Drivers and Strategies Influencing the German (European) Biofuels Market

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Summary

In the past decade, Germany has put policies in place to create the most extensive biofuels market in Europe and the largest biodiesel production capacity worldwide. In this report, we examine the reasons behind this rapid growth and the key players that have contributed to this success. Figure 1 illustrates the rate of this growth; including a 10-fold growth that occurred between 2000 and 2005. This summary also includes how biodiesel was marketed to both automobile manufacturers and consumers to gain widespread acceptance. Some of the more interesting innovations in this sector will also be touched on.

Even as the first generation biofuel markets are nearing maturity in Germany, work is underway to develop the next generation of biofuels. This will involve a transition from foodstuff-based fuels such as biodiesel from vegetable oils and bioethanol from cereals or corn to biofuels made from non-food agricultural biomass. Not only are they more efficient in converting the sun's energy to fuel, they are also ethically justifiable. The second generation biofuels include biomass to liquid fuels (BtL fuels), bioethanol from cellulosic biomass (straw) or biogas.

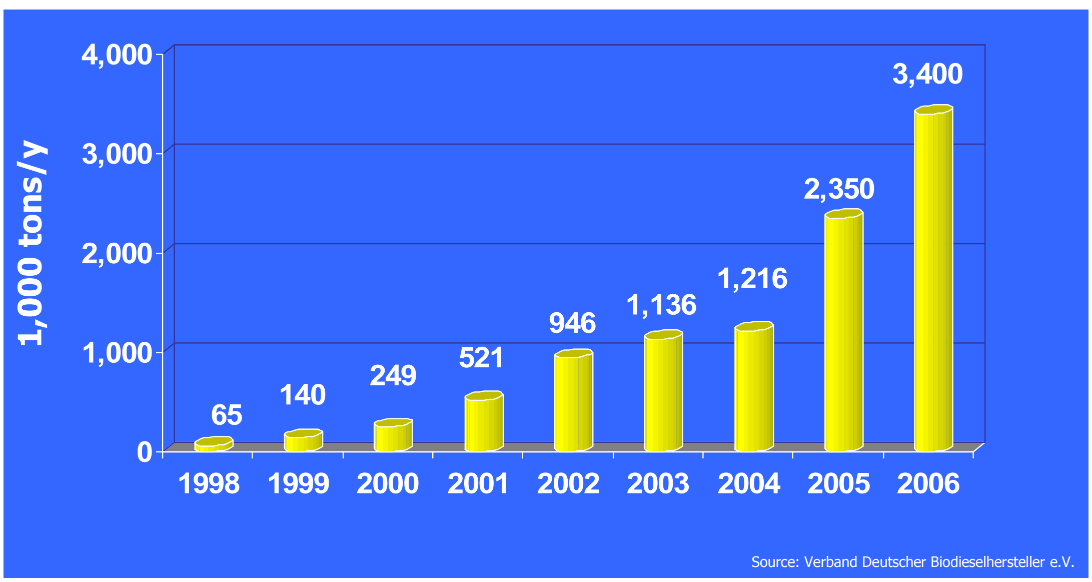

Figure 1 Development of biodiesel production capacity in Germany (www.biodieselverband.de)

The following report is based on publicly available data: media articles, conference presentations from industry representatives and associations and government reports.

Report

1 A Political Framework Conducive to Investment

The development of the current biofuels market in Germany can be traced back to the creation of a stable investment climate. Commencing with the initial EU directive requiring that member nations achieve fixed biofuel quotas, Germany was able to set up a framework that gave the industry its first impulses. Through modifications of the original legislation, they were able to introduce those measures to blended biofuels as well. One of the key political goals was that the financial benefits of biofuels were to be shared with the German farming community. A sign of the success of the program is that the German parliament is currently examining the reduction of the biodiesel subsidies.

1.1 Preparing the framework

The first concrete move to introduce biofuels originated in Brussels. In May 2003, the EU passed "Directive 2003/30/EC on the Promotion of the Use of Biofuels or Other Renewable Fuels for Transport" setting biofuel targets for member nations. It required that member states substitute 2% of fossil fuels by 2005, and increasing yearly by 0.75%, attain 5.75% substitution by 2010. The directive did not specify whether this was achieved through mandated quotas or subsidies.

The German cabinet opted on the use of subsidies. Quotas had been used by other member states and experience showed that these were not very effective in attracting investment. The German parliament, with a strong environmental mandate, decided to exempt biofuels from the mineral oil tax. This mineral oil tax had been significantly increased in the early '90s to finance the state pension plan. This resulted in some of the highest mineral oil excise taxes in Europe. So when the exemption for 100% biofuels was introduced in January 2004, this permitted manufacturers to sell B100 (100% biodiesel) at the pumps well under the price of the fully taxed fossil-based diesel. The legislation is to expire after a five-year period in 2009.

When it was realised that the legislation was insufficient to ensure Germany would meet the EU targets, the legislation was amended in January 2005 to include the biogenous portion of blended fuels. For example, these amendments meant that bioethanol could be blended with gasoline and receive the same tax breaks, just as biodiesel blends. The legislation specified that blended biofuels are tax exempt based on the amounts used. If a derivative of the biofuel is used, for example in the production of ETBE, the biogenous part of fuel molecule can be exempted from the mineral oil tax. Currently the exemptions work out to: € 0.47 / litre ($CAN 0.66 / litre) for biodiesel and € 0.65 / litre ($CAN 0.91 / litre) for bioethanol.

Since EU laws requires no changes in the labelling for biodiesel blends up to 5% (V/V) or bioethanol blends up to 5 vol % (or 15% (V/V) ETBE), this was seen as an incentive

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for oil companies as they have the option to use or not use biofuels depending on their price and availability.

A key lobbyist for biodiesel on behalf of the farming community was the German Union for the Promotion of Oil and Protein Plants (*Union für Förderung von Öl- und Proteinpflanzen* – UFOP – www.ufop.de). It is a group within the powerful German Farmer's Association (*Deutscher Bauernverband* – www.bauernverband.de). Their goal was to ensure that German farmers would be able to participate in the production of the biofuels. As the tax exemption was generous, this ensured that German rapeseed would not be too expensive for the industry. Similarly by promoting biodiesel standards that favoured rapeseed methyl esters, they were able to deter biodiesel made from other oil sources, such as rendered animal fats and used frying oils, from being widely accepted at gasoline stations.

1.2 The case for over-subsidisation

Although the original legislation is to expire in 2009, the EU had required the German Finance Ministry to supply an annual report on the level of subsidisation of biofuels. The formula for calculating the subsidy level had been provided by the EU. In the report to the EU from March 2006, it was determined that German biodiesel was over-subsidised and that corrective measures would need to be taken. A committee headed by the Finance Ministry examined the issue and made proposals to the German government to correct the situation.

As a consequence, biodiesel used for transportation lost its subsidy as of August 1, 2006. As of August 1, the tax on B100 was levied at a rate of € 0.09 / l. From 2008 and onwards, the B100 tax will be increased annually by a minimum of € 0.06 / l. The increases will end in 2012 when the rate reaches € 0.45 / l. It is expected that the B100 market will shrink rapidly as a result of the legislation. Blended biofuels, such as biodiesel or ethanol, will be fully taxed at the mineral oil rates. Only B100 fuel used on farms would be exempt from the tax.

Cellulosic ethanol, biogas and biomass-to-liquid fuels, deemed second generation biofuels, will continue to be tax-exempt until 2015.

The Finance Ministry has also announced biofuel quotas. As of January 1, 2007, diesel fuel for transportation must have a 4.4% biofuel blend (based on energy content) or a 5% volume blend. This creates an annual demand of 1.5 million tons of biodiesel. As the current national production capacity is approximately double this value (see Figure 1), the UFOP is advising the government to double the proposed quota to 10%.

2 Biodiesel Market in Detail

2.1 Standards

Biodiesel must meet the European standard, DIN EN 14214, to be sold as a diesel fuel in Europe. This standard can be met by biodiesel made from a variety of sources; rapeseed, sunflower, soy, palm oils, rendered animal fats and used vegetable oils. Blending is sometimes required to ensure that the standard is met.

In 1999, UFOP set up a separate association called the "Working Group for Quality Management of Biodiesel" *(Arbeitsgemeinschaft Qualitätsmanagement Biodiesel e.V. –* www.agqm-biodiesel.de*)*, AGQM, to set more stringent standards that could only be met by high quality rapeseed methyl ester. Although the AGQM standard is based on the EN 14214 standard, it sets much lower tolerances on the variability of the key characteristics. Testing was introduced from the crushing plant to the gasoline pump to ensure that a reliable product was offered. AGQM then worked together with German automobile manufacturers to obtain warrantee protection for their diesel engines if, and only if, the AGQM biodiesel was used. It must be added that quality control in the early stages of the industry had almost caused the automobile companies to refuse to endorse the use of B100. The endorsement of the car companies provided the consumer with an added level of confidence when using the new fuel. As a direct consequence, the car companies did not extend the warrantee protection to non-AGQM biodiesel and required that the responsibility of testing other biodiesel formulations lay with the fuel manufacturer. As a result, 53% of biodiesel now sold at German gas stations (B100) is AGQM certified (or 1,400 of 1,900 gas stations). Private trucking fleets, which were able to blend their own fuel, did not require the strict AGQM standard for their biodiesel.

A legal adoption of the AGQM biodiesel standard by Germany may be considered a non-tariff barrier and, consequently, attract the attention of the WTO.

The situation is changing with new car models that utilize particulate filters that were made to meet EURO V exhaust requirements, as they are not compatible with the currently available B100. Hence, car companies are advising consumers not to use B100 with these new models.

In September 2006, Volkswagen, Audi and Ford advise buyers of their diesel cars against exclusively using biodiesel. Differences in the fuel's purity may block soot filters and even damage car engines. Volkswagen says that these concerns do not relate to the 5% level of biodiesel in conventional diesel because the levels are too small to cause any damage.

Figure 2 Biodiesel certification standards (left: DIN EN 14214; right: AGQM)

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2.2 Marketing

UFOP has also carried out intensive marketing of biodiesel among consumers. Talking to visitors at agricultural fairs and home shows and using targeted advertising campaigns awareness was generated. Their arguments included that:

- Biodiesel is produced from native oilseed rape and is an economic alternative to the grain markets,
- Pure biodiesel offers a set of environmental advantages such as its biological degradability and a decrease in emissions, and
- Biodiesel is a technically mature & high quality fuel, which is subject to regular quality controls from the manufacturer to the gas station.

The method was effective in creating widespread demand among consumers, as can be seen from the production statistics.

2.3 The Current and Future Biodiesel Market

In August 2006, the wholesale price of biodiesel (B100) in Germany ranged between € 0.71 and 0.73 / litre and retailed for approx. € 1.05 / litre. The pricing is such that the B100 price is generally € 0.10 / litre less than regular diesel (i.e., fossil diesel sells for approx. € 1.13 / litre). Two-thirds of the wholesale price of biodiesel is set by the feedstock price.

The German biodiesel market consists predominantly of rapeseed biodiesel. Figure 3 illustrates the market distribution of biodiesel in Germany. Note that between 2004 and 2005, the biodiesel production capacity doubled from 1.2 to 2.4 million tons annually. So, although filling stations selling B100 have lost market share, their overall turnover has slightly increased. Biodiesel used in blends has increased dramatically due to the change in the legislation that extended the mineral oil tax exemption to blends.

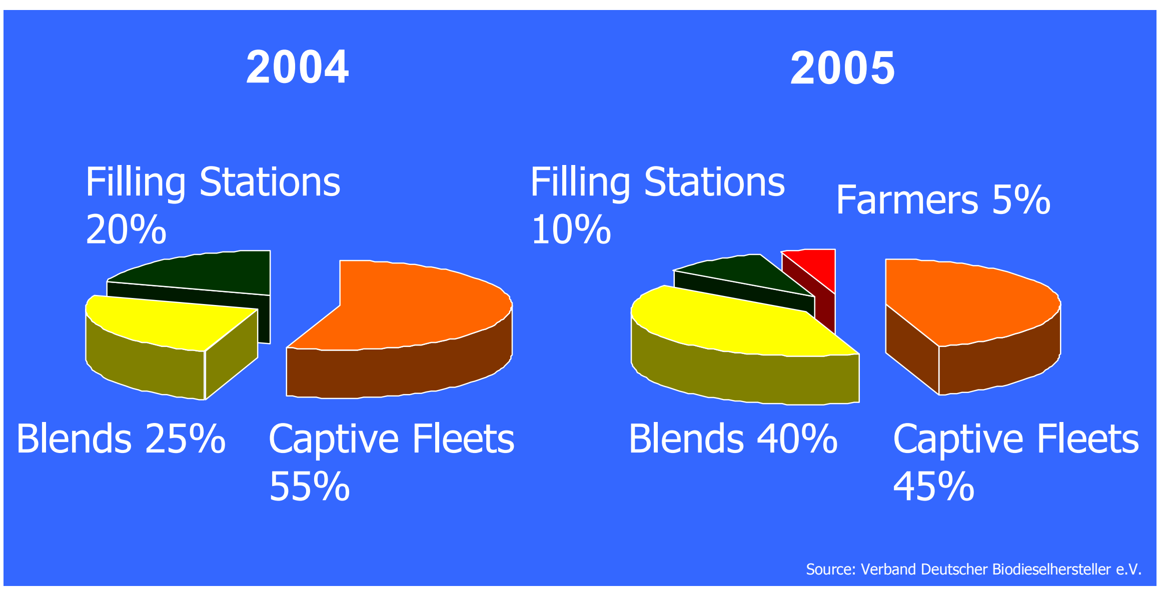

Figure 3 Markets for biodiesel in Germany (www.biodieselverband.de)

Figure 4 illustrates the expected increase in demand for biodiesel in Europe as a result of the EU biofuel quotas.

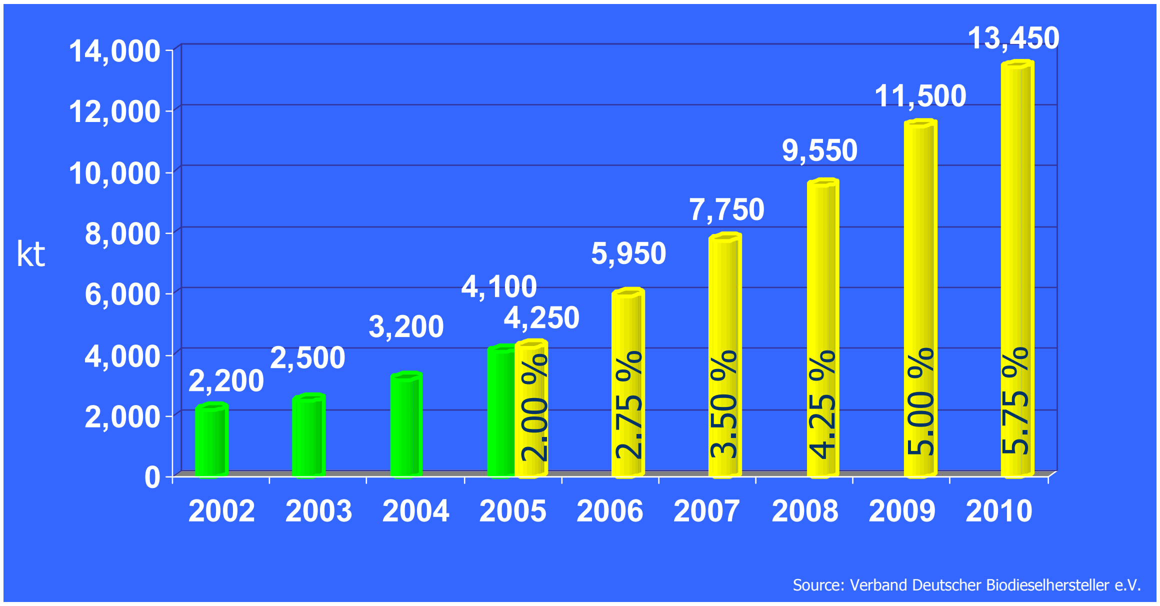

Figure 4 Existing and anticipated demand for biodiesel capacity in Europe (www.biodieselverband.de)

For Germany, the biodiesel consumption is illustrated in Table 1. In 2006, it is likely that German biodiesel production will exceed the demand (see the numbers highlighted in yellow). This would lead to an oversupply of biodiesel on the German market, probably resulting in a drop in the wholesale prices.

The German Finance Ministry may also re-examine the tax-exempt status of biodiesel for amounts exceeding the EU quota requirements. The additional amounts are not legally part of the EU requirements and are financial liabilities for the state through uncollected taxes.

	2005 t	**2006** t	**2010** t
Diesel consumption	30,200,000	30,800,000	31,300,000
Biodiesel / EU req.	2% or 744,000	2.75% or 1,040,000	5.75% or 2,216,000
(A) Blends	800,000 (5%)	1,200,000 (5%)	3,130,000 (10%)
(B) B100	1,175,000	1,300,000	1,700,000
Demand A+B	1,975,000	**2,500,000**	4,830,000
Production Capacity	2,350,000	**3,400,000**	

Table 1 Current and Expected Development of Biodiesel Market in Germany (Source: Verband Deutscher Biodieselhersteller e.V. - www.biodieselverband.de)

2.4 LCAs and other oil sources

A number of life cycle analyses (LCA) have been carried out on rapeseed based biodiesel and the results indicate that the environmental impact is somewhat positive. The energy inputs in the form of fertilizers and crop protection chemicals are high compared to the energy content of the resulting fuel. An LCA commissioned by UFOP can be found at www.ufop.de/downloads/Life_Cycle_IFEU.pdf or www.ufop.de/downloads/Co2_Neutrale_Wege.pdf.

The following table compares the biodiesel yield per hectare of land for different crops. Not surprisingly, tropical palm oil has a significantly higher yield than other oilseed crops. Jatropha is a bushy plant that is grown under arid conditions and yields a non-edible oil, is being promoted by some automotive companies as an ethically and morally justifiable source of biodiesel. It is claimed that Jatropha biodiesel benefits marginalised communities in the developing world and does not divert a food crop to a fuel application.

Crop	Production (l / ha)
Soy	370 – 470
Rapeseed (Canola)	1000 – 1,400
Mustard	1,300
Jatropha	1,600
Palm oil	6,000

Table 2 Biodiesel production potential in litres per hectare per year as a function of crop

2.5 Canadian canola and biodiesel

It is difficult to get precise statistics on the use of Canadian canola for the production of German (and Austrian) biodiesel. In 2006, Germany imported 60 thousand tons of canola oil, making it the second largest importer after the United States with 150 thousand tons. It is safe to assume that this oil is not going to food applications because of the European aversion to using gmo food products and the current gmo labelling requirements in Europe. The quantities imported into Germany and the Netherlands, which totals 86 thousand tons, is evidently used in Austrian and German biodiesel plants (up to 2006, the Netherlands had no biodiesel plants) and in power generators in Germany, Austria and the Netherlands. Power generation makes economic sense in these countries because the preferred feed-in tariff for biomass generated electricity more than makes up for the difference in feedstock price (0.65 Euro/l for canola oil vs. 0.55 Euro/l for fossil diesel).

2.6 Byproducts

One of the byproducts in the biodiesel manufacturing process is glycerine. The traditional markets are in the medical, food and cosmetics industries. As the production of biodiesel increased in Germany, the glycerine market has been flooded and prices have dropped considerably in the past year. There has been a push to develop new applications to use this new feedstock. The University of Dortmund (www.uni-dortmund.de) is carrying out research on the industrial synthesis of GTBE (glycerine t-butyl ether) as a gasoline additive. GTBE is considered safer than MTBE because it does not readily mix with water and, hence, reduce the likelihood of contaminating ground water in the case of a spill. The production of GTBE would be able to consume large quantities of the glycerine. The lower glycerine price has also made other processes economically attractive such as the manufacture of epichlorohydrin for epoxy resins, paper reinforcement and water purification (www.solvay.com).

Another byproduct, the rapeseed cake, has been typically used as an animal feed. As the supply exceeds demand, and prices continue to fall, its use in biomass power generation becomes more attractive. It can also be added to biogas reactors to boost the methane output. A Canadian company, MCN-Bioproducts (www.mcnbioproducts.com), has developed a fractionation process that isolates the proteins for use in specialised applications such as aquaculture fish food.

2.7 Innovations

Recently, the Fraunhofer Institute (www.fraunhofer.de) announced that they are working on a process for the incomplete esterification of the vegetable oil using fixed catalysts. The process will break 2 of 3 bonds in the esterification reaction, leaving the glycerine molecule attached to one of the hydrocarbon chains. This would result in a 10% increase in yield and a one-third reduction in the use of alcohol in the process. In addition, the glycerine would not need to be separated. The process will also be able to use either ethanol or methanol in the esterification reaction. The process is currently under development and no information was available on the quality of the resulting fuel.

3 Second generation biofuels

3.1 Oil and car company strategies

Given the ethical problems of using food crops, such as rapeseed and cereals, for the production of biofuels, a movement has emerged that calls for the rapid introduction of second generation biofuels. These are made from non-food biomass, such as wood or agricultural residues. In addition, a comparison of the fuel yield per hectare of land on an annual basis (see Figure 5) demonstrates that food crops are an inefficient feedstock for fuel production. Energy crops and other non-food biomass when converted to a fuel (biomass-to-liquid or BtL) are considerably more efficient. In addition, it frees the fuel industry from a feedstock that is subject to prices set on food commodity markets.

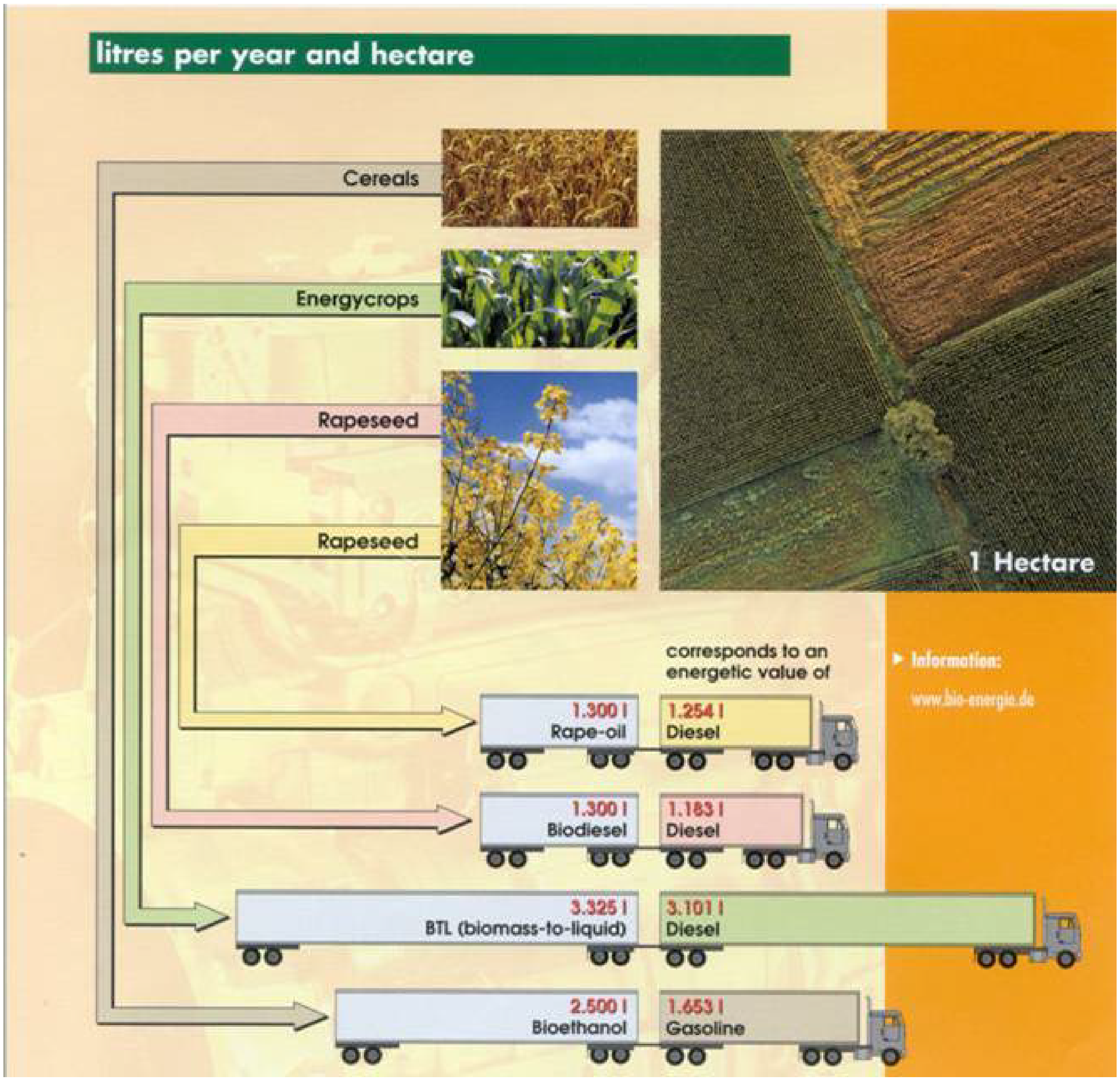

Figure 5 Biofuel production as a function of crop and process per hectare of land and per annum (www.bio-energie.de)

This has led German/European oil companies and automobile companies to formulate a fuel strategy that will move from fossil fuels to renewable hydrogen (see Figure 6). The first step in the process is the introduction of natural gas to liquid fuel (GtL) or coal to liquid fuel (CtL). GtL has already entered the consumer market: Shell's V-Power blends consist of ~ 5% GtL (www.shell.com/us/vpower). This is being marketed in selected markets as a premium fuel costing, in Germany, about € 0.10 / litre more than regular fuels. The success of this fuel will set the stage for the marketing of BtL fuel. BtL fuel is referred to as synthetic fuel, Sundiesel (VW), designer fuel or Biotrol (DaimlerChrysler). For a schematic review of BtL fuel preparation see Figure 7.

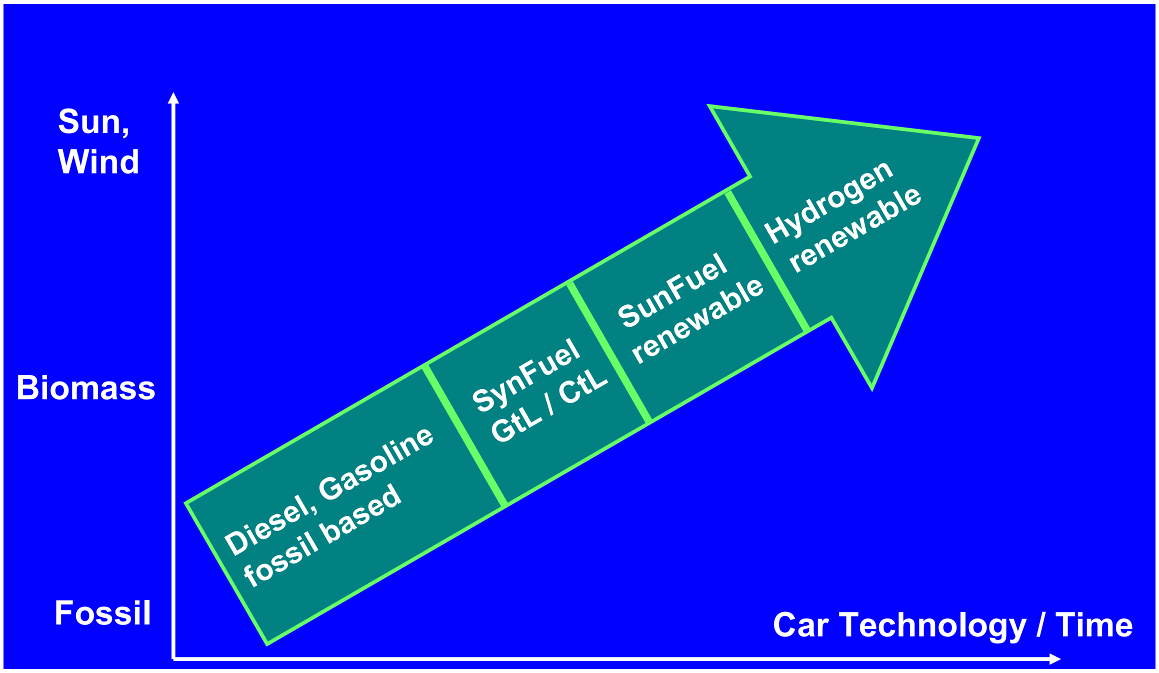

Figure 6 Fuel strategy as formulated by VW and Shell (from a presentation at a conference in Wolfsburg in 2005)

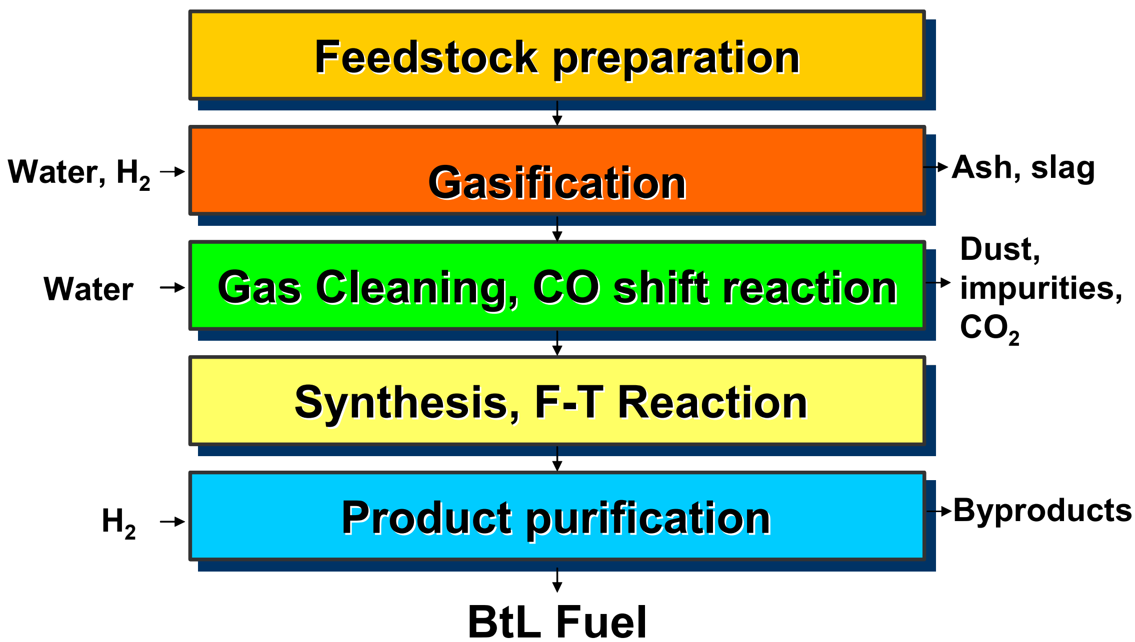

Figure 7 Schematic of the production steps for Biomass-to-Liquid (BtL) fuel

As BtL fuel requires no changes in the fuel distribution infrastructure, blends easily with fossil diesel and relies on technologies well known to the oil companies, its continued development as a future fuel appears very likely. In addition, the automobile companies welcome this designer fuel with its standardised composition because it permits the design of engines that are fuel efficient and low in noxious exhausts. As the fuel will have little chemical variation, the motor's performance can be optimised with minimal additional fuel treatment technologies. In the long run, emission standards for European cars can be tightened, making it difficult for imports. The final stage of the fuel strategy is the introduction of renewable hydrogen and fuel cell technologies.

3.2 Timeline

The BtL timeline is both ambitious and cost intensive. A 13,000 ton plant is to be built in 2006-7, with a 200,000 ton plant in 2008. Four additional 200,000 plants are to be online by 2010. To produce one ton of fuel, five tons of biomass are needed. Using Germany as an example, its one million hectares of set-aside-land can be used to generate approximately 4 million tons of fuel or 13% of current diesel use. If sustainable wood biomass is added this could take the total up to 40%. DaimlerChrysler has stated in one publication that BtL fuels can have up to 10% market share by 2015. The production cost of the BtL fuel is expected to be between € 0.50 and 0.70 / litre. The „Alliance for Synthetic Fuels in Europe" was founded in February 2006 by DaimlerChrysler, Renault, Royal Dutch Shell, Sasol Chevron and Volkswagen. BtL research is a political priority and is receiving government funding from both the EU and Germany.

So that rapeseed methyl ester continues to be part of the fuel sector in the future, tests are being carried out on the blending of synthetic fuels to examine its effects on emissions and lubricity. The blends which are being tested include: 60% fossil diesel + 20% RME + 20% GtL and 95% GtL + 5% RME . (RME = rapeseed methyl ester or rapeseed biodiesel)

Another second generation biofuel is bio-ethanol produced from straw. The Canadian company, Iogen (www.iogen.ca), is currently working together with VW to examine the feasibility of building a cellulosic bioethanol plant in Germany.

3.3 The potential of biogas as a transportation fuel

A recent study (see Figure 8) re-examined the maximum distance travelled for different biofuels as a function of hectare of agricultural land. In this case, biogas, typically produced from the anaerobic digestion of agricultural feedstocks or waste material, was determined to be the most effective biofuel, surpassing BtL fuels by 30%. If this study is an accurate assessment this could mean that interest in natural gas cars will receive a significant boost.

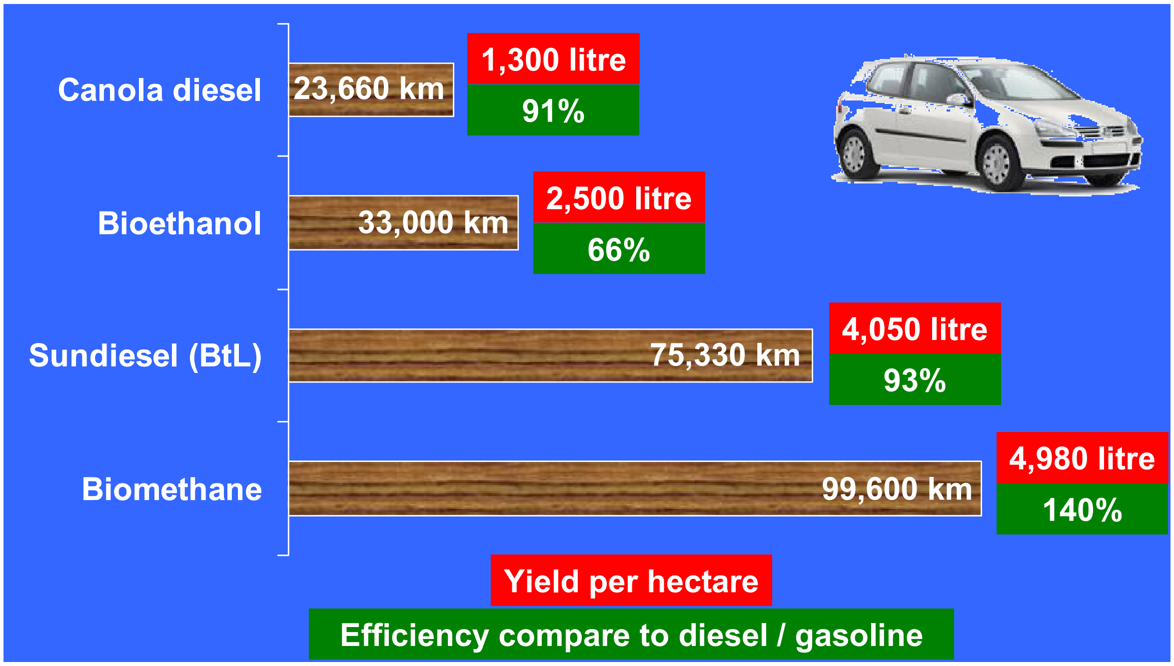

Figure 8 Distance travelled as a function of biofuel (per hectare of land per annum) (Source: "Biofuels", Fachagentur Nachwachsende Rohstoffe e.V. (FNR), 2006)

4 Conclusion

The German (European) biofuels market has developed rapidly and will continue to be vibrant for the foreseeable future. After a successful program to introduce biofuels such as rapeseed biodiesel and bioethanol, work is rapidly progressing to develop the more environmentally friendly second generation biofuels. The German example demonstrated the importance of cooperation with automobile manufacturers and consumer education in gaining market acceptance for the new fuels. Innovation continues to play an important role in increasing the efficiency of the chemical processes and in developing cost-effective BtL fuels.

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