

Biofuels in Europe

Resulting from programs launched in the late 1970s to help compensate for oil-related constraints, biofuels now have been under industrial development for over 20 years. Still handicapped by high costs, their future once again looks promising because they might be able to help reduce oil consumption and greenhouse gas emissions in the transport sector. This is especially true in Europe, where recently approved directives contain ambitious production volume targets encouraging member states to develop biofuels.

Following the oil shocks of the 1970s, many countries saw biofuels as a realistic solution to the problem of dependence on oil resources. Furthermore, biofuels could be blended with conventional fuels to achieve gains in the area of polluting vehicle emissions. Their development was slowed, however, by the counter-shock of 1986 and the persistence of high prices. The context has become more favorable subsequent to at least three changes:

- Public opinion is exerting pressure on public authorities to fight the greenhouse effect. The latter are looking for solutions to reduce greenhouse gas (GHG) emissions, especially in the transport sector. It is thought that the use of biofuels substantially reduces GHG emissions compared to conventional motor fuels. In fact, when biofuels are used in their pure form, the decrease in GHG emissions ranges from 60% to 70%, respectively, for ethanol versus gasoline and for vegetable oil methyl esters (VOME) versus diesel⁽¹⁾.
- Given that conventional crude reserves are concentrated in the Middle East, that there is uncertainty as to their medium- and long-term prospects and that regional production might peak, many governments are implementing policies to promote the emergence of alternative energy resources. In this respect, biofuels appear to be a significant option.
- Finally, the uptrend in oil prices over the last two years encourages the development of alternatives solutions, especially biofuels. The biggest barrier to the large-scale development of biofuels remains their excessive cost compared to petroleum motor fuels. But biofuels are attractive because they have a major advantage over other alternative fuels: they can be blended with conventional motor fuels, so that there is no need to adapt vehicles or develop a dedicated distribution system.

Two biofuels are already candidates for industrial development: vegetable oil methyl esters (VOME) and ethanol, mainly used in Europe in the form of ethyl tertio butyl ether (ETBE).

Vegetable Oil Methyl Esters (VOME)

VOME are produced from vegetable oils obtained by drying, baking, grinding and pressing seeds, such as rapeseed. This process yields the desired oil in addition to a solid residue (press cake) that is generally used for animal feed. One ton of grain yields about 0.6 ton of cake and 0.4 ton of oil. That is why press cake market trends significantly affect the economics of VOME biofuels.

Rapeseed oil and sunflower oil cannot be used directly in modern diesel engines. First, they must be transformed by transesterification with methanol, an operation that yields vegetable oil methyl esters.

The first references to VOME applied to a diesel fuel date to the early 1980s, when the IFP undertook research on the subject, with the support of France's Agency for the Environment and Energy Management (ADEME) and in cooperation with the agricultural world. This led to the construction of the first production reactor (using the IFP process) in 1988 in Compiègne, France. The first experiments on a captive fleet took place in the next few years. In 1991, work began under official auspices to obtain certification for motor fuels containing 5% VOME; certification was granted in 1994.

Today, this type of motor fuel is sold at the pump, with completely transparency for users. Most French refineries add VOME to motor fuels for sale, in proportions ranging from 2% to 5%. Up to 30%, it is used in captive fleets without any particular technical constraints. For Renault V.I. or PSA, however, the upper limit is 30%: neither will deliver a manufacturer's warranty if this threshold is exceeded.

(1) "Bilans énergétiques et gaz à effet de serre des filières de production de biocarburants en France" - PriceWaterhouseCoopers/IFP, on behalf of ADEME/DIREM - September 2002.

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Ethanol and ETBE

Ethanol for biofuels is produced from sucrose-producing plants (sugar cane, sugar beets), wheat or corn. Two countries in particular have developed this type of biofuel: Brazil and the United States.

In Brazil, the oil shocks of the 1970s triggered mass production of ethanol as an alternative fuel. Starting in 1979, the government assured the automotive industry that this alternative fuel would be available in all major urban centers. This guaranteed the establishment of a dedicated vehicle market, even if ethanol can also be blended directly with gasoline.

In the late 1980s and early '90s, the declining crude price and the liberalization of sugar production made this last market more attractive. At the same time, the government had to scale down its subsidies. This led to a new policy that no longer encouraged the production of dedicated vehicles running on ethanol. For the last 15 years, this alcohol has been incorporated into all gasolines for sale (content: about 24%). The Brazilian automobile fleet includes nearly 2.3 million dedicated vehicles and about 16 million vehicles that burn a gasoline-ethanol blend. The amount of ethanol used in motor fuels totaled 9.5 million tons in 2001 (which corresponds to 40% of national gasoline consumption).

The second country to launch a major initiative to promote ethanol is the United States. In 1978, President Carter introduced the first ethanol program: the Energy Tax Act, which provided tax incentives for the production of this alcohol. To obtain an alternative motor fuel, ethanol was usually blended with gasoline: E10⁽²⁾ and, more marginally, E85. In 2002, 73 industrial units produced nearly 6 million tons of ethanol for motor fuel applications.

In European countries, ethanol itself is practically never added to motor fuels, but used in the form of ETBE (produced from isobutylene and ethanol), to ensure volatility properties and avoid demixion of the mix in the presence of traces of water (separation of the alcohol and gasoline phases).

The European Legislative Framework

Several EC texts govern biofuel use and taxation.

European Directive 98/70/EC on motor fuel quality officially authorizes, for regular sale at the pump, gasolines that contain no more than 5% ethanol or 15% ETBE (cf. Directive 85/538/EC) as well as diesel fuels containing no more than 5% VOME. Higher content levels are perfectly compatible with today's engines, but in that case customer notification at the pump would be necessary.

(2) E10 is a blend: 10% ethanol and 90% gasoline.

In 2003, the Council of Europe and the European Parliament approved two draft directives concerning energy supply diversification and the reduction of GHG emissions:

- Directive 2003/30/EC promotes biofuels by setting progressive targets for their consumption in the transport sector. By 2005, biofuels should represent at least 2% of all gasoline and diesel motor fuels consumed in this sector. The objective for 2010 is 5.75%. These percentages will be computed using an energy base. Although these targets, provided as indications, are not mandatory, member states must keep the European Commission informed about the measures taken to reach them.
- Directive 2003/96/EC concerns taxation. It allows member states to grant partial or total exemption from excise tax on biofuels.

Motor fuel taxation remains the prerogative of each member state. By way of an indication, Brussels recently approved the minimum excise rates for unleaded premium, diesel fuel and heating oil, effective January 1, 2004: €359/m³, €302/m³ and €21/m³, respectively. For diesel, the minimum rate will be raised to €330/m³ by January 1, 2010.

Up to now, a number of member states have obtained dispensations for biofuels. The amounts of these tax incentives are listed below.

For VOME:

- In France, a tax break of €350/m³ is allowed for motor fuel blends containing VOME (up to 5% at service stations, up to 30% in captive fleets). The production quota (317,500 tons/year) will be raised by 70,000 tons in 2004, while the tax incentive is expected to drop to €330/m³.
- The tax incentive granted by Germany (€470/m³) includes a carbon tax exemption and only applies to pure VOME (about 1,500 pumps). However, unlike France or Italy, Germany has no production quota. As a result, and considering the price trends for vegetable oil and diesel fuel in recent years, Germany has invested substantially in new units. Today, it finds itself with excess capacity. Biodiesel blends should be authorized in the very near future, which will make it easier to sell off the volumes of VOME produced. Therefore, 5% and 30% blends should soon be available on the market, alongside the pure product.
- Italy only allows a tax break (€403/m³) for motor fuel blends containing VOME (up to 5% at service stations, up to 30% for captive fleets). For transport applications, there is a quota of 300,000 tons/year. In addition, pure VOME is totally exempt from tax when used for heating oil (25%).
- In Austria, the tax incentive (€290/m³) applies to pure VOME used in motor fuel blends (up to 2%).

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- Spain does not tax VOME, which represents savings at the pump of €294/m³.
- Sweden extends a tax exemption (€344/m³) to VOME. But, for local reasons, this country seems to be focusing on other biofuels (ethanol ex wood and synfuels obtained through the gasification of wood).
- The United Kingdom introduced a tax break for VOME of 20 p/l (€138/m³) on January 1, 2003.

For ethanol:

- In 2003, the French tax exemption will amount to €380/m³. It was €502.3/m³ in 2002.
- Germany grants a tax break of €654/m³ for ethanol.
- Spain does not levy tax, granting a total exemption equivalent to a tax break of €390/m³.
- As for VOME, Sweden's legislation allows a total tax exemption (€520/m³), to be revised annually.
- In the United Kingdom, a tax break of 20 p/l (€138/m³) will be applied to ethanol, effective January 1, 2005.

Production Levels

VOME

In Europe, VOME output has increased substantially in the last ten years (1992-2002): on average, it rose 35% a year. Finally, it represents a twenty-fold increase of production during this period. Two countries, France and Germany are responsible for the bulk of growth.

Table 1
VOME: Production in Europe, by country (2002)

Country	kt/year
Germany	450
France	365
Italy	210
Austria	25
Denmark	10
United Kingdom	3
Sweden	1
TOTAL	1,064

Source: European Biodiesel Board

Stimulated by growth, production capacity rose; now Europe finds itself saddled with excess capacity (cf. Table 2). This could limit the number of new units, at least in the near future. There is another aggravating factor: the production of VOME is accompanied by the production of glycerin (10% of the mass). With any substantial increase in VOME output, there is inevitably a proportionate increase in glycerin

volumes. This could saturate the world market and significantly reduce profitability for the VOME application. To ensure the future of this biofuel technology, new outlets must be found for this co-product.

Table 2
VOME: Production capacity in Europe (as of January 1, 2003)

Country	kt/year
Germany	1,025
France	500
Italy	420
Austria	50
Denmark	40
Sweden	8
United Kingdom	5
TOTAL	2,048

Source: European Biodiesel Board

In 2002, Germany became Europe's foremost VOME producer and consumer, with output standing at 450,000 tons (cf. Table 1). One should note that, starting in 2000, several factors promoted rapid development in Germany: favorable legislation, the absence of a quota, low vegetable oil prices and elevated diesel prices.

With nearly 1 million tons a year in capacity, Germany is now in a situation of surplus production capacity. The chosen mode of distribution (100% pure product) does not facilitate the sale of large volumes, and blends are expected to appear on the market.

Number One until 2001, France produced 365,700 tons of VOME in 2002, exceeding its quota and exported the surplus to Germany and Italy. Its production quota of 317,500 tons/year should be revised upwards in 2004, as indicated (+70,000 tons).

Ranked third, Italy produces nearly 140,000 tons of VOME a year, about 25% for heating oil. Finally, Austria and Sweden report lower production figures. In Austria, one notes an interesting trend: the effort to make VOME from used (frying) vegetable oil.

Other countries slated to join the European Union in the next few years, such as Poland, should also be able to expand in this area.

Ethanol

In 2002, France and Spain accounted for most of European ethanol production. Unlike in the United States or Brazil, ethanol is not used directly but transformed into ETBE, which is then blended with gasoline (Sweden is the only country to use ethanol in blends). The purpose of this

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European practice is to be in line with a standard on motor fuel properties, especially volatility (the use of pure ethanol yields an excessively volatile ethanol/gasoline mix) and to avoid demixtion.

For years, France led the European ethanol sector, but it has now been overtaken by Spain (see Table 3).

Table 3
Ethanol production in Europe

	ETBE		Ethanol	
	In tons	In toe	In tons	In toe
France	192,500	123,200	90,500	57,920
Spain	375,500	240,320	176,700	113,098
Sweden	0	0	50,000	32,000
Total	568,000	363,520	317,200	203,018

Source: *Observer*

Spain is today Europe's most dynamic player in this sector. Thanks to the Abengoa company, annual capacity is expected to rise to 500 million liters of ethanol, produced primarily from wheat and barley, but also from denatured vinic alcohol from the EU wine "lake".

Sweden consumes more ethanol than it produces: since early 2003, the E5 motor fuel has come into quasi-generalized use and the E85 is now available at about fifty service stations. Consumption should eventually total 200,000 m³ (or 158 kt). Most of the difference between production and consumption is covered by imports from Brazil and Spain.

Production Costs

France

The cost issue will be decisive to the long-term future of biofuels.

The table below gives one example of biofuel production costs.

Table 4
Example of biofuel production costs (in France)

	Ethanol	VOME	Petroleum-based motor fuels
€/l	0.38	0.35	0.21*
€/GJ	18	10.5	6*

* Given a crude price of \$25/bbl.

As we can see the energy content in ethanol is about one-third lower than in gasoline. This is a handicap, considering

the ratio formed by cost to available energy (€/GJ) compared to the cost per liter (cf. Table 4).

The only way to ensure that biofuels can be competitive is to implement a tax incentive policy even if they already receive indirect support via the Common Agricultural Policy (CAP).

Impact of the Common Agricultural Policy

In addition to the relevant European directives and the tax policies implemented by each member State, the CAP has always had and will continue to have a major impact on biofuel economics.

In 1992, it was decided to reform the CAP. Two mechanisms were introduced to help control production: the reduction of guaranteed intervention prices and the introduction of direct subsidies based on land area (i.e. average reference yields).

In the sector of high-yield crops (mainly cereals and oilseeds), eligibility for these direct aids was contingent on a "land freeze" (hence the notion of a fallow land premium). Raising sugar beets for ethanol was not covered by this framework (a system of guaranteed prices, about €42/t per quota).

Introducing the concept of "industrial freeze" paved the way for the allocation of aid when the land is cultivated for non-food purposes.

Starting in the 2000-2001 season (the Berlin Agreement), the amount of cultivated land to be left fallow was fixed at 10% and the amount of compensatory aid at €63/t (about €350/hectare for an average region) for cereals and oilseeds. The purpose of this aid was to guarantee compensation to the farmer for loss of income. For instance, in 1999, about 5.7 million hectares were left fallow in Europe of which 17% was used for non-food purposes (mostly to produce biofuels). In France, nearly 1.5 million hectares were left fallow in 1999 and 20% were used to produce biofuels.

For all intents and purposes, a portion of the land is "set aside" for the production of biofuels, whose future therefore depends directly on the CAP. Any change in the fallow land area or the amount of compensatory aid will directly affect the farmer's judgment as to whether it is worthwhile to raise crops for non-food purposes.

Last spring, a new CAP reform was approved for possible implementation in early 2005, through 2013. Its avowed purpose is to "decouple" aid and production by aiming for more quality and less quantity. Farmers would receive a single premium per farm, and payment would be contingent on compliance with environmental and public health

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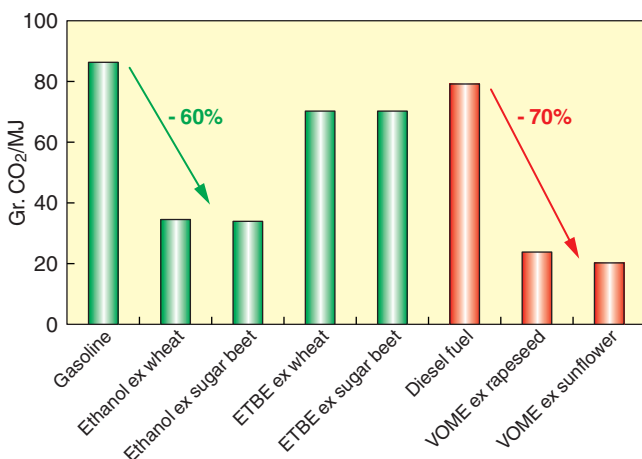
specifications. The allocation of aid would be computed on a historical basis.

As for biofuels, the use of fallow land for “non food” purposes is still allowed. Furthermore, a new aid of €45/hectare has been granted for energy-related crops raised on non-fallow land. This was justified by the fact that these crops should have a beneficial effect in the reduction of GHG emissions.

Environmental Benefits

For years, biofuels were saluted as offering the means of decreasing conventional polluting vehicle emissions (in the early 1980s). This is less true today, due to advances in the combustion technologies applied to engines and exhaust treatment systems (catalytic converters, particle filters). In the future, biofuels will be developed to help reduce GHG emissions and the degree of dependence on oil resources. According to Figure 1, biofuels are expected to yield gains of 60-70% compared to conventional solutions, when

Fig. 1 GHG emissions: The gains of biofuels compared to conventional motor fuels



Source: "Bilans énergétiques et gaz à effet de serre des filières de production de biocarburants en France" - PriceWaterhouseCoopers/IFP on behalf of ADEME/DIREM, September 2002

considering the entire production cycle (from raw materials to end product combustion). This is called life cycle analysis (LCA).

Conclusion

The long-time leading biofuel producer in Europe, France has been overtaken by Germany for VOME and Spain for ethanol. At the practical level, the latter largely anticipated the European directive stating that biofuels should make up 5.75% of transport energy consumption by 2010, thus expanding EU production by a factor of 20.

This is particularly true of vegetable oil methyl esters. Europe, especially France, is running a diesel deficit and a gasoline surplus. This being so, motor fuel producers would be more favorable to introducing a biodiesel than a biogasoline. Looking beyond 2010, the target date fixed by European directive, one can envisage new biofuel technologies, mainly pathways that convert lignocellulosic matter (wood, straw, etc.) into motor fuels. Two options are under considerations. One method using enzymes to synthesize ethanol has been under development in recent years, mainly in North America. The second, which uses the Fischer-Tropsch process to synthesize diesel fuels, includes a biomass gasification stage. For the most part, the latter option is being considered in Europe, where demand for diesel fuel is rising substantially. Several large-scale European R&D projects are underway, including a joint project involving IFP and the French Atomic Agency. Depending on the availability of vegetable matter for conversion, these pathways could serve to cover as much as 10% of the road transport requirements in the European Union by 2020.

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