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Biofuels in Germany - Prospects and limitations

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Report Highlights:
Germany has been very supportive in promoting biodiesel as a fuel alternative. Recent changes to German tax law combined with various other factors are now opening the door to other biofuels in Germany. The report discusses developments in the German biofuel sector and focuses on biodiesel, bio-ethanol, pure rapeseed oil and synthetic fuels. Biodiesel is currently still the most popular biofuel with production capacity projected to reach 1.3 million MT at the end of 2004. However, three plants for bio-ethanol production are being constructed. Upon completion, their combined production capacity will amount to 500,000 MT of bio-ethanol, annually. Prospects are better for blends than for 100 percent pure biofuels.

Includes PSD Changes: No
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[GM]

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1. Introduction

The development, use and support of biofuels, namely biodiesel, in Germany has a history of more than 15 years. The aim is to make use of their environmental benefits, in order to become less dependent on fossil fuels, and to generate additional income for farmers. With the Green Party gaining more and more influence in the German government but also on the EU level, the environmental benefits are playing a greater role in determining policy for biofuels.

Under the current market situation biofuels are not competitive without some sort of support, therefore EU and German legislation, especially regarding possible tax breaks, is vital for the development of the biofuel sector.

In our previous report “Biodiesel in Germany an overview” (GM2021) of October 2002 we focused on biodiesel exclusively. Since then a revision in European regulations and the German tax law has created better prospects for other biofuel types. Therefore this report covers the most common biofuels currently being used or developed in Germany, i.e. biodiesel, bioethanol, pure rapeseed oil, and synthetic bio-fuels. Biomass and biogas production for electricity is not covered in this report. In particular, this report focuses on the implications of bio-fuels on the production, import and export of agricultural crops in Germany. An assessment of the environmental benefits of the different bio-fuel types is not part of this report.

2. Definitions

<u>Biofuels:</u> EU directive 2003/30/EC, art. 2 (1) defines biofuels as “liquid or gaseous fuel for transport produced from biomass.”

Currently the EU directive 2003/30/EC, art. 2 (2) recognizes 10 different biofuel types: bio-ethanol, biodiesel, biogas, biomethanol, biodimethylether, bio-ETBE, bio-MTBE, synthetic biofuels, biohydrogen and pure vegetable oil. This list may be updated in the case of technical progress and the development of additional biofuels.

This report focuses on four biofuels: biodiesel, bio-ethanol, pure vegetable oil, and synthetic biofuels.

<u>Diesel</u> in this report is referred to as the diesel, which is based on petroleum as opposed to <u>Biodiesel</u>, or “fatty acid methyl ester” (FAME), which is based on biomass.

<u>Blends</u> are a mix of biofuel and petroleum-based fuel. A 5 percent blend contains 5 percent biofuel and 95 percent petroleum-based fuel. Diesel can be blended with biodiesel, gasoline can be blended with bio-ethanol. For technical reasons blends of diesel and bio-ethanol or gasoline and biodiesel are not possible.

<u>Feedstock</u> = raw material for the production of biofuels
<u>MT</u> = metric tons
<u>Ha</u> = hectares, 1 hectare = 2.471 acres

3. Legislation concerning biofuels

3.1. EU legislation

The two EU directives having the biggest impact on the use of biofuels in the EU are the directive on the promotion of the use of biofuels or other renewable fuels for transport (directive 2003/30/EC) and the directive on the harmonization of energy taxes (directive 2003/96/EC).

3.1.1. Biofuel Promotion directive

The EU commission aims to meet the Kyoto goals and lower EU dependency on petroleum-based oil by setting indicative[1] goals for a minimum use of biofuels. Directive 2003/30/EC establishes goals of 2 percent by the end of 2005, increasing to 5.75 percent by the end of 2010. The Commission's green paper, "Towards a European strategy for the security of energy supply" even calls for biofuels to comprise a 20 percent share of the total fuel use by the year 2020. Member states have to ensure compliance with the directive but retain the right to choose whether they promote the use of pure biofuels or a blend of biofuel and conventional fuels.

In order to achieve the replacement goals, biodiesel can technically replace petroleum-based diesel and bio-ethanol can replace gasoline. Biodiesel cannot replace gasoline and bio-ethanol cannot replace diesel. In the scenario that Germany attempts to meet the goals laid down in directive 2003/30/EC through the use of both, biodiesel and bioethanol, the required amounts of biodiesel and bioethanol that are needed to replace petroleum-based fuels are shown in table 1.

Table 1: Directive 2003/30/EC replacement goals and required biodiesel and bio-ethanol amounts in Germany

	Expected fossil fuel consumption[2]			Directive 2003/30/EC replacement goal		Amount needed to replace petroleum-based fuel*	
Year	Diesel 1,000 MT	Gasoline 1,000 MT	Total 1,000 MT	Percent	Fossil fuel to be replaced 1,000 MT	Biodiesel 1,000 MT	Bio-ethanol 1,000 MT
2005	30,100	25,200	55,300	2.00	1,106	662	756
2006	30,800	24,900	55,700	2.75	1,532	932	1,027
2007	31,300	24,500	55,800	3.50	1,953	1,205	1,286
2008	31,200	24,000	55,200	4.25	2,346	1,459	1,530
2009	31,000	23,500	54,500	5.00	2,725	1,705	1,763
2010	30,800	22,900	53,700	5.75	3,088	1,948	1,975

* due to different energy content the replacement ratios are as follows
1 MT of diesel is replaced by 1.1 MT of biodiesel
1 MT of gasoline is replaced by 1.5 MT of bioethanol

[1] While the goals are not mandatory, the EU member states have to give good reasons, if they are unable to comply.
[2] As estimated by the German Mineralölwirtschaftsverband in May 2004

Reading example:

In 2005 the projected use of diesel is 30,100 MT and that of gasoline 25,200 MT adding to a total of 55,300 MT. The replacement goal is 2 percent, which means 1,106 MT of fossil fuel have to be replaced. 2 percent of the 30,100 MT of diesel are 602 MT, due to the different energy content, 662 MT of biodiesel are needed to replace 602 MT of diesel. 2 percent of the gasoline consumption amounts to 504 MT. Due to the different energy content, 756 MT of bio-ethanol are needed to replace 504 MT of gasoline. Therefore 662 MT of biodiesel plus 756 MT of bioethanol are needed to replace 2 percent of the total fossil fuel use in 2005 in Germany.

Source: Mineralölwirtschaftsverband (expected fuel consumption)
FAS/Berlin calculation

3.1.2. Tax directive

Directive 2003/96/EC sets the rules for the exemption of biofuels and biofuel blends from energy taxes. Member states are allowed to grant a tax exemption for the share of biofuel in a blend. For example, a blend of 5 percent biofuel and 95 percent petroleum-based fuel receives a tax reduction of 5 percent, a 100 percent biofuel gets a 100 percent exemption from energy tax. This is necessary as high production costs make biofuels uncompetitive if they are subject to full taxation. However, the tax exemption may not overcompensate actual costs and will be subject to review in light of production costs and market development.

3.1.3. Energy plant premium

The reform of the EU common agriculture policy (CAP) of 2003 introduced a so-called “energy plant premium” of 45 Euro per hectare for production of crops that are used for energy production and do not enter the food chain. Crops on set-aside area are not eligible for the energy plant premium. In order to receive the premium, farmers have to sign a contract with a processor (e.g. oil-mill) by the May prior to the harvest. In 2004, Germany had 112,326 ha signed up under energy contracts, mainly in North-East Germany. Rapeseed was the largest crop under energy contract with 81,000 ha, followed by rye, and corn for silage, with 21,000, and 8,000 ha, respectively. This was about 6.4 and 3.5 percent of the total rapeseed and rye area, respectively.

3.1.4. Blair House Agreement

The Blair House Agreement (BHA) of 1992 limits the EU production of oilseeds. The BHA is a memorandum of understanding between the United States and the EU that was agreed upon under the Uruguay Round in order to resolve a U.S./EU dispute over EU domestic support programs. The BHA restricts the maximum EU oilseeds area for food use to the current level of 4.9338 million hectares. It also limits the annual output of side products (oil meals) from oilseeds (rapeseed, sunflowerseed and soybeans) planted on set-aside land for industrial purposes to 1 million MT of soybean meal equivalent.

The German "adjusted maximum guaranteed area" (MGA) currently amounts to 836,100 ha. Only as long as the EU as a whole does not exceed its MGA, individual countries may grow more than their national MGA without risking penalties. The last time the EU overshot its MGA was in MY 1999/2000.

Table 2: Development of rapeseed area and production in Germany by year

	"food" area		"non-food" area		total area	
	ha	MT	ha	MT	ha	MT
1998	876	3,025	131	363	1,007	3,388
1999	862	3,229	336	1,056	1,198	4,285
2000	746	2,655	332	930	1,078	3,586
2001	831	3,194	307	967	1,138	4,160
2002	970	2,881	327	968	1,297	3,849
2003	953	2,838	315	800	1,268	3,638
2004	1,082	n/a	197	n/a	1,279	5,252

Source: BMVEL, BLE

Production on set-aside area is done on a contract basis and has to be notified to the national control authority, in Germany that is the Bundesanstalt fuer Landwirtschaft (BLE) in Frankfurt. Oilseed meals resulting from production exceeding the limit must be plowed under or burned. Either way, the producer has to prove to the BLE that the meal was not used in feed or food. This requires additional administration and substantially reduces monetary returns. Therefore, producers make a special effort to remain within the production limits.

With the reform of the CAP (AGENDA 2000) the EU has reduced its oilseeds payments to the same level as for grains. In the mind of the EU these reforms have rendered the BHA obsolete. This opinion is not shared by the United States . If the increased importance of biodiesel results in EU oilseed plantings in excess of the BHA rules this could result in a conflict between the U.S. and the EU.

3.2. At German national level

3.2.1. German tax law

In Germany, pure biodiesel is traditionally exempt from the mineral oil tax in order to increase its competitiveness and usage. On November 28, 2003, the German government extended the tax exemption to all kinds of biofuels including for the first time the biofuel component of biofuel blends. The exemption is granted until December 31, 2009.

In order to prevent overcompensation, the German Ministry of Finance with the help of the Ministry of Consumer Protection, Food, and Agriculture has to report to the Bundestag (comparable to the House of Representatives) on annual basis the development of prices and market. In case of overcompensation, the amount of the tax exemption will be reduced for the following years.

At the moment, Germany has one of the most biofuel-friendly tax systems in the EU. Most other EU member states limit their tax breaks to certains quantities, if they have them at all. Therefore the German market is very attractive as an export destination for countries both inside and outside of the EU. For this reason, it is expected that the German government will ask the EU to introduce protective measures in case of market distortions caused by excessive biofuel imports from non-EU-25 countries that might endanger German biofuel production through very low prices. An example for such measures could be splitting the EU import quotas into separate quotas by member state. Protective measures against imports from other EU countries are not possible as they would interfere with the EU's free flow of trade goods – a cornerstone in the creation of the EU.

3.2.2. German emission regulation (fuel quality regulation)

The German emission regulation (Bundes-Immissions-Schutz-Verordnung, BImSchV) among other things, regulates the quality of fuels. Its 10^{th} adaptation includes gasoline (DIN EN 228), diesel (DIN EN 590) and for the first time biodiesel according to the EU Standard DIN EN 14214. This means that gas stations are subject to unannounced government checks concerning the quality of the biodiesel they sell. This is an important step as reports about problems caused by low quality biodiesel being sold at some gas stations caused irritations among consumers.

The same regulation also allows blends of diesel containing up to 5 % biodiesel on a volume basis and gasoline with up to 5 % bioethanol on a volume basis without labeling. Blends with higher shares of biodiesel or bio-ethanol have to be labeled "contains more than 5 percent biodiesel" or "contains more than 5 percent bio-ethanol." This could serve as an incentive for oil companies to use up to 5 %-blends as it allows them to use or not use biofuels depending on their price and availability. Oil companies will have the additional costs of having to change the label when they exceed the 5% content margin.

4. Biodiesel

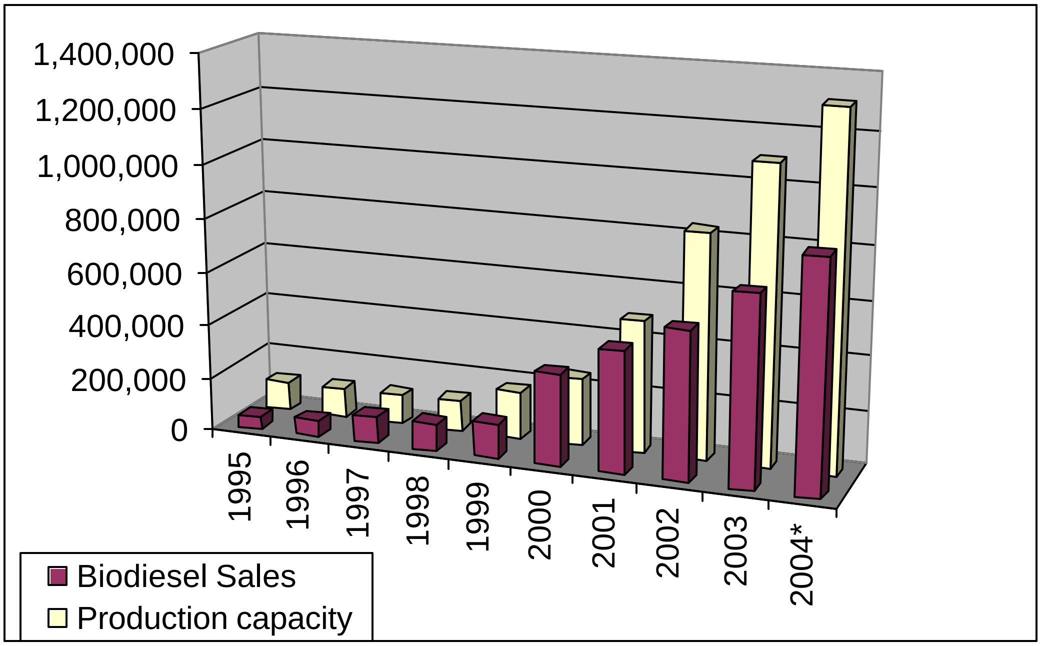
Biodiesel is the colloquial name for "fatty acid methyl ester" (FAME). It is produced from vegetable oil and methanol. For details on the production process please see report GM 2021. In Germany, the most common oil used for biodiesel is rapeseed oil, because it is the only type of biodiesel covered under warranty by German car manufacturers[3]. However, some captive fleet owners use biodiesels made from soybean oil, sunflower oil, or recycled cooking oils. Captive fleets use about 60 to 70 percent of the total German biodiesel consumption. The remaining 30 to 40 percent are distributed through gas stations[4] to the public.

4.1. Historic development

Production capacity for rapeseed biodiesel has increased dramatically in Germany over the past ten years. From 1995 to July 2004, capacity has increased tenfold from 110,000 MT to 1.12 million MT. By the end of 2004, capacity is forecast to reach 1.3 million MT. For 2005, a further increase of 300,000 MT in projected. This development was induced by price increases for fossil diesel over the past years. Most recently, the new EU promotion directive for biodiesel serves as an additional incentive. However, in the future, capacity is expected to increase further but at a lower rate than in the previous years as biodiesel sales have not kept pace with production capacity. Also, the augmented demand for rapeseed oil has increased production costs. This has led to tight margins for biodiesel producers, as consumer prices depend on the price of petroleum-based diesel rather than production costs for biodiesel. In fact one big plant had to file bankruptcy and was recently sold to a new investor.

[3] For details and background please see GM2021.
[4] Currently more than 1500 gas stations in Germany stock biodiesel.

Figure 1: Development of Biodiesel production capacity and sales in Germany by year (December) in MT



* projected
Source: FAS Berlin based on data from UFOP

4.2. Prospects and limitations – pure biodiesel

4.2.1. Influence of EU promotion directive

Table 2 summarizes the amount of biodiesel that is required to comply with directive 2003/30/EC as well as the area that is needed to produced this much biodiesel.

Table 2: Replacement goals in directive 2003/30/EC, required biodiesel amounts, and feedstock areas

	expected diesel consumption	Directive 2003/30/EC replacement goal	biodiesel amount needed to replace fossil diesel	Equivalent in rapeseed	Equivalent in area
Year	1000 MT	Percent	1000 MT	1000 MT	1000 ha
2005	30,100	2.00	662	1,656	487
2006	30,800	2.75	932	2,329	685
2007	31,300	3.50	1,205	3,013	886
2008	31,200	4.25	1,459	3,647	1,073
2009	31,000	5.00	1,705	4,263	1,254
2010	30,800	5.75	1,948	4,870	1,432

Assumptions for calculating equivalent in rapeseed and area:
3.4 rapeseed yield in MT/ha (average 1997-2001)
40% oil content
1.36 MT rapeseed oil per ha
less area than stated above is required if yield or oil content rise

Source: Mineralölwirtschaftsverband (expected fuel consumption)
FAS/Berlin calculation

At the end of 2004, the German production capacity for biodiesel is projected at 1.3 million MT. This is already enough to comply with the replacement goals through the year 2007 and it is expected to further increase in the future. On the feedstock[5] side, however, there are some limitations for the later years of the period covered by directive 2003/30/EC. German rapeseed area increased from 0.9 million ha in 1997, to 1.3 million ha in 2003. In 2003, 590,000 MT rapeseed oil were used for food use. With a yield of 3.0 or 3.7 MT/ha[6] this translates into 400,000 or 500,000 ha, respectively, being used to produce rapeseed oil for food use. Thus leaving only 800,000 or 900,000 ha for rapeseed oil production for biodiesel.

Phytosanitary issues limit the production of rapeseed on the same piece of land to once in every four years. German total crop area amounts to 11.8 million ha, a fourth of which is roughly 3 million ha. However, not all cropland is suitable for rapeseed production. Estimates on the amount of suitable land partly depend on rapeseed prices and vary between half and two-thirds of the total crop land, depending on the source. That translates into 1.5 million to 2 million ha that could potentially be used to produce rapeseed. About 400,000 to 500,000 ha are necessary for the production of rapeseed oil for the food sector. This leaves between 1 and 1.5 million ha for rapeseed oil production for technical uses[7]. This means that the replacement goals of 2010 could only be met with local rapeseed production, if all suitable land is used for rapeseed production and not for competitive crops such as grains, sugar beets or potatoes or if plant breeding is able to produce new rapeseed varieties with further increased yields or oil content.

Realistically Germany has the following option to meet the replacement goals:

a) import more rapeseed oil
b) export less rapeseed oil
c) import more rapeseed for crushing in Germany
d) export less rapeseed

[5] Feedstock = raw material for biodiesel/bio-ethanol production
[6] From 1997 through 2003 rapeseed yield varied from 3.0 to 3.7 MT/ha
[7] such as biodiesel, lubricants, chain saw oil

e) import biodiesel
f) increase the percentage of biodiesel produced from other feedstocks such as soybean oil, sunflower oil and recycled cooking oil.

On a short-term basis options a) through d) are the most likely but depend on price and availability of rapeseed/ rapeseed oil on the world market. Option e) is more of a mid-term option and would require large investments in the biodiesel plants in other countries such as Poland[8]. Option f) is a long-term option as it would require more research on other biodiesel types. The higher the price for rapeseed oil rises, the better the chances are for option f), as people will then look for cheaper alternatives.

4.2.2. Influence of EU emission standards

EU emission standards also have a big influence on the use of pure biodiesel. In the past this has worked in favor of biodiesel. In the future it might limit the use of biodiesel in its pure form.

A biodiesel molecule contains about 11 percent oxygen, this improves the burning process and results in lower emissions of carbon hydrogens (HC), carbon monoxide and soot-particles compared to petroleum-based diesel when using a standard engine. Provided a car is approved for biodiesel use, the driver can switch back and forth between biodiesel and diesel without difficulty and still comply with the current EU emission standard EURO III. Currently there are about 3.1 million cars approved for biodiesel use in Germany.

However, the introduction of tighter EU emission standards EURO IV (2005/2006[9]) and EURO V (2008/2009[10]) forced car/truck manufacturers to develop new engines that use different methods to comply with the emission standards depending on whether they are driven with biodiesel or petroleum-based diesel. If a driver wants to switch between the fuel types, the engines needs to be equipped with a sensor that monitors whether the fuel contains more biodiesel than petroleum-based diesel or vice versa[11], so that the on-board computer can adjust the spark time, the fuel flow or the time and course of injection accordingly[12]. Unfortunately, many of the new cars with modern engines do not contain such a sensor and therefore are not approved for biodiesel use.

[8] In September 2004, the first biodiesel plant opened in Trzebinia, South Poland. It is owned by the Polish fuel company PKN Orlen and has a production capacity of 100,000 MT, all of which is destined for export to Germany. (Source: *Ernährungsdienst* Nr. 79, October 16, 2004, page 1 and Nr. 80, October 20, 2004, page 4)
[9] Goes into effect on January 1, 2005 for new truck types and January 1, 2006 for all newly produced trucks. The one year difference is meant to allow car manufacturers to sell vehicles that were produced before the deadline.
[10] Goes into effect on October 1, 2008 for new trucks types and October 1, 2009 for all newly produced trucks. For cars the EURO V norm has not yet been confirmed.
[11] This is done by monitoring the conductivity. The higher the conductivity, the higher the percentage of biodiesel in the mix.
[12] Munack, Krahl, Speckmann : Biodieselsensorik, in Sonderheft 239 Landbauforschung Völkenrode p. 87

Table 3a: EU emission standards for newly manufactured cars g/km[13]

	EURO 0	EURO I	EURO II	EURO III	EURO IV	EURO V
		01/01/1992	01/01/1996	01/01/2000	01/01/2005	?
HC+ NO_x		1.13	0.70	0.56	0.30	?
CO		3.16	1.00	0.64	0.50	?
Soot particles		0.18	0.08	0.05	0.025	?

Source: Umweltbundesamt,
Euro 1: EU directives 91/441/EEC and 93/59/EEC
Euro 2: EU directives 94/12/EC and 96/69/EC
Euro 3: EU directive 98/69/EC
Euro 4: EU directive 98/69/EC
Euro 5: not yet confirmed for cars

Table 3b: EU emission standards for newly manufactured trucks and buses in g/kWh

	EURO 0	EURO I	EURO II	EURO III	EURO IV	EURO V
	19800/90	1992/93	1995/96	2000	2005/06	2008/09
HC	2.60	1.23	1.10	0.66	0.46	0.46
CO	12.30	4.90	4.00	2.10	1.50	1.50
NO_x	15.80	9.00	7.00	5.00	3.50	2.00
Soot particles	-	0.40	0.15	0.10	0.02	0.02

Source: Umweltbundesamt,
Euro 0: EU directive 88/77/EEC
Euro 1: EU directives 91/542/EEC
Euro 2: EU directives 91/542/EEC
Euro 3: EU directive 1999/96/EC
Euro 4: EU directive 98/69/EC
Euro 5: EU directive 98/69/EC

Car manufacturers have the option of using one of two systems in order for their engines to comply with EURO IV or EURO V emission standards: either an exhaust gas after treatment or a particle filter. In past discussions the German car industry favored a system with exhaust gas after treatment. The exhaust gas after treatment is compatible with the use of a fuel sensor and therefore with the use of biodiesel. Combining a particle filter with a fuel sensor and the use of biodiesel would not generate an additional advantage in terms of emissions. In addition, a particle filter without a sensor does not run well on biodiesel, as it would require frequent cleaning of the filter.

In July 2004, the German car industry gave in to pressure by the German Ministry of Environment and agreed to supply all newly manufactured cars with a particle filter by 2008/2009. As a result, this will further decrease the amount of cars that are able to run on pure biodiesel.

[13] Unit of measure is gram/kilometer for cars and g/kilowatt hours for trucks due to different testing methods

4.3. Prospects and limitations - Biodiesel blends

Traditionally biodiesel was used in its 100 % pure form as a substitute for petroleum-based diesel in Germany. However, the change in German tax law will likely boost the use of blended fuels. The new German tax laws introduces tax breaks for the biodiesel component in blends. This will serve as an incentive to use biodiesel in blends, as it allows the oil companies to increase their margin or to lower the diesel price. This is aided by the revision of the German DIN 560 standard for diesel which now allows for blends and exempts blends with biodiesel up to 5 percent volume from labeling, saving the extra costs otherwise attached.

The new tax law went into effect in January 2004. *Aral/BP* and *Shell*, started using 5 percent biodiesel/95 percent petroleum-based diesel as early as February 2004. *Total* followed suit in September 2004. Aral/BP used the introduction of the blend for a big promotion campaign, profiling the company as a pioneer for the environment.

The German Mineral Oil Association (Mineralölwirtschaftsverband, MWV) expects diesel consumption for 2004 to amount to 28.9 million MT. To replace 5 percent of this volume with biodiesel would require 1.45[14] million MT of biodiesel. This is equivalent to 3.6 million MT of rapeseed or 1.063 million ha[15] of rapeseed or 84 percent of the 2004 rapeseed plantings or 70 percent of the German potential rapeseed area. This is too much to be achieved entirely through local production and leads to the same consequences as stated in section 4.2.1.

As indicated above (section 4.2.2), the tightened emission standards will lead to a new generation of engines that will need newly “designed” fuels. These fuels need additives that work as lubricants. Due to its chemical specifications, biodiesel can be used as such an additive. As a result this would further increase the use of biodiesel blends.

All in all it appears that the future of biodiesel lies in blends rather than the traditional 100 percent pure biodiesel.

4.4 Possible impacts on U.S. exports

Rapeseed and rapeseed oil trade between the U.S. and Germany is marginal and is unlikely to be influence by the situation described above. However, some indirect effects on other commodities such as soybeans can be expected.

Possible positive impacts

The more rapeseed oil is used for biodiesel production, the less is available for the food market or export. This could lead to increased rapeseed/rapeseed oil imports and reduced rapeseed/ rapeseed oil exports. On the long run, this could generate opportunities for U.S. soybeans/soybean oil in those market from which Germany sources the rapeseed/rapeseed oil or to which Germany used to export rapeseed/ rapeseed oil. Secondly it could, theoretically, also lead to an increased use of soybean oil for food use in Germany[16].

[14] Replacement goals in directive 2003/30/EC are based on energy content, while the 5 % blend according to the fuel standard is based on volume, hence the different biodiesel amounts required to replace 5 %.
[15] Calculated with the assumption of a yield of 3.4 MT/ha and an oil content of 40 percent
[16] With some adjustments in the products composition, rapeseed oil and soybean oil can be substituted for each other in many products.

However, as GMO soybean oil is required to be labeled, it is unlikely that this would benefit U.S. exports. However, U.S. soybean oil use could increase in markets that export their rapeseed oil to Germany and that are less adverse to the use of GMO soybean oil than Germany.

Secondly, if rapeseed area in Germany is increased, the production of other crops will have to decrease. Sugar beets, cereal grains, and potatoes are the crops that will be the most likely to be affected. Rye will be less affected since most of the soil in the area under rye cultivation is of much poorer quality than that is needed for rapeseed production. Lower production of potatoes, wheat or triticale could benefit U.S. exports to Germany or competitor markets.

Possible negative impacts

Higher rapeseed crush also results in higher rapeseed meal production, which could displace some soybean meal as animal feed. The U.S. exports significant amounts of soybeans for crushing to Germany. If lower soybean meal use resulted in lower profitability for soybean crush in Germany it could also result in lower U.S. exports of soybeans to Germany.

However, there seems to be some resistance among farmers to increase the rapeseed meal share in their feed rations. While rapeseed meal production increased from 2.48 million MT in 2000/01 to 2.7 million MT in 2003/04, rapeseed meal use by compound feed producers idled around 1.3 million MT over the same period. The German association for the promotion of oil- and protein-plants recently conducted some trials to show that rapeseed meal has a high quality and can be used in animal feed without adverse effects on the animals. It will have to be seen whether this and other actions successfully persuade the farmers to use more rapeseed meal and if this results in lower soybean meal use.

5. Bio-ethanol

Bio-ethanol has a history for being used as a biofuel in the U.S. and France. In Germany interest in this kind of biofuel did not arise until 2004 with the change in the tax law mentioned under section 3.2.1.

5.1. Production

Bio-ethanol is produced from plants containing starch or sugar, by fermenting the sugar into alcohol.

Figure 2: Flow chart of bio-ethanol production

starch + water
$(C_6H_{10}0_5 + H_20)$

↓ enzymes

sugar
$(C_6H_{12}O_2)$

↓ plus yeast (fermentation)

bio-ethanol (86 % vol) + carbon dioxide
$(2\ C_2H_5OH + 2\ CO_2)$

↓ distillation

bio-ethanol (99 % vol) + distillers dried grains/feed stuff (DDGS)

? gasoline refinery

? animal feed

In 2002/2003 German agricultural distillers produced about 74,500 m^3 (58,800 MT)[17] of raw alcohol, of which 39 percent was made from potatoes, 25 percent from grains (wheat, rye, barley, oats or buckwheat), 16 percent from triticale and 6 percent from corn. The mostly small agricultural distillers deliver their raw alcohol to the *Bundesmonopolverwaltung für Branntwein* (Federal Alcohol Monopol Administration, BfB)[18]. About 60 percent of the raw alcohol was used for spirits, food products or vinegar and 40 percent for pharmaceuticals or cosmetics[19]. This alcohol could also be used for fuel production if the price for fuel was to be high enough.

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[17] 1 liter ethanol = 0.789 kg

[18] The BfB functions is a subordinate institution of the German Federal Ministry of Finance. From 1919 until 1976 the Government had a monopoly on alcohol imports, hence the name. Nowadays the BfB still takes over and purifies alcohol from agricultural distillers and grants them a fixed price for in-quota produced ethanol. For marketing, BfB has to compete on the open market, therefore the Federal German Government has to subsidize the BfB. At the end of the 90's this subsidy amounted to 150 million Euro annually. (Bioethanol in Deutschland, Landwirtschaftsverlag Münster, p. 127)

[19] Based on statistics on http://www.bfb-bund.de/pages/weiter.htm

Currently there are three plants under construction in Germany that will produce bio-ethanol for fuel use. They are located in Zoerbig (Saxony–Anhalt), Schwedt (Brandenburg) and Zeitz (Saxony – Anhalt). The plant in Zoerbig started test operations in September, Schwedt will follow in December 2004, and Zeitz in Spring of 2005. Upon completion, their combined annual production capacity will reach 500,000 MT of ethanol. All three plants will run on cereals. Zoerbig and Schwedt will operate with rye, as it is the cheapest feedstock – especially after the abolition of the rye intervention and the consequently expected price drop. The plant in Zeitz will use wheat, in part because the animal feed, a by-product in the ethanol production process, is believed to be of higher value[20] and can be sold more easily when it comes from wheat as opposed from rye.

In Germany, bio-ethanol could be produced from wheat, triticale, rye, sugar beets, corn, and potatoes, as well as from wine-ethanol, and in the future from wood, and residues/by-products such as straw. However, cereals are currently the most economic feedstock for bio-ethanol production in Germany. Sugar beets, potatoes, and corn do generate the highest energy yields per ha (see table 4). However, a number of disadvantages are attached to the use of these feedstocks. For one, their relatively high prices make them a less economic feedstock compared to cereals. Secondly, the production of bio-ethanol from sugar beets and potatoes also creates high amounts of waste water, the treatment and disposal of which adds to the production costs. And thirdly, a plant cannot switch between sugar and cereals for feedstock, due to incompatible technology. Since the German sugar season only lasts three month, a bio-ethanol plant dependent on sugar beets would therefore only be in operation for a short time of the year. Corn does not play an important role as it has to be dried before processing, which would create extra costs and reduces the net energy yield.

Table 4: Bio-ethanol yield and feedstock costs calculation for Germany based on commodity yields and prices for the year 2000

	Feedstock				Bio-Ethanol				
	Yield	Average Price	Total Production		Bio-Ethanol Production			Feedstock costs	
	MT/ha	Euro/MT	Million MT		m^3/ha	MT/ha	Kg / MT feedstock	ct/kg	ct/l
Sugar beets	61.7 beets/ 8.96 sugar	47 (A) 29 (B) 17 (C)	27.8 beets/ 4.4 sugar		6.62	5.22	85	34.3*	27.0*
Potatoes	43	63	13.1		3.55	2.80	65	96.7	76.3
Corn	9.2	123	3.3		3.52	2.78	302	40.7	32.1
Wheat	7.2	118	21.4		2.76	2.18	302	39.0	30.8
Rye	4.9	95	4.1		2.03	1.60	327	29.1	22.9
Triticale	5.6	100	4.1		2.23	1.76	314	31.8	25.1

* based on price for (B) sugar, as all (c) sugar has to be exported and is not available on the domestic market.

Source:
Bioethanol in Deutschland, Schriftenreihe "Nachwachsende Rotstoffe" Band 21 pages 39,44,45,47,50,51
FAS/Berlin calculations

[20] Reportedly DDGS from wheat contains fewer bitter substances than DDGS from rye.

Future changes in the CAP such as the abolition of import restrictions or subsidized surplus exports could make ethanol production a lucrative alternative use for sugar and wine-ethanol. It could also be a good alternative use for low quality cereals[21].

Wood and residues containing cellulose could be a possible future feedstock for ethanol production if difficulties in technology and waste water can be solved. Statements about when the respective technology to digest cellulose is expected to become commercially available vary from 2 to 10 years. Iogen, a private Canadian company has opened a demonstration plant in Ottawa, in April 2004. It has an annual production capacity of 1 million liters or 789,000 MT ethanol. Commercial plants are envisaged at an annual capacity of 170 million MT.[22]

5.2. Prospects and limitations of bio-ethanol

Bio-ethanol can be used in its pure form as a gasoline substitute or it can be blended with gasoline. Specially equipped cars powered by 100 % bio-ethanol are not currently for sale in Germany.

Bio-ethanol can be further processed into bio-ETBE (ethyl-tertio-butyl-ether) which could replace MTBE (methyl-tertio-butyl-ether) as an additive in gasoline.

The maximum vapor pressure specifications for gasoline are 60 kPa in summer and 90 Pa in winter. This poses a problem for gasoline/bio-ethanol blends in summer as their vapor pressure lies above the maximum value of 60 kPa. This problem can be circumvented by adding ETBE instead of bio-ethanol. However, this requires an additional processing step, which can only be done at the gasoline refinery and not at the bio-ethanol production plant. Research is also being done on another option, the use of special additives to reduce the vapor pressure.

5.2.1. Influence of promotion directive

Table 5 shows the required area for each feedstock if the replacement goal of directive 2003/30/EC for gasoline were to be met with this feedstock alone. It also shows the average area planted with that crop in the years 1997-2002. Comparing these numbers shows that the goals could be met with either sugar beet or wheat alone. However, it is unlikely that the whole German ethanol production would rely on just one feedstock. Therefore one can conclude that feedstock is not a limiting factor for complying with directive 2003/30/EC goals for ethanol in Germany. The truly limiting factor is a lack of production capacity to produce all required bio-ethanol locally.

The EU and Mercosur are in the process of negotiating a free trade agreement (FTA). The current EU offer includes a quota of 1 million MT at half the current duty of 19.2 percent. As only Germany and Sweden have a tax reduction for all bio-ethanol and thus an open market, most of the bio-ethanol from Mercosur (namely Brazil) would end up on the markets of these two countries.[23]

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[21] However, if low quality means excessive mycotoxin levels, this high mycotoxin cereal can only be used if the by-product DDGS is not intended to be marketed as animal feed.
[22] Handelsblatt Nr. 103, May 28, 2004 p 21 / www.iogen.ca
[23] Spain, France and Italy have tax reductions only for a limited quantity, which is already filled by local production.

If this is put into practice, Brazil would dominate the German bio-ethanol imports due to its price competitiveness. Most likely this would terminate all German initiatives for local bio-ethanol production. This issue is very controversial in Germany. Advocates state that the bio-ethanol should be produced where production is cheapest, opponents criticize the fact that the Brazilian and not the German economy would benefit from the German energy tax break.

Table 5: Replacement goals in directive 2003/30/EC, required bio-ethanol amounts, and respective feedstock areas and amounts (in 1,000 ha and 1,000 MT)

	Expected gasoline consumption	Replacement goal according to directive 2003/30/EC	amount of bioethanol needed to replace gasoline
	1000 MT	Percent	1000 MT
2005	25,200	2.00	756
2006	24,900	2.75	1,027
2007	24,500	3.50	1,286
2008	24,000	4.25	1,530
2009	23,500	5.00	1,763
2010	22,900	5.75	1,975

	Hectar equivalent					
	Sugar beets	Potatoes	Corn	Wheat	Rye	Triticale
	1000 ha	1000 ha	1000 ha	1000 ha	1000 ha	1000 ha
2005	145	270	272	347	472	430
2006	197	367	370	472	641	584
2007	246	459	463	591	803	731
2008	293	546	551	703	955	870
2009	337	629	635	809	1,100	1,002
2010	378	705	711	907	1,233	1,123
average area 1997-2002	476	297	373	2,834	823	481

	MT equivalent					
	Sugar beets	Potatoes	Corn	Wheat	Rye	Triticale
	1000 ha	1000 ha	1000 ha	1000 ha	1000 ha	1000 ha
2005	8,930	11,606	2,504	2,500	2,313	2,406
2006	12,133	15,768	3,402	3,396	3,142	3,269
2007	15,194	19,746	4,261	4,253	3,935	4,094
2008	18,073	23,488	5,068	5,059	4,681	4,870
2009	20,820	27,058	5,838	5,827	5,392	5,610
2010	23,332	30,322	6,543	6,530	6,043	6,286
average production 1997-2002	26,587	11,729	3,299	20,818	4,439	2,849

Assumptions:
One ha of feedstock delivers x m^3 / y MT bio-ethanol:
Sugar 6.62/5.22, potatoes 3.55/2.80, corn 3.52/2.78, wheat 2.76/2.18, rye 2.03/1.6, triticale 2.23/1.76

Source:
FAS/Berlin calculations based on m^3 production values in "Bioethanol in Deutschland", Schriftenreihe "Nachwachsende Rotstoffe" Band 21 pages 39,44,45,47,50,51
Average area/production: German Federal Office of Statistics, Wiesbaden

5.2.2 Influence of German Emission / Fuel Quality regulation

As stated in section 2.2. the new German fuel quality regulation will serve as an incentive to use gasoline blends with up to 5 percent bio-ethanol.

For 2004 the German Mineral Oil Association estimates a use of 25.4 million MT of gasoline. To replace 5 percent of the volume with bio-ethanol would require 1.27 million MT of bio-ethanol, a number well above the currently planned local production capacity.

5.3. Possible impact on U.S. exports

The U.S. is a major producer of bio-ethanol. However, due to tariffs and the competition from Brazil, U.S. exports of bio-ethanol to Germany are highly unlikely. Nevertheless, bio-ethanol production in Germany could have indirect impacts on other commodities.

Possible positive impacts

If cereal grains were to be used on a large scale, these grains would not be available for food use on the German market or for export. This could generate opportunities for U.S. exporters on the German market or on German export markets through reduced German competition.

Possible negative impacts

Over the past 5 years German farmers have fed their animals between 4.0 million and 4.6 million MT of soybean meal. About 66 percent of which was imported and 33 percent produced locally from imported soybeans. The U.S. is one of the countries from which Germany sources soybeans for crushing. Increased production of bio-ethanol goes along with increased production of dried distillers feedstuff[24], a high protein feed, that could displace some use of soybean meal and consequently lower the soybean meal price on the German market. If the price drop for soybean meal was not compensated for by increased soybean oil prices, to maintain profitability of soybean crush in Germany, this could lead to fewer U.S. soybeans exports to Germany in the future.

6. Pure Vegetable Oil

Pure vegetable oil for use as a biofuel recently attracted some attention especially among farmers, however, there are some technical difficulties attached to it. While biodiesel and diesel have similar specifications, pure vegetable oil differs substantially in viscosity and burning parameters. Therefore pure vegetable oil can only be used in specially-modified engines, which then can only run on vegetable oil. Thus far pure vegetable oil fuel is not available at gas stations, which limits the driving range for possible users. Therefore

[24] In the case of cereal grains, the by-product of bio-ethanol production is called "dried distillers grains with solubles" or DDGS. For every MT of bio-ethanol, 1 MT of DDGS is produced. According to literature, DDGS has a protein content between 27 percent of the dry matter (World Perspectives Ag review Vol 15 No 3, page 16, April 2003) and 30 to 35 percent (Bioethanol in Deutschland, p 109). Protein content of soybean meals varies between 50 and 55 percent of the dry matter. Thus, its takes about two MT DDGS to replace one MT of soybean meal. The projected bio-ethanol production capacity of 500,000 MT would generate 500,000 MT DDGS, which could replace about 250,000 MT of soybean meal.

vegetable oil is currently only practical for on-farm use in tractors. A trial is being conducted in Germany with 100 tractors running on pure rapeseed oil.

One problem with pure vegetable oil is the large variation in specifications from oil mill to oil mill, which could create difficulties in the motor. This could be overcome by a central oil mill that is dedicated to the production of vegetable oil for fuel use.

Other problems include its limited practicability for winter use as well as difficulties in complying with emission standards.

At this point it appears that in the long run, pure vegetable oil will continue to serve a very small, niche market unless research manages to dramatically improve the engines for vegetable oil use.

7. Synthetic Fuels

In their quest to comply with tighter emission standards, car manufacturers developed new engines and specially-designed fuels for these engines in order to reduce emissions below the maximum levels. Current fuel research focuses on two concepts: gas-to liquid (GTL) and biomass-to-liquid (BTL). Both concepts use a synthetic gas to produce a liquid fuel, however they use different feedstocks. GTL uses “flared gas” from petroleum production that is currently burned. BTL uses a synthetic gas derived from biomass. While biodiesel and bio-ethanol production so far only use parts of a plant, i.e. oil, sugar or starch, BTL production uses the whole plant. This results in smaller area requirement for the same amount of energy compared to biodiesel or bio-ethanol.

The production process for BTL starts with grinding and drying of biomass which is then formed into pellets. The biomass-pellets are diverted into a gas (smouldering gas) and solid fraction (charcoal) in a low temperature gasification process and transformed into a synthetic gas in a second step. After purification the gas is liquefied in a so called “Fischer – Tropsch” reaction, in which carbon monoxide (CO) and hydrogen (H) react and form carbo-hydrogen chains. The resulting paraffin-like liquid is isomerized to increase winterstability and then distilled or “hydro-treated”. In this step, the specifications of the fuel can be fine-tuned to match the requirements of the engines by altering the form or length of the fuel molecules. This fine-tuning is not possible in the currently used standards refining process for diesel or gasoline, hence BTL is also nicknamed “designer fuel”. 60 percent of the distillate can be used directly as a diesel fuel, while the other fractions can be used in the chemical industry or be further processed into gasoline or kerosene.

BTL is basically free of sulphur and aromatic components. It is also CO_2 – neutral as its combustion only releases the CO_2 contained in the biomass.

In Germany, Volkswagen and DaimlerChrysler started projects on BTL-technology. Volkswagen called their fuel “SunFuel” while DaimlerChrysler’s fuel was named “Biotrol” (biomass + petrol = biotrol). Nowadays both companies work together with a company called Choren[25] and call the fuel “sundiesel”. Choren is located in Freiberg (Saxony) and has developed the so-called and patented “Carbo-V®” gasification process[26]. The project is still in its experimental stage. A plant with an annual capacity of 13,000 MT is projected to go in

[25] Choren= **C**arbon, **H**ydrogen, **O**xygen **ren**ewable
[26] for details on the process se link in Annex

operation in 2006, followed by a commercial plant[27] with a 200,000 MT per year capacity in 2008.

According to Choren it takes 5 MT of biomass to produce 1 MT of sundiesel and 1 ha generates 4 MT of sundiesel. A plant like the one described above would need the biomass of 50,000 ha. In recent years the German set-aside area amounted to roughly 1 million ha. This could generate 4 million MT of sundiesel which is about 13 percent of the current diesel use in Germany.

DaimlerCrysler expects that BTL fuels could achieve a market share of 10 % in Europe by 2015[28]. Volkswagen cites a study that sees the production potential for BTL at 70 million MT of fuel in the EU-15, which would amount to one third of the fuel used by all vehicles (cars and trucks) in the EU-15 in the year 2000.[29]

Conclusion

The change of the European and German tax law has created additional incentives for the use of biofuels in Germany.

Biodiesel

So far biodiesel is the only well established biofuel that is used in Germany. By the end of 2004, production capacity is forecast to reach 1.3 million MT. Historically biodiesel was used in Germany in a 100 percent pure form, however, the future for biodiesel use in Germany lies in blends rather than in the pure format. On one hand, this is due to technical progress in engines that results in less cars being approved for the use of biodiesel in its pure form. On the other hand it is due to changes in the German fuel quality regulation that allows fuel blends with up to 5 percent biodiesel volume without the requirement to label the blend and attached costs. Another advantage of biodiesel is that it can replace other fuel additives used to improve the lubrication quality of standard diesel.

Blends of 5 percent biodiesel and 95 percent diesel were introduced in Germany in February 2004. Replacing 5 percent of the volume of current diesel consumption with biodiesel would require 1.45 million MT of biodiesel or 1.06 million ha rapeseed. In order to achieve this with local production, rapeseed area would have to be extended by 300,000 ha or a substantial amount of the rapeseed oil currently used for food use would need to be diverted to biodiesel production.

EU-directive 2003/30/EC states goals for the replacement of fossil fuels by biofuels. These goals increase from 2 percent in 2005 to 5.75 percent in 2010. Biodiesel production capacity suffices to meet the replacement goals for 2007, at the end of 2004 already.

While German rapeseed area suffices to meet the replacement goals for 2005 through 2007, it would only suffice to meet the 5.75 % replacement goal of 2010 if almost all rapeseed harvested was used domestically for biodiesel production. This is an unlikely scenario. Therefore Germany will have to increase its imports of rapeseed or rapeseed oil or biodiesel and/ or reduce its exports of rapeseed or rapeseed oil to meet the goals. This could render some opportunities for increased U.S. oilseeds exports to Germany and German trading partners to replace the rapeseed that is then used for biodiesel in Germany.

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[27] situated in Lublin/ Mecklenburg Western Pommerania at the German Baltic sea
[28] *Biogenous fuels* article on www.daimlerChrysler.com
[29] *Die Basis nachhaltiger Mobilität* article on www.volkswagen-umwelt.de , page 10

Bio-ethanol

Bio-ethanol production for fuel use is a nascent industry in Germany, although traditionally limited amounts of bio-ethanol are produced for other uses. Greater interest developed with a change in the German tax system that allows for an exemption for bio-ethanol fuel from the mineral oil tax. The first three plants are currently being constructed. Upon completion in spring of 2005, their combined annual bio-ethanol production capacity will amount to 500,000 MT. All three will operate on cereal grains, mainly rye, as this is the cheapest feedstock, one plant will run on wheat.

Currently there are no cars in Germany that can drive on 100 percent pure bio-ethanol. Also, blends of bio-ethanol and gasoline still await their introduction on the German market. They are attractive for fuel producers for the same reasons as stated for biodiesel.

Reaching the replacement goals of 2 to 5.75 percent laid down in directive 2003/30/EC can be achieved with local feedstock but would require further investments in bio-ethanol production facilities.

Should more German grains be diverted from the export market to bio-ethanol production, U.S. grains exports could benefit from increased German bio-ethanol production. However, the increased production of the by-product dried distillers grains with solubles (DDGS) could displace some soybean meal, which could harm U.S. soybean exports.

The developing German bio-ethanol sector faces a big threat from the current negotiations of a EU-Mercosur free trade agreement (FTA). If the current EU offer of a 1 million MT quota for bio-ethanol imports into the EU at half the current duty is put into place without changes, German producers will not be able to compete with cheap Brazilian imports and consequently will be driven out of the market. Therefore, further investments in this sector will be put off until the future of the EU-Mercosur FTA becomes clearer.

Pure rapeseed oil

Due to technical limitations, pure rapeseed oil at best may achieve a niche market for on-farm use in tractors but is not viable for wide-spread use in cars or trucks.

Synthetic biofuels

Synthetic biofuels use biomass (whole plants) to produce highly specific fuels to be used in modern car engines. The technique is still in an experimental stage but is very promising for the mid- to long-term future. DaimlerChrysler expects BTL to achieve a market share of 10 percent of the EU fuel market by 2015. As the BTL production process uses the whole plant and not just parts of it, less area would be need for the production of energy plants as compared to current technology. If the technology reaches commercial practicability, it is likely that synthetic biofuels will overtake biodiesel as the primary biofuel in Germany in the long run.

Annex

Useful links

Directive 2003/30/EC of May 8, 2003, on the promotion of the use of biofuels or other renewable fuels for transport
http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_123/l_12320030517en00420046.pdf
(English)

Directive 2003/96/EC of October 27, 2003, restructuring the Community framework for the taxation of energy products and electricity
http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_283/l_28320031031en00510070.pdf
(English)

German association for the promotion of oil- and protein-plants (UFOP)
www.UFOP.de (German)
http://www.ufop.de/hilfe.html (English)

German Association of Biodiesel Producers
http://www.biodieselverband.de/vdb (German)

German Mineral Oil Association, fuel consumption projection
http://www.mwv.de/Statistik.html

Volkswagen sunfuel strategy
http://www.volkswagen-umwelt.de/_download/sunfuel_de.pdf (German)

DaimlerChrysler Energy for the future
http://www.daimlerchrysler.com/dccom/0,,0-5-7165-1-142465-1-0-0-0-0-0-1371-7165-0-0-0-0-0-0-0,00.html (English)

Choren production flowchart
http://www.choren.de/cgi-bin/choren.cgi?menu=start&akt=rubr4616737335&akt1=untrubr1131841852&sprache=2
(English)

Bundesmonopolverwaltung fuer Branntwein
http://www.bfb-bund.de/pages/weiter.htm (German)

Related reports:

October 24, 2002 Germany Oilseeds and Products Biodiesel in Germany - an overview GM2021 *Voluntary Report - public distribution* Berlin German biodiesel is mostly produced from rapeseed oil. Production capacity for biodiesel increased fivefold from 110,000 MT to 533,000 MT over the period of 1995 to 2001. By the end of 2002, capacity is forecast to reach close to 1 million MT. The German government supports biodiesel use through a generous tax break.