A Comparative Analysis of the Development of the United States and European Union Biodiesel Industries

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Abstract

Worldwide production of biodiesel is growing at a rapid pace. Arguably, the European Union (EU) is the global leader in biodiesel production, but the United States has recently expanded its production. The growth of the biodiesel industry in both regions has been fueled by a series of government-provided financial incentives. However, the timing of the growth and incentive provisions, the nature of the main incentives, and the market conditions differ across regions. This article provides a comparative analysis of the EU and U.S. biodiesel industries, highlighting market and policy aspects that are leading to a rapid but distinct growth.

Keywords: biodiesel, biodiesel industry, biodiesel quality, biofuels, energy security, rapeseed oil, rapeseed methyl ester, soybean oil, soydiesel, ultra low sulfur diesel.

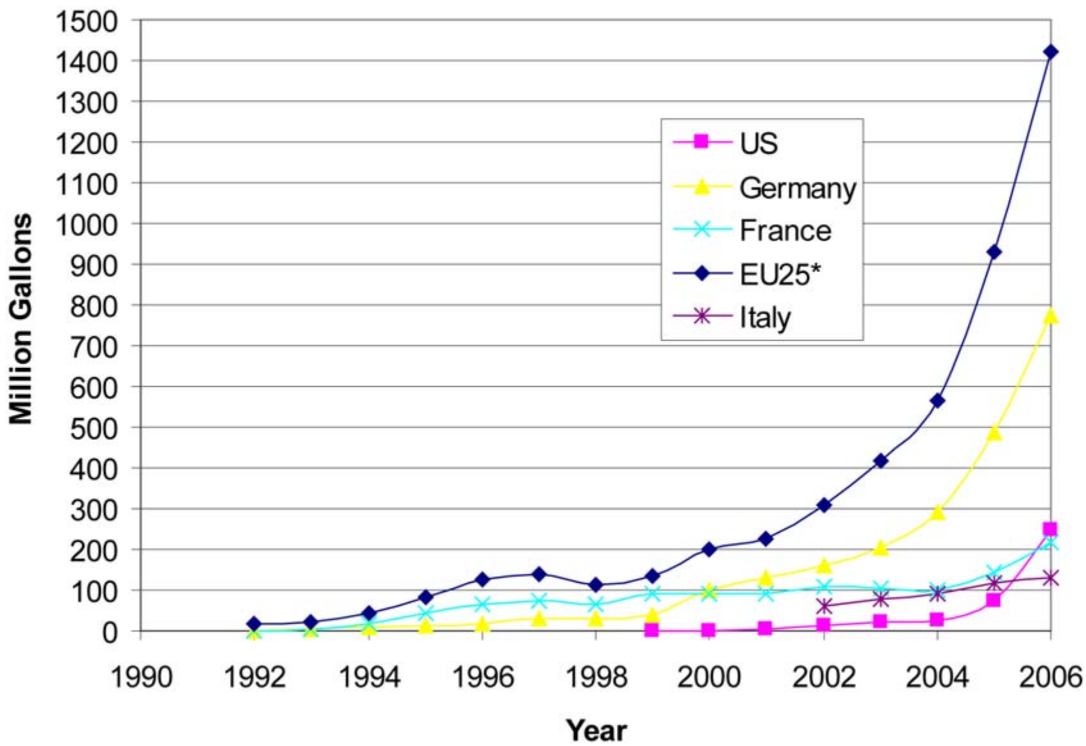
A COMPARATIVE ANALYSIS OF THE DEVELOPMENT OF THE UNITED STATES AND EUROPEAN UNION BIODIESEL INDUSTRIES

Introduction

Biodiesel has recently experienced a major surge worldwide. A rapid expansion in production capacity is being observed not only in developed countries like Germany, Italy, France, and the United States but also in developing countries like Brazil, Argentina, Indonesia, and Malaysia. Interest and expansion of the production of the renewable fuel can be seen worldwide and has been fostered by mandates and financial incentives provided by the countries' governments. The interest can be mostly attributed to the commonly cited advantage of biofuels. A short (and obviously incomplete and arbitrarily ordered) list of reasons cited is that biofuels (a) reduce the emission of gasses responsible for global warming,[1] (b) promote rural development, (c) contribute toward the energy security of countries, (d) are renewable, and (e) reduce pollution. Another feature that proponents of biodiesel put forward is that the fuel can be used without major modifications to engines currently in use.

The European Union (EU) has arguably been the global leader in biodiesel. However, the United States has recently increased its production, from 0.5 million gallons in 1999 to an estimated 250 million gallons in 2006 (National Biodiesel Board). While the latter number is smaller than the EU production (Germany alone estimates its 2006 production at about 775 million gallons), it represents growth at a rate of 36 million gallons a year between 1999 and 2007. The trend has recently accelerated, and production grew at a pace of 113 million gallons a year between 2004 and 2006. Figure 1 shows biodiesel production levels for the world's largest producers. The figure shows that France was the largest producer of biodiesel in 1999, but its production remained fairly constant and was surpassed by Germany in 2000.

The figure shows that the rapid expansion of the biodiesel industry occurred first in Europe; the United States entered the industry in a measurable way in 2000 and



Source: Constructed by author using NBB, EBB, UFOP, FAS 2003, and EurObserver figures.
*Production from the EU25 since 2004 is taken into account (please note that EU membership has changed over the years).

FIGURE 1. Biodiesel production in main producing countries

accelerated production beginning in 2004. In contrast, ethanol production (not shown) expanded first and at a faster rate in the United States than in Europe. Many reasons are behind the rapid and differential development processes between the two types of biofuels in the United States and the EU. This article provides a comparative analysis of the EU and U.S. biodiesel industries, analyzing some of the market and policy aspects that led to their rapid and continued expansion.

Recent Development of the U.S. and European Biodiesel Industries

The development of the U.S. and European biodiesel industries was driven by different forces. Whereas the European industry expanded production in response to signals from EU institutions (European Biodiesel Board), the U.S. industry developed from the bottom up (Pahl 2005). U.S. soybean producers are persistent advocates of biodiesel, and their efforts (both in financial and lobbying terms) are paying off. Government initiatives for the support of biodiesel in the EU predate by far those of the United States. Policy support came earlier in the United States for ethanol than for biodiesel, explaining in part the lagged development of the latter industry.[2]

According to a 2006 report by the Biofuels Research Advisory Council (BRAC 2006), large-scale penetration of biofuels is only possible in the near future if existing engine technology, storage, distribution systems, and sales logistics can be used. BRAC goes on to say, “ideally, future biofuels could be used as blends to gasoline, diesel or natural gas, or as neat products. Also alternating between biofuels, conventional fuels and blends should be possible” (p. 12). With 30% of total energy consumption, transportation is the sector that uses the most energy in Europe. A recent study (DG Tren 2003) projecting energy consumption through 2030 in the EU concluded that while fuel demand by trucks is expected to exceed that of passenger cars and motorcycles, the latter will remain the most important form of personal transport. The same study indicated that diesel will increase its proportion of consumption at the expense of gasoline.

Thus, transportation provides a sector in which large amounts of fossil fuels could be displaced. The BRAC report also indicates that biodiesel production in Europe could be more competitive at lower oil prices (€60 per barrel) than ethanol (€90 per barrel).[3] This vision and differences in the fleet composition (a result of earlier differential incentives on both continents), described in a later section, hint that rapid adoption of biodiesel was more likely in Europe than in the United States. Additionally, the EU is a net importer of corn and uses large amounts of wheat as feed, indicating that there are smaller quantities of feedstocks available to develop an ethanol industry. As a result, most EU countries placed their bets first in the development of the biodiesel industry.

European Industry’s Recent Development

The EU considers the transportation sector the main reason for failing to meet their commitments under the Kyoto Protocol (BRAC 2006). According to a European Commission white paper (EC 2001), CO_2 emissions from that sector are expected to increase by 50% between 1990 and 2010, accounting for 90% of the total increase. Road transportation would be responsible for 84% of all transport-related CO_2 emissions (EC 2001), providing large opportunities for reduction.[4] However, serious attention by the EU only started in 2001, when the Commission introduced the legislative proposal adopted in

2003 in the form of directive 2003/30/EC and Article 16 of the directive 2003/96/EC (COM 2007). The main implications of these directives are outlined below.

A few European countries took interest in biofuels during the 1990s (mostly Austria, Germany, and France). According to Pahl (2005), the first industrial-scale plant capable of delivering biodiesel of a consistent quality started operations in 1991 in Austria. The plant had a production capacity of 10,000 metric tons (mt) or about 3 million gallons (mmg) a year. The following year, a plant with a capacity of 80,000 mt (about 23 mmg) a year was installed in Italy. The 2006 yearly production capacity for the EU has been estimated by EBB at 6.069 million mt (1.768 billion gallons).

Policy Incentives in the EU. The first change in European common agricultural policy (CAP) to have a significant impact on the industry was the creation of set-aside lands in 1992, removing 10% of farmers' arable land from food or feed production. However, that area could be used to plant crops for industrial uses. The production of rapeseed, soybeans, and sunflower as a feedstock for biodiesel was allowed. Producers responded quickly to this policy change, and the biodiesel industry took off in some countries, especially in Germany and France. Whereas Germany doubled its biodiesel production the following year (from 5,000 mt to 10,000 mt), France's production increased to 20,000 mt from nearly zero.[5]

A 2003 reform of the CAP (Council Regulation No. 1782/2003) introduced a supplemental subsidy of €45 per hectare per year for energy crops planted under contract with a buyer (with the exception of self-consumption) on land that is not part of the mandatory set-aside. The subsidy was for a maximum of 1.5 million hectares, and the provision indicates that if claims exceed that area, payments will be prorated.

As previously mentioned, serious promotion for biofuels production did not appear until approval of the 2003/30/EC and 2003/96/EC directives. The 2003/30/EC directive targeted the use of biofuels and other renewable fuels for transportation. It assigned member states the task of ensuring that a minimum proportion of biofuels (and other renewable fuels) is placed in their markets. For that purpose, member states would select national indicative targets (Article 3(1)). The fuel directive includes not only a reference target of 5.75% of market share for biofuels by 2010 but also recommends that member countries set an interim target of 2% for 2005.[6] Table 1 presents the indicative targets set

TABLE 1. National indicative targets for the share of biofuels by EU member states (percent)

Member State	2005	2006	2007	2008	2009	2010
Austria	2.5	2.5	4.3	5.75	5.75	5.75
Belgium	2	2.75	3.5	4.25	5	5.75
Cyprus	1					
Czech Rep.	3.7	1.78	1.63	2.45	2.71	3.27
Denmark	0.1	0.1				
Estonia	2	2				5.75
Finland	0.1					
France	2			5.75		7
Germany	2	2				5.75
Greece	0.7	2.5	3	4	5	5.75
Hungary	0.6					5.75
Ireland	0.06	1.14	1.75	2.24		
Italy	1	2	2	3	4	5
Latvia	2	2.75	3.5	4.25	5	5.75
Lithuania	2					5.75
Luxemburg	0	2.75				5.75
Malta	0.3					
The Netherlands	2	2	2			5.75
Poland	0.5	1.5	2.3			5.75
Portugal	2	2	3	5.75	5.75	5.75
Slovakia	2	2.5	3.2	4	4.9	5.75
Slovenia	0.65	1.2	2	3	4	5
Spain	2					
Sweden	3					5.75
UK	0.19			2	2.8	3.5
EU	**1.4**					5.45

Source: Annex 2 in COM 2007.

for biofuels from 2005 through 2010. The guideline targets, however, are not mandatory, and, as can be seen in Table 1, most countries set intended values well below 2% for 2005. Although some countries announced targets above the directive's suggested values, overall, the resulting EU target was 1.4%. While the EU knew that mandatory targets might be needed, it chose to refrain from imposing them at that point.[7] It is also important to note that the directive refers only to market share and not to production, which leaves the door open to importing biofuels in order to comply with it.[8] According to Bockey

(2006), the EU would need to consume 3.69 and 11 million tons of biodiesel in 2005 and 2010 respectively to comply with the guidelines set under this directive.

The 2003/96/EC directive (in its Article 16) allowed individual EU members to reduce excise taxes to all biofuels starting in 2004 and lasting up to six consecutive years. Incentives for the production of biofuels in Europe vary by country but have been historically biased toward biodiesel over ethanol. For example, France sets higher quotas for the amount of biodiesel as compared to the amount of ethanol that will be tax exempt. These numbers were 417,000 mt and 100,000 mt for biodiesel and ethanol, respectively, in 2005 (FAS 2006). As another example, the Mineral Oil Duty Act of Germany only allowed tax exemptions of biofuels in pure form until the 2004 amendment. Thus, it effectively exempted only biodiesel and vegetable oil. Ethanol and biodiesel used in blends was taxed. The amendment of the Mineral Oils Duty Act (effective January 1, 2004), a response to the 2003/96/EC Directive, allowed for full duty exemption of biofuels (including blends) and heating oils until 2009 (von Lampe 2005).

Production and consumption of biofuels have increased sharply since 2003. In most countries the diesel used contains biodiesel, at least in low blends;[9] production capacity keeps growing and car manufacturers started to market cars that can run on high bioethanol blends. By 2005, biofuels were being used in all but four EU countries for which there is data, with an estimated market share of 1% (see Table 2). The approximate breakdown of biofuels in the EU for the 2002–2005 period was 76% biodiesel and 24% ethanol (Schnepf 2006; COM 2007).

Despite the rapid growth, the market share is below the reference value of 2%. Furthermore, it is less than the 1.4% that would have been achieved if all countries had met their targets. The only two countries that met their targets were Germany (3.8%) and Sweden (2.2%). As shown in Table 1, in early 2007, 19 member states had set targets for 2010, which, if achieved, would lead to a market share of 5.45%, 0.3% below the objective. Based on these numbers, and the failure to achieve the 2005 indicative target, the COM 2007 report concludes that the biofuel’s directive for 2010 is not likely to be achieved if further actions are not taken.

TABLE 2. Share of biofuels use by EU member states (percent)

Member State	Biofuel Share 2003	Biofuel Share 2004	Biofuel Share 2005
Austria	0.06	0.06	0.93
Belgium	0	0	0
Cyprus	0	0	0
Czech Rep.	1.09	1	0.05
Denmark	0	0	
Estonia	0	0	0
Finland	0.11	0.11	
France	0.67	0.67	0.97
Germany	1.21	1.72	3.75
Greece	0	0	
Hungary	0	0	0.07
Ireland	0	0	0.05
Italy	0.5	0.5	0.51
Latvia	0.22	0.07	0.33
Lithuania	0	0.02	0.72
Luxemburg	0	0.02	0.02
Malta	0.02	0.1	0.52
The Netherlands	0.03	0.01	0.02
Poland	0.49	0.3	0.48
Portugal	0	0	0
Slovakia	0.14	0.15	
Slovenia	0	0.06	0.35
Spain	0.35	0.38	0.44
Sweden	1.32	2.28	2.23
UK	0.026	0.04	0.18
EU	**0.5**	**0.7**	**1.0 (estimate)**

Source: COM 2007.

Looking at the two countries that complied with their 2005 targets, Germany's success was based mostly on biodiesel, while Sweden relied on bioethanol. According to the COM 2007 report, the two countries' success can be attributed to several factors: both have been active in the field for several years, promote both high-blends or pure biofuels and low blends, have tax exemptions without limiting quantities eligible for the benefits,[10] combine domestic production with imports, have invested in R&D, and have treated first-generation biofuels as paving the way to the second-generation (COM 2007).

Germany also imposed an ecological tax on fossil fuels in 1999 with the aim of reducing greenhouse gases and at the same time transferring some of the costs to polluters.

Several countries have recently increased the support for biofuels beyond tax incentives. Increasingly, and as an alternative (and sometimes in tandem), some countries have implemented or announced biofuel obligations. In 2005-2006, France, Austria, and Slovenia announced biofuels obligations. Germany implemented mandatory blends in early 2007. The Netherlands and the Czech Republic announced that they will introduce obligations in 2007, as will the United Kingdom in 2008. The biofuel obligations are instruments requiring fuel suppliers to include a given percentage of biofuels in the fuel they sell. However, mandating a blend on each unit sold is not compatible with the EU quality directive (COM 2007).

The COM 2007 report concluded that the reasons the directive targets for 2010 are not likely to be achieved cannot be viewed as justified. Additionally it recommended several measures to increase the share of biofuels, such as the modification of the fuel quality directive and the diesel standard to allow higher blends of biodiesel (e.g., from the current 5% to 10%) without the need for special labeling, inclusion in new vehicles of affordable adaptations that enable the use of higher blends, and acceleration of the presence of second-generation biofuels.

U.S. Industry’s Recent Development

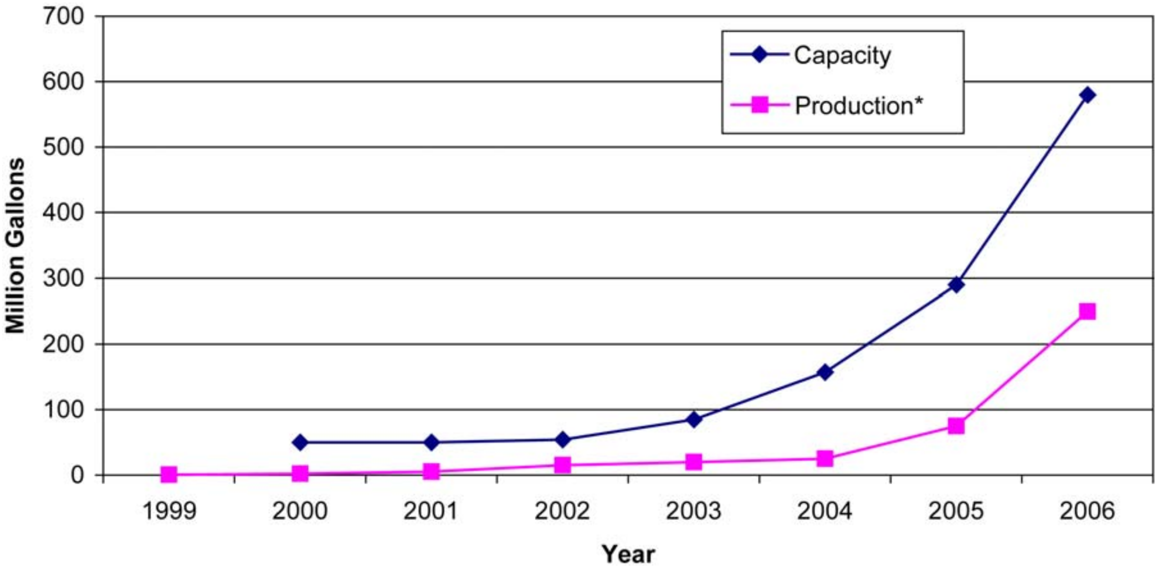
The biodiesel industry in the United States has been driven and developed mainly by the effort of soybean producers seeking more outlets for their product. One of the first programs supported by the national soybean check-off was for biodiesel (soydiesel) through research, legislative, and market development activities. In 1992, state soybean commodity groups founded the National Biodiesel Board (NBB), which funds research and development of biodiesel. A portion of NBB’s mission statement (available on their Web site) reads: “The mission of the National Biodiesel Board is to advance the interest of its members by creating sustainable biodiesel growth.” The NBB also represents the industry and coordinates research, education, and development with a broad range of industry, government, and academic cooperators. Among its members are state, national, and international feedstock growing and processing organizations, biodiesel suppliers, marketers and distributors, and technology providers. By comparison, the European

Biodiesel Board (EBB), which has similar goals to the NBB, was not created until 1997. The formal organization of the private sector did not occur until a later date in Europe. This can be interpreted as reflecting the fact that the development of the biodiesel sector in the United States was mostly pushed by private entities whereas the European biodiesel industry's development was at least partially pulled by EU institutions.

Despite the fact that research activity in biodiesel in the United States was occurring long before, commercial production did not start until the early 1990s (similar to the EU). The first dedicated commercial plant in the United States (Midwest Biofuels) started production in 1993. The production capacity was 100 gallons per batch, which later was expanded to batches of 500 gallons (Pahl 2005). Several other plants started production in subsequent years, including Twin Rivers Technology (1994), NOPEC (1995), Ag Processing Inc. (1996), West Central Cooperative (1996), Columbus Foods (1996), and Pacific Biodiesel (1996). However, by 1999, only 0.5 million gallons were produced. After that, a series of events, such as the development of the ASTM D6751 quality standard, the 1998 modifications to the 1992 Energy Policy Act, the USDA Commodity Credit Corporation's Bioenergy Program in fiscal year 2000, the Jobs Act of 2004, the 2005 Energy Policy Act, and several state initiatives, led to a rapid growth in both plant capacity and production of biodiesel (see Figure 2). A short description of each event is provided in the next section.

Figure 2 shows that production capacity was estimated by NBB at 580 million gallons in mid-2006. By early 2007, NBB indicated that 105 plants were in production, with an annual capacity of 864 million gallons. According to the board, an additional 1.7 billion gallons of annual capacity may come on line by mid-2008 if the 85 plants that are being built or expanded are actually completed.

Policy Incentives in the United States. Rapid development of biodiesel production did not occur until the 1998 amendment of the 1992 Energy Policy Act (EPAct) and the cash support brought through the creation of the USDA Commodity Credit Corporation's (CCC) Bioenergy Program in fiscal year 2000 (Collins 2006). The EPAct required that a portion of the new vehicle purchases by certain fleets be alternative fuel vehicles. The fleets included mostly vehicles owned by federal and state governments (required at 75% of new purchases) and alternative fuel providers (at a rate of 90% of their new



Source: National Biodiesel Board.
*NBB report sales. However, since U.S. participation in international trade of biodiesel has been small, and assuming that carryover stocks and self-consumption is small, sales are a good proxy for production.

FIGURE 2. U.S. biodiesel sales (by fiscal year) and installed capacity (by September of each year)

purchases).[11] Originally, the EPAct excluded the use of biodiesel. The 1998 amendment (effective in January of 2001) allowed fleet managers to comply with part of their alternative fuel usage requirement by consuming biodiesel, as long as it was used by heavy-duty vehicles in blends including at least 20% of the biofuel (B20). Managers could obtain one alternative fuel credit per 450 gallons of B100 used. Suddenly, fleet operations could partially replace purchases of new vehicles (up to half of the alternative fuel vehicle) by using biodiesel. The amendment created a somewhat captive demand for the fuel.

The CCC Bioenergy Program aimed to alleviate crop surpluses (strengthening prices) and to encourage expanded production of biofuels (Duffield and Collins 2006) by lowering a plant's costs of production. Clearly the result should be an outward shift in the supply of biodiesel. The subsidy was given to new plants, or plants expanding production over the previous year, and depended on the size of the operation. Plants with capacity under (over) 65 mmg per year were reimbursed 1 bushel of feedstock for every 2.5 (3.5) bushels used for increased production. The payments a producer could collect annually were not to exceed 5% of the available funds for the program. In cases in which payments would exceed the funding allocation for the program, the funds would be prorated.

Since few biodiesel plants were in operation at the beginning of the program, each was able to collect, on average, significant amounts per gallon produced. The average payments were $1.24, $1.43, $1.28, $1.07, and $0.50 per gallon for fiscal years 2001 through 2005[12] (Promar International 2005). Although initially only biodiesel made from oil crops was eligible for payments, the 2002 farm bill (in its Section 9010 "Continuation of the Bioenergy Program") extended the list of allowed feedstocks to include animal by-products, fats, and recycled oils of an agricultural origin. According to Eidman (2006), payments for plants basing production on yellow grease were about 60% of the payments for plants processing soybeans. Duffield (2004) argued that the payment rates for non-soybean oils and fats were lower to be more equitable with soybean oil–based producers.

The program was expected to provide up to $150 million a year but later experienced funding problems, reducing levels to $100 million and $60 million for fiscal years 2005 and 2006, respectively. The program ended in June of 2006.

Further support for the industry has come from the American Jobs Creation Act (the Jobs Act) of 2004. While as previously mentioned, corn ethanol enjoyed tax exemptions since 1978 through the Energy Tax Act of that year and later policies,[13] the biodiesel industry did not receive tax credits until the Jobs Act. Through tax breaks, the Act provides incentives for the biofuels industry, again on the demand side. Under the Act, blenders can claim $1 per gallon of biodiesel made from first-use vegetable oils or animal fats (agri-biodiesel as named in the legislation) and $0.50 per gallon made from recycled oils and fats mixed with diesel, making the biofuel more competitive with fossil diesel.[14] This tax exemption accounts for most of the support received by the industry (Koplow, 2006). A source of friction with U.S. producers is that the Jobs Act does not distinguish between biodiesel elaborated with domestic versus imported feedstock. As further discussed below, however, to receive the tax credit, the blender needs to use biodiesel registered as fuel with the Environmental Protection Agency (EPA) and meeting the ASTM D6751 standard, as certified by its supplier (NBB n.d.).

The Energy Policy Act of 2005 (EPAct2005) provides incentives on both the supply and demand sides. On the supply side, the 2005 EPAct again seeks to lower production costs by providing (income) tax credits at a rate of $0.10 per gallon to small producers of agri-biodiesel. The credit is available for the first 15 million gallons produced by a plant with an annual production capacity of less than 60 mmg. According to Promar International (2005), the capacity of different biodiesel plants is aggregated for a single owner, and the credit is capped at $1.5 million per producer. This tax credit is set to expire at the end of 2008.

On the demand side, EPAct2005 mandates a renewable fuels phase-in (the Renewable Fuels Standard, or RFS), requiring fuel producers to include a minimum amount of biofuels by year. It extends the excise credit to blenders (originally set to expire at the end of 2006 in the Jobs Act) until the end of 2008.[15] Under the RFS, fuel producers were required to include 4 billion gallons of renewable fuels by 2006. They are to increase the amount to a minimum of 7.5 billion gallons by 2012. Credit trading is allowed as a way to lower the costs of the transition (Promar International 2005).

Lobbying efforts are intensifying to extend the tax incentives beyond 2008. In March 2007, legislation was introduced to extend the federal excise and income tax credit for biodiesel through 2017. Legislation seeking to make the excise tax credit for biodiesel permanent was introduced in January of that year. Efforts are also being undertaken to revive the CCC Bioenergy Program with increased funding and include it in the 2007 farm bill.

Tax credits (at a rate of 30%) are also provided under EPAct2005 for the cost of installing fueling facilities for vehicles using diesel blended with at least 20% biodiesel, among other alternative fuels such as E85, natural gas, liquid natural gas, propane, and hydrogen (Duffield and Collins 2006).

The states have also provided 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, which creates a captive demand)[16] to further tax credits and cost sharing of investments and research. According to Koplow (2006), 38 states currently have at least one incentive in place for biodiesel or ethanol.

The aggregate support for the industry has been estimated (Koplow 2006) to be between $378 million and $481 million for 2006. The same figure would be between $5.1 billion and $6.8 billion for ethanol. Again, the bulk of the support comes in the form of tax exemptions provided through the volumetric excise tax credit.

TABLE 3. Biodiesel capacity and actual production in the United States and Europe

	United States			European Union		
	Production[a]	Capacity	Util. Rate[b]	Production	Capacity	Util. Rate
Year	(Million Gallons)		(%)	(Million Gallons)		(%)
2000	2	50	4	198		
2001	5	50	10	227		
2002	15	54	28-29	310		
2003	20	85	24-29	418	597	70
2004	25	157	16-21	563	654	86
2005	75	290	26-34	928	1,232	75
2006	250	580	43-57	1,420	1,768	80

Source: NBB, EBB.
[a] As in Figure 2, we use sales as a proxy for production.
[b] The range reflects different assumptions on the time of the year in which plants start to operate.

Comparing U.S. and EU Rates of Production and Capacity Utilization

Table 3 shows actual biodiesel production and capacity constructed for the EU and the United States. Clearly there exists idle capacity in both regions, possibly indicating that supply is outpacing demand. However, this is more prevalent in the United States than in Europe. A potential explanation for the diverging plant utilization rate can be found in the way the industries were developed.

Whereas European institutions seem to have guided the development of the industry in that region, agricultural producers were the most enthusiastic supporters of biodiesel in the United States. In a sense, the growth of supply and demand in Europe seems to have been more balanced. Through tax exemptions for biodiesel, and as a consequence of its vehicle fleet composition (described in the next section), Europe was able to grow the demand for biodiesel more rapidly than the United States. Although the government created some incentives for demand in the United States, they appear to have been insufficient for a strong rise in consumption of biodiesel until 2005. As discussed in more detail below, quality issues have been a strong deterrent to a more rapid up-take of biodiesel in the United States. Initially, the only important consumers (in terms of volume purchased) of the alternative fuel were captive fleets, trying to meet their requirements under the 1992 EPAct. Only after the 2004 Jobs Act and EPAct2005 did the growth in demand for (and supply of) the fuel accelerate. The rapid expansion of U.S. capacity (past and projected by NBB), with a large share of it idled, seems to indicate investors are expecting demand for the fuel to grow at an accelerated pace in the near future. Based on current oil and feedstock prices, the occurrence of this scenario is not highly likely, unless government support for the industry is increased (or at least extended beyond 2008, the scheduled expiration date of the excise tax credit for blenders). This point can be illustrated through the German experience. Recent analysis conducted for the German Parliament (German Bundestag 2005) concluded that tax exemptions were overcompensating the biodiesel industry for its higher production costs (as compared to fossil fuels). Following the recommendations of the report, the German government decided to tax biodiesel at a rate of 9¢/liter in pure form (15¢/liter in blends) starting in August of 2006. The tax is scheduled to stay at that level for 2007 and then increase at a rate of 6¢/liter per year until reaching full taxation in 2012 (Union for the Promotion of Oil and Protein Plants [UFOP] 2005). According to industry representatives, this measure has already decimated the sales of the fuel (Hogan 2007).[17]

Despite the EU's higher utilization rates compared with the United States, representatives of the EBB indicate that the production capacity of the EU biodiesel industry is currently not being fully utilized, mainly because of lack of markets due to delayed political support (Hogan 2007).

Influence of Divergent Fleet Compositions on the Development of Biofuels

European transport fleets rely on diesel fuels to a much higher extent than those of the United States. While the demand for gasoline in Europe has been decreasing since the mid-1990s, the consumption of diesel for road transportation more than doubled during the 1985-2003 period, mostly because of sustained growth in the passenger car segment and in the transport of goods by road (French Institute of Oil [IFP] 2005).[18] The difference is most notable for passenger cars, whereby the share of cars using diesel engines in 2005 was around 50% for some European countries.

Table 4 shows the share of passenger cars that are fueled with diesel in selected European countries. The table also shows that the share of diesel passenger cars has increased (doubled) between 1995 and 2005 for the countries listed. At the other end, diesel vehicles had a much lower penetration rate in countries such as Greece and

TABLE 4. Number of passenger cars and share of diesel cars for selected European countries in 1995 and 2005

	2005		1995	
Country	**Passenger Cars**	**Diesel Share (%)**	**Passenger Cars**	**Diesel Share (%)**
Austria	4,156,746	51.2	3,593,588	23.0
Belgium	4,861,352	49.5	4,239,051	32.4
France	30,100,000	47.7	25,100,000	27.6
Spain	20,250,377	41.7	14,212,259	14.5
Italy	34,667,485	28.3	30,301,424	10.2
Germany	46,090,303	21.9	40,404,294	13.7
Great Britain	29,747,546	19.6	24,306,781	8.4
The Netherlands	7,299,000	15.9	5,633,000	11.0
Average[a]		30.6		15.2

Source: European Automobile Manufacturers Association (ACEA).
[a] Weighted by the number of cars in each country.

TABLE 5. Diesel share of new passenger car registrations for selected European countries, 2000-2006 (percent)

Country	2000	2001	2002	2003	2004	2005	2006
Austria	61.9	65.7	69.6	71.5	70.7	64.7	62.1
Belgium	56.3	62.6	64.3	68.2	70.0	72.6	74.5
France	49.0	56.2	63.2	67.4	69.2	69.1	71.4
Germany	30.3	34.5	37.9	39.9	44.0	42.0	44.2
Italy	33.6	36.6	43.4	48.7	58.0	58.3	58.2
Spain	53.1	52.5	57.1	60.9	65.4	67.8	68.2
The Netherlands	22.5	22.9	21.6	22.6	24.6	26.8	27.0
Great Britain	14.1	17.8	23.5	27.3	32.5	36.8	38.3
EU15	32.8	36.7	41.0	44.3	48.9	49.8	51.2

Source: ACEA with data from AAA (Association Auxiliaire de l’Automobile).

Sweden, with 2005 market shares of 1.1% and 5.2%, respectively. However, the fleet size of these countries is also relatively small.

The share of diesel-fueled passenger cars in European countries will be higher in the near future. Table 5 shows the share of diesel vehicles among new passenger car registrations since 2000. The table shows that the share of diesel engines in new cars is higher than the share in the current passenger car fleet. Thus, as older vehicles are replaced, the share of diesel vehicles in European countries is expected to increase.

Hence, increasing levels of dieselization of the EU passenger car fleet (the fastest-growing segment of the transportation sector) combined with the fact that biodiesel can be used in most regular engines (even in its pure form) seem to have made this the biofuel with highest development potential.

For comparison purposes, Table 6 shows the diesel share of new passenger cars and light and medium-duty trucks in the United States. Clearly, even when a trend toward dieselization of the fleet is observed for the segments reported in the table, the trend and market share of these vehicles is much lower than for Europe. Some analysts predict the diesel share of light vehicle sales will increase to more than 10% by the middle of the next decade (J.D Power and Associates 2006; F.O. Licht 2006).

Product Quality Standards

Quality is still one of the main factors preventing equipment manufacturers from increasing the blends they will allow (Goodrich 2007). Since biodiesel can be produced through different processes and from widely differing feedstocks, the quality of the product is expected to be variable. This was a major deterrent for the biodiesel industry in the past. Engine manufacturers were not prone to approve its use, and their warranties were void if biodiesel was used as fuel.

Quality standards are very important for the biodiesel industry. Again, Germany's experience is illustrative. In 1999, biodiesel of inferior quality entered the market, resulting in engine problems, complaints from consumers and auto-manufacturers, and a setback to the industry. Similar issues were raised in the United States, where the

TABLE 6. Diesel share of new car registrations in the United States, by selected categories (percent)

Share of	2000	2001	2002	2003	2004	2005
Passenger Cars	0.24	0.27	0.38	0.37	0.30	
Light Duty Trucks	0.06	0.06	1.97	2.02	2.48	
New Vehicles[a]	2.25	2.60	2.71	3.10	3.37	3.60

Source: Automotive Fuel Economy Program of the National Highway Traffic Safety Administration, and R.L. Polk and Company.
[a] Share of the new passenger vehicle market (Class 1, 2, and 3 vehicles). Includes medium- and light-duty trucks and vehicles as well as other vehicles such as the Diesel Hummer and Sprinter passenger vans.

mandated B2 use in Minnesota strained the local supply, and low-quality biodiesel was released in the market, resulting in engine sputtering, stalled vehicles in cold weather, plugged fuel lines (Methanol Institute and International Fuel Quality Center [IFQC] 2006), and overall discontent with the fuel. According to the Oil Price Information Service (OPIS 2006), the Minnesota experience had some lawmakers reconsidering their support for such mandates. Additionally a recent study by the National Renewable Energy Laboratory, cited in the February (2007) issue of *Biodiesel Magazine,* found that 50% of the 32 samples of B100 collected nationwide failed to meet the current U.S. (ASTM D6751) standard.[19] In part because of the quality variability, NBB developed the quality assurance system BQ-9000 and is aggressively encouraging its adoption by producers.

The development of the D6751 standard by the American Society for Testing Materials[20] (ASTM D6751) was a major step in the process of providing a more uniform product and hence better acceptance for biodiesel. While a task force started work on the standard as early as 1994, the final form was not approved and published until 2001.[21] The ASTM D6751 standard applies to pure biodiesel (B100) to be used in blends up to 20%, and not as a pure fuel. ASTM is currently working on a standard for B20 as a blend.

The Engine Manufacturers Association (EMA) currently approves the use of B5, if the biodiesel used meets the U.S. ASTM D6751 or European EN14214 standards.[22] However, potential users of higher blends are encouraged to contact individual manufacturers regarding the implications of using these fuels (EMA 2003). EMA has developed specifications to identify a standard blend suitable for further evaluation, and it asserts that a blend of 20% biodiesel satisfying the U.S. or European standard and 80% petrodiesel meeting ASTM D975 should comply with the requirements. However, EMA states explicitly that “the development and release of the specification does not imply or constitute any endorsement for use of B20 blends by EMA or its member companies.” (EMA 2006, p. 1). Today, as a general rule, most diesel engine manufacturers follow the guidelines of EMA by recommending B5. Current exceptions are Cummins Inc. and New Holland. The former approved usage of B20 produced by plants that are BQ-9000 certified (meeting the test specifications provided by EMA) in some 2002 and later engines. New Holland was the first original equipment manufacturer to support the use of the B20 blend in all equipment using its engines. However, Weaver (2006) points out that manufacturers will not cover damage due to usage of biodiesel.

There is no federal requirement that biodiesel on the market must meet the ASTM D6751 standard, and testing and enforcement varies on a state-by-state basis. As of early 2007, 33 states have adopted the ASTM D6751 standard as a specification for B100, and 15 have adopted the ASTM D975 for low blends (B1-B5). However, strong incentives are available to commercial retailers and fleet managers for using B100 that meets the standard. To be eligible for the volumetric biodiesel credit (described above) as passed by the Jobs Act (and later notices),[23] the blender needs to obtain certification (from the producers or reseller) identifying the product as a fuel registered with the EPA and meeting the ASTM D6751 standard.

The EU has also published strict guidelines in compliance with CEN Standardization (EN14214) in order to ensure quality and performance. Although the motivation behind the development of the European standard was, as in the U.S. case, to ensure production of biodiesel of a consistently high quality, it evolved in a somewhat different fashion.

The first standard for rapeseed methyl ester emerged in 1991 in Austria. France and the Czech Republic developed their own standards a couple of years later. Germany, the current world leader in biodiesel production, did not develop its quality standard until 1997. The European standard, EN14214, was developed by the European Committee on Standardization, with input from the biodiesel, oil, and automotive industries (Pahl 2005). While individual European countries started efforts to develop quality standards for biodiesel earlier than in the United States, a common standard (EN14214) was not approved until 2003. These standards were instrumental in creating a demand for biodiesel by convincing several engine manufacturers to warrant its use as a vehicle fuel in these countries (Pahl 2005). The new standard replaced those of the individual countries, and biodiesel satisfying this standard could be used without blending.

According to EMA (2003), the EN14214 standard is more stringent than the ASTM specification by setting lower limits for sulfur and water and a test for oxidation stability.[24] The standard is also seen by some as a non-tariff barrier since it cannot be easily achieved using feedstocks that are most common in other parts of the world, such as soybean and palm oil (Ericsson 2006). To meet the standard, only small proportions of these oils could be blended. Beyond the EU-wide standard, the voluntary quality assurance scheme developed by a group of biodiesel manufacturers and distributors in Germany and Austria (the AGQM) requires that only rapeseed methyl ester be sold at public filling stations. The argument is that several vehicle manufacturers approve only this fuel for use in their vehicles (Methanol Institute and IFCQ 2006).

Ultra-Low-Sulfur Diesel

Emission reductions are an objective of regulators on both continents. The use of ultra-low-sulfur diesel (ULSD) will reduce the levels of sulfate emitted by diesel engines. Additionally, it will enable the use of catalytic converters and other equipment that traps particles, lowering emission of particles and nitrogen oxides. According to the Diesel Technology Forum, the use of ULSD, in combination with the systems just mentioned, has the potential to reduce emissions of particles by more than 90% and of hydrocarbons to negligible levels.[25]

Europe took the lead in the introduction of desulfurization mandates. According to Energy Security Analysis Inc. (ESAI 2005), the move toward ULSD started in Germany with the introduction in 2001 of 50 parts per million (ppm) sulfur diesel. A major increase in the use of ULSD occurred in January 2005, when the European Union mandated the same maximum (50 ppm) sulfur level (down from 350 ppm), and the introduction of a 10 ppm diesel grade. The EU will make the 10 ppm sulfur cap for on-road diesel mandatory in 2009. ESAI (2005) also claims that it is a matter of time until the European Union requires tighter specifications for non-road diesel.

The EPA issued the ULSD rule affecting on-highway diesel in 2001. However, desulfurization of diesel did not start until 2006. Starting on June 1, 2006, federal regulations required refiners to reduce the sulfur content from the current U.S. standard of 500 ppm to less than 15 ppm in 80% of the on-road diesel they produce until 2010,[26] after which all the diesel produced needs to have less than 15 ppm of sulfur.[27] Refined product terminals and retailers had until September 1 and October 15, respectively, to make the transition.[28] The latter deadline allows firms downstream to clear their inventories before receiving the new lower-sulfur product. Since testing will occur at the retail level and

ULSD can be contaminated by sulfur at different points in the distribution system, refiners claim they will release diesel with 5 to 6 ppm (OPIS 2006).

The process used to reduce sulfur levels also reduces the lubricity of the fuel, which could damage diesel engines. Biodiesel has been shown, even at low percent blends (2%), to increase the lubricity of the fuel (Goodrum and Geller 2005). This can potentially increase the demand for biodiesel, if it is available and competitively priced relative to alternative lubricant additives (Jessen 2006).

Feedstocks

Biodiesel can be produced through a wide range of vegetable oils and animal fats (e.g., chicken fats, tallow, and fish oil). While the main feedstock in the United States, due to its cost, availability, and early incentives (and industry promoters), is soybean oil, rapeseed oil occupies the center stage in the EU. An approximation to the shares of the different oils and fats used to produce biodiesel in the United States was obtained based on the CCC Bioenergy Program and is presented in Table 7. As shown in the table, the U.S. industry relies on soybean oil for over 90% of production.[29] This also likely reflects

TABLE 7. Share of the different feedstocks compensated by the CCC bioenergy program used for biodiesel production in the United States (percent of production)

Feedstock	**FY 01[a]**	**FY 02[b]**	**FY 03[c]**	**FY 04**	**FY 05**	**FY 06**
Soybeans	100.00	98.95	88.55	90.07	91.58	94.66
Animal Fats & Yellow Grease	0.00	1.03	11.45	9.93	8.05	5.06
Cottonseed Oil					0.18	0.11
Corn Oil					0.10	0.07
Canola Oil					0.09	0.10
Sunflower Oil					0.01	0.00
Mustardseed	0.00	0.01	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00

Source: Adapted from table provided by NBB.
Note: Biodiesel made from palm is not included since palm oil was not an eligible commodity under the program.
[a] Vegetable oils are the only eligible commodity.
[b] Yellow and waste greases and animal fats became eligible commodities.
[c] The Bioenergy Program payment determination formula was redesigned to take into account the cost differences among feedstocks.

the fact that the industry was most strongly promoted by soybean producers. However, plants able to use other types of vegetable oils to produce biodiesel are becoming more common.[30]

The Food and Agricultural Policy Research Institute's (FAPRI) 2007 projections indicate that the share of soybean oil–based biodiesel in the United States is likely to decrease to 72% by 2016. Canola oil is expected to increase its share to about 17% in a decade, and the remaining production is projected to be obtained from animal fats and other oils.

Recycled oils and animal fats are also used as feedstock for biodiesel production. These types of feedstock are less costly than virgin vegetable oils but are usually found in smaller quantities and require pre-treatment before they can be used, which limits their contribution to the total feedstock mix. However, biodiesel plants can reduce the cost of their feedstock by blending vegetable oils with animal fats (Paulson and Ginder 2007).[31] The estimated 250 million gallons of biodiesel production for 2006 would use about 6% of the average domestic production of feedstock for the 2000-2004 period (reported at 4.178 billion gallons per year by Eidman [2006]).

In contrast, European production is based mostly on rapeseed oil, and European technical standards for biodiesel were developed with a bias toward this feedstock. As mentioned above, production using soybean and palm oil would not comply with the European biodiesel standard (Ericsson 2006; Albanese 2007). Soybean and palm oil could only be used in blends containing at least 75% rapeseed oil (Ericsson 2006).[32] This has limited the use of soybean oil for biodiesel in Europe until recently. However, some analysts believe that it may be allowed in blends in the future because of rising deficits in vegetable oils in Europe (Ash, Livezey, and Dohlman 2006). The European Commission (COM 2006a) recognizes this fact and indicates that the biodiesel standard should be amended to allow a wider range of vegetables oils.

Political support measures discussed earlier, such as the freedom to plant industrial crops in set-aside land, along with its higher oil yield per acre, have made rapeseed, with its 85% market share, the crop of choice for producing biodiesel in Europe. The remaining 15% is shared mostly between soybean, palm, and sunflower oil (Methanol Institute and IFQC 2006).[33] Projections for 2020 by the European Commission (COM 2006b) indicate that biodiesel made from rapeseed will account for about 70% of all biodiesel made from vegetable oils, under a scenario of 7% share of biofuels of the fuels used for transportation. If the 2020 share of biofuels is assumed to be 20%, the proportion of vegetable oil–based biodiesel obtained from rapeseed decreases to the 45%-52% range, depending on assumptions on the relative magnitude of imports versus domestic production.

Final Remarks and Industry Prospects

Despite the rapid development of the EU biodiesel industry, most member states failed to meet the indicated 2005 targets put forward in response to Directive 2003/30/EC. Most countries (and the EU overall) fell short of the chosen targets, despite the fact that for many member states (12 out of 25) these were lower than the 2% target suggested by the Commission’s Directive, and fiscal incentives were provided. This might be signaling that reliance on biodiesel alone may be insufficient for countries to be able to displace significant amounts of fossil fuels unless financial incentives are increased. A major source of vulnerability for the biodiesel industry is the fact that feedstocks account for over 80% of production costs. Thus, any change in commodity prices can modify, in a significant fashion, the margin of the industry. In contrast to corn-based ethanol, in which the price of the main feedstock (corn) seems to be determined by its value in the energy market, biodiesel feedstock prices are largely determined in the markets for food. Additionally, supplies of oils and fats are relatively inelastic, indicating that their prices are expected to increase in a relatively significant fashion with the quantities demanded for biodiesel production.

As previously discussed, production in the United States has also been growing rapidly, fueled by high diesel prices, government provided financial incentives, mandates for the use of alternative fuels, and state mandates to blend diesel with biodiesel. However, production capacity is still well underutilized. While this may be the result of newer plants running at lower capacity while still adjusting their production process, it could also be signaling that supply capacity is outpacing demand. Demand may be delayed because the industry is still experiencing quality issues. Significant idle capacity could also indicate that current market conditions are not very favorable for the production of biodiesel and/or that some of the potential capacity is being diverted to the production of other ester-based products (Paulson and Ginder 2007). A significant factor has been the "first mover" position of the ethanol industry, leading to attractive prices for corn, which places some upward pressure on the prices of oilseeds in order to attract area.

Revenues for a biodiesel plant are mostly provided by fuel and glycerin (a co-product) sales, which are produced in a ratio of 1:10. The contribution of the main by-product (glycerin) in its raw form is relatively small but nonetheless important for the plant's profitability. However, the market for glycerin has not been able to absorb large quantities without sharp price discounts. Consumption of glycerin in the United States was between 400 and 450 million pounds per year between 2003 and 2005, which was mostly supplied with domestic production (Nilles 2006). Using the 1:10 production ratio, the 250 mmg of estimated biodiesel production in 2006 would have produced about 193 million pounds of glycerin (assuming 7.7 pounds of vegetable oil per gallon). The excess supply, which is also occurring in Europe, has already been reflected in the glycerin prices. While crude glycerin fetched between 20¢ and 25¢ per pound in the past, it is now getting below 5¢ per pound (Nilles 2006), which erodes the margins of the plants. Other authors indicate that a large expansion of biodiesel production could drive the price of glycerin to near zero (Fulton 2005). A floor price would exist for glycerin as a source of energy (Nilles 2006). Further refining the glycerin (at a cost) could increase the price of the product. A lot of effort is being made to find new uses for glycerin that will absorb large quantities of the product.

Table 8 presents projections of production margins of soybean oil–based biodiesel in the United States. The figures in the table seem to indicate that biodiesel margins are being reduced by both an increase in feedstock costs and a projected decrease in the biodiesel price.

Technological advances helped maintain the viability of biodiesel plants in the past. According to Pahl (2005), the yield of the transesterification process was between 85% and 95% in early plants, but newer plants have been able to take the yield to 100%. This is significant, as Pahl indicates that a 10% decrease in yields could lower profits by 25%. Also, new discoveries allowed for the construction of multi-feedstock plants, which could rapidly adjust their feedstock mix to take advantage of (or to protect against) price differentials among individual feedstocks. The projections presented in Table 8 seem to

TABLE 8. Projected net returns for biodiesel production in the United States (dollars per gallon, Oct.-Sept. year)

Cost and Returns	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Biodiesel Value	3.4	3.17	3.16	3.14	3.12	3.1	3.07	3.05	3.05	3.05	3.06
Glycerin Value	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Soybean Oil Cost	-2.1	-2.36	-2.58	-2.64	-2.64	-2.62	-2.62	-2.62	-2.64	-2.66	-2.69
Other Operating Cost	-0.53	-0.54	-0.54	-0.55	-0.56	-0.56	-0.57	-0.57	-0.58	-0.58	-0.59
Net Operating Returns	0.83	0.32	0.08	0.0	-0.02	-0.04	-0.07	-0.1	-0.13	-0.15	-0.17

Source: FAPRI-UMC 2007.

indicate that unless increases in crude oil prices are observed, and/or further technological improvement occurs (higher-yielding feedstock oil varieties, higher-value glycerin use, technology-induced operation cost reductions, etc.), the industry is highly likely to be dependent on strong government support for the next decade.

Prospects in Europe are not much better than in the United States. Prices for rapeseed oil have also increased and are projected to remain high in the near future, squeezing the margins for biodiesel producers in the EU. FAPRI (2007) projects that FOB Hamburg prices for rapeseed oil will be above $900/mt for the next three years (reaching as high as $945/mt for the 2008/2009 marketing year), up from the average $700/mt for the 2003-2006 period. A $900/mt price of rapeseed oil would translate into a feedstock cost of $3.14/gallon of biodiesel (assuming 7.7 pounds of oil are needed), up from the $2.44/gallon average from 2003 to 2006, a 29% increase. The average price for biodiesel producers in Germany between July 2006 and May 2007 was $3.70/gallon,[34] indicating that $0.56 per gallon is available to cover all other operating and capital costs.

The preceding discussion indicates that in order for the biodiesel industry to grow further and contribute to significant displacements of fossil energy in the short to medium term under expected market conditions, maintained or increased government financial support is needed on both sides of the Atlantic. However, any increase in government support needs to be carefully engineered, as it may lead to some international trade disputes. An example can be found in the recent complaint of the European biodiesel industry, through EBB, before the European Commission. In this complaint, EBB claimed that the way the U.S. government supports the industry creates unfair competition and places the EU industry at a competitive disadvantage. Specifically, the complaint argues that the blenders tax credit allows for U.S. biodiesel and biodiesel from other countries to be blended in the United States and dumped as B99 in Europe where it can also benefit from Europe’s support scheme. In the view of EBB, this is a breach of the World Trade Organization rules.

Endnotes

1. While testing has shown that usage of biodiesel reduces the release of CO_2, CO, unburned hydrocarbons, and particulate matter, it is unclear whether it increases or decreases the emissions of nitrogen oxides as compared with fossil diesel.

2. While subsidization of ethanol at the federal level started with the Energy Act of 1978, it did not start until 1998 for biodiesel (Koplow 2006).

3. Other reports put these break-even points in 69-76 and 63-85 euros per barrel of oil for biodiesel and ethanol respectively (COM 2007).

4. While passenger transport by bus, coach, and rail has remained fairly constant over time, passenger transport by car has more than doubled since 1970. Private cars are responsible for more than half the oil consumed by the transportation sector (EC 2001). Transport of goods by road has tripled since 1970 (EC 2001).

5. By the late 1990s, a time when the set-aside lands were reduced to 5%, the price of oilseeds was high and that of crude oil (and diesel) was low, biodiesel producers searched for alternative (lower cost) feedstock. This was a time when commercial production of biodiesel based on used frying oils expanded rapidly (Pahl 2005). However, the growth of the industry was halted until 1999 (see figure 1).

6. The targets are based on energy content.

7. This recognition is clearly stated in the directive's review clause (article 4.2), which states: "on the basis of this report [a biannual evaluation report by the Commission required by the same article] the Commission shall submit, where appropriate, proposals to the European Parliament and to the Council on the adaptation of the system of targets…If this report concludes that the indicative targets are not likely to be achieved for reasons that are unjustified and/or do not relate to new scientific evidence, these proposals shall address national targets, including possible mandatory targets in the appropriate form."

8. Imports from countries outside the EU are assessed an ad valorem duty of 6.5%.

9. Biodiesel can be blended up to 5% with fossil diesel without requiring special labeling.

10. This is not the case for other countries such as Italy and France.

11. Roughly speaking, the alternative fuel providers include businesses involved in production, handling, or trade of alternative fuels that control fleets of more than 50 light-duty vehicles within the U.S., of which 20 or more are primarily driven in a single Metropolitan Statistical Area (as defined by the Department of Energy). The companies need to be able to refuel these same cars at least 75% of the time in stations under their control (or under contract) to be subject to EPAct requirements. For more details, see http://www1.eere.energy.gov/vehiclesandfuels/epact/state/alt_fuel_prov.html.

12. The 2005 figure is for October-June.

13. The current support is set at $0.51 per gallon.

14. The credit is only available for mixtures containing at least 0.1% by volume of diesel. B100 as fuel can claim income tax credit but not the excise credit. According to Promar International (2005), this alternative is less attractive than the blender's tax credit since there is no mechanism for a refund in case the credit exceeds the liability.

15. The tax credit for ethanol was extended until 2010.

16. In the state of Washington, 2% by volume of all diesel sales must be biodiesel by November 30, 2008. This requirement then changes to 5% when the Washington-based crushing capacity and feedstock is certified by state officials to cover 3% of the biodiesel blending. State agencies are instructed to use at least B20 beginning June 1, 2009. The first phase of the requirement is expected to boost biodiesel demand to 20 million gallons per year.

17. The same sources indicated sales of biodiesel decreased between 30% to 40% from December of 2006 (Hogan 2007). Remarks along the same line were made before by the chairman of the German Bioenergy Association (BBE) in September of 2006 at the BBE/UFOP Fourth International Conference on Biofuels.

18. Diesel consumption in Europe accounted for 60% of the road transport fuels (gasoline, 40%) in 2005. According to IFP (2005), the growth in the market penetration of diesel passenger cars and in truck freight traffic is due to technological advances in diesel engines as well as favorable tax conditions.

19. The most common problem was the amount of glycerin in the fuel.

20. ASTM is a consensus-based standards group.

21. The same year, John Deere approved B5 for use in all of its products, and since March 2005, new equipment leaving its factories has been filled with B2.

22. The blend needs to meet the ASTM D975 standard, the U.S. standard for petrodiesel.

23. IRS Notice 2005-04 and IRS Notice 2005-62.

24. ASTM is expected to make official the already approved introduction of a specification for oxidative stability.

25. http://www.dieselforum.org/meet-clean-diesel/what-is-clean-diesel/new-technologies/ultra-low-sulfur-diesel/.

26. Retailers had until October 1, 2006, to sell existing inventories of higher-sulfur diesel.

27. Reduced sulfur content for off-road diesel started phasing in on June 1, 2007. Most non-road diesel must be 15 ppm, and non-road locomotive and marine must be under 500 ppm by June 1, 2010 (OPIS 2006), and under 15 ppm by 2012 (ESAI 2005).

28. Terminals and retailers will no longer sell 500 ppm fuel on October 1and December 1 of 2010, respectively. Fines for not complying could be as high as $32,500 per day (OPIS 2006).

29. Koplow (2006) cites a 75%-90% range.

30. ADM is building a plant with a yearly capacity of 85 million gallons to be run on canola oil in Velva, North Dakota. Additionally, several plants listed as under construction by NBB will be able to use different feedstocks (multi-feedstock).

31. According to industry sources contacted by Paulson and Ginder (2007), a blend of 70% vegetable oil and 30% animal fats could reduce feedstock costs by $0.033 per pound when compared to 100% vegetable oil.

32. According to Albanese (2007), Argentine producers are blending small fractions of soybean oil (less than 20%) with rapeseed oil to meet the standard. The same article indicates that to increase the percentage of soybean oil in the blend, it needs to be pretreated, which increases production costs.

33. The EU used about 4.1 mmt of rapeseed in 2004 (27% of the total crop) to make biodiesel (Schnepf 2006).

34. Based on F.O. Licht World Ethanol and Biofuels Report (several issues). An exchange rate of $1.303 per euro (average for the period) was used.

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