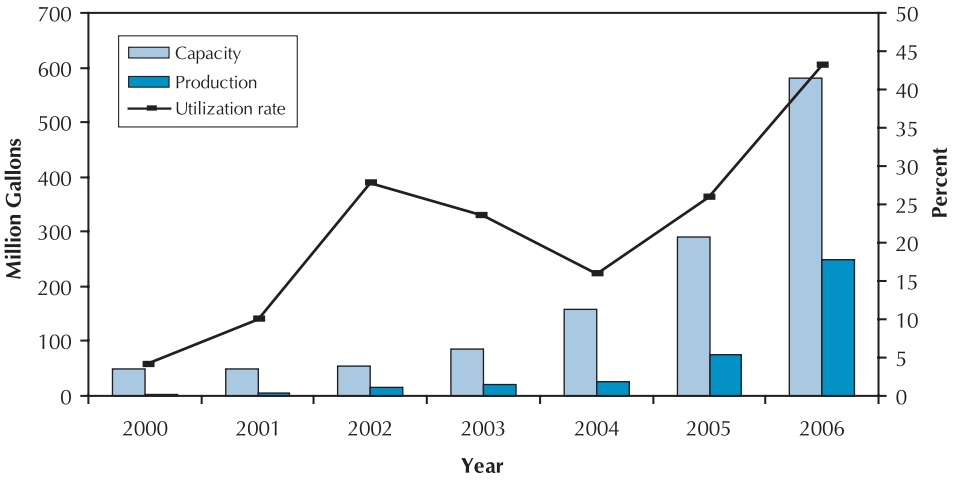
The rapid growth in the industry has been fueled by a series of government-provided financial incentives combined with historically high energy prices. As shown in Figure 1, despite these economic incentives, the industry carries a significant (though decreasing) idle capacity. A review of the main policy incentives contributing to the rapid increase in U.S. production, an estimation of current margins for a typical biodiesel plant, and discussion of opportunities and threats faced by the biodiesel industry will prove useful in increasing our understanding of where the U.S. biodiesel industry is headed.

Policy Drivers

The rapid expansion of biodiesel production observed between 2000 and 2006 was triggered by a 1998 amendment to the 1992 Energy Policy Act and cash support from the USDA Commodity Credit Corporation's (CCC) Bioenergy Program. Further support was created through the American Jobs Creation Act (the Jobs Act) of 2004 and the Energy Policy Act of 2005.

The 1992 Energy Policy Act requires that a portion of the new vehicle purchases by certain fleets (mostly owned by federal and state governments and alternative fuel providers) be alternative fuel vehicles. Originally, biodiesel was excluded as an alternative fuel, but the 1998 amendment allowed fleet managers to comply with part of their alternative fuel usage requirement by using biodiesel, as long as it was used by heavy-duty vehicles in blends, including at least a 20 percent blend (B20).

The CCC Bioenergy Program provided payments to producers to encourage biodiesel production. Plants with capacity under 65 million gallons per year were reimbursed 1 bushel of feedstock for every 2.5 bushels used for increased production (those over 65 million gallons were reimbursed 1 bushel for every 3.5 bushels used for increased production). Although initially only biodiesel made from



Source: National Biodiesel Board.
Note: Capacity given is on September 1 of each year.

Figure 1. U.S. biodiesel production and installed capacity for 2000 to 2006

Table 1. Net operating returns for a biodiesel plant

Biodiesel Price ($/gal)	Feedstock Price ($/lb)				
	0.20	0.25	0.30	0.35	0.40
2.00	0.16	-0.21	-0.59	-0.96	-1.33
2.40	0.56	0.19	-0.19	-0.56	-0.93
2.80	0.96	0.59	0.21	-0.16	-0.53
3.20	1.36	0.99	0.61	0.24	-0.13
3.60	1.76	1.39	1.01	0.64	0.27
4.00	2.16	1.79	1.41	1.04	0.67

oil crops was eligible for payments, the 2002 farm bill extended the list of allowed feedstocks to include animal by-products, fats, and recycled oils of an agricultural origin. The program ended in June of 2006.

The Jobs Act provided incentives for the biofuels industry again on the demand side. Under the act, blenders can claim $1.00 per gallon of biodiesel made from virgin vegetable oils or animal fats and $0.50 per gallon made from recycled oils and fats mixed with diesel. To receive the tax credit, the blender needs to use biodiesel registered as fuel with the Environmental Protection Agency and meeting the ASTM D6751 standard, as certified by its supplier.

The Energy Policy Act of 2005 provided incentives on both the supply and demand sides. On the supply side, the act sought to lower production costs by providing tax credits at a rate of 10¢ per gallon to small producers of biodiesel. The credit is available for the first 15 million gallons produced by a plant with annual production capacity of less than 60 million gallons. This tax credit is set to expire at the end of 2008.

On the demand side, the 2005 act mandated a renewable fuels phase-in (the Renewable Fuels Standard, RFS), requiring fuel producers to include a minimum amount of biofuels, and extended the excise credit to blenders until the end of 2008. Under the RFS, fuel producers were required to include 4 billion gallons of renewable fuels by 2006, increasing the amount to a minimum of 7.5 billion gallons by 2012.

Lobbying efforts are intensifying to extend the tax incentives beyond 2008. There are also state-specific incentives for the use of biodiesel, ranging from requirements to blend biofuels with petrofuels (for example, the requirement for the use of B2 in effect in Minnesota) to further tax credits and cost sharing of investments and research. Other states are also considering the introduction of blend mandates.

The Environmental Protection Agency's diesel regulations, requiring the introduction of Ultra Low Sulfur Diesel (ULSD) for 80 percent of the on-road diesel by mid-2006 (and off-road for mid-2007), are also expected to increase demand for biodiesel as a lubricant additive. ULSD has low lubricity, which can damage diesel engines. Research has shown that blending it with biodiesel to produce B2 could restore the lubricity of diesel fuel to adequate levels.

Industry Margins and Prospects

Since feedstock expenses account for about 80 percent of a biodiesel plant's operating cost, margins are highly sensitive to the prices of oils and fats. Between 75 and 90 percent of U.S. biodiesel production is based on the U.S. production of soybean oil, indicating that margins for many industry participants will be dependent on soybean oil prices. The share is expected to decrease over time, as many new plants will be able to produce biodiesel using multiple feedstocks, thereby giving producers the flexibility to switch among feedstocks as relative costs dictate.

To calculate the net operating returns of a representative plant in the industry, we constructed a simple economic model of a 60 million gallon biodiesel plant. The plant modeled has an operating cost (excluding feedstocks) of 42¢ per gallon and uses 7.48 pounds of feedstock to produce a gallon of biodiesel. We assume that the glycerin that is co-produced is sold (raw), as are other co-products (fatty acids and filter cake), at 5¢ per pound. Net operating returns, calculated as revenues minus operating costs (excluding capital and other fixed costs) for the modeled plant are presented in Table 1.

The table shows that as feedstock prices exceed 30¢ per pound, the price of biodiesel needs to be above $3 per gallon for the plant to make a profit. Operating returns are positive at $2.80 per gallon, but outlays to cover capital and other fixed costs and returns to investors are likely to be more than 21¢ per gallon. The Food and Agricultural Policy Research Institute projects that the price of soybean oil will be 30.7¢ per pound for the 2007/08 crop year and will surpass 34¢ per gallon by the 2009/10 crop year.

As highlighted in the table, the current viability of the biodiesel industry depends on financial support by the government, as the wholesale #2 diesel price has been below $2 per gallon since September of 2006.

Near-Term Outlook

As evidenced by the amount of idle capacity, supply of biodiesel has

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It is interesting to note that production in 2006 exceeded expectations by a small amount. Yet we still had an unprecedented increase in corn prices, as ethanol production grew at a rapid pace.

It is an open question whether future supply shocks will follow the historical patterns. Many feel that current corn hybrids are better able to withstand hot and dry weather of the type seen in 1983 and 1988. This has yet to be demonstrated, though, as we have not had a severe drought since 1988. Dry weather in Illinois in 2005 and in the western Corn Belt in 2002 caused significant local yield losses, which suggests that corn crops remain vulnerable to drought. The odds of a repeat of the cold summer of 1993 are likely lower than suggested by a simple historical average because that event was linked to volcanic activity. Increasing corn acreage outside the Corn Belt will tend to increase variability in corn supplies.

If we use historical variations since 1957 as a guide, we can estimate the probability distribution of the size of the 2007 corn crop. Assuming that U.S. farmers plant 90.5 million acres of corn, we expect them to harvest 91 percent of planted acreage. With a 2007 trend yield of 149.4 bushels per harvested acre, expected U.S. corn production is 12.3 billion bushels. Figure 2 shows the probability distribution of the corn crop in one billion bushel increments. As shown, there is a 1 in 50 chance (a repeat of 1988) that the corn crop will fall below 9 billion bushels. There is a 12 percent chance that the corn crop will fall below 11 billion bushels. If the crop does fall short of 11 billion bushels then we should expect corn prices to rise to levels that may cause ethanol plants to shut down. On the other hand, there is a 70 percent chance that the corn crop will exceed 12 billion bushels, in which case prices will be moderate. Of course if planted acreage falls short of planting intentions, then the odds of high corn prices could grow substantially. ◆

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outpaced demand for the biofuel, and consumption has not picked up until recently. A partial explanation may be found in the relative prices of biodiesel versus diesel fuels and the reluctance of engine manufacturers to approve usage of the fuel until recently. However, quality standards for biodiesel are developing and quality certification systems have started to emerge, prompting engine manufacturers to extend their warranties. More manufacturers are approving the use of B20 in some or all of their engines. This may improve the acceptance of biodiesel. Additionally, mandates for the use of blends combined with the fuel's use as an additive to improve the lubricity of ULSD may create additional demand for the product. However, the economics of today's diesel prices and the prices of potential feedstock sources do not seem promising without continued government support and technological improvements. Projected increases in vegetable oil prices, especially soybean oil, will continue to squeeze margins for biodiesel producers. ◆