

## PROGRESS WITH BIODIESEL UPTAKE IN EUROPE A STATUS REPORT

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### ABSTRACT

The EU White Paper: Energy for the future: Renewable Sources of Energy, COM (97)599, recognises that there is a need for actions to promote the uptake of liquid biofuels for transport applications. The rationale includes changing to alternative road transport fuels, which offer lower emissions of greenhouse gases and/or reduced emissions of local air pollutants. However, only a few member states have commercial activities in the field (Austria, Germany, and France) while others are still at the early stages of consideration, having relevant data and information from feasibility studies and laboratory analyses. This paper aims to present a status report on biodiesel uptake in Europe by presenting the situation in a number of Member States.

### INTRODUCTION

Despite long term efforts in research and demonstration projects, the proportionate share of biofuels in the European Union is still very small. The EU15 production of biofuels in 2000 was 868,000 tonnes of which biodiesel accounted for 680,000 tonnes. The respective figure for fuel consumption in transport was 305.8 Mtoe [5]. Taking a factor of 0.812 ktoe/Kt [6], biodiesel accounted for 552 ktoe (or 0.19% of all fuels for transport). The principle obstacle to its use is the price differential with fossil fuel which currently varies at a scale of 1.5 (biodiesel) to 4 for products before tax [2]. Predictions in the same document on security of supply indicate that the transport sector will grow some 2% per annum over the coming decade. If no energy saving measures are applied, diesel and gasoline consumption for transport will be approximately 304 Mtoe in 2010 in the EU as a whole. The contribution of biofuels predicted in the proposal for 2010 will then be around 17.5 Mtoe (5.7%).

### CURRENT SITUATION IN EUROPE

In Europe rape seed and sunflower biodiesel production has increased substantially since 1992. The total European production in 2000 was equal to 680,000 tonnes, representing more than ten times the production levels of 1992. Biodiesel is currently used in pure form or blended with conventional diesel. Nowadays, **Germany**, **Austria** and **Sweden** use 100% pure biodiesel in adapted vehicles. In **France**, biodiesel is blended at 30% in captive fleets and also used

in blends of 5% in normal diesel fuel. In **Italy**, it is blended at 5% in normal diesel fuel.

With more than half the total rape methyl ester (RME) European production, **France** is the leader Member State. **Italy** is in second place with 20% of the total volumes and has the peculiarity of consuming 90 % of its production for heating purposes. **Germany**, **Belgium** and **Austria** have respectively 14 %, 5 % and 3 % of the total. Attention is drawn to the fact that **Austria** and **Germany** are the only countries that have made the choice of using biodiesel as a pure fuel.

In terms of production facilities, there are 21 units spread out over the five countries mentioned previously, plus one unit in **Sweden** and a few very small ones in the **Czech Republic**.

The following table gives the evolution of rape and sunflower methyl ester production and consumption.

TABLE 1: EVOLUTION OF RAPE AND SUNFLOWER VOME PRODUCTION/CONSUMPTION IN 2000 IN EUROPE Source: [15]

Country	Production (t)	Capacity (t)	Nr Plants	Planned extension Capacity or quota (t)	Notes
Austria	26,500	31,900	6	8,000	
Belgium	23,000*	100,000*	2		Export
France	308,600	320,000	4	90,000	
Germany	247,000	247,000	6	760,000 (8 units)	
Italy	76,000*	668,000 (1)*	7		(1) estimate d
Total	681,100			858,000	

In **France**, in 1991, a major programme was developed to involve the main sectors concerned in biodiesel production: oilseeds manufacturers, oil producers, engine manufacturers and public authorities. As a result of this programme and the existing tax relief on pilot projects on rapeseed and sunflower esters, a 5% biodiesel blend with diesel fuel was developed by one oil company and applied on a general basis [6, 15]. In detail, the quantity of rape methyl ester (RME) for fuel uses placed for consumption on the French market has risen dramatically from 5,000 tonnes in 1993; to 70,000 tonnes in 1994; 150,000 tonnes in 1995; 210,000 tonnes in 1996, 250,000 tonnes in 1997 and 300,000 tonnes in 1999 [17]. Given its functional and environmental advantages, biofuel is proposed to the end consumer in two forms [15]:

- A standardised form that represents the majority of sales with a blend factor of between 2 and 3% for which its functional properties (lubricant) are sought.
- A 30% blend for the public transport fleets of certain French towns where, in this case, its environmental properties are turned to better advantage. Thirty or so cities using this blend have formed the Club des Villes Diester (Diester Cities Club). The Diester designation being registered trademark and representing an abbreviation of Diesel and Ester (commonly used term in France).

TABLE 2: INDUSTRIAL APPROVALS FOR BIODIESEL PRODUCTION IN FRANCE FOR 2000

Cognis in Boussens:	33,000t
Robbe in Compiègne:	60,500t
Dico in Grand-Couronne:	180,500t
Novaol in Verdun :	33,500t

Connemann	in	10,000
Leer:		
Total:		317,500t

In **Austria** [6, 12], biomass is increasingly penetrating the market satisfying some 11% of the country's total energy consumption. This is partly 'top-down' driven through the government taking an active role in promoting biodiesel use; a meeting in Bad Aussee in January 1999 decided to improve the basic conditions for the introduction of biofuels and introduced a mandatory addition of biodiesel. Beginning with January 2000 fossil diesel is to contain 2% of biodiesel. This first step forward has then been completed by an amendment of the Austrian tax law published in July 1999. On 1<sup>st</sup> January 2000 the utilisation of fuels from renewable raw materials will be free of tax: a) if they are used as sole biofuels, b) if biofuels are blended to gasoline up to 5% (Ethanol or ETBE) and c) if biofuels are blended with diesel fuel up to 2% (Biodiesel).

Up to now and without taking into account these new regulations, the national biodiesel production used as a pure biofuel was 18 400 tonnes in 1999 and could reach 27 600 tonnes by the end of 2000 for a total capacity of 30 100 tonnes. In 1999, seven plants have produced biodiesel but more than 70% of the total production arises from just one plant: in Bruck.

As concerning **Italy**, [6] the national production of biodiesel started in the year 1992. Today, seven firms produce biodiesel but only two are specialised in this market. In Italy, biodiesel is mainly used in both public and private household heating systems (theatres, hotels, The Vatican) and is principally rape methyl ester with a small quantity of sunflower methyl ester. The vegetable oils are almost totally imported from France and Germany because of the scarcity and the high production cost of a national product. The average yield of oil is very low, less than 1 t/ha and the land used is very limited (60 000 ha). This is why the fuel is imported. However, in spite of poor national production, Italy has managed to produce 90 000 tonnes of biodiesel in 1998, production which is mainly sold on the national market.

The commercialisation of blends in fuel pumps is free up to 5%. The tax exemption is fixed by the Decree n°504/1995 up to the global quota of 125 000 tonnes/year and is allocated by the Ministry of Finance.

The Italian government has adopted measures to promote the use of biodiesel, specifically as a 20% blend with diesel oil in towns of 100 000 inhabitants and over, such as Genova, Ravenna, Venice, and Mantua.

**Germany** is also one of the leading countries in the field of biodiesel along with France and Austria. The sales of biodiesel presented an increasing rate since 1992. In detail, about 5,000 tonnes were sold in 1992; this number rose to 25,000 in 1994; 45,000 in 1995; 60,000 in 1996 and roughly 100,000 in 1997. The rapid rise in the last two years can be attributed to the fact that super leaded petrol was withdrawn from the market in October 1996 and has no longer been offered by public filling stations since [8, 9].

In 1999 EUROSTAT official statistics lists that 130,000 tonnes biodiesel were produced, which amounts to 15% of total EU biofuel consumption by then. The production increased to 330 and 430 thousand tonnes in 2000 and 2001 respectively [16], anticipating a production capacity of 930 thousand tonnes per year by the end of 2002.

TABLE 3: BIODIESEL CAPACITY IN GERMANY FOR 1999 AND 2000

Name of the company	Place	Capacity (1999)	Capacity (2000)*
Oelmuehle Leer	Leer	100 000	100 000
Campa Biodiesel	Ochsenfurt	0	75 000
Biodiesel Wittenberge	Wittenberg	60 000	60 000

		e		
Hallertauer Verwertungsgesellschaft	Hopfen-	Mainburg	5 000	5 000
ADIB GmbH&Co KG		Wiegleben	4 000	4 000
Verwertungsgesellschaft Biokraftstoffe		Grossfries en	2 000	2 000
<b>TOTAL</b>			<b>171 000</b>	<b>246 000</b>

### United Kingdom

The production and use of biodiesel has not, until recently, been well publicised and promoted in the United Kingdom and the biodiesel production level is far from that of other European and international countries. Several small producers of biodiesel have emerged in the last few years due to the need to reduce the consumption of fossil fuels and to find alternative methods of waste cooking oil disposal. Production has also been encouraged by the promised reduction in fuel duty to take effect in April 2002. This potential tax break has made the production and commercial sale of biodiesel in the UK a much more feasible possibility than in the past although it will not be sufficient to make biodiesel fully competitive with ultra low sulphur diesel (ULSD).

The majority of biodiesel production in the UK focuses mainly on RVO (reclaimed vegetable oil) from restaurants and other catering facilities and also the possibility of using beef tallow. RVO in the UK currently undergoes separate collection and is processed and blended with other oils and fats for use in the animal feed industry [1]. The other potentially viable option for biodiesel production in the UK is the use of rapeseed oil [3]. There have been a significant number of studies regarding the use of rapeseed oil for the production of biodiesel. These have generally shown that with the quantity of 'set-aside' land available in the UK and the suitable climate, rapeseed would be ideal for biodiesel production.

It has been stated by BABFO, the British Association of Biofuels and Oils, that according to the 1999 figures for crops, 500,000 hectares of land are available for the growth of oilseed crops for biodiesel [2]. It is also estimated that the UK RVO market approximates to 200 million litres sold each year of which 85 million litres is reclaimed and sold [10]. These quantities of raw materials could add considerable value to the biodiesel industry in the UK.

A significant number of biodiesel trials have also been conducted in the UK mainly using fleet vehicles such as buses and HGV's. Trials have been conducted by the Reading Bus Company who used biodiesel in three buses of their fleet for a period of five months. Other county councils and organisations undertook trials such as Cleveland County Council, Kent County Council and the Royal Mail [4]. Projects such as these only went so far as to monitor the emissions and assess the engine performance. They were not assessed in terms of supply and demand, social and economical aspects or environmental life cycle assessment as the fuel used for the majority of these studies was imported from Italy. Few of these projects were continued for extended periods as importing the fuel was highly uneconomical.

With the introduction of the 20ppl reduction in fuel duty in April 2002, the prospects for biodiesel look set to improve. The interest of various fleets is greatly increased due to the proven benefits of biodiesel, the 'green' image it can help portray and its prospective competitiveness with its petroleum equivalent. However, the government must do more for the promotion of alternative fuels such as biodiesel to help the industry in the UK really develop. Programmes such as the Department of Trade and Industry's (DTI) Green Fuels Challenge and the Energy Savings Trust (EST) PowerShift are very much focused towards fuels such as compressed natural gas (CNG), liquid petroleum gas (LPG). These fuels, although better than standard petrol and diesel are not 'green' fuels. The UK government, to an extent, considers them to be 'green' and alternative, an

opinion which is reflected in the taxation of these fuels compared with biodiesel and bioethanol; taxed at the same rate as their fossil counterparts.

TABLE 4: CURRENT FUEL DUTY RATE (INTRODUCED IN MARCH 2001 BUDGET)

Fuel	Taxation (pence per litre)
ULSD (& biodiesel)	45.82
Unleaded petrol (& bioethanol)	46.82
LPG (pence per kg)	9

## Greece

Except for waste oils and conventional crops such as sunflower [14], other crops (*Brassica carinata* and *Brassica napus*) have recently been tested in Greece, concerning their adaptability and seed yielding capacity [13].

In 1997, a demonstration project had been undertaken entitled "*Pilot Actions Aimed at Introducing Liquid fuels Derived from Biomass in place of Petroleum Products in the Transport Sector*" with the participation of the greatest petroleum refinery in Greece and an Italian company. In an effort to investigate the perspectives of biodiesel production from raw materials that are abundant in Southern Europe, this study included fleet tests in Athens by consuming blends of typical diesel fuel with biodiesel produced from sunflower, corn, olive and used frying oils. This research marked the first actual utilisation of biodiesel in Greece and has served to illustrate the attractiveness of this renewable and environmentally friendly fuel in the day to day operation of a variety of vehicles.

A third project financed by the Altener II Programme, entitled "A Global Strategy Approach for the Penetration of Biodiesel in the Greek Fuel Market" stamps the first commercial application of FAME in Greece, as fuel blends containing up to 7% rapeseed oil biodiesel, produced in Austria, are already distributed through selected fuel stations of a private petroleum company, to consumers in the region of Thrace. The results from monitoring showed that the biodiesel/diesel blends are very well accepted.

Currently, there is a fourth project (Altener II Programme) ongoing, entitled: 'Implementation of a biodiesel production plant in northern Greece'. The aim of this action is to examine the techno-economic viability of a biodiesel plant in northern Greece. The aim is further analysed into the following objectives: a) assessment of the proper biodiesel production chain from an economic and quality point of view and b) to develop a methodology for the implementation of similar investments, in Greece.

## ECONOMICS OF BIODIESEL

Against the backdrop of security of supply, reduced CO<sub>2</sub> emissions and rural economy, biofuels would look to have a significant future potential. The dramatic fall in oil prices in the early/mid 1980s and their persistently low level since then (even today's ± 25\$/barrel is less than half the price it was in 1980-82 in real terms) means, however, that biofuels are not competitive [6].

Biodiesel has a production cost of approx. 500€/1000-litre, against 250-300€/1000-litre for traditional petroleum-based diesel including the refinery cost [11]

Production cost of biodiesel depends on a number of factors, particularly the price of the raw material (usually rapeseed oil), the size and type of production plant, the yield and the value of by-products (protein, glycerol). The estimate of 500€/1000-litre is based on average raw material cost, low production cost of large scale plant and glycerine by-product price of 50€/1000-litre biodiesel produced. In view of the fact that it takes 1100 litres of biodiesel to replace

1000 litre of petroleum-based product, the economic calculation shows an additional cost of around 250€/1000-litre of diesel replaced by biodiesel.

## **BIODIESEL AND THE ENVIRONMENT**

The use of biodiesel decreases the solid carbon fraction of particulate matter (since the oxygen in biodiesel enables more complete combustion to CO<sub>2</sub>) and reduces the sulphate fraction (biodiesel contains less than 24 ppm sulphur), while the soluble, or hydrocarbon, fraction stays the same or increases. Therefore, biodiesel works well with new technologies such as catalysts (which reduce the soluble fraction of diesel particulate but not the solid carbon fraction), particulate traps, and exhaust gas recirculation.

Emissions of nitrogen oxides increase with the concentration of biodiesel in the fuel. Some biodiesel produces more nitrogen oxides than others, and some additives have shown promise in modifying the increases. More R&D is needed to resolve this issue.

*The benefits of CO<sub>2</sub> avoidance:* The energy consumption of transport represented in 1998 28% of the CO<sub>2</sub> emissions. Although transport accounts for only 28% of total CO<sub>2</sub> emissions, it will be the main reason for the European Union failing to meet the commitments given at Kyoto unless radical changes are made rapidly. According to the last estimates, if nothing is undertaken to reverse the growth trend, CO<sub>2</sub> emissions due to transport would increase by approximately 50% between 1990 and 2010 reaching 1,113 million tonnes of emissions, compared with 739 million in 1990 [7]. One possible way for the reduction of CO<sub>2</sub> emissions is the use of liquid biofuels in the transport sector.

Avoidance of CO<sub>2</sub> emissions from fossil fuel substitution with biofuels depends on the way it is produced. CO<sub>2</sub> emission from fossil diesel is around 3.2 tonnes CO<sub>2</sub>/1000-litre (including CO<sub>2</sub> emissions from production, transport, etc.) used. However, even though CO<sub>2</sub> emission from biofuels combustion is neutral in principle, actual CO<sub>2</sub> avoidance is less than the 3.2 tonnes because of the emissions produced in the process of growing the crops and the conversion of raw material into biofuels. Realistic CO<sub>2</sub> saving for biodiesel is around 2 to 2.5 tonnes CO<sub>2</sub>/1000-litre. If there were no other benefits, for instance, in the agriculture sector and in the security of supply, this would mean that at current oil prices and biofuel production costs, the cost of CO<sub>2</sub> avoidance would be around 100 €/tonne CO<sub>2</sub>, which is above the range for cost-effective measures to meet the EU's commitments during the first Kyoto commitment period. However, economies of scale in the production of biofuels and rising oil prices will bring these costs down, and although the use of biofuels at this moment cannot yet be justified by the benefits alone of CO<sub>2</sub> avoidance, it should certainly be considered as a strategic choice for future climate change policy.

## **REFERENCES**

1. Affiliated Cooking Oil Reclaimers Nationwide (ACORN) (1997). Information Sheet.
2. British Association for Biofuels and Oils (BABFO). Submission for Biofuels [www.biodiesel.co.uk/press\\_releases/submission\\_for\\_biofuels\\_5.htm](http://www.biodiesel.co.uk/press_releases/submission_for_biofuels_5.htm) (06/2001)
3. Bruton, CJ. 2001. Feasibility study into the use of biodiesel on the Isle of Wight: Commercial report for ITC, Isle of Wight Council, Isle of Wight Grain Storage Company and Biffa.
4. Department of the Environment, Transport and the Regions, Alternative Fuels - UK Trials, [www.detr.gov.uk/roads/vehicle/environment/altfuel/fpart6.htm](http://www.detr.gov.uk/roads/vehicle/environment/altfuel/fpart6.htm) (05/2001)
5. DG-TREN: Statistical Data, 2001
6. E.C, 2001. Proposal for a Directive of the European parliament on the promotion of the use of biofuels for transport.

7. Green Paper. Towards a European strategy for the security of energy supply, COM (2000) 769 final).
8. Groenen, K. 1998. Successful marketing for biodiesel in Germany. In "Biomass for Energy and Industry". Proc. 10<sup>th</sup> European Conference. Ed. Chartier et. al., C.A.R.M.E.N. Press. Germany. pp. 128-130.
9. Groscurth H.-M (ZEW), G. A. Reinhardt et al.: Total Costs and Benefits of Biomass in Selected Regions of the European Union. Energy, Vol. 25 (2000), Issue 11, pp. 1081-95
10. Jones, P (1999). The UK Reclaimed Vegetable Oil (RVO) Market.
11. IEA/OECD, 1994. Biofuels
12. Körbitz W.; "New Trends in Developing Biodiesel World-wide", International Conference Renewable Energy Sources on the Verge of XXI CenturyEC, Warsaw, Poland (2001)
13. Namatov, I., Kavadakis, G., Nikolaou, A. and C. Panoutsou, 2000: "Growth and productivity of *Brassica carinata* and *Brassica napus* varieties for oil production in central Greece". ". Proceedings of the 1st World Conference on Biomass for Energy and Industry, Seville, Spain, 5-9/6/2000. James & James Ltd, pp.1741-1744.
14. Nikolaou, A., Kavadakis, G. and C. Panoutsou, 2001: "Comparative Life Cycle Assessment of Bioenergy and Fossil Energy Systems in Greece", 7th Conference on Environmental Science and Technology, Syros, in press.
15. Poitrat, E. 2001. State-of art in Liquid Biofuels. ADEME : Agency for Environment and Energy Management. Department of Agriculture and Bioenergies .27, rue Louis Vicat F75015 PARIS-France. Email: [etienne.poitrat@ademe.fr](mailto:etienne.poitrat@ademe.fr)
16. Reinhardt G.A.. 2001. Personal Communication
17. Staat, F. 1998. Development of biodiesel activity in France. In "Biomass for Energy and Industry". Proc. 10<sup>th</sup> European Conference. Ed. Chartier et. al., C.A.R.M.E.N. Press. Germany. pp. 112-115.