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Biofuel development at stake in the European Union

In March 2007, the European Council announced that a minimum proportion of 10% of biofuels should be incorporated into the fuels used for road transport by 2010. The European public authorities put forward three main factors to justify such an ambition: the reduction in Greenhouse gas emissions (GHG), the diversification of energy supplies and farm income support. While we wonder how the 5.75% incorporation could be reached by 2010, this new boost to Community policy on biofuels raises several questions.

Biofuel in the European Union: a voluntarist European policy, heterogeneous national interpretations

The development of biofuels in the EU results from a voluntarist policy, which results in incentives in both sectors of agriculture and energy.

The 1992 reform of the Common Agricultural Policy (CAP) gave the first impulse by permitting non-food crops on set-aside lands. Until 2003, nearly all of the energy crops were produced on set-aside lands, where production for food purposes was not -and is not yet- allowed. The 2003 CAP reform introduced a second incentive with a specific aid of 45 euros/ha (within a maximum limit of 2 billion hectares for Eu-25) for energy crops produced on non set-aside lands.

Both agricultural policy measures must not be underestimated. However, it was chiefly the implementation of a policy aiming at encouraging biofuel use which helped their development. In 2003, two European community (EC) directives set the common framework while leaving the member states (MS) the choice of measures to be implemented. The directive promoting biofuels (2003/30/EC) fixes the biofuel incorporation targets to be reached in road transport fuels: (2% in 2005 and 5.75% in 2010. The directive on energy tax (2003/96/EC) allows MS to adopt partial or full tax exemption for biofuels in relation to the general tax system for fossil fuels. These two directives are not restrictive in the sense that MS are not penalized for failing to implement them. So among the different MS, there is a big heterogeneity in the translation of the directive and therefore, quite various levels of production and use from one country to the next.

In 2005, the average biofuel incorporation rate was only 1% for EU-25 for a declared target of 2%. At that time, several MS had not yet translated EC directives into concrete national measures (EC, 2007). The two countries presenting the highest incorporation rates were Germany (3.7%) and Sweden (2.2%). In the case of Germany, it was mostly biodiesel. In the case of Sweden, it was mostly bioethanol. The incorporation rate reached by both countries can be explained by concrete national policies which show great similarities: simultaneous support to pure biofuels, to blends with high content of biofuels and blends with low content of biofuel (compatible blends without modifying existing engines; generous tax exemptions without any quantitative ceilings). Furthermore, to meet domestic biofuel demand, both countries resorted to imports, from other European MS in the German case, and from Brazil in the Swedish case.

National positions evolve quite quickly. Since 2005, many other MS have adopted voluntarist measures favouring biofuels. France defined a more ambitious incorporation rate than the EC recommendation, that is to say 7% in 2010. To this end, France uses two instruments: on the one hand, the reduction of tax on domestic fuel consumption, (previously called domestic tax on fossil oils) for predetermined quantities (through a European call for proposals from the French governement); on the other hand, the increase in general tax on polluting activities (GTPA) for the fuel retailers who do not respect the incorporation rate. The high penalty level virtually forces retailers to respect an incorporation rate equal to the fixed targets.

As a rule, member States intended to encourage biofuel development through total or partial tax deduction. However, the cost of these incentive measures progressively leads them to take or at least consider taking mandatory incorporation measures.

Biofuel demand and supply in the EU
Consumption/production essentially made up of biodiesel

In the UE-25, fuel consumption is divided into 55% diesel and 45% gasoline. We do not find this relative balance with biofuel, either in terms of incorporation rate (in 2005, 1.6% for biodiesel and only 0.4% for bioethanol) or for produced biofuels (80% for biodiesel and only 20% for bioethanol). While the EU is a marginal actor on the world bioethanol market (2% in 2005), it is by far the leader on the world biodiesel market (88% in 2005). Graph 1 illustrates the strong growth in EC diesel production since the beginning of the 1990s, and more particularly since the beginning of 2000.

Very moderate use of imports

The biodiesel consumed in the EU is entirely produced on European lands, while about 20% of the ethanol used as biofuel is imported. EC biodiesel imports are subject to low custom duties (6.5% *ad valorem*). They are almost null simply because biodiesel production outside EU is also very low. Import taxes on the oils used in the diesel production are also very low. At this stage, it is essentially because of technical and/or ruling obstacles that the use of oils other than rapeseed oil is very limited. Today, 95% of EC biodiesel production comes from domestic rapeseed oil, the rest coming from domestic sunflower oil or from imported palm oil. However, EC imports of palm oil has increased over the last months, making waves in EU regarding the deforestation risk in tropical countries, particularly in Indonesia and Malaysia but also in Latin America. Several MS and the European Parliament have expressed the wish to restrict palm oil imports via the limitation of their use for energy purposes.

EC ethanol imports from ACP countries (Africa, Caribbean isles, and Pacific) and Central America are free of taxes; those from Brazil, the world's leading exporter, are heavily taxed. Several MS have expressed the wish for a cut in these customs duties in order to get their supplies at the lowest cost. Other MS, chiefly the two biggest farming countries, Germany and France, are against such a measure, mainly because they are also conducting, via biofuel development policy, an objective to support their farm producers.

Production concentrated in a few members States

The unequal distribution of production between MS is a direct consequence of the diversity of national biofuel policies. In 2006, the main biodiesel producing countries were Germany (almost half of EC production), France and Italy (see graph 2). For several years, EC bioethanol production was dominated by Spain (see graph 3). Over recent years, production has significantly increased in several other European countries: in 2006, this increase was especially strong in Germany, turning the country into not only the leading EU biodiesel producer but also the main bioethanol producer.

A significant impact on the EC oleaginous markets (seeds, oils, and cakes)

The recent development of EC biodiesel production has had a direct impact on the consumption of rape oil inside the EU as a whole: from 4 MT in 2002/03 to 6.6 MT in 2005/06. For the first time in 2005/06, non-food uses of rape oil were higher than food use. In 2006/07, biodiesel should represent 64% of total rape oil use inside the EU-25.

The increase in domestic rapeseed production is the direct consequence of the increase in consumption of rape oil. This has doubled in 15 years, going from 8 MT in 1992 to 16 MT in 2006. Until 2005, this increase in production was enough to meet triturating needs and maintain rapeseed exports towards third countries. It will not be the case anymore in 2006/07 when the rapeseed trade balance becomes negative.

These evolutions of supplied and required quantities have had direct effects on the prices of rape products (grains, oils, and cakes). In particular, from the beginning of 2000 we have noted an increase in rape oil prices in relation to other oil prices and a simultaneous drop in rape cakes price in relation to soya cakes (Dronne and Gohin, 2006).

The situation is quite different with bioethanol, which, nowadays, still represents only a very low share of the sugar and cereal outlets in the EU. However, this proportion is increasing. The cereal quantities used to make bioethanol amounted to 0.5 MT in 2004, 1.3 MT in 2005 and 1.9 MT in 2006 (that is to say less than 1% of EC cereal production). As for sugarbeets, the quantities used to make bioethanol went up to around 5% of domestic production. But if cereal and sugar prices are high today, it is only partly due to the EC demand for bioethanol; other factors interfere: biofuel development in other areas of the world (particularly in the United States and Brazil), the economic growth supported at the worldwide level, climate accidents, minimum world stocks, speculative behaviours, and so on.

Some questions raised by biofuel development in the EU
Assessment of the areas required for biofuel production

In order to appreciate the plausibility of reaching the biofuel incorporation target of 5.75% by 2010 based on a solely domestic production (as is widely the case at present), we assessed the acreages which would be necessary to mobilize.

The need would be around 13 M ha, that is to say a little less than 20% of the acreage dedicated to arable lands in the EU-25. Mobilizing such a surface for energy purposes will have a significant impact on European farm prices, since it is already the case with much lower incorporation levels. Furthermore, this high demand for lands devoted to energy purposes could also have an impact on the environment, via at least two channels: first, at the extensive margin via the re-cultivation of presently set-aside lands (a process, which should be of a limited extent, bearing in mind that a large share of potentially mobilized set-aside lands are already in use), the increase in acreages devoted to rape beyond recommended agronomic practices and/or the conversion of pastures into cultivation; then, at the intensive margin, via the search for high yields/hectare, under the influence of high farm prices (with potentially negative impacts on pollution by fertilizers and pesticides, water consumption and so on).

Increasing use of imports is one of the potential solutions to limit this need for lands in the EU, the increasing impacts on domestic farm prices and the potentially negative consequences on the environment. Yet is this not just shifting the problem to another scale, the planetary scale? In other words, the major question is that of lands that can be mobilized for different uses, food and non-food, and that of the effects of competition between these two types of uses if an increasing number of countries set ambitious objectives as regards biofuel use.

What impact on greenhouse gas emissions?

A priori, biofuels show more favourable results than fossil fuels in terms of greenhouse gas (GHG) emissions because the carbon dioxide emitted at combustion is compensated for by CO_2 absorption by plants in the vegetation phase. There is no consensus on these results because their measure implies methodological choices and calculation assumptions. According to these choices, results may widely diverge (see table 1).

An essential factor, which explains much of these differences, is the counting of by-products, more particularly the cost allocation to different products generated during the biofuel manufacturing process. A first method relies on the allocation of fossil energy quantities consumed inside a given biofuel chain to by-products, proportionally to the mass of the latter. A second one uses an approach by substitution, assigning the by-products of a given biofuel chain with the necessary fossil fuel to produce the goods that will be replaced by these by-products. The surveys based on the second approach lead to more modest results than those using the first one, both in terms of energy effectiveness and reduction in Greenhouse gas (GHG) emissions.

On table 1, we compare three survey results, the first one based on the allocation method in proportion to masses, the other two on the substitution approach. Except in exceptional circumstances, the biofuels considered here reduce GHG emissions. The EC biofuel, which presents the most favourable results is that produced from pure vegetable oil; next come biodiesel and sugarbeet ethanol, and last wheat ethanol. Both surveys based on the substitution method provide intervals: the width of this interval may be essentially explained by the production technology used, more specifically by the sources and energy quantities used in the industrial process of biofuel manufacturing. Therefore, a biofuel from an ethanol bio-refinery which uses straw to produce electricity and heating will show much more favourable energy and GHG emission results than the same biofuel from a conventional unit: in relation to gasoline, the reduction in GHG emissions would be 60% in the first case, and only 15% in the second one (JRC *et al*., 2007).

A major limit of the surveys above is that they do not take into account the impacts of changes in soil use on GHG emissions. In the EU, at least until now, this chiefly concerns the possible cultivation of areas, which are today on set-aside and/or in pasture. On the world level, it is chiefly a matter of forest destruction: on that scale, excessive development of biofuels via deforestation and/or the ploughing of meadows could result not in a reduction in EU GHG emissions but in their increase (UN, 2007).

We will remember that the contribution of first-generation biofuels to the reduction in GHG emissions in the EU can only be modest (according to our assessments, reduction of 1% emissions for biofuel incorporation of 5%). However, any contribution - even marginal - to the reduction in GHG emissions must be welcome. Furthermore, we may reasonably anticipate that the results of second-generation biofuels should be more positive as regards both energy effectiveness and the reduction in GHG emissions (see box).

What impact on energy dependency?

Today, the EU is 50% dependent on imports for its total energy supply (up to 80% for fossil oil). If “nothing is done”, dependency should keep on growing up to 63% for energy as a whole and 93% for fossil oil by 2030. In this context, the use of biomass in transportation is encouraged since it is one of the rare substitutes for fossil oil. The contribution of first-generation biofuels to the reduction of EU energy dependency, especially fossil oil, will however only represent a few percentage points (3% according to the European Commission, for 5.75% incorporation). Increasing biofuel imports in a large way should allow that ceiling to be exceeded. Nevertheless, it would be more a matter of diversification of the fuel/biofuel supply sources than a real reduction in energy dependency. Furthermore, the expected positive impact on the EC crop farmers’ incomes would be lower.

What policy for the promotion of biofuels: Tax incentives and/or mandatory incorporation?

A biofuel-promoting policy based on tax exemptions brings most of the burden of biofuel support onto the taxpayer. The fear of an excessive increase in the budgetary cost because of tax exemptions leads (could lead) to an increasing number of MS replacing tax incentives by mandatory incorporation measures: the consumer bears (would bear) the cost of support to biofuels.

The competitiveness of biofuels in relation to fossil fuels depends on the price of the latter. It also depends on the prices of the farm raw materials used to manufacture the biofuel: These raw materials represent the main budgetary item in the (variable), cost of biofuel production up to 90% in the case of biodiesel manufactured from rape. In a system, where the demand for biofuels is determined by prices as market signals, a high fossil oil price results in an improvement of the relative competitiveness of biofuels, in an increase in their demand, in an increase in the demand for the raw materials necessary for biofuel manufacture, and following this, in a reduction in relative biofuel competitiveness compared to fossil oil (Schmidhuber, 2007). Therefore, the final balance on the biofuel markets depends on the force of the initial effect (positive impact of growth of fossil oil price on biofuel consumed and quantities produced) in relation to that of the final induced effect (negative impact of growth of fossil oil price on biofuel consumed and quantities produced).

According to our estimates based on a model of the French crop sector supply, biodiesel would be competitive at current incorporation levels for an oil barrel price of about US$60. If the French incorporation target of 7% should only be met using French rape, the biodiesel break-even point would be US$90 per barrel. Indeed, to meet this ambitious incorporation target, domestic rapeseed production would have to be increased. This would entail a rise in rapeseed production costs (especially because of the agronomic constraints of crop rotation): the rapeseed opportunity cost, that is to say the rapeseed price that should be paid to producers in order for them to accept to provide the required rapeseed volumes, would be 330 Euros per ton (Jacquet et al., 2007).

To summarise, biofuel development could be slowed down by the rise in agricultural material prices induced by this development. This may be even more likely if the use of imports is reduced one way or another. Moreover, if public policies "mechanically" try to fill the competitiveness gap between biofuels and fossil fuels (a competitiveness gap that is an increasing function of the consumed/produced quantity of biofuels), the budgetary cost of these policies could rapidly become too high. Making incorporation compulsory would indeed reduce the budgetary cost, but to the detriment of consumers who would then have to support the economic cost of biofuel development.

By way of conclusion

EC first-generation biofuels show a very likely positive result in terms of the reduction of GHG emissions, though less positive than the first assessments of 2000 would suggest. They should also reduce EU energy dependency, but also in very modest proportions. The question is to know whether the public support to first generation biofuels is justified because they allow reduce the GHG emissions and energetic dependence (in oil) of the EU. More precisely, the question is to determine the "right" level of public support in return for these two effects, considered as desirable from a collective point of view. In this perspective, we should not forget the potentially negative environmental effects, which would arise due to changes in soil use and/or agricultural practices, with excessive consumption of water, fertilizers, and treatment products, and so on. Naturally, these effects, which are prejudicial to the environment, will be greater as the targets get higher and the use of imports limited. Let us remember that an increase in imports would only "shift the problem" if it led to deforestation in other areas of the world. This last point brings us back to the two questions regarding land availability on the planet and the yield gains to be expected from research/development to meet tomorrow's food and non-food needs.

Another point that may be put forward to justify public support to first-generation biofuels is that of the nascent. industry and the necessary apprenticeship as we await second-generation biofuels (see box). It is via the development of second-generation biofuels that the EU hopes to reach the new 10% incorporation target that has just been fixed for 2020. With this in mind, it is mainly a matter of arbitrating between support to the production of first-generation biofuels and support to research and development for second-generation biofuels. These have at least three advantages in relation to first-generation biofuels:

1) Their productivity per hectare is far greater. For a same quantity of biofuels, they require about six times less surface area: while one hectare of rape produces around 1.2 tons oil equivalent (TOE), one hectare of miscanthus could produce up to 7 tons.

2) Their effectiveness in terms of the reduction of GHG emissions is far greater. Ethanol produced from ligno-cellulose could allow a reduction of GHG emissions within a bracket of 75 to 89% and second-generation biodiesel could reduce them by 96% (JRC et al., 2007).

3) Last, they are made from more diverse farm produce grown under various pedo-climatic conditions. In particular, they may be produced from plants requiring little water. They would therefore be more interesting from the twofold point of view of the environment and land use.

Let us finish by going back to the consequences of the development of first-generation biofuels on EC agriculture and the CAP. No one can argue that this is the "shot in the arm" expected by European farmers, at least by large crop producers. Consequences for European cattle-breeders are more uncertain, medium term; one factor will have a favourable impact on stockbreeders' incomes (by-product availability, particularly in proteic cakes, at a low cost), but two factors will have a negative impact (rises in cereal and land prices). Let us not forget either the role played by the CAP in terms of domestic price stabilization. These could turn out to be more unstable in the future, in a context of increased tension on the markets. To summarise, we must be careful not to yield too quickly to the temptation of simplification by concluding that the CAP reform is now easier because prices are higher

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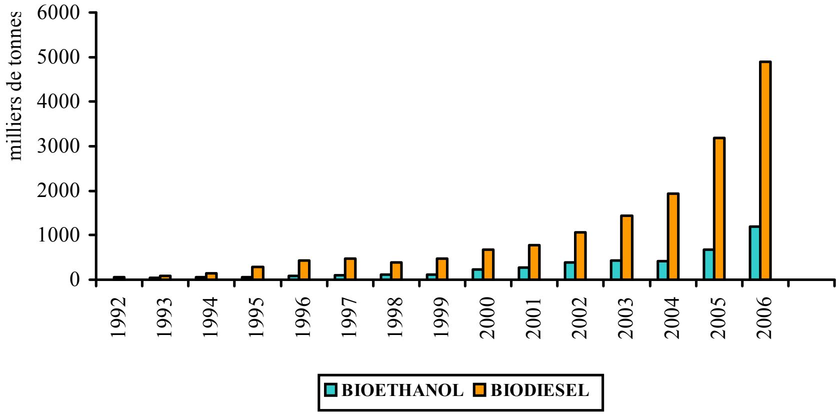
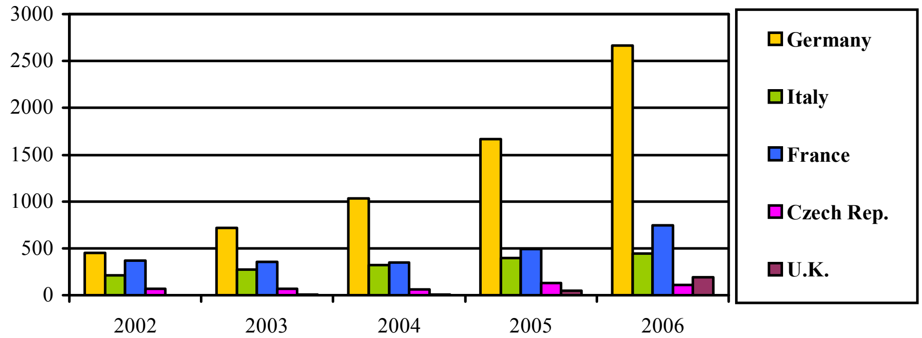
Graph 1: European Community production of bioethanol and biodiesel, 1992-2006. For EU-15- until 2004, EU-25 in 2005 and EU-27 in 2006



Source: European Biodiesel Board for biodiesel (http://www.ebb-eu.org/stats.php, consulted in July 2007) Eur'Observer, the biofuel barometer (yearly n° from 2004 to 2007) for ethanol

Graph 2: Biodiesel production in different MS (in thousand tons)



Source European Biodiesel Board, (http://www.ebb-eu.org/stats.php, consulted in July 2007)

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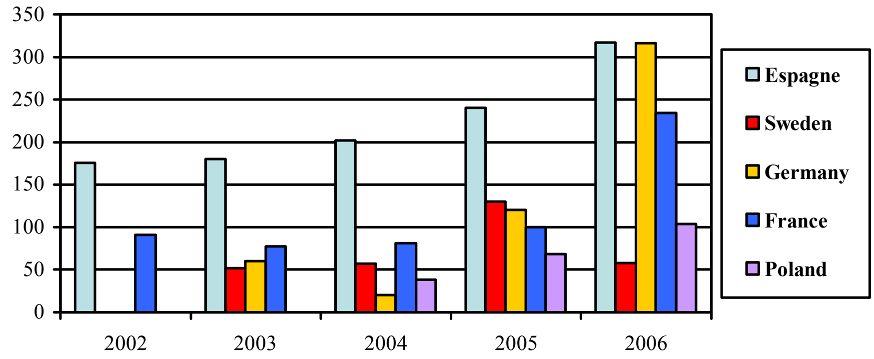
Graph 3: Ethanol production in different MS (in thousand tons)



Source: Eur'Observer, the biofuel barometer (yearly n° from 2004 to 2007)

Table 2: Reduction of biofuel GHG emissions compared to reference biofuel

	ADEME 2002 (1)	VIEWLS 2005 (2)	JRC 2007 (3)
Wheat ethanol	60%	-21 à 32%	-8 à 80%
Beet ethanol	60%	20 à73%	32 à 65 %
Rapeseed biodiesel	70%	18 à 64%	39 à 52%
Sunflower biodiesel	75%		45 à 70%
Pure rapeseed vegetable oil	78%		

(1) ADEME/PWC/DIREME (2002) : French energy results and Greenhouse gases in biofuel production chains . Technical Report, last version, November 2002.

(2) VIEWLS (2005): Environmental and Economic Performance of Biofuels.

(3) JRC Ispra, Concawe, Eucar (2007): Well-to-Wheel Analysis of Future Automotive Fuels and Power Trains in the European Context. http://ies.jrc.cec.eu.int/WTW

Box: Second-generation biofuels

Second-generation biofuels are produced by the processing of lignocellulosic biomass from farms, forests or farming and industrial waste. There are two processes of biochemical transformation, the biochemical pathway (enzymatic hydrolysis) and the thermo-chemical pathway (high temperature gasification).The farm resources that can/could be mobilized are traditional crops, the whole plant of which would be used (alfalfa, triticale and so on), or devoted crops chosen for their high production of lignocellulosic biomass per hectare (miscanthus, switchgrass, forest coppice and so on). Today these second-generation biofuels are at the experimentation stage. They are supported by many substantial public and private research funds, with the purpose of removing some technical obstacles and of lowering industrial manufacturing costs.

- With regard to the biochemical pathway, this is mainly a matter of improving the effectiveness of the enzymes used. Pilot plants exist in various MS, particularly in Sweden (ETEK), Spain (Abengoa) and Denmark.

- Regarding the thermo-chemical pathway, the technologies of biomass gasification were first focused on heat and electricity production. Production from blended gas of liquid biofuels (BtL, DME) and hydrogen was addressed only recently. Germany is the most advanced country in this pathway, with the development of vehicles using BtL and production units for this biofuel (Choren).

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