Recent Developments and Prospects for the Production of Biofuels in the EU: Can they really be "Part of The Solution"?

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Abstract: The European Union has launched an ambitious policy aiming at increasing the use of biofuels in land transport "with a view to contributing to objectives such as meeting climate change commitments, environmentally friendly security of supply and promoting renewable energy sources". Another motivation, at least for some member states, is that the development of biofuels is expected to provide larger outlets for domestic farm products and new employment opportunities in rural areas and make future adjustments of the Common agricultural policy easier. The EU policy of support to energy crops, tax exemption for biofuels and mandatory incorporation targets in some member states, has resulted in a significant increase in the demand and supply of biofuels. The market share of biofuels remains modest (1 % in 2005 in the EU-25) but has increased dramatically over the last few months. The paper provides an analysis of recent developments and prospects for the production and utilization of biofuels in the EU. Its presents the potential benefits of biofuels in the EU as well as their possible drawbacks. In particular, it addresses the three related issues of energy efficiency, environmental benefits and cost competitiveness of EU biofuels.

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Introduction

In 2003, the European Union (EU) has launched an ambitious policy aiming at increasing the use of biofuels in land transport "with a view to contributing to objectives such as meeting climate change commitments, environmentally friendly security of supply and promoting renewable energy sources" (Commission of the European Communities, 2003). The target for 2010 is that biofuels represent 5.75 % of the market for gasoline and diesel in transport. The 2003 biofuels directive also included an interim target for 2005 (2 %) and the commitment for the European Commission (EC) to provide evaluation reports on the progress made in the use of biofuels and other renewable fuels in the various Member States (MS). The 2006 biofuels progress report was issued on 10 January 2007 (Commission of the European Communities, 2007). It reviews measures implemented in the MS to promote the use of biofuels. Measures include Common Agricultural Policy (CAP) subsidies to agricultural producers to grow energy crops, financial support to investments in biofuels production facilities, tax reductions or exemptions, biofuels obligations under which companies are required to include a given percentage of biofuels in the total amount of fuel, etc. This policy, together with the rise in oil world prices that occurred over the 2003-2006 period, have resulted in a significant increase in the supply of biofuels, in particular biodiesel from rapeseed. The biofuels market share reached 1 % in 2005, that is a doubling compared to 2003 (Commission of the European Communities, 2007, Annex 1, page 15).

The situation, however, is more complex than it appears at first glance, and one should not draw quick conclusions from what has been observed over the last four years regarding the future development of the EU biofuels industry. Firstly, the 2005 biofuels market share is less that the European indicative target. Progress over the 2003-2005 period was very unequal according to the countries. Only Germany and Sweden had met the European target of 2 %, and in many countries, including countries from the EU-15 (for example, Belgium or Portugal), there was no significant increase in the use of biofuels over the 2003-2005 period. Secondly, until very recently, the expansion of biofuels has essentially taken place on land that could not be used for growing food crops, that is under mandatory set-aside provisions that are likely to be removed. Third, the energy and greenhouse gases balances of EU biofuels are increasingly appearing less positive than first evaluations suggested, and other environmental effects of EU biofuels are now being questioned. Finally, the economic costs of EU biofuels make their supply competitive only for the high oil prices observed during some months in 2006. Production subsidies and tax reductions or exemptions that have played a decisive role in the initial development of the EU biofuels production are unlikely to be sustainable for larger quantities. Their granting is not guaranteed in the future.

In most EU countries, the most energy efficient as well as cost competitive EU first-generation biofuel is biodiesel. In 2005, biodiesel achieved a share of 1.6 % of the diesel market while bioethanol achieved a share of only 0.4 % of the gasoline market. It would be thus tempting for the EU to concentrate effort on biodiesel. The biodiesel option is however questionable in a longer run perspective. It is perhaps not the most consistent strategy with the expected technical change brought by the cellulosic transformation. Future development in the cellulosic technology might rely on raw materials and geographic production areas that might be very different from those currently used in the biodiesel industry.

To sump up, European public authorities and private investors are now at a difficult crossroad for making choices regarding the production of biofuels in the EU. All the uncertainties raised above make it problematic to assess what could be the future of the EU biofuels industry. In that respect, it is symptomatic to observe that the European public opinion is increasingly critical as regards the development of biofuels in the EU and that a growing number of organizations are expressing their opposition to the incorporation targets presently discussed for 2020 (a 10 % market share).

1. The EU biofuels policy

The development of biofuels in the EU has largely been driven by incentives set up by public authorities in both the agricultural and energy sectors. Without the present set of subsidies, tax reductions and exemptions as well as mandatory incorporation rates, the EU production would certainly be much more limited. The CAP provides incentives for producing biofuels (more specifically for producing crops for an energy use). On the demand side, measures essentially aim at increasing the use of biofuels in land transport. However, because of high tariffs on imports of some biofuels and/or some raw agricultural materials used for producing biofuels, these consumption oriented measures also encourage production.

Measures developed at the farm sector level are part of the CAP. They are thus common to all MS. This is also the case of external tariffs. By contrast, most of the incentives for using biofuels are the responsibility of MS. The EU sets the objectives, mainly an incorporation rate target, but it leaves national governments free to take "appropriate measures" to meet these objectives. These measures are funded on national budgets. This explains why incentives to production and utilization of biofuels differ a lot across the EU-27 MS. This is particularly the case as far as the tax exemptions / reductions are concerned. This is also the case as far as the relative incentives for bioethanol and biodiesel are concerned: the EU legislation sets only the objectives that MS can achieve by promoting different crops and technologies.

1.1. The EU biofuels policy at the farm sector level

A set of incentives to biofuels production is thus given by the CAP. First, biofuels are encouraged by allowing farmers to grow energy crops on mandatory set-aside. Since the 1992 CAP reform, EU farmers of arable crops (grains, oilseeds and protein crops) are in effect required to set aside part of their land to qualify for CAP direct aids. Participating producers receive set-aside compensation payments. The "normal" set-aside rate is 10 % but the Council of Ministers can vary the applied rate on an annual basis.[1] The Blair House Agreement (a bilateral agreement concluded in 1992 between the EU and the United States) has limited the oilseed production for non-food use on set-aside land [2] (as well as the oilseed production for food use on non set-aside land): one estimates that this constraint restricts oilseed supply for energy purposes on set-aside land to a maximum of around 0.7 million hectares (USDA, 2005). However, following the June 2003 CAP reform and in particular the decoupling of first pillar direct aids (see below), one can reasonably consider that the EU is no longer subject to the Blair House Agreement limitations. This question is currently shelved. It could be a contentious subject between the EU and its partners in World Trade Organization (WTO) talks.

[1] The set-aside rate is 10 % for the marketing year 2006/07.
[2] Non-food uses include energy and industrial uses. Energy crops correspond to crops grown for the production of biofuels or for use as biomass in the production of electricity and thermal energy.

The June 2003 CAP reform has replaced the compensatory area payments that applied for arable crops by the so-called Single Farm Payment (SFP) mechanism. The SFP is payable to all eligible farmers independently of what products they choose to produce. Producers can even choose to produce anything at all. They however are constrained to maintain non set-aside land as well as set-aside land in good agricultural and environmental conditions. As part of this June 2003 CAP reform, an additional aid of 45 euros per hectare has been granted for growing energy crops, up to a maximum of 2 million hectares for the EU-25 (from 2007). In 2005, around 0.5 million hectares received these energy crop payments. While energy crops on (mandatory) set-aside land compete only with industrial crops, energy crops on non set-aside land compete with all other uses, that is for food, feed and industrial purposes.

1.2. The EU trade policy on biofuels

Biodiesel imports into the EU are subject to an ad-valorem duty of 6.5 %. Despite this low tariff, there is nearly no imports of biodiesel, mainly because biodiesel production outside the EU is very limited. Tariffs on vegetable oils are either nil or very low. There are some technical difficulties for using large quantities of soybean oil in biodiesel.[3] However, low percentages of soya and palm oil can be combined with rapeseed oil without particular problems. As a result, one observes an increase in EU imports of palm oil, mainly from Malaysia. The ambitious incorporation targets set by the EU might require importing significant quantities of palm oil, not only for their use for biodiesel production but also because of substitution possibilities between the various vegetable oils in food uses.

As noted by the European Commission, “there is currently no specific customs classification for bioethanol for biofuel production” and “it is not possible to establish from trade data whether or not imported alcohol is used in the fuel ethanol sector in the EU” (Commission of the European Communities, 2006). Despite this uncertainty, one can reasonably assume that the increase in EU imports of alcohol (from 1.45 million hectoliters in 1999-2001 to 2.56 million hectoliters in 2002-2004) is largely due to the bioethanol demand. Thanks to the various preferential agreements in force in the EU, in particular the EU Generalized System of Preferences (GSP) for the Least Developing Countries (the "Everything But Arms” initiative), the GSP+ granted to 14 countries including all Latin American countries except Argentina, Brazil, Chili, Paraguay and Uruguay, and the Cotonou Agreement with 77 African, Caribbean and Pacific (ACP) States, large quantities of alcohol can enter into the EU at a zero or reduced tariff: EU imports of alcohol at a reduced or zero duty increased from 1.2 million hectoliters in 2002 to 2.0 million hectoliters in 2004. With the growing number of developing countries interested in accessing the EU market under the GSP+, it is expected that these favored imports will keep growing.[4] Alcohol imports from major producers, in particular Brazil and the United States, face high Most Favored Nation (MFN) tariffs, that is 19.2 euros par hectoliter on undenatured alcohol and 10.2 euros per hectoliter on denatured alcohol. Despite this protection, EU imports from MFN suppliers are increasing (from 0.66 million hectoliters in 2002 to 1.1 million hectoliters in 2004).

[3] In the EU, the maximum iodine index is set to 120 units, a level slightly less than the one of soybean oil.

[4] It seems that ethanol is already used as a way to “jump” the tariff on sugar for some Latin American countries. The EU customs suspect that a growing quantity of sugar (normally subject to a 170 % ad valorem equivalent tariff under the MFN regime) is exported to the EU under the regime of imported inputs for processing reexporting (i.e., duty free), turned into ethanol in the EU, taken outside territorial waters and brought back to the EU.

The issue of allowing easier imports, in particular of bioethanol, divides European countries. Some countries (Portugal and Sweden for example) are highly favorable to the idea arguing that the energy and greenhouse gas balances of Brazilian ethanol are far better than the ones of EU bioethanol produced from wheat or sugar beets. Other countries (in first place France and Germany) strongly oppose the idea: clearly France and Germany play the biofuel card also with the view to supporting their own farmers.

1.3. The EU directives on biofuels

The EU targets. In 2001, the European Commission (EC) adopted a communication recognizing hydrogen, natural gas and biofuels as substitutes for fossil fuels in transport (COM(2001) 547). This communication included legal proposals so as to foster a larger use of biofuels in the EU. These proposals resulted in three directives that govern biofuels use, taxation and quality. The biofuels use directive (Council Directive 2003/30/EC) sets short- and medium-run targets for the percentage of biofuels to be incorporated into conventional fuels (2 % in 2005 and 5.75 % in 2010, this medium-run objective being satisfied by increasing the market share of biofuels by 0.75 % annually). These targets are not mandatory and hence, there is no penalty for noncompliance. The energy taxation directive (Council Directive, 2003/96/EC) which allows MS to grant tax reductions and exemptions on biofuels and the fuel quality directive were also adopted in 2003.

In December 2005, the EC presented a Biomass Action Plan (BAP) under which the EU strategy in favor of biofuels is made more explicit (COM(2005) 628). In February 2006, it presented a new communication on the EU strategy for biofuels which sets out how to take a "regulated market approach" to biofuels (COM(2006) 34). For the first time in January 2007, it has suggested binding minimum targets for biofuels. As part of the "Energy Policy for Europe" package that aims to make the EU a "low carbon" economy (by reducing Carbon Dioxide (CO2) emissions by at least 20 % in 2010 compared to 1990 levels), the EC has also indicated that the market share of biofuels in land transport fuels should account for at least 10 % by 2020.

Implementation at the MS level. The various European countries will not be subject to penalties if they do not meet the 5.75 % incorporation target in 2010. They however will have to provide justifications in case of non compliance. More precisely, they will have to report the measures undertaken to achieve compliance.[5] Today, the EC explicitly recognizes that the 2003 biofuels use directive target for 2010 will very likely not be achieved. Rather, the EC expects an incorporation rate of 4 % only (Commission of the European Communities, 2007).

In a large majority of MS, the main policy instrument to promote biofuels use in transport is the tax exemption, partial or complete. By contrast, fossil oils are generally subject to very high taxes. Tax reductions and exemptions can be unlimited (biodiesel in Germany for example) or defined for predetermined quantities (biodiesel and bioethanol in France for example). The higher the market share of biofuels, the higher the budgetary cost of these incentive policies. As a result, command-and control measures that imposes a mandatory percentage of biofuels incorporation without providing the economic incentives are emerging. In most cases, command and control as well as incentive measures are used simultaneously

[5] In practice, each MS shall report annually from 2005 to 2010 the measures undertaken to meet compliance with the growing objective of incorporation, from 2 % in 2005 to 5.75 % in 2010.

(either for a transition period - case of the United Kingdom – or without time limit – case of France). Box 1 below details the national policy instruments used in some MS.

Box 1. National biofuels policies

France has set a biofuels incorporation target of 7 % in 2010. In order to achieve this ambitious target (more ambitious than the EU recommendation), the French government has combined fiscal incentives with penalties for not complying. The first instrument is a tax reduction of the domestic tax applied on fossil fuels used in land transport (in French, Taxe Intérieure sur les Produits Pétroliers or TIPP). Tax cuts are granted for specific quantities, auctioned to companies at the EU wide level. They can be revised annually according to price levels of petroleum products on the one hand, agricultural raw materials on the other hand. In addition, wholesalers selling petroleum products are subject to another tax, i.e., the General Tax on Polluting Activities (In French, Taxe Générale sur les Activités Polluantes or TGAP). They can avoid paying this second tax by incorporating a certain percentage of biofuels. Tax rates increase over time in line with the increase in the incorporation target up to 7 % in 2010. These measures result in a high penalty for a seller of transportation fuel that would not include any biofuel, therefore providing them a strong incentive to do so and pass through the extra cost to the final consumer. This has recently turned the main French consumers' organization against the whole biofuels policy (UFC, 2007).

Sweden is one of the MS which promotes the most the use of biofuels (essentially under the form of bioethanol). This emphasis on biofuels use rather than production suggests that motivations of the Swedish government are more connected to environmental concerns than to farm support. This contrasts with France which strongly opposes importing larger quantities of biofuels or raw agricultural materials that could be used for producing biofuels. In other words, efforts on the biofuels dossier are in France for a large part, if not essentially, motivated by the farm support objective. Sweden has imported ethanol tax free from Brazil using some loopholes in EU tariffs linked to ambiguities in alcohol denomination and classification. This was ended in the beginning of 2006 following pressures from EU agricultural producers. The incorporation target for 2010 is 5.75 % but the interim indicative target for 2005 (3 %) was higher than the EC recommendation (2 %). Since April 2006, the largest gas pump must supply either ethanol of biogas. The obligation will be extended to medium gas stations in 2009. In addition, some imported biofuels, that is the ones subject to high tariffs, are exempted from domestic taxes on fuels. Flex-fuel cars are also exempted from specific fees, for example urban taxes in Stockholm.

Germany is the sole country which met the 2005 target with a biofuels market share of 3.8 %. This is the result of an ambitious tax exemption plan initially implemented without quantitative limits. However, from August 2008, the German government went back to a limited exemption tax (tax of €0.15 per liter of biodiesel if mixed with gas oil and €0.1 if used pure). Bioethanol is so far exempted from excise duty (63€/hl). Germany has decided to implement a mandatory incorporation of 6.75% in transport fuel by 2010.

Since January 1 2007***, the Netherlands*** have established a mandatory incorporation target for biofuels of 2 %. This target is bound to reach 5.75 % in 2010. 2007 is the first year where tax exemptions kick in. However, the Dutch government wishes to implement an environmental certification before promoting further the use of biofuels because of concerns raised by various organizations as regards the negative consequences of biofuels expansion in third countries (deforestation).

The United Kingdom (UK) is now giving priority to mandatory incorporation under the Renewable Transport Fuel Obligation (RTFO). If retailers of petroleum products do not include a given rate of biofuels in transport fuels, they will have to pay a penalty (buy-out price) of 0,15£/l (i.e., roughly 0,23 €/l). Tax exemptions will be maintained until 2010/11: together with the buy-out price mechanism, they will provide a level of support of 0,35£/l (0,52 €/l). From 2010/11, tax exemptions will be removed and replaced by mandatory incorporation for a slightly lower level of support (0,30£/l, i.e., 0,45 €/l). The UK points out that the EU incorporation target of 5.75 % in 2010 will be excessively costly if achieved through subsidies and tax exemptions / reductions. Unsurprisingly and unlike many other European countries, the UK is vigilant to comply with the spirit of the 2003 directives on biofuels stating that there should not be overcompensation for the costs of using biofuels. The UK has officially announced that it will very likely not achieved the 2010 incorporation target of 5.75 %. Simultaneously, it has also announced supplementary measures to increase incorporation of biofuels (accelerated depreciation rules for biofuels plants and support to distribution infrastructures of ethanol mixed gasoline).

1.4. The motivations of the EU biofuels policy

EU authorities invoke several motives to justify and legitimate public support to biofuels. Climate change is one of these motives.

Environment. The EU has been much more active than many other developed countries in implementing the constraining provisions of the Kyoto protocol. Even though the overall balance is unevenly distributed across MS, significant reductions in GreenHouse Gas (GHG) emissions have already been obtained in some European countries, for example in the United Kingdom, thanks to political willingness.[6] In that context, biofuels are presented as a significant instrument of the EU strategy to reduce GHG emissions. Nevertheless, the biofuels contribution to the fight against GHG emissions will undoubtedly remain modest (at least as far as first generation biofuels are concerned). According to the more recent proposals of the EC (see section 1.3), biofuels could replace 10 % of fossil fuels used in the transport sector by 2020. Knowing that the transport sector accounts for "only" 25 to 30 % of GHG emissions and that the assessment in terms of GHG emissions of first generation biofuels relative to fossil fuels is limited, the effect of biofuels on EU GHG emissions will be small, less than 1 % of total EU GHG emissions (our estimates). Of course, any contribution, even marginal, to the Kyoto Protocol objectives is welcome. But the costs of the GHG emission reduction induced by an increasing use of biofuels should be counted against alternatives offered by the Kyoto Protocol, including the Clean Development Mechanism. In that perspective, until recently, the price of traded carbon emission rights provided a useful benchmark for stakeholders involved in the biofuels industry (as well as for public authorities). The recent collapse of this price, due to a very generous allocation of emission rights, makes the assessment more difficult. This episode is unlikely to increase incentives to boost investment in biofuels.

Energy. The development of biofuels is also motivated by the concern of reducing dependence on EU energy suppliers given the threats of supply cut by Russia and the ongoing uncertainties in the Middle East. Today, the EU depends on imports for half of its energy needs. According to current trends, the dependence should increase in the next years to reach 65 % in 2030 (Fischer Boel, 2007). However, according to the EC analysis, the EU biofuels policy if fully implemented and respected might help saving only 3 % of imported fossil oil (COM(2006) 34). Even if this marginal contribution will be welcome, it cannot alone justify the EU biofuels strategy, notably tax exemptions or reductions. Importing (very) large amounts of biofuels would allow the EU to diversify energy sources and reduce dependence on a handful of suppliers, but not to gain more self-sufficiency in terms of energy needs.

The CAP. Behind the Commission's policy promoting biofuels, and more perhaps behind that of some MS, is the objective of providing larger outlets and employment to the farm in a context where exports subsidies have been significantly cut, reducing substantially foreign market access, and considerable adjustments have been asked to European farmers during 15 years of almost permanent reform. The farm sector represents a few points only of the EU-27 Gross Domestic Product (GDP), roughly 3 %. However, it remains a major economic sector in some countries, not only in new MS (the percentage of population employed in the farm sector is 30 % in Romania and 16 % in Poland) but also in some MS of the South of the EU-

[6] However, as noted by the agriculture Commissioner Mariann Fischer Boel herself, "as they currently stand, EU CO2 emissions would increase by around 5 % by 2030." (Fischer Boel, Conference at Carnegie Bank, Copenhagen, 12 January 2007).

15 (more than 10 % of the population is employed in the farm sector in Greece and Portugal). Even in Northern Europe where the share of population in farming is only a few points of percentage, the sector still occupies a large part of land. In several regions, the first transformation food industry which is closely linked to agricultural activity represents a large share of the whole industrial activity (Schmitt et al., 2002). Analyses at a regional level of domestic reform and trade liberalization scenarios suggest that these regions are the areas where the negative impacts would be the highest and the economic prospects the less favorable (Jean and Laborde, 2007). In addition, the future leaves little hope for an ambitious CAP. Income support decoupled payments will very likely be reduced. At best, they will be reoriented towards environmental and territorial objectives within a constant budget. More probably, there will be a significant reduction in the total agricultural envelope for reassignment on other EU priorities after 2013, if not before. Lastly, the multilateral agricultural negotiations of the Doha Round should result in an increased access to the EU market for foreign competitors. This larger openness of the EU agricultural market should more particularly affect the cattle-rearing areas and the livestock products, but also some cereals (barley and corn) as well as sugar beets. All these evolutions should result in reductions in European agricultural production. In that context, biofuels are seen as offering more favorable economic prospects to EU farmers. Incidentally, biofuels would also make more acceptable by EU farmers future adjustments of the CAP, agricultural budget cuts and/or an agricultural agreement within the WTO.

2. Demand and supply of biofuels in the EU

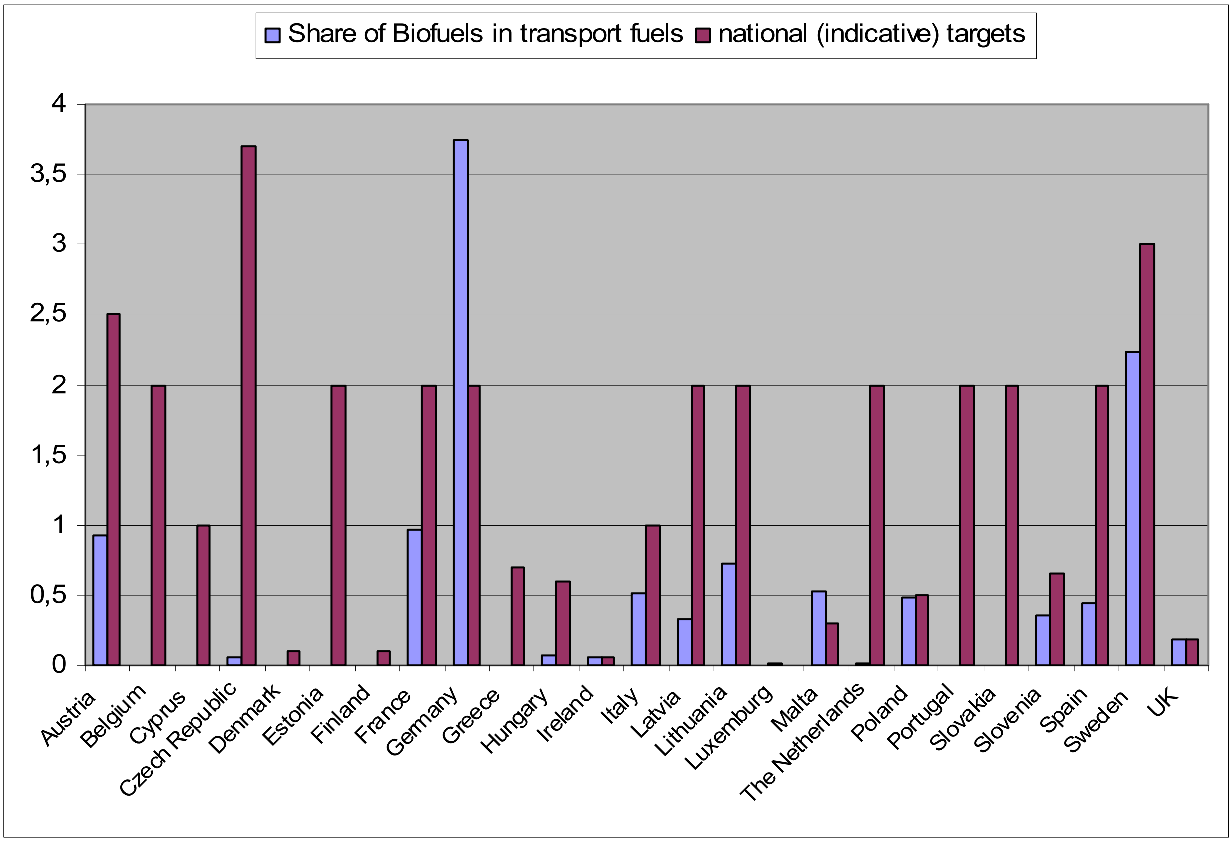
2.1. The use of biofuels in the EU

The previous section shows that the development of biofuels production and consumption in the EU is the result of a voluntary European policy. This policy leaves MS considerable flexibility in terms of instruments that can be implemented. It also shows that the various MS have variable ambition levels in this area. This is illustrated by Figure 2.1 which shows that many European countries had set national incorporation targets for 2005 lower than the biofuels use directive objective for that date (2 %). In practice, only 10 countries of the EU-25 had set their 2005 national targets at 2 % while 3 countries had established higher national objectives (2.5 % in Austria, 3.7 % in the Czech Republic and 3.0 % in Sweden). In addition, even in countries with a 2005 target of 2 %, the biofuels market share at that date was generally much lower (0 % in Belgium, Estonia and Portugal, 0.02 % in the Netherlands, 0.44 % in Spain, etc.). Germany (3.7 %) and Sweden (2.2 %) were indeed the only two countries that had exceeded the incorporation rate of 2 % in 2005. Overall, biofuels only accounted for 1 % of the transport fuel market in the EU in 2005, that is half of the reference amount of 2 % (Figure 2.1).

Fourteen MS have set their national indicative targets to 5.75 % for 2010, one country (France) being even more ambitious with a target of 7 %. However, four countries have set lower objectives (the Czech Republic, Italy, Slovenia and the UK) and six counties have not established incorporation objectives for 2010 (Cyprus, Denmark, Finland, Hungary, Malta and Spain). Globally, if the 19 MS that have set objectives for 2010 reach their targets, biofuels should account for 5.45 % of the EU transport fuel market at the end of the decade.

Most commentators however, including the EC, consider that the EU will be unlikely to reach a substitution rate of 5.45 % by 2010.[7]

Figure 2.1. Share of biofuels in transportation fuel (left hand bar) and national (indicative) targets (right hand bar) in 2005



At this stage, two points should be emphasized. First, the situation is changing rapidly. Over the last few months, several MS have managed to increase dramatically, in a very short period, their biofuels consumption. Austria, Latvia, Lithuania, Slovenia and the UK are examples. Let us consider the case of Austria: after introducing a mandatory incorporation rate of 2.5 % in October 2005, the biofuels market share in this country has increased from practically 0 % in 2004 and in the beginning of 2005 to 3.2 % today. Second, it is noteworthy that the higher use of biofuels in 2005 (in percentage terms) is found in Germany and Sweden (see Figure 2.1). This success is clearly the result of the generous tax exemption policy in place in these countries that have encouraged the use of biofuels under different forms (pure or mixed), without quantitative ceilings. It also reflects the fact that both Germany and Sweden have a biofuels policy more oriented towards biofuels use rather than production. In practice, they have had a rather open attitude regarding using imported biofuels, with Sweden even taking some liberties with the EU tariff structure to import sugarcane ethanol from Brazil – see Box 1 – Germany importing biofuels from other EU countries. The fact that the

[7] The EC estimates that the incorporation rate in 2010 will be closer than 4 % than the planned 5.75 % (Commission of the European Communities, 2007). Other observers are much more pessimistic with a biofuels market share in 2016 as low as 2.2 % for J. Fabiosa, technical director of the Food and Agriculture Policy Research Institute (FAPRI) at Iowa State University (quoted in Agra Europe (London), December 1, 2006).

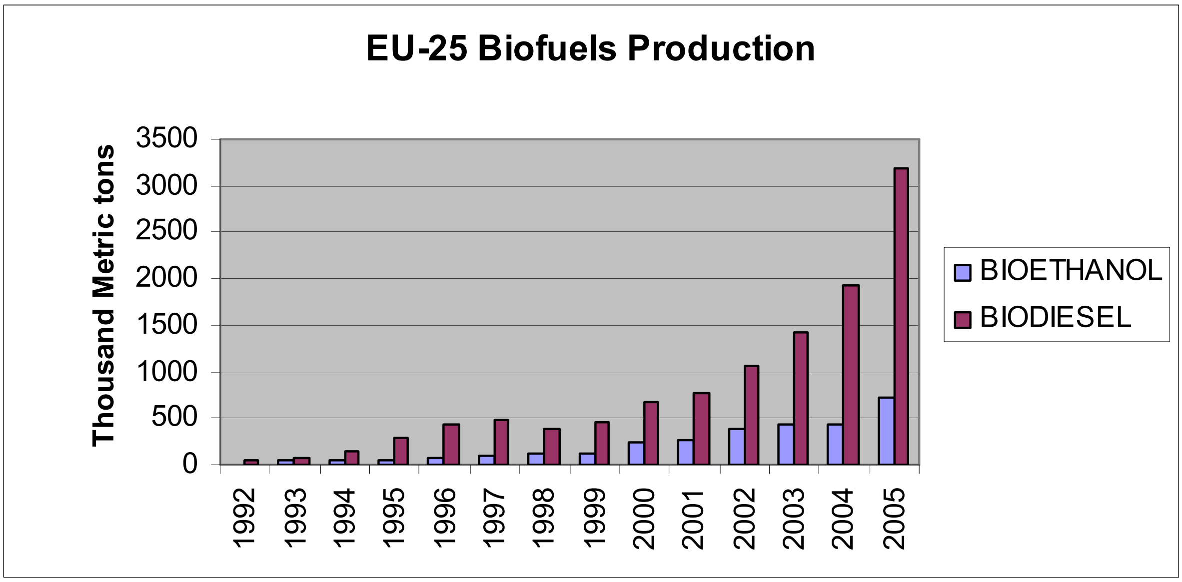
only countries that have met the target set by the EU for 2005 are also the ones that have most imported biofuels suggests that ambitious incorporation objectives may be difficult to reach with local production unless devoting considerable resource to support the latter. In that context, it is unclear whether a country like France, which has set a 2010 target more ambitious that the EU recommendation while trying to achieve this objective essentially thanks to a domestic production (Ministère de l'Agriculture et de la Pêche, 2007), will be able to do so (even though France has a larger agricultural potential than many other MS).

2.2. The production of biofuels in the EU

Biodiesel rather than ethanol. Many MS see advantages to local production of biofuels, in terms of outlets for their farm sector and/or as a way to reduce dependence on foreign energy sources. Liquid biofuels in the EU-25 amounted to around 4000 ktoe in 2005 (around 1.4 % of the market). Production growth has been particularly marked from 2003 (see Figure 2.2).

Biofuels production in the EU is strongly oriented towards biodiesel. In the EU-25, total fuel consumption in transport is shared between diesel (55 %) and gasoline (45 %). However, the incorporation of bioethanol in gasoline is only 0.4 % while the incorporation of biodiesel in diesel reaches 1.6 %. This unbalanced utilization of bioethanol and biodiesel reflects the supply structure since roughly 80 % of the biofuels domestically produced are biodiesel. EU production of bioethanol has not experienced a development similar to what has been observed in other countries, more specifically Brazil and the United States. Brazil is the world's leader of bioethanol production for more than 25 years with a production of about 16 billion liters in 2004. Brazil is also the world's leader of bioethanol consumption. Bioethanol production growth is more recent in the United States (from 4 billion liter in 1996 to 14 billion liter in 2004). While the EU is a very minor supplier of bioethanol, it is by far the world's leader of biodiesel. In 2004, world production of biodiesel was more than 2 billion liters. More than 90 % of this quantity was produced in the EU-25 (Biofuels Research Advisory Council, 2006). Figure 2.2 shows the contrasting evolution of bioethanol and biodiesel supply in the EU.

Figure 2.2. Biofuels production in the EU



EU biodiesel production is concentrated in three Member States. Biodiesel production started in the aftermath of the 1992 CAP reform essentially on set-aside land (see Subsection 1.1). Production was very modest in 1992 (55 000 tons). It was multiplied by 20 over the 10-year period 1992-2002. Production in tons has increased dramatically since 2003 (see Figure 2.2).

Table 2.1. presents the evolution of biodiesel production in the various MS over the 2002-05 period together with the production capacity evolution built by the latter. Supply is highly concentrated, three countries (Germany, Italy and France) accounted for more than 80 % of quantities in 2005. Germany is by far the EU leader (52 % of EU-25 production in 2005). Growth has been particularly marked in this country (from 0.45 million metric tons in 2002 to 1.7 million metric tons in 2005) thanks to the 100 % tax exemption on pure biodiesel. This country has today more than 1 500 fuelling stations selling pure biodiesel (Biofuels Research Advisory Council, 2006) and the 2006 production capacity is 2.6 million metric tons. France is the second producer (492 000 metric tons in 2005) and Italy the third (396 000 tons in 2005). French biodiesel production has increased by more than 140 000 metric tons between 2004 and 2005 essentially as a result of tax exemptions that have taken place on larger contingents. One can reasonably expect that the 2006 figure will be higher as a result of the increase in French production capacity, from 532 000 metric tons in 2005 to 775 000 metric tons in 2006. At the EU level, production capacity has been multiplied by 2.7 in two years, from 2.2 million metric tons in 2004 to 6.1 million metric tons in 2006. This has occurred not only in the three "traditional" suppliers but also in newcomers, notably in the UK, Spain, Portugal, Lithuania and Poland).

Table 2.1. Biodiesel production in the UE-25 (1000 metric tons)

	Production				**Production capacity**		
	2002	**2003**	**2004**	**2005**	**2004**	**2005**	**2006**
Germany	450	715	1035	1669	1088	1903	2681
Italy	210	273	320	396	419	827	857
France	366	357	348	492	502	532	775
Czech Rep.	69	70	60	133		188	203
UK	3	9	9	51	15	129	445
Spain		6	13	73	70	100	224
Austria	25	32	57	85	100	125	134
Denmark	10	41	70	71	44	81	81
Portugal				1		6	146
Sweden	1	1	1.4	1	8	12	52
Slovakia			15	78		89	89
Poland				100		100	150
Lithuania			5	7		100	150
Slovenia				8		17	17
Estonia				7		10	20
Other countries				12		15	45
Total UE-25	**1134**	**1504**	**1933**	**3184**	**2246**	**4228**	**6069**

Source: EurObserv'ER (Biofuel Barometer) for production and European Biodiesel Board for capacities

EU bioethanol. Spain is the main producer but other Member States are entering the market. Even though the EU is a marginal player at the world level, European bioethanol production has increased over the recent years reaching 720 000 metric tons in 2005, to be compared to 200 000 metric tons of imports. With the noticeable exception of Sweden, bioethanol is generally not used pure in the EU but processed into Ethyl Tertiary Butyl Ether (ETBE) as an additive to gasoline. Although there are no official statistics, the European Fuel Oxygenates Association estimates that there were some 2 million tons of ETBE produced in the EU in 2005.[8]

Spain is the main EU producer (240 000 metric tons in 2005), but other suppliers are progressively entering the market (Sweden, Germany, France, Poland). This development of bioethanol production in several MS can be linked to the political willingness and in particular, to tax exemption or reduction schemes which offset some rather high production costs. Spain is a good example as bioethanol is fully exempted, without quantitative limits, in this country. The 2006 figures should show a further increase in the Spanish bioethanol production thanks to a new plant adding 160 000 tons to the production capacity of 2005 (346 000 tons). Sweden is the second European producer of bioethanol (130 000 metric tons in 2005), followed by Germany (120 000 metric tons) and France (100 000 metric tons). The 2006 figures should exhibit a significant increase in the French production with larger contingents benefiting from tax exemptions (for a total of 785 000 metric tons) and the building of new plants. Overall, EU-25 bioethanol production capacity was estimated to 1.204 million tons in 2005, i.e., 66 % in excess relative to effective production at that date (EuObserv'ER, 2006).

Table 2.2. Bioethanol production in the EU-25 (1000 metric tons)

	2002	2003	2004	2005
Spain	176	160	202	240
Sweden		52	57	130
Germany		60	20	120
France	91	82	81	100
Poland		60	38	68
Finland			4	37
Hungary				12
Netherlands			11	6
Lithuania				6
Other countries			10	3
Total EU-25	**383**	**424**	**423**	**722**

Source: EurObserv'ER (Biofuel Barometer)

3. Impacts of biofuels on EU agriculture

3.1. Biofuels and EU agricultural production

The EU-25 biodiesel supply relies almost exclusively (95%) on rapeseed oil, the remaining 5% being produced from imported palm or soybean oil. The rapid and important development of biodiesel production since 2002 has resulted in a huge increase in domestic rapeseed oil utilization (from 4.1 million tons in 2002/03 to 6.6 million tons in 2005/06, and preliminary figures suggest a utilization around 7.2 million tons for 2006/07). This increase in rapeseed oil utilization has been caused uniquely by the biodiesel demand since the food demand of

[8] Poland experienced a decrease in 2004 relative to 2003 because the Polish Parliament finally decided not to ratify the 2003 energy bill which would have offer full tax exemption. Tax exemptions in Poland are now decided on an annual basis (Eikeland, 2006)

rapeseed oil has been constant over the last five years. For the first time in 2005/06, non-food uses of rapeseed oil have exceeded food uses. In 2006/07, biodiesel will represent 64 % of rapeseed oil total uses (Table 3.1).

A very large part of the rapeseed oil consumed in the EU is also produced in the EU. However, this was not the case in the 1990s. At that time, the EU was a major exporter of rapeseed oil (there were no imports). Progressively, exports have gone down while imports have increased. The EU is now a net importer of rapeseed oil (0.57 million tons in 2006/07) while exports are quasi null (0.06 million tons in 2006/07). The increase in rapeseed oil utilization (and imports) coincides with an increase in rapeseed domestic production: the latter was equal to 11.8 million tons in 2002/03; it is equal to 15.9 million tons in 2006/07.[9]

Bioethanol in the EU is essentially produced from wheat and to a lesser extent sugar beet (production from corn is marginal). Bioethanol is still a very minor outlet for EU cereals (more specifically wheat) since it represents less than 1 % of end uses of the latter. However, the trend is positive, from 0.5 million tons in 2004 to 1.9 million tons in 2006, in line with the development of the EU bioethanol supply. According to the EC (2007), about 1 million tons of white sugar equivalent was processed into bioethanol in 2005, that is 5 % of total domestic consumption. Sugar used for bioethanol is today only slightly less than gross sugar exports (1.3 million tons in 2006).

Table 3.1. Utilization of rapeseed oil in the EU-25 (million metric tons)

Marketing year	Total utilization	Biodiesel	Food
2002/03	4.14	1.45	2.69
2003/04	4.38	1.77	2.61
2004/05	5.37	2.70	2 .67
2005/06	6.60	3.98	2.62
2006/07*	7.24*	4.65*	2.59

*Preliminary. Source: Oil World (2006)

3.2. Biofuels and agricultural land use in the EU

The main impact of biofuels on agricultural land use in the EU is linked to the increase in rapeseed production (see Subsection 3.1). Part of rapeseed production takes place on set-aside land. Total set-aside land in the UE-25 was equal to 7.2 million hectares in 2006, more specifically 4.0 million hectares in mandatory set aside and 3.2 million hectares in voluntary set aside. On the 4.0 million hectares in mandatory set aside, one can estimate that between 700 000 and 800 000 hectares were devoted to energy crops, essentially rapeseed. In other words, the Blair House Agreement constraint that limits oilseed supply on set-aside land (see Subsection 1.1) would be binding. Our estimate is that roughly 2.5 million hectares of rapeseed (on a total of 4.75 million hectares) were devoted to biodiesel in 2005. This means that more that 50 % of the acreage grown in rapeseed was devoted to biodiesel in 2005. This also means that energy rapeseed grown on set-aside land (between 700 000 and 800 000 hectares) has represented only a minor component of the overall production of energy rapeseed.

[9] Tables A.3 and A.4 in the Appendix present the balance sheets for rapeseed oil and rapeseed, respectively.

3.3. Competition between food and non-food use

Even though biofuels represent today at best 1.5 % of transportation fuel in the EU-25, they already have had an impact on domestic agricultural product prices, essentially on rapeseed oil and cake prices. It is of course difficult to isolate this “EU biofuel effect” from other forces driving market prices, notably the CAP reform of June 2003, supply and demand conditions worldwide and fossil oil price variations. However, it is noteworthy that the (domestic) prices of rapeseed oil and cake have been significantly altered in comparison with those of other oilseeds that have not faced the same demand for transformation in biodiesel: while rapeseed oil prices have increased those of rapeseed cakes have decreased (Dronne and Gohin, 2006).

This suggests that reaching the 5.75 % incorporation target, *a fortiori* the 10 % target presently suggested by the EC (2007), would have significant impacts on EU agricultural prices, notably the prices of cereals and oilseeds. To meet the 5.75 % objective, a significant share of the surface devoted to arable crops would need to be diverted towards biofuels production. EU exports of cereals (essentially wheat) would decrease while imports of vegetable oils would increase. Domestic prices of cereals and vegetable oils would increase while domestic prices of protein cakes would decrease. The livestock sector would be affected, first through an increased competition in terms of land use, second through feed price changes (increased price for cereals and decreased price for protein cakes as well as for byproducts generated by bioethanol production). In section 5, we provide more elements on these points using micro-economic simulation models while Gohin (2007), for example, provides an assessment using a macro-economic simulation approach. In this subsection, we provide an estimate of the acreage that would be needed to devote to energy crops in order to meet the 5.75 % target. This estimate assumes that the incorporation objective is achieved without imports (of biofuels or agricultural raw materials for use to produce biofuels). As a result, the estimate presented below can be considered as an upper bound of the acreage that would be needed to meet the 5.75 % incorporation target. This acreage need estimate has been obtained as follows (details of results are presented in Table 3.2).

Total fuel consumption in EU-25 land transport is 300 million tons of petrol equivalent, shared between diesel (55 %) and gasoline (45 %). Assuming that the 5.75 % objective is fulfilled for both biodiesel (as a substitute for conventional diesel) and bioethanol (as a substitute for gasoline), biodiesel and bioethanol productions are estimated to 10.6 and 9.1 million tons, respectively.[10]

Under the assumption that the biodiesel production of 10.6 million tons would be obtained for 90 % from rapeseed and for 10 % from sunflower, rapeseed and sunflower productions are estimated to 23.4 and 2.5 million tons, respectively. Assuming rapeseed yields of 3.6 tons per hectare, the required rapeseed production would occupy about 6.6 million hectares. In the same way, assuming sunflower yields of 1.8 tons per hectare, the required sunflower production would occupy about 1.4 million hectares. In total, the acreage in energy oilseeds would thus be equal to 8 million hectares, i.e., more than the total acreage currently devoted to oilseeds in the EU-25 (7.3 million hectares).

We proceed in a similar way for bioethanol. It is obtained from wheat (80 %) and sugar beet (20 %). Under this assumption, the required bioethanol production of 9.1 million tons would

[10] We assume that ethanol would be used entirely under the form of ETBE. Of course, our calculations take account of the lower heating values of biofuels compared to fossil fuels.

occupy 4.6 million hectares of wheat (with wheat yields of 5.6 tons per hectare) and 0.4 million hectares of sugar beet (with sugar beet yields of 54 tons per hectare).

If the EU chose to rely on its own domestic production only, satisfying the 5.75 % incorporation target would require a considerable amount of land, i.e., roughly 13 million hectares or approximately 20 % of the current arable land surface in the EU. It is hard to imagine that this would only have a minor impact on market equilibria and prices. Without even mentioning the possible unwanted effects in terms of intensification of agriculture or conservation programs, this suggests that the 10 % target proposed by Commissioner Fisher Boel would be difficult to reach with the current technology unless relying on significant imports.

Table 3.2. Acreage requirements for the 5.75 % target compliance in the EU-25

Biofuel production required to meet the target	
Total fuel consumption	300 million toep
Target	5.75 %
biodiesel target equivalent	9.49 million toep
bioethanol target equivalent	7.76 million toep
Acreage requirements	
Biodiesel production	10.62 million tons
Rapeseed production	23.89 million tons
Rapeseed acreage requirement	**6.63 million ha**
Sunflower production	2.55 million tons
Sunflower acreage requirement	**1.42 million ha**
Bioethanol production	9.05 million tons
Wheat production	25.35 million tons
Wheat acreage requirement	**4.56 million ha**
Sugar beet production	23 million tons
Sugar beet acreage requirement	**0.43 million ha**

Source: authors' estimates

4. How far can the EU public support to biofuels go?

The large increase in biofuel production in the EU can largely be explained by the political will, which has resulted in either a large degree of subsidization (through tax exemptions). While the development of both the consumption and the production of biofuels has been impressive in relative growth, the overall use hardly exceeded 1 percent of transportation fuels in 2005, while it already had a significant impact on markets, driving up the price of rapeseed oil, for example. Even which such limited use of biofuels, the costs for member states budgets have become significant, so that several countries are moving towards less tax exemptions and more constraining targets for mandatory incorporation of biofuels in transportation fuels. However, such a policy ends up passing significant costs to the final consumers, who have already expressed their discontent (UFC, 2007).

If the use of biofuel grows and reaches the EU target of 5.75 % in 2010, and the possible new target of 10 % in 2020, clearly the cost of the public support will become more apparent. One may consider that, for much larger quantities of biofuels used in the EU, there is a need to keep public support consistent with major market forces, or at least with the valuation of the actual positive externalities. More practically, either biofuels will have to compete with fossil fuels in terms of cost (either by reducing the production costs of biofuels or because oil prices will be higher). Or the subsidies should be in line with what can be considered as a reasonable price of the GHG emission avoided. This raises several questions about which there is still a considerable degree of uncertainty in the EU. The first one is the extent of the actual positive externalities as far as GHG emissions are concerned. The second one is the actual degree of competitiveness of the EU biofuels, compared to fossil fuel and biofuel produced in other countries. All these elements play a crucial role in the cost benefit analysis of the EU program.

4.1. Energy efficiency

The issue of the energy balance of the EU biofuels is a matter of considerable controversy. For a long time, the debates have been confined to a rather academic and industry audience. During the year 2006, however, many stakeholders, including environmental organizations, farmers' unions and the media have shown a considerable interest in the matter, leading to a very lively debate in the EU. Indeed, many figures regarding the actual energy balance have circulated, ranging from very positive figures to slightly negative ones.

Some of the differences in the results can be explained by the different concepts used. Because of the large use of nuclear electricity in some countries, the fact of counting all energy or only oil and gas when counting the fossil fuel used and saved by biofuel matters. Many differences come from assumption on the agricultural technology (yields, the use of irrigation or not, etc.) and the efficiency in the production of inputs, such as fertilizers and the processing techniques that lead to biofuels themselves.

However, a close look at the different studies shows that a large share of the differences can be explained by the valorization of co-products. The production of biofuel results in joint outputs, some good ones and some “bad” ones. Some authors tend to allocate the energy consumed to produce this set of joint outputs to the whole set of co-products, using a particular allocation rule. Others use different allocation rules, or consider even than some of the byproducts that some authors have considered as "goods" are "bads" (and therefore should not be counted as using valuable energy for their production). The status of a byproduct can even shift from "good" to "bad" depending on the quantity produced, if there is little use beyond a given threshold. This has led different authors to value differently, say the glycerin produced, the CO2 produced (which can be used for example in the soft drink industry, but only to a certain extent), or even the cake produced, in a vary different way, and to allocate a different share of the energy consumed in producing the set of biofuel and co-products. Studies that find the most favorable energy balance in the production of ethanol or biodiesel in the EU are often those that consider as legitimate to affect a significant share of the energy inputs to co-products, and that consider that there are profitable outlets for pulps and must. They sometimes understate the technical difficulty of increasing the dry matter content of these products for transportation, or the cost of disposing or spreading the whole material, say as fertilizer.

As in every technology characterized by jointness, the allocation of inputs to the various inputs is hardly satisfactory. Results appear to differ a lot between the studies that use an ad hoc convention to allocate the fossil fuel consumed in the whole process to the different co-products (e.g. proportionality to the weight of the different co-products) and those that use a more systemic approach relying on counterfactual scenarios. In the latter case, which is recommended by many authors and has been used in the most recent studies, one affects to the co-products the fossil energy required to produce the goods that these co-products will replace (for example rapeseed cake from biodiesel production might replace soybean cake used in livestock production). With this method costs are imputed to the whole production of biofuel, but the energy saved is estimated by a counterfactual scenario on the utilization of the co-products. This method provides a better image of the insertion of the biofuel in the economic system, but may rely on fragile data. One may also go beyond this systemic approach and work with economic models that include the changes in the farming system and the energy market in a very detailed way so as to assess all the changes brought about by the policy of supporting biofuels.

It appears that studies relying on the systemic approaches tend to result in a less favorable balance for the production and use of biofuels than the ones that use a proportional allocation of the inputs to all co-products. Some studies have recently found some very low, and sometimes negative balances with EU bio-ethanol production, and in particular the one use as ETBE, which is currently the main use of bioethanol in the EU (RAC-F, 2006).

Overall, most studies find that the EU production of bioethanol has a rather limited energy balance, with 1.3. ratio of fossil energy equivalent produced for one consumed, both in the sugar beet case and the wheat case, and even less for ethanol produced for corn. That is, the saving in fossil fuel by using ethanol would be only 30 percent, once all the fossil fuel used to produce it saved by and using it and its co-products has been accounted for. The analyses that use the weight based allocation of fossil energy costs to all co-products give higher efficiency ratios.

Regarding biodiesel the differences between the different methods are much lower, and the findings more consistent. Most studies show an energy balance much more favorable than in the case of ethanol, with between 2.5 and 3 units of fossil fuel saved for 1 used, the lower estimates being around 1.7. However, it is noteworthy that the crops used for biodiesel (rapeseed and sunflower) have much lower per hectare yields than the ones used for ethanol. That is, while requiring less fossil fuel, biodiesel requires much more land. This is likely to strengthen the use problem of the competition between food and energy products for land.

4.2. Environmental benefits

The differences between studies regarding the energy balance result in significant differences in the overall assessment of the positive externalities of EU biofuels regarding GHG. Table 4.1. provides an estimate of the findings of the main studies on the EU.

Table 4.1. Reduction in GHG emissions compared with fossil fuel emissions (percentage reduction if positive)

Source of the study	Year of the study	Bioethanol from sugar beets	Bioethanol from grains	Biodiesel from rapeseed

RAC-F	2006	Positive (44%)	Positive (24% to 48%)	Positive (74%)
WTW	2005	Positive (37%-44%)	From Negative (minus 6%) to positive (+43%)	Positive (16% to 62%)
VIEWLS	2005	Positive (20% to 73%)	From negative (minus 21%) to positive (32%)	Positive (18% to 64%)
Imperial College	*2004*	*From negative (minus 11%) to Positive (63%)*	*Positive (5% to 68%)*	*Positive (48% to 80%)*
IEA	2004	Positive, 40%	Positive, (18% to 46%)	Positive (43% to 63%)
Mortimer et al (Sheffield Hallam University)	2002	*Positive (47% to 54%)**	*Positive (62% ot 67%)**	Positive (54%)
ADEME/Price Waterhouse Cooper	2002	Positive (75%)	Positive (75%)	Positive (74%)

Note: the figures in italics are quotations from the Table 5.2.1 of the impact assessment by the EU Commission (European Commission, 2006c), we did not access the primary source. The RAC-F, INRA and ADEME study refer to France. References of the studies in the list at the end of the paper.

Overall, it is therefore difficult to have reliable estimates of the reduction in GHG emissions. Following the most recent studies, both on the EU biofuels and those produced in other countries, there seems to be a consensus that the gains in GHG emissions are rather modest, closer to the 25-30% range than the 60% range (Concave, 2005; Farrel et al 2006). Again, the results of studies that rely on a systemic approach appear in the lower range of the results.

Few studies provide results on the other environmental effects than GHG emissions. Some non governmental organizations have expressed concerns regarding water resources, given that corn and to some extent wheat use irrigation in countries such as France. Sugar beets, corn and wheat also use a significant amount of pesticides. In a simulation of the effect of various economic scenarios on groundwater pollution on French and German regions, and using a combination of economic, technical and hydrogeological modeling Graveline et al (2006) find that the extension of biofuels as a way to cut GHG emission is actually the worst case among their scenarios regarding nitrate pollution of groundwater. A major explanation for this result is the extension of rapeseed production. They point out the tradeoffs between the two environmental problems, GHG emission and water pollution.

One must also account for the impact increase in the arable crops acreage on the conservation programs. From that point of view, ambitious targets on biofuels, in particular when reached by the production of biodiesel, which is more land consuming for one ton of petrol equivalent, might go against the present incentives to promote environmental set aside and have an adverse impact the efforts to promote biodiversity through agri-environmental measures. There is a risk of a serious contradiction between various CAP instruments, given that agri-environmental measures, funded by CAP payments might no longer become attractive if the production of energy crops becomes profitable enough.

However, the Commission points out that there might be some positive externalities due to the production of energy crops themselves (EC, 2007). In some areas, maintaining agricultural production might prevent erosion, sometimes landslides. However, the direct positive impact would certainly be very limited, at least with the current generation of biofuels, which are not particularly adapted to the regions where many of these problems occur. Energy crops might provide more incentive for crop rotations, and have positive agronomic effects. However, it is likely that overall, the non-GHG environmental balance of growing more energy crops is negative. Most of the environmental organizations, including many who supported biofuels as a way to reach Kyoto objectives a few years ago, are now expressing serious doubts regarding the environmental consequences of a large scale program like the 5.75 percent target.

4.3. The competitiveness of EU biofuels

Just like the assessments in term of GHG emission, the economic assessments of the European biofuel programs reflect the uncertainty and the dissensions mentioned above on the energy balances. Uncertainty regarding price elasticities and cross effects with other markets, including the energy market and the demand of similar agricultural products for food use add to the uncertainties on the technical aspects and energy balances. Economic assessment requires taking into account many interactions, some of them complex, like the one with the oil price which affects the competitiveness of biofuels with fossil fuels in both ways, and the feedback between biofuel production, food prices and therefore competition between food and non food use of agricultural products, which affects the production costs of biofuels. Until now, no model has managed to provide a global analysis that takes into account the interactions in a detailed way, at least as far EU biofuels are concerned.

Up to now the production of biofuels only covers a very small amount of the demand for transportation fuel. However, one cannot rely on analyses at the margin and the extrapolation of past trends. If the production grows significantly, the outlet of some of the by-products will become more limited. This means that the break-even point of biofuels, compared to fossil fuel, will increase. The farm prices will go up, which would drive biofuels further away from being competitive with fossil fuels. Is thus posed the risk to artificially support investments which will not find any more raw material competitive (Schmidhuber, 2007).

The most recent studies suggest that the European biofuels are competitive for an oil barrel of about 70-80 dollars on average, this figure seeming a reasonable order of magnitude, even if the range of results that brackets this central result is broad. One must remember that the same studies find that Brazilian ethanol is competitive with the gasoline as soon as the price of a barrel of oil prices exceeds 30 dollars. Our estimates suggest that, in the case of France, the methyl esters would become the first ones to be competitive. That is, biodiesel from rapeseed can be produced profitably without public subsidies if the price of barrel of oil exceeds 75 dollars, under the assumption of an exchange rate of 1.25 dollars per euro (Sourie et al., 2005). These estimates take into account the extra consumption of given engines when using biofuels compared fossil fuels, as well as other leakages in the production process. The economic advantage of biodiesel over other EU current biofuels is even more important with a higher oil price and this because the ethanol has a less favorable energy balance. Thus, for wheat ethanol, profitability would undoubtedly not be achieved without oil prices reaching levels of more than 100 dollars a barrel. The price of the barrel of oil ensuring the economic profitability of beet ethanol would be lower than the one that makes corn ethanol profitable, but it would still be higher than the one making rapeseed based biodiesel profitable. Under the assumption of high world prices, and if one takes into account the ongoing technical change regarding engine performances with biofuels, the profitability of rapeseed biodiesel is therefore not that distant. Nevertheless, for more central scenarios of oil prices, in the range of 50 to 60 dollars per barrel, EU ethanol covers hardly half of its production costs. The situation is only slightly more favorable for the biodiesel (Sourie et al., 2005).

It should be stressed that in the EU, compared to the North American biofuels, a greater part of the cost is represented by the raw material. Indeed, the oilseeds account for nearly 80 % of the manufacturing cost of the biodiesel, whereas corn represents only half of the US production costs. Changes in the CAP could thus modify the overall current economic assessment. In addition, economies of scale all are not fully exploited yet. It seems that when one German plant expanded its production capacity from 50 million liters to 200 million liters of beet ethanol, this resulted in a 15 % decrease in production costs (Rainelli, 2007). Lastly, technical change in the biofuel production process itself should not be underestimated.

At the present time, EU biofuels however fall short of being profitable without government intervention. The present growth in production largely results from the combination of the mandatory targets, tax exemptions and CAP subsidies (the combination of instruments used being very variable depending on the MS). In the case of France, the second largest producer of biodiesel, a set of generous subsidies and tax cuts make French biofuels to be profitable at a price of oil that is much lower than the market one. Sourie et al (2005) estimate that, given the various tax deductions, the break even price for a private producer makes French biofuels profitable for a price of oil of roughly 30 dollars a barrel. That is, there would actually be overcompensation over the 2006-07 period, where oil prices have been higher. However, this raises the issue of the capacity to keep funding an ambitious program if the production develops so as to match the EU incorporation target of 5.75 %. For such a level, public finances would be under strong pressure, with the current level of support. In addition, the issue of competition with the food productions will become more acute. Up to a recent period, French biofuels have been largely produced on land that was left in fallow to satisfy the obligations of the CAP Now that biofuels compete with food production for land, the total economic assessment for the society is reduced considerably.

4.4. What legitimacy for further public support?

Public support to the utilization (and production) of biofuels can be justified on behalf of the "infant industry" argument. That is, it is worth using public money to fund initial sunk costs in an industry that will soon pick up and expand, thanks to increasing returns of scale and endogenous technical change. However, the "infant industry" argument only has a limited validity in time. In addition, this argument can be questioned in the case of biodiesel, which so far has been the most competitive biofuel in the EU. Indeed, as in the United States, expectations are high regarding the "second" (or third according to some authors) generation of biofuels, through the cellulosic way. Second generation technology would dramatically increase the energy balance because of the valorization of all the plant rather than simply the seeds. This would also make it possible to grow specifically devoted crops on more marginal areas, which would reduce the competition for land with food production. Overall, this second generation might result in biofuels that would compete more favorably with fossil fuel and generate more positive externalities.

In the long run, it is unlikely that a level of public support will be sustainable if it exceeds considerably the economic value of the positive externalities generated by biofuels. The calculations carried out by the INRA show that, in France the tax exemption which makes it possible to produce profitably return rapeseed based biodiesel (assuming an oil price of 65 dollars the barrel) implicitly values the reduction of GHG at a price of 43 euros per ton of carbon (Sourie and al., 2005). Even though the current level of the market price for carbon is meaningless (the market has collapsed because of overgenerous quota allocation and a mild winter), this figure seems high compared to the standards used in public evaluation (the European Commission recommends using a value of 20 euros per ton of carbon, even though this estimate results from rather old studies and would need to be revised). The tax exemption required to make bioethanol competitive implicitly values GHG reductions at a much higher price. The implicit valuation of the ton of emitted CO2 saved go even much higher if one considers the present tax exemption granted to ETBE in France (estimates go up to a valorization of 2000 euros per ton of C, see RAC-F 2006). In brief, the present level of support is hardly in line with what can be considered as a reasonable valorization of the positive externalities.

5. The prospects for EU production of biofuels

5.1. Model simulations for the EU biofuel sector

Several authors have attempted to gauge the future developments of biofuels in the EU, even though there is still a lack of models that fully include the linkage with the energy markets.

The EC has compared the consequences of three scenarios (COM (2006) 34 final and the impact study SEC (2006) 142). The first scenario is "business as usual", the second one is a "regulated market-based approach" and the third one is called "deregulated market-based approach". Scenarios 2 and 3 differ essentially on the tariffs (trade liberalization in scenario 3 for the biofuels and the agricultural raw materials used for their production) and on the magnitude of the public support. The documents of the EC provide little information on the methodology, but scenarios 2 and 3 are theoretically designed so as to meet the 5.75 percent objective. In the second scenario, the demand for biofuels raises from 0.5 Mtoe in 2002 to 18.6 Mtoe in 2010, 25 % of them supplied by an increase in EU production of arable crops, 11 % by a reduction of food use of EU production and 17 % by a fall in EU exports. Half of the EU demand would be met by imports. In the third scenario, all the demand for bioethanol and half the demand for biodiesel would be met by imports. In scenario 2, EU prices of grains increase (between 6 to 11 percent relative to 2002) while they fall by 15 to 20 percent in scenario 3 due to the cut in tariffs. In both cases the price of oilseeds increases by 5 to 15 percent. The comparison of scenarios 2 and 3 clearly shows the interrelations between the tariff policy and the development of local production. The tariff policy has a significant impact on the acreage and production of the crops used for bioethanol. The acreage in cereals and sugar beets would decrease with more competition from imports, while the acreage in oilseeds would not.

The OECD has used a more formal partial equilibrium model, and the scenarios include also a demand of biofuel in the rest of the world (while the EC study was a simulation of the EU policy *ceteris paribus*). The OECD relies on four scenarios. The differences between scenarios are mainly on the assumptions regarding production of biofuels in third countries, and on the price of oil. If the stated targets for biofuels are achieved in the various countries, this would result in serious tensions on markets for grains, oilseeds and sugar. According to the OECD (2006), EU exports of wheat would fall by 41 % and EU imports of vegetable oil would increase by 300 % relative to the 2004 situation. Under the assumptions that other countries also meet their target, some significant increase in the world price of oilseeds, wheat and even more of sugar would take place. There would also be an indirect effect on the dairy market given the substitution between butter and vegetable oils, as well as the lower cost of feedstuffs. According to the OECD, a high price of oil might lead the EU to exceed its 5.75% target under the present policies.

In these two studies, however, some effects might have been neglected. In particular, in the OECD study, it is possible that the interrelations with the meat markets have been underestimated. While the higher price of grains could offset the lower price of cakes in the pig and poultry sector, there might be some effect through the availability of land in the EU which could affect both the price of land and the production of beef. Recent studies presented at the International Agricultural Trade Research Consortium (IATRC) in December 2006 also challenge the idea, implicit in both the EC and OECD study (i.e., imposed by assumption), that the various EU MS will reach their targets as far as the percentage of biofuels in transportation fuel is concerned (Banse and Grethe, 2006). The analyses presented by these authors suggest that the EC and OECD results are perhaps an upper bound. They can also be interpreted by saying that the same results would take a few more years, given the evolution observed in the beginning of 2007 where more countries seem to be heading towards their targets.

5.2. What prospects for the second generation?

The existing models show some limitations regarding the interactions with the meat sector, the linkages with the energy sector (the determinants of the biofuels prices seem to be based on a rather simplistic approach). The results rely a lot on the assumptions regarding imports. In addition, none of the existing models seems to be able to cope with the considerable uncertainty brought about by technical change. Indeed, assessing the impact of the development of the new investments in the "second generation" has, so far, been outside the capacity of the modellers. The second generation of biofuels is nevertheless seen as playing a significant role in the EU policy. In the White Paper on renewable energies (Com (97) 599), the EU set the following objectives for 2010:

- 12 % of RES in total energy consumption,
- 21 % of bio-electricity in gross energy consumption,
- 5.75 % of biofuels in transport fuels (the Commission is now proposing 10 % in 2020),
- 135 Mtoe of biomass used per year (i.e., 8.5% of the estimated energy consumption in 2010), of which 15 Mtoe of biogas and 18 Mtoe of liquid biofuels. The target was set to 150 Mtoe in the meantime.

The three categories of biomass used for bioenergy production are agricultural biomass, forest biomass and wastes. Currently woody biomass, wastes and residues are mainly used for heat and electricity, whereas agricultural biomass is mainly used to produce first-generation biofuels for utilization in land transport. Given the European targets for biofuels incorporation, the first generation could rapidly reach some limits, particularly in terms of agricultural acreage that can be mobilized for energy. Expectations are high regarding the second generation.

Second generation biofuels are produced with lignocellulosic biomass (i.e., the whole plant) from agriculture, forest, residues and wastes, Agricultural lignocellulosic resources are for instance annual crops (full plant), dedicated perennial crops (miscanthus, short rotation coppice, etc.) and residues of crops such as straw.

Second generation biofuels are still at the experimental or demonstration stage. They benefit from research and development programmes funded by the EU and several MS. There are two principal pathways to convert lignocellulosic biomass into biofuels. First, the enzymatic hydrolysis of cellulose still requires some research to be carried out on enzymes efficiency to be marketable. There are currently three demonstration plants in Europe: in Sweden (ETEK, 150 000 L/year of ethanol), Spain (Abengoa) and Denmark.[11] Then, concerning the thermo-chemical pathway, lignocellulosic biomass gasification technologies have been mainly developed by Finland, Sweden, Denmark, Germany and Austria (as far as the EU is concerned). These technologies focus above all on heat and power cogeneration with demonstration plants in Varnamö (Sweden) and Güssing (Austria). The production of liquid biofuels (including BtL) and hydrogen from the gas blend obtained through the gasification process was tackled only recently. In Germany, Volkswagen will sell vehicles using Sunfuel, a second generation biofuel of the BtL type, which will be produced by Choren.[12] The first BtL industrial plant is under construction in Freiberg (capacity 15 000 t/year). The building of an other commercial pilot plant with a capacity of 200 000 t/year should be completed by 2010. Fischer-Tropsch and bio-DME demonstration plants can be found in Sweden and Germany.

There are no precise forecasts regarding the second generation biofuels from agricultural resources. Right now, technical and economic uncertainties are still too high to assess future developments. Here we compare the results of two studies which deal with the potential European biomass production for bioenergy by the year 2030. The European Environmental Agency (EEA) assessed the quantity of biomass available for energy purposes without increasing the environmental pressure. The comparison is made with a "business as usual" situation without incentives given to the production of bioenergy. The study shows that the EU-25 biomass potential could rise from 190 M toe in 2010 to 295 M toe in 2030 (EEA, 2006). Most of the expansion would come from the agricultural sector, with a significant potential in short rotation coppice, dedicated perennial crops and crops for biogas. According to the EEA, seven MS (Spain, France, Germany, Italy, the UK, Lithuania and Poland) would represent 85 % of the EU potential, and the available arable land for energy production should reach 19 M ha in 2030. The assessment of the EU potential by the EEA suggests that it would be possible to fulfil the 150 M toe target in 2010. However, the EAA assumes that an increase in productivity and liberalization in the agricultural sector would make large quantities of land available for energy crops, which is a questionable assumption.

A second study by the University of Lund (Ericsson and Nilsson, 2006) assessed the potential biomass supply from forest and agriculture in Europe (EU-15 and ACC-10) at different time frames ranging from 10 to 40 years. In the first scenario, energy crops are cultivated on set-aside land (10 %), i.e. 11.6 M ha; in the second scenario, the compulsory set-aside rate is supposed to be 25 % (29.1 M ha); and in the third scenario, energy crops are grown on agricultural land that is not required for food production, i.e. 77.3 M ha. The European potential ranges from 97 M toe of total biomass (scenario 1) to 409 M toe (scenario 3). The energy crops account for 74 M toe in scenario 1 and 278 M in scenario 2. It is noteworthy that none of the two studies fully takes into account the competition with food for using land. In addition, none of the studies provides a compelling assessment of the future technology used in the second generation of biofuels from the potential supply.

[11] COM(2006)34, 08/02/2006.
[12] http://www.forum-newbeetle.fr/topic4477.html and http://www.mobility-and-sustainability.com/_download/141205_RZ05GB_sunf_ccp_30.pdf#search=%22SunFuel%20Beetle%20%22.

Box 2: The OSCAR model

INRA has developed a biofuels supply model aiming at assessing the impact of public policies in that domain, given the growing importance of the issue for French authorities and the quick development of biofuels production over the last period. The OSCAR [1] model is composed of an supply model based on microeconomic data (activity model) and an industrial transformation module of liquid biofuels production. It maximizes the net income of both stages, taking into account technical constraints at the farm level. It deals with the competition between food and non-food use for crops, the competition between the various energy crops and the competition between liquid biofuels chains. It allows analyzing the impacts of the CAP and the "French" biofuels policy (tax exemptions and mandatory incorporation rates) on the French arable crops sub-sector.

More precisely, 1094 farms are represented in the activity model. Sample farms, from the Farm Accountancy Data Network (FADN), are specialized in arable crops (OTEX 13 and 14). Through this sample, OSCAR represents roughly 70 % of the total French area devoted to arable crops. Six biofuels chains are included in the model: ethanol from wheat (1) and sugar beet (2), ETBE from wheat (3) and sugar beet (4), as well as biodiesel (Vegetable Oil Methyl Ester) from rapeseed (5) and sunflower (6). The model is based on 2004 data.

OSCAR can be used in two ways. Either the demand is given, biofuels prices and/or tax cuts are set to zero and the agro-industrial chain is constrained to satisfy the demand. In this case, the model determines the price and tax conditions at which the agro-industrial chain is ready to "spontaneously" satisfy the demand. Or, on the contrary, demand constraints are removed, biofuels prices and tax cuts are set exogenously, and the model determines the production and supply level of biofuels and energy crops.

[1] *"Optimisation du Surplus économique des Carburants Agricoles Renouvelables", developed by INRA, UMR 210 "Economie Publique", 78850 Thiverval-Grignon, France*

5.3. Simulations on the French case using the OSCAR model

We explore the future developments of the biofuels supply and the interaction with food production using a detailed micro-economic model of the French sector, OSCAR (see Box 2). Here, we present the results of three scenarios, compared to a baseline (called S0 in the tables below). Under the baseline, the present percentage (i.e., 1 %) of biofuels in transportation fuels is kept unchanged in 2010, and so are the relative percentage of diester / biodiesel (75 %) and ethanol (25 %), the latter being produced from sugar beet (two thirds) and wheat (one third). The future demand for transportation fuels is based on the French Biofuels Progress Report to the EC estimation of current demand to which we applied a growth rate (EC's "Energy Demand in Transport" Report). This reference scenario takes into account the June 2003 CAP reform, the sugar reform and the 45 €/ha energy premium which is supposed to be limited to 424 235 ha in France. This last figure was obtained by multiplying the maximum guaranteed area for the EU-25 (2 million ha) by the share of the French area in arable crops in the total EU arable crops area. The mandatory set-aside rate is fixed at 10 %. It is assumed that the prices the various arable crops are kept unchanged at their 2004 levels, except for sugar beet because of the sugar reform. Future crop yields are estimated on the basis of past trends for each farm of the sample. Because the sample taken in consideration in the model represents 70 % of the French arable area, the required adjustments are made on the biofuels quantities produced.

Under the S0 baseline scenario, we impose that the farm sector meets the above demand for biofuels in 2010, i.e., 258 520 tons of ester, 29 938 t of wheat ethanol and 59 875 tons of sugar beet ethanol. Energy crops prices are first set to zero in order to determine their respective opportunity costs and calculate the share of raw materials in the opportunity costs of biofuels. The ester opportunity cost is then calculated from opportunity costs of raw materials, industrial costs and taking into account the price of by-products (rape meal and glycerine).

This baseline is compared to a scenario S1 which represents the French incorporation targets in 2010, i.e., 7 % of biofuels. This means 3.08 million toe divided into 0.77 million toe of ethanol and 2.31 million toe of ester. Other assumptions related to CAP reform parameters and product prices are similar to those under S0. We impose that the farm sector meets the corresponding demand for biofuels, i.e., 1 809 660 tons of ester, 502 955 tons of ethanol from wheat and 125 739 tons of ethanol from sugar beet (Table 5.1.).

Table 5.1. Characteristics of the baseline and the simulation

		S0	S1
Biofuels incorporation rate		1%	7%
Simulation horizon		2010	2010
Maximum area benefiting from energy payments (sample, in ha)		296964.5	296964.5
Transportation fuels consumption (million toe)		44	44
Demand for biofuels (million toe)		0.44	3.08
Ethanol	France Million toe	0.11	0.77
	energy content coefficient	0.857	0.857
	France Million t	0.12830	0.89813
	Sample Million t	0.08981	0.62869
Ester	France Million toe	0.33	2.31
	energy content coefficient	0.894	0.894
	France Million t	0.36932	2.58522
	Sample Million t	0.25852	1.80966

In the baseline S0, 2.35 % of the area represented by our sample is required to be cultivated in energy crops in order comply with the 1 % incorporation rate. Energy crops are mainly located on the set-aside area (96 %). The remaining benefits from the energy premium. Under the scenario S1, biofuels use 19.1 % of the area. This is the percentage required to meet the 7 % incorporation rate with domestic production. Most of the expansion takes place outside the set-aside area. Indeed, the energy crops grown on set-aside land only account for 28 percent of the total acreage in biofuel under S1. The 7 % mandatory percentage modifies the allocation of land between the different energy crops. Indeed, under the baseline S0, rapeseed and wheat are more profitable than sugar beet and sunflower on set-aside land. They are therefore grown on set-aside areas. Under the scenario S1, the maximum guaranteed area for the energy premium is fully cultivated, and more than half of energy crops are being cultivated on areas that are not under the set-aside program neither under the Energy Crop Premium program. When shifting to the baseline to the S1 scenario, a large surface grown in rapeseed and sunflower switches from food use to energy use. Wheat and sugar beet are still mainly grown for food, though (Table 5.2.).

Table 5.2. Share of food and non-food use in crop areas (ha)

	S0		S1	
	food	**non food**	**food**	**non food**
Rapeseed	89.9%	10.1%	24.1%	75.9%
Sunflower	82.8%	17.2%	0%	100%
Wheat	99.6%	0.4%	92.9%	7.1%
Sugar beet	97.3%	2.7%	94.6%	5.4%

The model provides the opportunity costs of growing energy crops for both the baseline and the S1 scenario. The fact that under the baseline most of the energy crops are grown on set-aside land, which would otherwise remain idle, while this is no longer the case under S1 modifies significantly the opportunity costs of the final product. In the S1 case, energy rapeseed, sunflower and wheat opportunity costs are equal to food crop producer prices (Table 5.3.). This affects the overall competitiveness of biofuels with oil.

Table 5.3. Opportunity costs of energy crops (€/t)

	S0	S1
Rapeseed	156.7 €/t	221 €/t
Sunflower	158.6 €/t	232.8 €/t
Wheat	62.9 €/t	104.6 €/t
Sugar beet	10.4 €/t	11.7 €/t

The opportunity cost of ester is calculated using the opportunity cost of rapeseed and sunflower, to which processing costs are added and the price of by-products are deducted. The latter are rapeseed cake and glycerine. We call “biodiesel price equivalent” the level where the biodiesel is competitive with fossil oil. It is obtained by multiplying the diesel oil price with the ester / diesel oil substitution rate (based on energy content coefficients). By comparing the cost of ester to this price (tax free), we can deduce the minimum tax cut required to make it competitive. The comparison is done for different oil prices: current price (60 $/br), “low” price (40 $/br) and “high” price (80 $/br). The comparison of Table 5.4. and Table 5.5. shows the difference made by the 7 % target (S1) compared to the baseline (S0).

Under the baseline, biodiesel is competitive with a price of oil at 60 $/br without any exemption or subsidies. That is, the present price cuts overcompensate the actual extra cost of including biofuels made from oilseeds.

With the 7 % target, which again requires to grow energy crops on non set-aside land, results for the S1 scenario presented in Table 5.5. suggest that biodiesel is competitive with fossil oil without subsidies if oil price exceeds 80$/br. For a price of oil at 60$/br and an exchange rate of 1.26$/€, a tax cut of 9 €/hl is required to make biodiesel competitive. This is 16 € less than the actual tax cut.

The results presented in Tables 5.4. and 5.5. are only valid for France. They however show that the problem of competition for land between food and energy crops will arise if the targets are to be met. This impacts the competitiveness of biofuels with fossil oil. At today’s price of oil, biodiesel would not need any subsidy or tax cut. That is, the present tax exemptions can either be seen as a rent to producers, or at least as an insurance against oil price fluctuations or a further fall in the exchange rate between the dollar and the euro. In the future, however, if we assume that the price of oil remains around 60 $/bl, meeting the French target for 2010 (7 %) will require some tax exemptions or subsidies. Results in Table 5.5. suggest that the present rate of tax exemption is higher than necessary, even under the S1 scenario. However, if one takes into account the world demand for biofuels, it is likely that the price of rapeseed oil would increase significantly. For example, Gohin (2007) foresees a 46 % increase in the EU price of rapeseed. Unless oil prices increase in the same proportion, this means that public support will be higher than the results presented in Table 5.5. to make the locally grown biofuels competitive with fossil fuel. Given the large quantities required to meet the 7 % target, if the French government maintains its policy of favouring local production over imports, the burden on public finances might become significant.

Table 5.4. Competitiveness of biodiesel under the baseline (S0) and the S1 scenario

S0	**40$/br**	**60$/br**	**80$/br**
Raw material cost (€/L)	0.340	0.340	0.340
Biodiesel cost * (€/L)	0.346	0.346	0.346
Biodiesel price equivalent** (€/L)	0.269	0.399	0.529
Minimum tax cut (€/L)	0.076	-0.053	-0.183
Current tax cut (€/L)	0.250	0.250	0.250
Difference	0.174	0.303	0.433

S1	**40$/br**	**60$/br**	**80$/br**
Raw material cost (€/L)	0.483	0.483	0.483
Biodiesel opportunity cost * (€/L)	0.489	0.489	0.489
Minimum biodiesel price** (€/L)	0.269	0.399	0.529
Minimum tax cut (€/L)	0.220	0.090	-0.040
Current tax cut (€/L)	0.250	0.250	0.250
Difference	0.030	0.160	0.290

* Assumptions: prices of rape meal 110€/t, glycerin 180€/t and methanol 300 €/t
** Gazole / ester energy content ratio: 1.088, exchange rate: 1.26 $/€

6. Conclusion

The EU has set ambitious targets for the development of biofuels. Both the consumption and production of biofuels has grown dramatically over the last two years, even though they still represent less than 2 percent of transport fuel. Support to energy crops is provided under the CAP, but as far as the actual biofuel policy is concerned, the practical implementation and the funding are left to MS. This has resulted in a rather heterogenous development of production between EU countries. Germany and France are now significant producers of biodiesel.

The EU motivates its policy mainly by environmental concerns and the need to reduce GHG emissions, as well as the reduction of energy dependance on imports, particularly given the recent threats on the supply of Russian oil and gas. However, those member states that have set ambitious national targets for biofuels (France has set a 7% target, to be compared to EU wide target of 5.75% in transportation fuels in 2010) seem particularly motivated by providing new outlets for farmers. They see biofuels as an important source of income for farmers, directly or through cross price effects with the food sector, and as a way to make it easier for farmers to accept future CAP reforms (which are likely to result in a strong reduction in EU agricultural budgets).

Recently, EU authorities have have given a new impetus to biofuel policy.[13] In order to reduce further GHG emissions, they commited to a have 20% of the EU's overall energy consumption coming from renewables by 2020, and as part of the overall target, to achieve at least 10% of their transport fuel consumption from biofuels. Note, however, that the binding character of this target is "subject to production being sustainable" and to "second-generation biofuels becoming commercially available", which represent an important conditionality to the whole decision.

If the biofuels production in the EU has increased in an impressive way, at least in percentage terms, uncertainties persist regarding the sustainability of such a development. Indeed, one should keep in mind that a large share of the initial development of biofuel production took place on land (set aside under mandatory CAP provisions) that could not be used for other purposes. The simulations provided in the French case by the OSCAR model show that the opportunity cost of growing energy crops when they compete with food crops is much different.

A key variable in the development of EU production of biofuels is obviously the price of oil. Estimates suggest that EU biofuels are competitive without subsidies with a price of oil of roughly 80 dollars a barrel. It is expected that they will become competitive with a barrel of oil at 60-70 dollars in the coming years, and second generation biofuels might drive costs of production down after 2020. However, the cost of production of biofuels is not exogenous, and the interactions with the food market must be taken into account. The EU biofuel production still covers a very small percentage of the transportation fuel, but in the rapeseed sector, the consequences on markets are already apparent. Tensions on food market prices, should the EU attempt to rely mainly on local fuels, would interact with cost of biofuels and their competitiveness compared to fossil fuels. Because of the limited availability of land in the EU, and the low production per hectare of the EU biofuels (rapeseed and sunflower based biodiesel) this is a serious limitation to the production. It is unlikely that the 10% target could be met by domestic supply without serious tensions on the food markets.

If the price of oil remains at rather low levels, EU member states willing to support the production of biofuels will need to provide subsidies. The generous tax cuts that have been given to the initial development of biofuels would draw considerable resources from member states budgets if the consumption of biofuels was large enough to meet the 10% target. This should be kept in mind when assessing the future development of EU biofuel production.

Finally, the initial amibtious biofuel policy was largely supported by the society as a whole. Indeed, the reduction in GHG emissions was seen as a legitimate reason to subsidize the use of biofuels. However, recently, an intensive debate has taken place regarding the actual positive externalities of biofuels. Many non governmental organisations have investigated carefully the energy balance of EU biofuels, and have question the actual level of reduction in GHG emissions. Others are now questioning the side environmental effects of an ambitious policy promoting biofuels, i.e. the water problem, the nitrates and pesticide pollution, and the risk that subsidized biofuels offset the positive environmental impacts of other EU (subsidized) policies, in particular the ones that promote setting land aside for conservation and biodiversity management. This is likely to play a significant role in the future, since major organizations have become critical of biofuel promotion policies. Consumers also fear the impact on food as well as transportation fuel prices and have started to express their

[13] EU heads of states Council in Brussels on 8-9 March 2007

dissatisfaction. Consumers groups favor imports of cheaper biofuels. On the environmentalists' side, it is acknowledged that the GHG emission reduction achieved by using imported ethanol is larger than the one achieved by using EU biofuels. However, environmental organisations fear that imports of palm oil accelerate the destruction of rainforest worldwide (they imposed to some MS governments to remove some incentive to use palm oil and are likely to press for an environmental certification of imports).

Overall, there are many reasons to curb the enthusiasm of those who believe that the production of EU biofuels is bound to reach very high levels in the EU. The limited availability of land will raise the issue of competition with food use, which will in turn reduce the competitiveness of biofuels regarding fossil fuels. The rate of present public support will not be sustainable given the large quantities at stake, should biofuels represent 10% of transportation fuel. And the public opinion is no longer a strong supporter for an ambitious policy in the EU. If the EU production of biofuels is likely to keep growing, it is likely that a larger share of the consumption will be met by imports. Member states are divided regarding import liberalization. Some argue that the EU should encourage consumption, not production, and in particular should make it easier to import ethanol made from sugar cane, which has a better energy balance. Others keep opposing large tariff reductions, and already worry about the new provisions allow developing countries (Africa, Caribbean, Pacific, Central American and Andean countries) to export ethanol duty free to the EU. However, ongoing trade negotiations and the pressure on food and fuel prices are likely to have the EU move towards more liberalization in the future. In such a case, the EU would become a significant importer of biofuels.

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Recent Developments and Prospects for the Production of Biofuels in the EU: Can they really be "Part of The Solution"?

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Abstract: The European Union has launched an ambitious policy aiming at increasing the use of biofuels in land transport "with a view to contributing to objectives such as meeting climate change commitments, environmentally friendly security of supply and promoting renewable energy sources". Another motivation, at least for some member states, is that the development of biofuels is expected to provide larger outlets for domestic farm products and new employment opportunities in rural areas and make future adjustments of the Common agricultural policy easier. The EU policy of support to energy crops, tax exemption for biofuels and mandatory incorporation targets in some member states, has resulted in a significant increase in the demand and supply of biofuels. The market share of biofuels remains modest (1 % in 2005 in the EU-25) but has increased dramatically over the last few months. The paper provides an analysis of recent developments and prospects for the production and utilization of biofuels in the EU. It presents the potential benefits of biofuels in the EU as well as their possible drawbacks. In particular, it addresses the three related issues of energy efficiency, environmental benefits and cost competitiveness of EU biofuels.

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Introduction

In 2003, the European Union (EU) has launched an ambitious policy aiming at increasing the use of biofuels in land transport “with a view to contributing to objectives such as meeting climate change commitments, environmentally friendly security of supply and promoting renewable energy sources” (Commission of the European Communities, 2003). The target for 2010 is that biofuels represent 5.75 % of the market for gasoline and diesel in transport. The 2003 biofuels directive also included an interim target for 2005 (2 %) and the commitment for the European Commission (EC) to provide evaluation reports on the progress made in the use of biofuels and other renewable fuels in the various Member States (MS). The 2006 biofuels progress report was issued on 10 January 2007 (Commission of the European Communities, 2007). It reviews measures implemented in the MS to promote the use of biofuels. Measures include Common Agricultural Policy (CAP) subsidies to agricultural producers to grow energy crops, financial support to investments in biofuels production facilities, tax reductions or exemptions, biofuels obligations under which companies are required to include a given percentage of biofuels in the total amount of fuel, etc. This policy, together with the rise in oil world prices that occurred over the 2003-2006 period, have resulted in a significant increase in the supply of biofuels, in particular biodiesel from rapeseed. The biofuels market share reached 1 % in 2005, that is a doubling compared to 2003 (Commission of the European Communities, 2007, Annex 1, page 15).

The situation, however, is more complex than it appears at first glance, and one should not draw quick conclusions from what has been observed over the last four years regarding the future development of the EU biofuels industry. Firstly, the 2005 biofuels market share is less that the European indicative target. Progress over the 2003-2005 period was very unequal according to the countries. Only Germany and Sweden had met the European target of 2 %, and in many countries, including countries from the EU-15 (for example, Belgium or Portugal), there was no significant increase in the use of biofuels over the 2003-2005 period. Secondly, until very recently, the expansion of biofuels has essentially taken place on land that could not be used for growing food crops, that is under mandatory set-aside provisions that are likely to be removed. Third, the energy and greenhouse gases balances of EU biofuels are increasingly appearing less positive than first evaluations suggested, and other environmental effects of EU biofuels are now being questioned. Finally, the economic costs of EU biofuels make their supply competitive only for the high oil prices observed during some months in 2006. Production subsidies and tax reductions or exemptions that have played a decisive role in the initial development of the EU biofuels production are unlikely to be sustainable for larger quantities. Their granting is not guaranteed in the future.

In most EU countries, the most energy efficient as well as cost competitive EU first-generation biofuel is biodiesel. In 2005, biodiesel achieved a share of 1.6 % of the diesel market while bioethanol achieved a share of only 0.4 % of the gasoline market. It would be thus tempting for the EU to concentrate effort on biodiesel. The biodiesel option is however questionable in a longer run perspective. It is perhaps not the most consistent strategy with the expected technical change brought by the cellulosic transformation. Future development in the cellulosic technology might rely on raw materials and geographic production areas that might be very different from those currently used in the biodiesel industry.

To sump up, European public authorities and private investors are now at a difficult crossroad for making choices regarding the production of biofuels in the EU. All the uncertainties raised above make it problematic to assess what could be the future of the EU biofuels industry. In that respect, it is symptomatic to observe that the European public opinion is increasingly critical as regards the development of biofuels in the EU and that a growing number of organizations are expressing their opposition to the incorporation targets presently discussed for 2020 (a 10 % market share).

1. The EU biofuels policy

The development of biofuels in the EU has largely been driven by incentives set up by public authorities in both the agricultural and energy sectors. Without the present set of subsidies, tax reductions and exemptions as well as mandatory incorporation rates, the EU production would certainly be much more limited. The CAP provides incentives for producing biofuels (more specifically for producing crops for an energy use). On the demand side, measures essentially aim at increasing the use of biofuels in land transport. However, because of high tariffs on imports of some biofuels and/or some raw agricultural materials used for producing biofuels, these consumption oriented measures also encourage production.

Measures developed at the farm sector level are part of the CAP. They are thus common to all MS. This is also the case of external tariffs. By contrast, most of the incentives for using biofuels are the responsibility of MS. The EU sets the objectives, mainly an incorporation rate target, but it leaves national governments free to take "appropriate measures" to meet these objectives. These measures are funded on national budgets. This explains why incentives to production and utilization of biofuels differ a lot across the EU-27 MS. This is particularly the case as far as the tax exemptions / reductions are concerned. This is also the case as far as the relative incentives for bioethanol and biodiesel are concerned: the EU legislation sets only the objectives that MS can achieve by promoting different crops and technologies.

1.1. The EU biofuels policy at the farm sector level

A set of incentives to biofuels production is thus given by the CAP. First, biofuels are encouraged by allowing farmers to grow energy crops on mandatory set-aside. Since the 1992 CAP reform, EU farmers of arable crops (grains, oilseeds and protein crops) are in effect required to set aside part of their land to qualify for CAP direct aids. Participating producers receive set-aside compensation payments. The "normal" set-aside rate is 10 % but the Council of Ministers can vary the applied rate on an annual basis.[1] The Blair House Agreement (a bilateral agreement concluded in 1992 between the EU and the United States) has limited the oilseed production for non-food use on set-aside land [2] (as well as the oilseed production for food use on non set-aside land): one estimates that this constraint restricts oilseed supply for energy purposes on set-aside land to a maximum of around 0.7 million hectares (USDA, 2005). However, following the June 2003 CAP reform and in particular the decoupling of first pillar direct aids (see below), one can reasonably consider that the EU is no longer subject to the Blair House Agreement limitations. This question is currently shelved. It could be a contentious subject between the EU and its partners in World Trade Organization (WTO) talks.

[1] The set-aside rate is 10 % for the marketing year 2006/07.

[2] Non-food uses include energy and industrial uses. Energy crops correspond to crops grown for the production of biofuels or for use as biomass in the production of electricity and thermal energy.

The June 2003 CAP reform has replaced the compensatory area payments that applied for arable crops by the so-called Single Farm Payment (SFP) mechanism. The SFP is payable to all eligible farmers independently of what products they choose to produce. Producers can even choose to produce anything at all. They however are constrained to maintain non set-aside land as well as set-aside land in good agricultural and environmental conditions. As part of this June 2003 CAP reform, an additional aid of 45 euros per hectare has been granted for growing energy crops, up to a maximum of 2 million hectares for the EU-25 (from 2007). In 2005, around 0.5 million hectares received these energy crop payments. While energy crops on (mandatory) set-aside land compete only with industrial crops, energy crops on non set-aside land compete with all other uses, that is for food, feed and industrial purposes.

1.2. The EU trade policy on biofuels

Biodiesel imports into the EU are subject to an ad-valorem duty of 6.5 %. Despite this low tariff, there is nearly no imports of biodiesel, mainly because biodiesel production outside the EU is very limited. Tariffs on vegetable oils are either nil or very low. There are some technical difficulties for using large quantities of soybean oil in biodiesel.[3] However, low percentages of soya and palm oil can be combined with rapeseed oil without particular problems. As a result, one observes an increase in EU imports of palm oil, mainly from Malaysia. The ambitious incorporation targets set by the EU might require importing significant quantities of palm oil, not only for their use for biodiesel production but also because of substitution possibilities between the various vegetable oils in food uses.

As noted by the European Commission, “there is currently no specific customs classification for bioethanol for biofuel production” and “it is not possible to establish from trade data whether or not imported alcohol is used in the fuel ethanol sector in the EU” (Commission of the European Communities, 2006). Despite this uncertainty, one can reasonably assume that the increase in EU imports of alcohol (from 1.45 million hectoliters in 1999-2001 to 2.56 million hectoliters in 2002-2004) is largely due to the bioethanol demand. Thanks to the various preferential agreements in force in the EU, in particular the EU Generalized System of Preferences (GSP) for the Least Developing Countries (the "Everything But Arms” initiative), the GSP+ granted to 14 countries including all Latin American countries except Argentina, Brazil, Chili, Paraguay and Uruguay, and the Cotonou Agreement with 77 African, Caribbean and Pacific (ACP) States, large quantities of alcohol can enter into the EU at a zero or reduced tariff: EU imports of alcohol at a reduced or zero duty increased from 1.2 million hectoliters in 2002 to 2.0 million hectoliters in 2004. With the growing number of developing countries interested in accessing the EU market under the GSP+, it is expected that these favored imports will keep growing.[4] Alcohol imports from major producers, in particular Brazil and the United States, face high Most Favored Nation (MFN) tariff that is 19.2 euros par hectoliter on undenatured alcohol and 10.2 euros per hectoliter on denatured alcohol. Despite this protection, EU imports from MFN suppliers are increasing (from 0.66 million hectoliters in 2002 to 1.1 million hectoliters in 2004).

[3] In the EU, the maximum iodine index is set to 120 units, a level slightly less than the one of soybean oil.

[4] It seems that ethanol is already used as a way to “jump” the tariff on sugar for some Latin American countries. The EU customs suspect that a growing quantity of sugar (normally subject to a 170 % ad valorem equivalent tariff under the MFN regime) is exported to the EU under the regime of imported inputs for processing reexporting (i.e., duty free), turned into ethanol in the EU, taken outside territorial waters and brought back to the EU.

The issue of allowing easier imports, in particular of bioethanol, divides European countries. Some countries (Portugal and Sweden for example) are highly favorable to the idea arguing that the energy and greenhouse gas balances of Brazilian ethanol are far better than the ones of EU bioethanol produced from wheat or sugar beets. Other countries (in first place France and Germany) strongly oppose the idea: clearly France and Germany play the biofuel card also with the view to supporting their own farmers.

1.3. The EU directives on biofuels

The EU targets. In 2001, the European Commission (EC) adopted a communication recognizing hydrogen, natural gas and biofuels as substitutes for fossil fuels in transport (COM(2001) 547). This communication included legal proposals so as to foster a larger use of biofuels in the EU. These proposals resulted in three directives that govern biofuels use, taxation and quality. The biofuels use directive (Council Directive 2003/30/EC) sets short- and medium-run targets for the percentage of biofuels to be incorporated into conventional fuels (2 % in 2005 and 5.75 % in 2010, this medium-run objective being satisfied by increasing the market share of biofuels by 0.75 % annually). These targets are not mandatory and hence, there is no penalty for noncompliance. The energy taxation directive (Council Directive, 2003/96/EC) which allows MS to grant tax reductions and exemptions on biofuels and the fuel quality directive were also adopted in 2003.

In December 2005, the EC presented a Biomass Action Plan (BAP) under which the EU strategy in favor of biofuels is made more explicit (COM(2005) 628). In February 2006, it presented a new communication on the EU strategy for biofuels which sets out how to take a "regulated market approach" to biofuels (COM(2006) 34). For the first time in January 2007, it has suggested binding minimum targets for biofuels. As part of the "Energy Policy for Europe" package that aims to make the EU a "low carbon" economy (by reducing Carbon Dioxide (CO2) emissions by at least 20 % in 2010 compared to 1990 levels), the EC has also indicated that the market share of biofuels in land transport fuels should account for at least 10 % by 2020.

Implementation at the MS level. The various European countries will not be subject to penalties if they do not meet the 5.75 % incorporation target in 2010. They however will have to provide justifications in case of non compliance. More precisely, they will have to report the measures undertaken to achieve compliance.[5] Today, the EC explicitly recognizes that the 2003 biofuels use directive target for 2010 will very likely not be achieved. Rather, the EC expects an incorporation rate of 4 % only (Commission of the European Communities, 2007).

In a large majority of MS, the main policy instrument to promote biofuels use in transport is the tax exemption, partial or complete. By contrast, fossil oils are generally subject to very high taxes. Tax reductions and exemptions can be unlimited (biodiesel in Germany for example) or defined for predetermined quantities (biodiesel and bioethanol in France for example). The higher the market share of biofuels, the higher the budgetary cost of these incentive policies. As a result, command-and control measures that imposes a mandatory percentage of biofuels incorporation without providing the economic incentives are emerging. In most cases, command and control as well as incentive measures are used simultaneously

[5] In practice, each MS shall report annually from 2005 to 2010 the measures undertaken to meet compliance with the growing objective of incorporation, from 2 % in 2005 to 5.75 % in 2010.

(either for a transition period - case of the United Kingdom – or without time limit – case of France). Box 1 below details the national policy instruments used in some MS.

Box 1. National biofuels policies

France has set a biofuels incorporation target of 7 % in 2010. In order to achieve this ambitious target (more ambitious than the EU recommendation), the French government has combined fiscal incentives with penalties for not complying. The first instrument is a tax reduction of the domestic tax applied on fossil fuels used in land transport (in French, Taxe Intérieure sur les Produits Pétroliers or TIPP). Tax cuts are granted for specific quantities, auctioned to companies at the EU wide level. They can be revised annually according to price levels of petroleum products on the one hand, agricultural raw materials on the other hand. In addition, wholesalers selling petroleum products are subject to another tax, i.e., the General Tax on Polluting Activities (In French, Taxe Générale sur les Activités Polluantes or TGAP). They can avoid paying this second tax by incorporating a certain percentage of biofuels. Tax rates increase over time in line with the increase in the incorporation target up to 7 % in 2010. These measures result in a high penalty for a seller of transportation fuel that would not include any biofuel, therefore providing them a strong incentive to do so and pass through the extra cost to the final consumer. This has recently turned the main French consumers' organization against the whole biofuels policy (UFC, 2007).

Sweden is one of the MS which promotes the most the use of biofuels (essentially under the form of bioethanol). This emphasis on biofuels use rather than production suggests that motivations of the Swedish government are more connected to environmental concerns than to farm support. This contrasts with France which strongly opposes importing larger quantities of biofuels or raw agricultural materials that could be used for producing biofuels. In other words, efforts on the biofuels dossier are in France for a large part, if not essentially, motivated by the farm support objective. Sweden has imported ethanol tax free from Brazil using some loopholes in EU tariffs linked to ambiguities in alcohol denomination and classification. This was ended in the beginning of 2006 following pressures from EU agricultural producers. The incorporation target for 2010 is 5.75 % but the interim indicative target for 2005 (3 %) was higher than the EC recommendation (2 %). Since April 2006, the largest gas pump must supply either ethanol of biogas. The obligation will be extended to medium gas stations in 2009. In addition, some imported biofuels, that is the ones subject to high tariffs, are exempted from domestic taxes on fuels. Flex-fuel cars are also exempted from specific fees, for example urban taxes in Stockholm.

Germany is the sole country which met the 2005 target with a biofuels market share of 3.8 %. This is the result of an ambitious tax exemption plan initially implemented without quantitative limits. However, from August 2008, the German government went back to a limited exemption tax (tax of €0.15 per liter of biodiesel if mixed with gas oil and €0.1 if used pure). Bioethanol is so far exempted from excise duty (63€/hl). Germany has decided to implement a mandatory incorporation of 6.75% in transport fuel by 2010.

Since January 1 2007***, the Netherlands*** have established a mandatory incorporation target for biofuels of 2 %. This target is bound to reach 5.75 % in 2010. 2007 is the first year where tax exemptions kick in. However, the Dutch government wishes to implement an environmental certification before promoting further the use of biofuels because of concerns raised by various organizations as regards the negative consequences of biofuels expansion in third countries (deforestation).

The United Kingdom (UK) is now giving priority to mandatory incorporation under the Renewable Transport Fuel Obligation (RTFO). If retailers of petroleum products do not include a given rate of biofuels in transport fuels, they will have to pay a penalty (buy-out price) of 0,15£/l (i.e., roughly 0,23 €/l). Tax exemptions will be maintained until 2010/11: together with the buy-out price mechanism, they will provide a level of support of 0,35£/l (0,52 €/l). From 2010/11, tax exemptions will be removed and replaced by mandatory incorporation for a slightly lower level of support (0,30£/l, i.e., 0,45 €/l). The UK points out that the EU incorporation target of 5.75 % in 2010 will be excessively costly if achieved through subsidies and tax exemptions / reductions. Unsurprisingly and unlike many other European countries, the UK is vigilant to comply with the spirit of the 2003 directives on biofuels stating that there should not be overcompensation for the costs of using biofuels. The UK has officially announced that it will very likely not achieved the 2010 incorporation target of 5.75 %. Simultaneously, it has also announced supplementary measures to increase incorporation of biofuels (accelerated depreciation rules for biofuels plants and support to distribution infrastructures of ethanol mixed gasoline).

1.4. The motivations of the EU biofuels policy

EU authorities invoke several motives to justify and legitimate public support to biofuels. Climate change is one of these motives.

Environment. The EU has been much more active than many other developed countries in implementing the constraining provisions of the Kyoto protocol. Even though the overall balance is unevenly distributed across MS, significant reductions in GreenHouse Gas (GHG) emissions have already been obtained in some European countries, for example in the United Kingdom, thanks to political willingness.[6] In that context, biofuels are presented as a significant instrument of the EU strategy to reduce GHG emissions. Nevertheless, the biofuels contribution to the fight against GHG emissions will undoubtedly remain modest (at least as far as first generation biofuels are concerned). According to the more recent proposals of the EC (see section 1.3), biofuels could replace 10 % of fossil fuels used in the transport sector by 2020. Knowing that the transport sector accounts for "only" 25 to 30 % of GHG emissions and that the assessment in terms of GHG emissions of first generation biofuels relative to fossil fuels is limited, the effect of biofuels on EU GHG emissions will be small, less than 1 % of total EU GHG emissions (our estimates). Of course, any contribution, even marginal, to the Kyoto Protocol objectives is welcome. But the costs of the GHG emission reduction induced by an increasing use of biofuels should be counted against alternatives offered by the Kyoto Protocol, including the Clean Development Mechanism. In that perspective, until recently, the price of traded carbon emission rights provided a useful benchmark for stakeholders involved in the biofuels industry (as well as for public authorities). The recent collapse of this price, due to a very generous allocation of emission rights, makes the assessment more difficult. This episode is unlikely to increase incentives to boost investment in biofuels.

Energy. The development of biofuels is also motivated by the concern of reducing dependence on EU energy suppliers given the threats of supply cut by Russia and the ongoing uncertainties in the Middle East. Today, the EU depends on imports for half of its energy needs. According to current trends, the dependence should increase in the next years to reach 65 % in 2030 (Fischer Boel, 2007). However, according to the EC analysis, the EU biofuels policy if fully implemented and respected might help saving only 3 % of imported fossil oil (COM(2006) 34). Even if this marginal contribution will be welcome, it cannot alone justify the EU biofuels strategy, notably tax exemptions or reductions. Importing (very) large amounts of biofuels would allow the EU to diversify energy sources and reduce dependence on a handful of suppliers, but not to gain more self-sufficiency in terms of energy needs.

The CAP. Behind the Commission's policy promoting biofuels, and more perhaps behind that of some MS, is the objective of providing larger outlets and employment to the farm in a context where exports subsidies have been significantly cut, reducing substantially foreign market access, and considerable adjustments have been asked to European farmers during 15 years of almost permanent reform. The farm sector represents a few points only of the EU-27 Gross Domestic Product (GDP), roughly 3 %. However, it remains a major economic sector in some countries, not only in new MS (the percentage of population employed in the farm sector is 30 % in Romania and 16 % in Poland) but also in some MS of the South of the EU-

[6] However, as noted by the agriculture Commissioner Mariann Fischer Boel herself, "as they currently stand, EU CO2 emissions would increase by around 5 % by 2030." (Fischer Boel, Conference at Carnegie Bank, Copenhagen, 12 January 2007).

15 (more than 10 % of the population is employed in the farm sector in Greece and Portugal). Even in Northern Europe where the share of population in farming is only a few points of percentage, the sector still occupies a large part of land. In several regions, the first transformation food industry which is closely linked to agricultural activity represents a large share of the whole industrial activity (Schmitt et al., 2002). Analyses at a regional level of domestic reform and trade liberalization scenarios suggest that these regions are the areas where the negative impacts would be the highest and the economic prospects the less favorable (Jean and Laborde, 2007). In addition, the future leaves little hope for an ambitious CAP. Income support decoupled payments will very likely be reduced. At best, they will be reoriented towards environmental and territorial objectives within a constant budget. More probably, there will be a significant reduction in the total agricultural envelope for reassignment on other EU priorities after 2013, if not before. Lastly, the multilateral agricultural negotiations of the Doha Round should result in an increased access to the EU market for foreign competitors. This larger openness of the EU agricultural market should more particularly affect the cattle-rearing areas and the livestock products, but also some cereals (barley and corn) as well as sugar beets. All these evolutions should result in reductions in European agricultural production. In that context, biofuels are seen as offering more favorable economic prospects to EU farmers. Incidentally, biofuels would also make more acceptable by EU farmers future adjustments of the CAP, agricultural budget cuts and/or an agricultural agreement within the WTO.

2. Demand and supply of biofuels in the EU

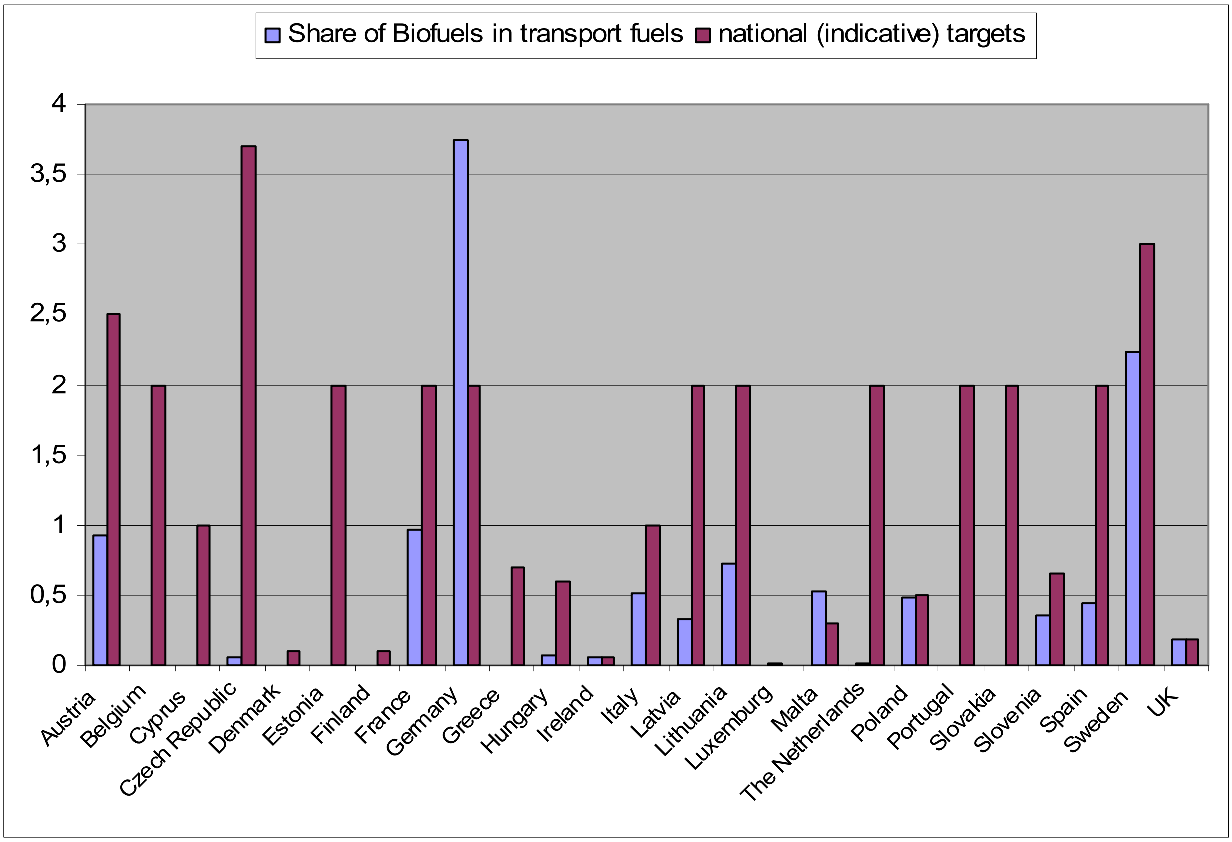
2.1. The use of biofuels in the EU

The previous section shows that the development of biofuels production and consumption in the EU is the result of a voluntary European policy. This policy leaves MS considerable flexibility in terms of instruments that can be implemented. It also shows that the various MS have variable ambition levels in this area. This is illustrated by Figure 2.1 which shows that many European countries had set national incorporation targets for 2005 lower than the biofuels use directive objective for that date (2 %). In practice, only 10 countries of the EU-25 had set their 2005 national targets at 2 % while 3 countries had established higher national objectives (2.5 % in Austria, 3.7 % in the Czech Republic and 3.0 % in Sweden). In addition, even in countries with a 2005 target of 2 %, the biofuels market share at that date was generally much lower (0 % in Belgium, Estonia and Portugal, 0.02 % in the Netherlands, 0.44 % in Spain, etc.). Germany (3.7 %) and Sweden (2.2 %) were indeed the only two countries that had exceeded the incorporation rate of 2 % in 2005. Overall, biofuels only accounted for 1 % of the transport fuel market in the EU in 2005 that is half of the reference amount of 2 % (Figure 2.1).

Fourteen MS have set their national indicative targets to 5.75 % for 2010, one country (France) being even more ambitious with a target of 7 %. However, four countries have set lower objectives (the Czech Republic, Italy, Slovenia and the UK) and six counties have not established incorporation objectives for 2010 (Cyprus, Denmark, Finland, Hungary, Malta and Spain). Globally, if the 19 MS that have set objectives for 2010 reach their targets, biofuels should account for 5.45 % of the EU transport fuel market at the end of the decade.

Most commentators however, including the EC, consider that the EU will be unlikely to reach a substitution rate of 5.45 % by 2010.[7]

Figure 2.1. Share of biofuels in transportation fuel (left hand bar) and national (indicative) targets (right hand bar) in 2005



At this stage, two points should be emphasized. First, the situation is changing rapidly. Over the last few months, several MS have managed to increase dramatically, in a very short period, their biofuels consumption. Austria, Latvia, Lithuania, Slovenia and the UK are examples. Let us consider the case of Austria: after introducing a mandatory incorporation rate of 2.5 % in October 2005, the biofuels market share in this country has increased from practically 0 % in 2004 and in the beginning of 2005 to 3.2 % today. Second, it is noteworthy that the higher use of biofuels in 2005 (in percentage terms) is found in Germany and Sweden (see Figure 2.1). This success is clearly the result of the generous tax exemption policy in place in these countries that have encouraged the use of biofuels under different forms (pure or mixed), without quantitative ceilings. It also reflects the fact that both Germany and Sweden have a biofuels policy more oriented towards biofuels use rather than production. In practice, they have had a rather open attitude regarding using imported biofuels, with Sweden even taking some liberties with the EU tariff structure to import sugarcane ethanol from Brazil – see Box 1 – Germany importing biofuels from other EU countries. The fact that the

[7] The EC estimates that the incorporation rate in 2010 will be closer than 4 % than the planned 5.75 % (Commission of the European Communities, 2007). Other observers are much more pessimistic with a biofuels market share in 2016 as low as 2.2 % for J. Fabiosa, technical director of the Food and Agriculture Policy Research Institute (FAPRI) at Iowa State University (quoted in Agra Europe (London), December 1, 2006).

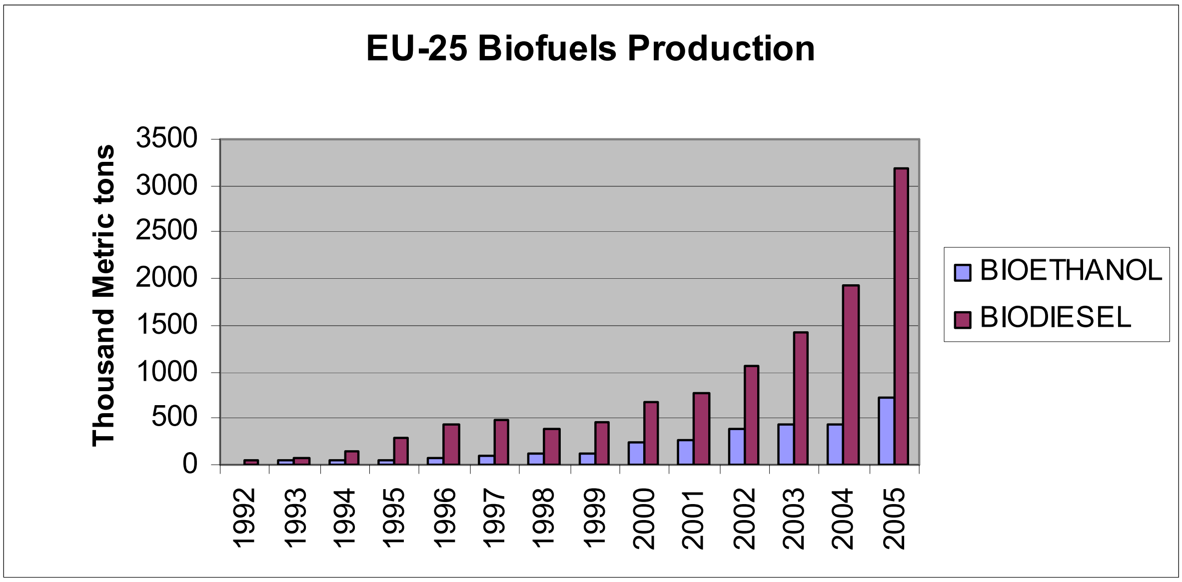
only countries that have met the target set by the EU for 2005 are also the ones that have most imported biofuels suggests that ambitious incorporation objectives may be difficult to reach with local production unless devoting considerable resource to support the latter. In that context, it is unclear whether a country like France, which has set a 2010 target more ambitious that the EU recommendation while trying to achieve this objective essentially thanks to a domestic production (Ministère de l'Agriculture et de la Pêche, 2007), will be able to do so (even though France has a larger agricultural potential than many other MS).

2.2. The production of biofuels in the EU

Biodiesel rather than ethanol. Many MS see advantages to local production of biofuels, in terms of outlets for their farm sector and/or as a way to reduce dependence on foreign energy sources. Liquid biofuels in the EU-25 amounted to around 4000 ktoe in 2005 (around 1.4 % of the market). Production growth has been particularly marked from 2003 (see Figure 2.2).

Biofuels production in the EU is strongly oriented towards biodiesel. In the EU-25, total fuel consumption in transport is shared between diesel (55 %) and gasoline (45 %). However, the incorporation of bioethanol in gasoline is only 0.4 % while the incorporation of biodiesel in diesel reaches 1.6 %. This unbalanced utilization of bioethanol and biodiesel reflects the supply structure since roughly 80 % of the biofuels domestically produced are biodiesel. EU production of bioethanol has not experienced a development similar to what has been observed in other countries, more specifically Brazil and the United States. Brazil is the world's leader of bioethanol production for more than 25 years with a production of about 16 billion liters in 2004. Brazil is also the world's leader of bioethanol consumption. Bioethanol production growth is more recent in the United States (from 4 billion liter in 1996 to 14 billion liter in 2004). While the EU is a very minor supplier of bioethanol, it is by far the world's leader of biodiesel. In 2004, world production of biodiesel was more than 2 billion liters. More than 90 % of this quantity was produced in the EU-25 (Biofuels Research Advisory Council, 2006). Figure 2.2 shows the contrasting evolution of bioethanol and biodiesel supply in the EU.

Figure 2.2. Biofuels production in the EU



EU biodiesel production is concentrated in three Member States. Biodiesel production started in the aftermath of the 1992 CAP reform essentially on set-aside land (see Subsection 1.1). Production was very modest in 1992 (55 000 tons). It was multiplied by 20 over the 10-year period 1992-2002. Production in tons has increased dramatically since 2003 (see Figure 2.2).

Table 2.1. presents the evolution of biodiesel production in the various MS over the 2002-05 period together with the production capacity evolution built by the latter. Supply is highly concentrated, three countries (Germany, Italy and France) accounted for more than 80 % of quantities in 2005. Germany is by far the EU leader (52 % of EU-25 production in 2005). Growth has been particularly marked in this country (from 0.45 million metric tons in 2002 to 1.7 million metric tons in 2005) thanks to the 100 % tax exemption on pure biodiesel. This country has today more than 1 500 fuelling stations selling pure biodiesel (Biofuels Research Advisory Council, 2006) and the 2006 production capacity is 2.6 million metric tons. France is the second producer (492 000 metric tons in 2005) and Italy the third (396 000 tons in 2005). French biodiesel production has increased by more than 140 000 metric tons between 2004 and 2005 essentially as a result of tax exemptions that have taken place on larger contingents. One can reasonably expect that the 2006 figure will be higher as a result of the increase in French production capacity, from 532 000 metric tons in 2005 to 775 000 metric tons in 2006. At the EU level, production capacity has been multiplied by 2.7 in two years, from 2.2 million metric tons in 2004 to 6.1 million metric tons in 2006. This has occurred not only in the three "traditional" suppliers but also in newcomers, notably in the UK, Spain, Portugal, Lithuania and Poland).

Table 2.1. Biodiesel production in the UE-25 (1000 metric tons)

	Production				**Production capacity**		
	2002	**2003**	**2004**	**2005**	**2004**	**2005**	**2006**
Germany	450	715	1035	1669	1088	1903	2681
Italy	210	273	320	396	419	827	857
France	366	357	348	492	502	532	775
Czech Rep.	69	70	60	133		188	203
UK	3	9	9	51	15	129	445
Spain		6	13	73	70	100	224
Austria	25	32	57	85	100	125	134
Denmark	10	41	70	71	44	81	81
Portugal				1		6	146
Sweden	1	1	1.4	1	8	12	52
Slovakia			15	78		89	89
Poland				100		100	150
Lithuania			5	7		100	150
Slovenia				8		17	17
Estonia				7		10	20
Other countries				12		15	45
Total UE-25	**1134**	**1504**	**1933**	**3184**	**2246**	**4228**	**6069**

Source: EurObserv'ER (Biofuel Barometer) for production and European Biodiesel Board for capacities

EU bioethanol. Spain is the main producer but other Member States are entering the market. Even though the EU is a marginal player at the world level, European bioethanol production has increased over the recent years reaching 720 000 metric tons in 2005, to be compared to 200 000 metric tons of imports. With the noticeable exception of Sweden, bioethanol is generally not used pure in the EU but processed into Ethyl Tertiary Butyl Ether (ETBE) as an additive to gasoline. Although there are no official statistics, the European Fuel Oxygenates Association estimates that there were some 2 million tons of ETBE produced in the EU in 2005.[8]

Spain is the main EU producer (240 000 metric tons in 2005), but other suppliers are progressively entering the market (Sweden, Germany, France, Poland). This development of bioethanol production in several MS can be linked to the political willingness and in particular, to tax exemption or reduction schemes which offset some rather high production costs. Spain is a good example as bioethanol is fully exempted, without quantitative limits, in this country. The 2006 figures should show a further increase in the Spanish bioethanol production thanks to a new plant adding 160 000 tons to the production capacity of 2005 (346 000 tons). Sweden is the second European producer of bioethanol (130 000 metric tons in 2005), followed by Germany (120 000 metric tons) and France (100 000 metric tons). The 2006 figures should exhibit a significant increase in the French production with larger contingents benefiting from tax exemptions (for a total of 785 000 metric tons) and the building of new plants. Overall, EU-25 bioethanol production capacity was estimated to 1.204 million tons in 2005, i.e., 66 % in excess relative to effective production at that date (EuObserv'ER, 2006).

Table 2.2. Bioethanol production in the EU-25 (1000 metric tons)

	2002	2003	2004	2005
Spain	176	160	202	240
Sweden		52	57	130
Germany		60	20	120
France	91	82	81	100
Poland		60	38	68
Finland			4	37
Hungary				12
Netherlands			11	6
Lithuania				6
Other countries			10	3
Total EU-25	**383**	**424**	**423**	**722**

Source: EurObserv'ER (Biofuel Barometer)

3. Impacts of biofuels on EU agriculture

3.1. Biofuels and EU agricultural production

The EU-25 biodiesel supply relies almost exclusively (95%) on rapeseed oil, the remaining 5% being produced from imported palm or soybean oil. The rapid and important development of biodiesel production since 2002 has resulted in a huge increase in domestic rapeseed oil utilization (from 4.1 million tons in 2002/03 to 6.6 million tons in 2005/06, and preliminary figures suggest a utilization around 7.2 million tons for 2006/07). This increase in rapeseed oil utilization has been caused uniquely by the biodiesel demand since the food demand of

[8] Poland experienced a decrease in 2004 relative to 2003 because the Polish Parliament finally decided not to ratify the 2003 energy bill which would have offer full tax exemption. Tax exemptions in Poland are now decided on an annual basis (Eikeland, 2006)

rapeseed oil has been constant over the last five years. For the first time in 2005/06, non-food uses of rapeseed oil have exceeded food uses. In 2006/07, biodiesel will represent 64 % of rapeseed oil total uses (Table 3.1).

A very large part of the rapeseed oil consumed in the EU is also produced in the EU. However, this was not the case in the 1990s. At that time, the EU was a major exporter of rapeseed oil (there were no imports). Progressively, exports have gone down while imports have increased. The EU is now a net importer of rapeseed oil (0.57 million tons in 2006/07) while exports are quasi null (0.06 million tons in 2006/07). The increase in rapeseed oil utilization (and imports) coincides with an increase in rapeseed domestic production: the latter was equal to 11.8 million tons in 2002/03; it is equal to 15.9 million tons in 2006/07.[9]

Bioethanol in the EU is essentially produced from wheat and to a lesser extent sugar beet (production from corn is marginal). Bioethanol is still a very minor outlet for EU cereals (more specifically wheat) since it represents less than 1 % of end uses of the latter. However, the trend is positive, from 0.5 million tons in 2004 to 1.9 million tons in 2006, in line with the development of the EU bioethanol supply. According to the EC (2007), about 1 million tons of white sugar equivalent was processed into bioethanol in 2005, that is 5 % of total domestic consumption. Sugar used for bioethanol is today only slightly less than gross sugar exports (1.3 million tons in 2006).

Table 3.1. Utilization of rapeseed oil in the EU-25 (million metric tons)

Marketing year	Total utilization	Biodiesel	Food
2002/03	4.14	1.45	2.69
2003/04	4.38	1.77	2.61
2004/05	5.37	2.70	2 .67
2005/06	6.60	3.98	2.62
2006/07*	7.24*	4.65*	2.59

*Preliminary. Source: Oil World (2006)

3.2. Biofuels and agricultural land use in the EU

The main impact of biofuels on agricultural land use in the EU is linked to the increase in rapeseed production (see Subsection 3.1). Part of rapeseed production takes place on set-aside land. Total set-aside land in the UE-25 was equal to 7.2 million hectares in 2006, more specifically 4.0 million hectares in mandatory set aside and 3.2 million hectares in voluntary set aside. On the 4.0 million hectares in mandatory set aside, one can estimate that between 700 000 and 800 000 hectares were devoted to energy crops, essentially rapeseed. In other words, the Blair House Agreement constraint that limits oilseed supply on set-aside land (see Subsection 1.1) would be binding. Our estimate is that roughly 2.5 million hectares of rapeseed (on a total of 4.75 million hectares) were devoted to biodiesel in 2005. This means that more that 50 % of the acreage grown in rapeseed was devoted to biodiesel in 2005. This also means that energy rapeseed grown on set-aside land (between 700 000 and 800 000 hectares) has represented only a minor component of the overall production of energy rapeseed.

[9] Tables A.3 and A.4 in the Appendix present the balance sheets for rapeseed oil and rapeseed, respectively.

3.3. Competition between food and non-food use

Even though biofuels represent today at best 1.5 % of transportation fuel in the EU-25, they already have had an impact on domestic agricultural product prices, essentially on rapeseed oil and cake prices. It is of course difficult to isolate this "EU biofuel effect" from other forces driving market prices, notably the CAP reform of June 2003, supply and demand conditions worldwide and fossil oil price variations. However, it is noteworthy that the (domestic) prices of rapeseed oil and cake have been significantly altered in comparison with those of other oilseeds that have not faced the same demand for transformation in biodiesel: while rapeseed oil prices have increased those of rapeseed cakes have decreased (Dronne and Gohin, 2006).

This suggests that reaching the 5.75 % incorporation target, *a fortiori* the 10 % target presently suggested by the EC (2007), would have significant impacts on EU agricultural prices, notably the prices of cereals and oilseeds. To meet the 5.75 % objective, a significant share of the surface devoted to arable crops would need to be diverted towards biofuels production. EU exports of cereals (essentially wheat) would decrease while imports of vegetable oils would increase. Domestic prices of cereals and vegetable oils would increase while domestic prices of protein cakes would decrease. The livestock sector would be affected, first through an increased competition in terms of land use, second through feed price changes (increased price for cereals and decreased price for protein cakes as well as for byproducts generated by bioethanol production). In section 5, we provide more elements on these points using micro-economic simulation models while Gohin (2007), for example, provides an assessment using a macro-economic simulation approach. In this subsection, we provide an estimate of the acreage that would be needed to devote to energy crops in order to meet the 5.75 % target. This estimate assumes that the incorporation objective is achieved without imports (of biofuels or agricultural raw materials for use to produce biofuels). As a result, the estimate presented below can be considered as an upper bound of the acreage that would be needed to meet the 5.75 % incorporation target. This acreage need estimate has been obtained as follows (details of results are presented in Table 3.2).

Total fuel consumption in EU-25 land transport is 300 million tons of petrol equivalent, shared between diesel (55 %) and gasoline (45 %). Assuming that the 5.75 % objective is fulfilled for both biodiesel (as a substitute for conventional diesel) and bioethanol (as a substitute for gasoline), biodiesel and bioethanol productions are estimated to 10.6 and 9.1 million tons, respectively.[10]

Under the assumption that the biodiesel production of 10.6 million tons would be obtained for 90 % from rapeseed and for 10 % from sunflower, rapeseed and sunflower productions are estimated to 23.4 and 2.5 million tons, respectively. Assuming rapeseed yields of 3.6 tons per hectare, the required rapeseed production would occupy about 6.6 million hectares. In the same way, assuming sunflower yields of 1.8 tons per hectare, the required sunflower production would occupy about 1.4 million hectares. In total, the acreage in energy oilseeds would thus be equal to 8 million hectares, i.e., more than the total acreage currently devoted to oilseeds in the EU-25 (7.3 million hectares).

We proceed in a similar way for bioethanol. It is obtained from wheat (80 %) and sugar beet (20 %). Under this assumption, the required bioethanol production of 9.1 million tons would

[10] We assume that ethanol would be used entirely under the form of ETBE. Of course, our calculations take account of the lower heating values of biofuels compared to fossil fuels.

occupy 4.6 million hectares of wheat (with wheat yields of 5.6 tons per hectare) and 0.4 million hectares of sugar beet (with sugar beet yields of 54 tons per hectare).

If the EU chose to rely on its own domestic production only, satisfying the 5.75 % incorporation target would require a considerable amount of land, i.e., roughly 13 million hectares or approximately 20 % of the current arable land surface in the EU. It is hard to imagine that this would only have a minor impact on market equilibria and prices. Without even mentioning the possible unwanted effects in terms of intensification of agriculture or conservation programs, this suggests that the 10 % target proposed by Commissioner Fisher Boel would be difficult to reach with the current technology unless relying on significant imports.

Table 3.2. Acreage requirements for the 5.75 % target compliance in the EU-25

Biofuel production required to meet the target	
Total fuel consumption	300 million toep
Target	5.75 %
biodiesel target equivalent	9.49 million toep
bioethanol target equivalent	7.76 million toep
Acreage requirements	
Biodiesel production	10.62 million tons
Rapeseed production	23.89 million tons
Rapeseed acreage requirement	**6.63 million ha**
Sunflower production	2.55 million tons
Sunflower acreage requirement	**1.42 million ha**
Bioethanol production	9.05 million tons
Wheat production	25.35 million tons
Wheat acreage requirement	**4.56 million ha**
Sugar beet production	23 million tons
Sugar beet acreage requirement	**0.43 million ha**

Source: authors' estimates

4. How far can the EU public support to biofuels go?

The large increase in biofuel production in the EU can largely be explained by the political will, which has resulted in either a large degree of subsidization (through tax exemptions). While the development of both the consumption and the production of biofuels has been impressive in relative growth, the overall use hardly exceeded 1 percent of transportation fuels in 2005, while it already had a significant impact on markets, driving up the price of rapeseed oil, for example. Even which such limited use of biofuels, the costs for member states budgets have become significant, so that several countries are moving towards less tax exemptions and more constraining targets for mandatory incorporation of biofuels in transportation fuels. However, such a policy ends up passing significant costs to the final consumers, who have already expressed their discontent (UFC, 2007).

If the use of biofuel grows and reaches the EU target of 5.75 % in 2010, and the possible new target of 10 % in 2020, clearly the cost of the public support will become more apparent. One may consider that, for much larger quantities of biofuels used in the EU, there is a need to keep public support consistent with major market forces, or at least with the valuation of the actual positive externalities. More practically, either biofuels will have to compete with fossil fuels in terms of cost (either by reducing the production costs of biofuels or because oil prices will be higher). Or the subsidies should be in line with what can be considered as a reasonable price of the GHG emission avoided. This raises several questions about which there is still a considerable degree of uncertainty in the EU. The first one is the extent of the actual positive externalities as far as GHG emissions are concerned. The second one is the actual degree of competitiveness of the EU biofuels, compared to fossil fuel and biofuel produced in other countries. All these elements play a crucial role in the cost benefit analysis of the EU program.

4.1. Energy efficiency

The issue of the energy balance of the EU biofuels is a matter of considerable controversy. For a long time, the debates have been confined to a rather academic and industry audience. During the year 2006, however, many stakeholders, including environmental organizations, farmers' unions and the media have shown a considerable interest in the matter, leading to a very lively debate in the EU. Indeed, many figures regarding the actual energy balance have circulated, ranging from very positive figures to slightly negative ones.

Some of the differences in the results can be explained by the different concepts used. Because of the large use of nuclear electricity in some countries, the fact of counting all energy or only oil and gas when counting the fossil fuel used and saved by biofuel matters. Many differences come from assumption on the agricultural technology (yields, the use of irrigation or not, etc.) and the efficiency in the production of inputs, such as fertilizers and the processing techniques that lead to biofuels themselves.

However, a close look at the different studies shows that a large share of the differences can be explained by the valorization of co-products. The production of biofuel results in joint outputs, some good ones and some “bad” ones. Some authors tend to allocate the energy consumed to produce this set of joint outputs to the whole set of co-products, using a particular allocation rule. Others use different allocation rules, or consider even than some of the byproducts that some authors have considered as "goods" are "bads" (and therefore should not be counted as using valuable energy for their production). The status of a byproduct can even shift from "good" to "bad" depending on the quantity produced, if there is little use beyond a given threshold. This has led different authors to value differently, say the glycerin produced, the CO2 produced (which can be used for example in the soft drink industry, but only to a certain extent), or even the cake produced, in a vary different way, and to allocate a different share of the energy consumed in producing the set of biofuel and co-products. Studies that find the most favorable energy balance in the production of ethanol or biodiesel in the EU are often those that consider as legitimate to affect a significant share of the energy inputs to co-products, and that consider that there are profitable outlets for pulps and must. They sometimes understate the technical difficulty of increasing the dry matter content of these products for transportation, or the cost of disposing or spreading the whole material, say as fertilizer.

As in every technology characterized by jointness, the allocation of inputs to the various inputs is hardly satisfactory. Results appear to differ a lot between the studies that use an ad hoc convention to allocate the fossil fuel consumed in the whole process to the different co-products (e.g. proportionality to the weight of the different co-products) and those that use a more systemic approach relying on counterfactual scenarios. In the latter case, which is recommended by many authors and has been used in the most recent studies, one affects to the co-products the fossil energy required to produce the goods that these co-products will replace (for example rapeseed cake from biodiesel production might replace soybean cake used in livestock production). With this method costs are imputed to the whole production of biofuel, but the energy saved is estimated by a counterfactual scenario on the utilization of the co-products. This method provides a better image of the insertion of the biofuel in the economic system, but may rely on fragile data. One may also go beyond this systemic approach and work with economic models that include the changes in the farming system and the energy market in a very detailed way so as to assess all the changes brought about by the policy of supporting biofuels.

It appears that studies relying on the systemic approaches tend to result in a less favorable balance for the production and use of biofuels than the ones that use a proportional allocation of the inputs to all co-products. Some studies have recently found some very low, and sometimes negative balances with EU bio-ethanol production, and in particular the one use as ETBE, which is currently the main use of bioethanol in the EU (RAC-F, 2006).

Overall, most studies find that the EU production of bioethanol has a rather limited energy balance, with 1.3. ratio of fossil energy equivalent produced for one consumed, both in the sugar beet case and the wheat case, and even less for ethanol produced for corn. That is, the saving in fossil fuel by using ethanol would be only 30 percent, once all the fossil fuel used to produce it saved by and using it and its co-products has been accounted for. The analyses that use the weight based allocation of fossil energy costs to all co-products give higher efficiency ratios.

Regarding biodiesel the differences between the different methods are much lower, and the findings more consistent. Most studies show an energy balance much more favorable than in the case of ethanol, with between 2.5 and 3 units of fossil fuel saved for 1 used, the lower estimates being around 1.7. However, it is noteworthy that the crops used for biodiesel (rapeseed and sunflower) have much lower per hectare yields than the ones used for ethanol. That is, while requiring less fossil fuel, biodiesel requires much more land. This is likely to strengthen the use problem of the competition between food and energy products for land.

4.2. Environmental benefits

The differences between studies regarding the energy balance result in significant differences in the overall assessment of the positive externalities of EU biofuels regarding GHG. Table 4.1. provides an estimate of the findings of the main studies on the EU.

Table 4.1. Reduction in GHG emissions compared with fossil fuel emissions (percentage reduction if positive)

Source of the study	Year of the study	Bioethanol from sugar beets	Bioethanol from grains	Biodiesel from rapeseed
RAC-F	2006	Positive (44%)	Positive (24% to 48%)	Positive (74%)
WTW	2005	Positive (37%-44%)	From Negative (minus 6%) to positive (+43%)	Positive (16% to 62%)
VIEWLS	2005	Positive (20% to 73%)	From negative (minus 21%) to positive (32%)	Positive (18% to 64%)
Imperial College	*2004*	*From negative (minus 11%) to Positive (63%)*	*Positive (5% to 68%)*	*Positive (48% to 80%)*
IEA	2004	Positive, 40%	Positive, (18% to 46%)	Positive (43% to 63%)
Mortimer et al (Sheffield Hallam University)	2002	*Positive (47% to 54%)**	*Positive (62% ot 67%)**	Positive (54%)
ADEME/Price Waterhouse Cooper	2002	Positive (75%)	Positive (75%)	Positive (74%)

Note: the figures in italics are quotations from the Table 5.2.1 of the impact assessment by the EU Commission (European Commission, 2006c), we did not access the primary source. The RAC-F, INRA and ADEME study refer to France. References of the studies in the list at the end of the paper.

Overall, it is therefore difficult to have reliable estimates of the reduction in GHG emissions. Following the most recent studies, both on the EU biofuels and those produced in other countries, there seems to be a consensus that the gains in GHG emissions are rather modest, closer to the 25-30% range than the 60% range (Concave, 2005; Farrel et al 2006). Again, the results of studies that rely on a systemic approach appear in the lower range of the results.

Few studies provide results on the other environmental effects than GHG emissions. Some non governmental organizations have expressed concerns regarding water resources, given that corn and to some extent wheat use irrigation in countries such as France. Sugar beets, corn and wheat also use a significant amount of pesticides. In a simulation of the effect of various economic scenarios on groundwater pollution on French and German regions, and using a combination of economic, technical and hydrogeological modeling Graveline et al (2006) find that the extension of biofuels as a way to cut GHG emission is actually the worst case among their scenarios regarding nitrate pollution of groundwater. A major explanation for this result is the extension of rapeseed production. They point out the tradeoffs between the two environmental problems, GHG emission and water pollution.

One must also account for the impact increase in the arable crops acreage on the conservation programs. From that point of view, ambitious targets on biofuels, in particular when reached by the production of biodiesel, which is more land consuming for one ton of petrol equivalent, might go against the present incentives to promote environmental set aside and have an adverse impact the efforts to promote biodiversity through agri-environmental measures. There is a risk of a serious contradiction between various CAP instruments, given that agri-environmental measures, funded by CAP payments might no longer become attractive if the production of energy crops becomes profitable enough.

However, the Commission points out that there might be some positive externalities due to the production of energy crops themselves (EC, 2007). In some areas, maintaining agricultural production might prevent erosion, sometimes landslides. However, the direct positive impact would certainly be very limited, at least with the current generation of biofuels, which are not particularly adapted to the regions where many of these problems occur. Energy crops might provide more incentive for crop rotations, and have positive agronomic effects. However, it is likely that overall, the non-GHG environmental balance of growing more energy crops is negative. Most of the environmental organizations, including many who supported biofuels as a way to reach Kyoto objectives a few years ago, are now expressing serious doubts regarding the environmental consequences of a large scale program like the 5.75 percent target.

4.3. The competitiveness of EU biofuels

Just like the assessments in term of GHG emission, the economic assessments of the European biofuel programs reflect the uncertainty and the dissensions mentioned above on the energy balances. Uncertainty regarding price elasticities and cross effects with other markets, including the energy market and the demand of similar agricultural products for food use add to the uncertainties on the technical aspects and energy balances. Economic assessment requires taking into account many interactions, some of them complex, like the one with the oil price which affects the competitiveness of biofuels with fossil fuels in both ways, and the feedback between biofuel production, food prices and therefore competition between food and non food use of agricultural products, which affects the production costs of biofuels. Until now, no model has managed to provide a global analysis that takes into account the interactions in a detailed way, at least as far EU biofuels are concerned.

Up to now the production of biofuels only covers a very small amount of the demand for transportation fuel. However, one cannot rely on analyses at the margin and the extrapolation of past trends. If the production grows significantly, the outlet of some of the by-products will become more limited. This means that the break-even point of biofuels, compared to fossil fuel, will increase. The farm prices will go up, which would drive biofuels further away from being competitive with fossil fuels. Is thus posed the risk to artificially support investments which will not find any more raw material competitive (Schmidhuber, 2007).

The most recent studies suggest that the European biofuels are competitive for an oil barrel of about 70-80 dollars on average, this figure seeming a reasonable order of magnitude, even if the range of results that brackets this central result is broad. One must remember that the same studies find that Brazilian ethanol is competitive with the gasoline as soon as the price of a barrel of oil prices exceeds 30 dollars. Our estimates suggest that, in the case of France, the methyl esters would become the first ones to be competitive. That is, biodiesel from rapeseed can be produced profitably without public subsidies if the price of barrel of oil exceeds 75 dollars, under the assumption of an exchange rate of 1.25 dollars per euro (Sourie et al., 2005). These estimates take into account the extra consumption of given engines when using biofuels compared fossil fuels, as well as other leakages in the production process. The economic advantage of biodiesel over other EU current biofuels is even more important with a higher oil price and this because the ethanol has a less favorable energy balance. Thus, for wheat ethanol, profitability would undoubtedly not be achieved without oil prices reaching levels of more than 100 dollars a barrel. The price of the barrel of oil ensuring the economic profitability of beet ethanol would be lower than the one that makes corn ethanol profitable, but it would still be higher than the one making rapeseed based biodiesel profitable. Under the assumption of high world prices, and if one takes into account the ongoing technical change regarding engine performances with biofuels, the profitability of rapeseed biodiesel is therefore not that distant. Nevertheless, for more central scenarios of oil prices, in the range of 50 to 60 dollars per barrel, EU ethanol covers hardly half of its production costs. The situation is only slightly more favorable for the biodiesel (Sourie et al., 2005).

It should be stressed that in the EU, compared to the North American biofuels, a greater part of the cost is represented by the raw material. Indeed, the oilseeds account for nearly 80 % of the manufacturing cost of the biodiesel, whereas corn represents only half of the US production costs. Changes in the CAP could thus modify the overall current economic assessment. In addition, economies of scale all are not fully exploited yet. It seems that when one German plant expanded its production capacity from 50 million liters to 200 million liters of beet ethanol, this resulted in a 15 % decrease in production costs (Rainelli, 2007). Lastly, technical change in the biofuel production process itself should not be underestimated.

At the present time, EU biofuels however fall short of being profitable without government intervention. The present growth in production largely results from the combination of the mandatory targets, tax exemptions and CAP subsidies (the combination of instruments used being very variable depending on the MS). In the case of France, the second largest producer of biodiesel, a set of generous subsidies and tax cuts make French biofuels to be profitable at a price of oil that is much lower than the market one. Sourie et al (2005) estimate that, given the various tax deductions, the break even price for a private producer makes French biofuels profitable for a price of oil of roughly 30 dollars a barrel. That is, there would actually be overcompensation over the 2006-07 period, where oil prices have been higher. However, this raises the issue of the capacity to keep funding an ambitious program if the production develops so as to match the EU incorporation target of 5.75 %. For such a level, public finances would be under strong pressure, with the current level of support. In addition, the issue of competition with the food productions will become more acute. Up to a recent period, French biofuels have been largely produced on land that was left in fallow to satisfy the obligations of the CAP Now that biofuels compete with food production for land, the total economic assessment for the society is reduced considerably.

4.4. What legitimacy for further public support?

Public support to the utilization (and production) of biofuels can be justified on behalf of the "infant industry" argument. That is, it is worth using public money to fund initial sunk costs in an industry that will soon pick up and expand, thanks to increasing returns of scale and endogenous technical change. However, the "infant industry" argument only has a limited validity in time. In addition, this argument can be questioned in the case of biodiesel, which so far has been the most competitive biofuel in the EU. Indeed, as in the United States, expectations are high regarding the "second" (or third according to some authors) generation of biofuels, through the cellulosic way. Second generation technology would dramatically increase the energy balance because of the valorization of all the plant rather than simply the seeds. This would also make it possible to grow specifically devoted crops on more marginal areas, which would reduce the competition for land with food production. Overall, this second generation might result in biofuels that would compete more favorably with fossil fuel and generate more positive externalities.

In the long run, it is unlikely that a level of public support will be sustainable if it exceeds considerably the economic value of the positive externalities generated by biofuels. The calculations carried out by the INRA show that, in France the tax exemption which makes it possible to produce profitably return rapeseed based biodiesel (assuming an oil price of 65 dollars the barrel) implicitly values the reduction of GHG at a price of 43 euros per ton of carbon (Sourie and al., 2005). Even though the current level of the market price for carbon is meaningless (the market has collapsed because of overgenerous quota allocation and a mild winter), this figure seems high compared to the standards used in public evaluation (the European Commission recommends using a value of 20 euros per ton of carbon, even though this estimate results from rather old studies and would need to be revised). The tax exemption required to make bioethanol competitive implicitly values GHG reductions at a much higher price. The implicit valuation of the ton of emitted CO2 saved go even much higher if one considers the present tax exemption granted to ETBE in France (estimates go up to a valorization of 2000 euros per ton of C, see RAC-F 2006). In brief, the present level of support is hardly in line with what can be considered as a reasonable valorization of the positive externalities.

5. The prospects for EU production of biofuels

5.1. Model simulations for the EU biofuel sector

Several authors have attempted to gauge the future developments of biofuels in the EU, even though there is still a lack of models that fully include the linkage with the energy markets.

The EC has compared the consequences of three scenarios (COM (2006) 34 final and the impact study SEC (2006) 142). The first scenario is "business as usual", the second one is a "regulated market-based approach" and the third one is called "deregulated market-based approach". Scenarios 2 and 3 differ essentially on the tariffs (trade liberalization in scenario 3 for the biofuels and the agricultural raw materials used for their production) and on the magnitude of the public support. The documents of the EC provide little information on the methodology, but scenarios 2 and 3 are theoretically designed so as to meet the 5.75 percent objective. In the second scenario, the demand for biofuels raises from 0.5 Mtoe in 2002 to 18.6 Mtoe in 2010, 25 % of them supplied by an increase in EU production of arable crops, 11 % by a reduction of food use of EU production and 17 % by a fall in EU exports. Half of the EU demand would be met by imports. In the third scenario, all the demand for bioethanol and half the demand for biodiesel would be met by imports. In scenario 2, EU prices of grains increase (between 6 to 11 percent relative to 2002) while they fall by 15 to 20 percent in scenario 3 due to the cut in tariffs. In both cases the price of oilseeds increases by 5 to 15 percent. The comparison of scenarios 2 and 3 clearly shows the interrelations between the tariff policy and the development of local production. The tariff policy has a significant impact on the acreage and production of the crops used for bioethanol. The acreage in cereals and sugar beets would decrease with more competition from imports, while the acreage in oilseeds would not.

The OECD has used a more formal partial equilibrium model, and the scenarios include also a demand of biofuel in the rest of the world (while the EC study was a simulation of the EU policy *ceteris paribus*). The OECD relies on four scenarios. The differences between scenarios are mainly on the assumptions regarding production of biofuels in third countries, and on the price of oil. If the stated targets for biofuels are achieved in the various countries, this would result in serious tensions on markets for grains, oilseeds and sugar. According to the OECD (2006), EU exports of wheat would fall by 41 % and EU imports of vegetable oil would increase by 300 % relative to the 2004 situation. Under the assumptions that other countries also meet their target, some significant increase in the world price of oilseeds, wheat and even more of sugar would take place. There would also be an indirect effect on the dairy market given the substitution between butter and vegetable oils, as well as the lower cost of feedstuffs. According to the OECD, a high price of oil might lead the EU to exceed its 5.75% target under the present policies.

In these two studies, however, some effects might have been neglected. In particular, in the OECD study, it is possible that the interrelations with the meat markets have been underestimated. While the higher price of grains could offset the lower price of cakes in the pig and poultry sector, there might be some effect through the availability of land in the EU which could affect both the price of land and the production of beef. Recent studies presented at the International Agricultural Trade Research Consortium (IATRC) in December 2006 also challenge the idea, implicit in both the EC and OECD study (i.e., imposed by assumption), that the various EU MS will reach their targets as far as the percentage of biofuels in transportation fuel is concerned (Banse and Grethe, 2006). The analyses presented by these authors suggest that the EC and OECD results are perhaps an upper bound. They can also be interpreted by saying that the same results would take a few more years, given the evolution observed in the beginning of 2007 where more countries seem to be heading towards their targets.

5.2. What prospects for the second generation?

The existing models show some limitations regarding the interactions with the meat sector, the linkages with the energy sector (the determinants of the biofuels prices seem to be based on a rather simplistic approach). The results rely a lot on the assumptions regarding imports. In addition, none of the existing models seems to be able to cope with the considerable uncertainty brought about by technical change. Indeed, assessing the impact of the development of the new investments in the “second generation” has, so far, been outside the capacity of the modellers. The second generation of biofuels is nevertheless seen as playing a significant role in the EU policy. In the White Paper on renewable energies (Com (97) 599), the EU set the following objectives for 2010:

- 12 % of RES in total energy consumption,
- 21 % of bio-electricity in gross energy consumption,
- 5.75 % of biofuels in transport fuels (the Commission is now proposing 10 % in 2020),
- 135 Mtoe of biomass used per year (i.e., 8.5% of the estimated energy consumption in 2010), of which 15 Mtoe of biogas and 18 Mtoe of liquid biofuels. The target was set to 150 Mtoe in the meantime.

The three categories of biomass used for bioenergy production are agricultural biomass, forest biomass and wastes. Currently woody biomass, wastes and residues are mainly used for heat and electricity, whereas agricultural biomass is mainly used to produce first-generation biofuels for utilization in land transport. Given the European targets for biofuels incorporation, the first generation could rapidly reach some limits, particularly in terms of agricultural acreage that can be mobilized for energy. Expectations are high regarding the second generation.

Second generation biofuels are produced with lignocellulosic biomass (i.e., the whole plant) from agriculture, forest, residues and wastes, Agricultural lignocellulosic resources are for instance annual crops (full plant), dedicated perennial crops (miscanthus, short rotation coppice, etc.) and residues of crops such as straw.

Second generation biofuels are still at the experimental or demonstration stage. They benefit from research and development programmes funded by the EU and several MS. There are two principal pathways to convert lignocellulosic biomass into biofuels. First, the enzymatic hydrolysis of cellulose still requires some research to be carried out on enzymes efficiency to be marketable. There are currently three demonstration plants in Europe: in Sweden (ETEK, 150 000 L/year of ethanol), Spain (Abengoa) and Denmark.[11] Then, concerning the thermo-chemical pathway, lignocellulosic biomass gasification technologies have been mainly developed by Finland, Sweden, Denmark, Germany and Austria (as far as the EU is concerned). These technologies focus above all on heat and power cogeneration with demonstration plants in Varnamö (Sweden) and Güssing (Austria). The production of liquid biofuels (including BtL) and hydrogen from the gas blend obtained through the gasification process was tackled only recently. In Germany, Volkswagen will sell vehicles using Sunfuel, a second generation biofuel of the BtL type, which will be produced by Choren.[12] The first BtL industrial plant is under construction in Freiberg (capacity 15 000 t/year). The building of an other commercial pilot plant with a capacity of 200 000 t/year should be completed by 2010. Fischer-Tropsch and bio-DME demonstration plants can be found in Sweden and Germany.

There are no precise forecasts regarding the second generation biofuels from agricultural resources. Right now, technical and economic uncertainties are still too high to assess future developments. Here we compare the results of two studies which deal with the potential European biomass production for bioenergy by the year 2030. The European Environmental Agency (EEA) assessed the quantity of biomass available for energy purposes without increasing the environmental pressure. The comparison is made with a "business as usual" situation without incentives given to the production of bioenergy. The study shows that the EU-25 biomass potential could rise from 190 M toe in 2010 to 295 M toe in 2030 (EEA, 2006). Most of the expansion would come from the agricultural sector, with a significant potential in short rotation coppice, dedicated perennial crops and crops for biogas. According to the EEA, seven MS (Spain, France, Germany, Italy, the UK, Lithuania and Poland) would represent 85 % of the EU potential, and the available arable land for energy production should reach 19 M ha in 2030. The assessment of the EU potential by the EEA suggests that it would be possible to fulfil the 150 M toe target in 2010. However, the EAA assumes that an increase in productivity and liberalization in the agricultural sector would make large quantities of land available for energy crops, which is a questionable assumption.

A second study by the University of Lund (Ericsson and Nilsson, 2006) assessed the potential biomass supply from forest and agriculture in Europe (EU-15 and ACC-10) at different time frames ranging from 10 to 40 years. In the first scenario, energy crops are cultivated on set-aside land (10 %), i.e. 11.6 M ha; in the second scenario, the compulsory set-aside rate is supposed to be 25 % (29.1 M ha); and in the third scenario, energy crops are grown on agricultural land that is not required for food production, i.e. 77.3 M ha. The European

[11] COM(2006)34, 08/02/2006.
[12] http://www.forum-newbeetle.fr/topic4477.html and http://www.mobility-and-sustainability.com/_download/141205_RZ05GB_sunf_ccp_30.pdf#search=%22SunFuel%20Beetle%20%22.

potential ranges from 97 M toe of total biomass (scenario 1) to 409 M toe (scenario 3). The energy crops account for 74 M toe in scenario 1 and 278 M in scenario 2. It is noteworthy that none of the two studies fully takes into account the competition with food for using land. In addition, none of the studies provides a compelling assessment of the future technology used in the second generation of biofuels from the potential supply.

Box 2: The OSCAR model

INRA has developed a biofuels supply model aiming at assessing the impact of public policies in that domain, given the growing importance of the issue for French authorities and the quick development of biofuels production over the last period. The OSCAR [1] model is composed of an supply model based on microeconomic data (activity model) and an industrial transformation module of liquid biofuels production. It maximizes the net income of both stages, taking into account technical constraints at the farm level. It deals with the competition between food and non-food use for crops, the competition between the various energy crops and the competition between liquid biofuels chains. It allows analyzing the impacts of the CAP and the "French" biofuels policy (tax exemptions and mandatory incorporation rates) on the French arable crops sub-sector.

More precisely, 1094 farms are represented in the activity model. Sample farms, from the Farm Accountancy Data Network (FADN), are specialized in arable crops (OTEX 13 and 14). Through this sample, OSCAR represents roughly 70 % of the total French area devoted to arable crops. Six biofuels chains are included in the model: ethanol from wheat (1) and sugar beet (2), ETBE from wheat (3) and sugar beet (4), as well as biodiesel (Vegetable Oil Methyl Ester) from rapeseed (5) and sunflower (6). The model is based on 2004 data.

OSCAR can be used in two ways. Either the demand is given, biofuels prices and/or tax cuts are set to zero and the agro-industrial chain is constrained to satisfy the demand. In this case, the model determines the price and tax conditions at which the agro-industrial chain is ready to "spontaneously" satisfy the demand. Or, on the contrary, demand constraints are removed, biofuels prices and tax cuts are set exogenously, and the model determines the production and supply level of biofuels and energy crops.

[1] *"Optimisation du Surplus économique des Carburants Agricoles Renouvelables", developed by INRA, UMR 210 "Economie Publique", 78850 Thiverval-Grignon, France*

5.3. Simulations on the French case using the OSCAR model

We explore the future developments of the biofuels supply and the interaction with food production using a detailed micro-economic model of the French sector, OSCAR (see Box 2). Here, we present the results of three scenarios, compared to a baseline (called S0 in the tables below). Under the baseline, the present percentage (i.e., 1 %) of biofuels in transportation fuels is kept unchanged in 2010, and so are the relative percentage of diester / biodiesel (75 %) and ethanol (25 %), the latter being produced from sugar beet (two thirds) and wheat (one third). The future demand for transportation fuels is based on the French Biofuels Progress Report to the EC estimation of current demand to which we applied a growth rate (EC's "Energy Demand in Transport" Report). This reference scenario takes into account the June 2003 CAP reform, the sugar reform and the 45 €/ha energy premium which is supposed to be limited to 424 235 ha in France. This last figure was obtained by multiplying the maximum guaranteed area for the EU-25 (2 million ha) by the share of the French area in arable crops in the total EU arable crops area. The mandatory set-aside rate is fixed at 10 %. It is assumed that the prices the various arable crops are kept unchanged at their 2004 levels, except for sugar beet because of the sugar reform. Future crop yields are estimated on the basis of past trends for each farm of the sample. Because the sample taken in consideration in the model represents 70 % of the French arable area, the required adjustments are made on the biofuels quantities produced.

Under the S0 baseline scenario, we impose that the farm sector meets the above demand for biofuels in 2010, i.e., 258 520 tons of ester, 29 938 t of wheat ethanol and 59 875 tons of sugar beet ethanol. Energy crops prices are first set to zero in order to determine their respective opportunity costs and calculate the share of raw materials in the opportunity costs of biofuels. The ester opportunity cost is then calculated from opportunity costs of raw materials, industrial costs and taking into account the price of by-products (rape meal and glycerine).

This baseline is compared to a scenario S1 which represents the French incorporation targets in 2010, i.e., 7 % of biofuels. This means 3.08 million toe divided into 0.77 million toe of ethanol and 2.31 million toe of ester. Other assumptions related to CAP reform parameters and product prices are similar to those under S0. We impose that the farm sector meets the corresponding demand for biofuels, i.e., 1 809 660 tons of ester, 502 955 tons of ethanol from wheat and 125 739 tons of ethanol from sugar beet (Table 5.1.).

Table 5.1. Characteristics of the baseline and the simulation

		S0	S1
Biofuels incorporation rate		1%	7%
Simulation horizon		2010	2010
Maximum area benefiting from energy payments (sample, in ha)		296964.5	296964.5
Transportation fuels consumption (million toe)		44	44
Demand for biofuels (million toe)		0.44	3.08
Ethanol	France Million toe	0.11	0.77
	energy content coefficient	0.857	0.857
	France Million t	0.12830	0.89813
	Sample Million t	0.08981	0.62869
Ester	France Million toe	0.33	2.31
	energy content coefficient	0.894	0.894
	France Million t	0.36932	2.58522
	Sample Million t	0.25852	1.80966

In the baseline S0, 2.35 % of the area represented by our sample is required to be cultivated in energy crops in order comply with the 1 % incorporation rate. Energy crops are mainly located on the set-aside area (96 %). The remaining benefits from the energy premium. Under the scenario S1, biofuels use 19.1 % of the area. This is the percentage required to meet the 7 % incorporation rate with domestic production. Most of the expansion takes place outside the set-aside area. Indeed, the energy crops grown on set-aside land only account for 28 percent of the total acreage in biofuel under S1. The 7 % mandatory percentage modifies the allocation of land between the different energy crops. Indeed, under the baseline S0, rapeseed and wheat are more profitable than sugar beet and sunflower on set-aside land. They are therefore grown on set-aside areas. Under the scenario S1, the maximum guaranteed area for the energy premium is fully cultivated, and more than half of energy crops are being cultivated on areas that are not under the set-aside program neither under the Energy Crop

Premium program. When shifting to the baseline to the S1 scenario, a large surface grown in rapeseed and sunflower switches from food use to energy use. Wheat and sugar beet are still mainly grown for food, though (Table 5.2.).

Table 5.2. Share of food and non-food use in crop areas (ha)

	S0		S1	
	food	**non food**	**food**	**non food**
Rapeseed	89.9%	10.1%	24.1%	75.9%
Sunflower	82.8%	17.2%	0%	100%
Wheat	99.6%	0.4%	92.9%	7.1%
Sugar beet	97.3%	2.7%	94.6%	5.4%

The model provides the opportunity costs of growing energy crops for both the baseline and the S1 scenario. The fact that under the baseline most of the energy crops are grown on set-aside land, which would otherwise remain idle, while this is no longer the case under S1 modifies significantly the opportunity costs of the final product. In the S1 case, energy rapeseed, sunflower and wheat opportunity costs are equal to food crop producer prices (Table 5.3.). This affects the overall competitiveness of biofuels with oil.

Table 5.3. Opportunity costs of energy crops (€/t)

	S0	**S1**
Rapeseed	156.7 €/t	221 €/t
Sunflower	158.6 €/t	232.8 €/t
Wheat	62.9 €/t	104.6 €/t
Sugar beet	10.4 €/t	11.7 €/t

The opportunity cost of ester is calculated using the opportunity cost of rapeseed and sunflower, to which processing costs are added and the price of by-products are deducted. The latter are rapeseed cake and glycerine. We call “biodiesel price equivalent” the level where the biodiesel is competitive with fossil oil. It is obtained by multiplying the diesel oil price with the ester / diesel oil substitution rate (based on energy content coefficients). By comparing the cost of ester to this price (tax free), we can deduce the minimum tax cut required to make it competitive. The comparison is done for different oil prices: current price (60 $/br), “low” price (40 $/br) and “high” price (80 $/br). The comparison of Table 5.4. and Table 5.5. shows the difference made by the 7 % target (S1) compared to the baseline (S0).

Under the baseline, biodiesel is competitive with a price of oil at 60 $/br without any exemption or subsidies. That is, the present price cuts overcompensate the actual extra cost of including biofuels made from oilseeds.

With the 7 % target, which again requires to grow energy crops on non set-aside land, results for the S1 scenario presented in Table 5.5. suggest that biodiesel is competitive with fossil oil without subsidies if oil price exceeds 80$/br. For a price of oil at 60$/br and an exchange rate of 1.26$/€, a tax cut of 9 €/hl is required to make biodiesel competitive. This is 16 € less than the actual tax cut.

The results presented in Tables 5.4. and 5.5. are only valid for France. They however show that the problem of competition for land between food and energy crops will arise if the targets are to be met. This impacts the competitiveness of biofuels with fossil oil. At today's price of oil, biodiesel would not need any subsidy or tax cut. That is, the present tax exemptions can either be seen as a rent to producers, or at least as an insurance against oil price fluctuations or a further fall in the exchange rate between the dollar and the euro. In the future, however, if we assume that the price of oil remains around 60 $/bl, meeting the French target for 2010 (7 %) will require some tax exemptions or subsidies. Results in Table 5.5. suggest that the present rate of tax exemption is higher than necessary, even under the S1 scenario. However, if one takes into account the world demand for biofuels, it is likely that the price of rapeseed oil would increase significantly. For example, Gohin (2007) foresees a 46 % increase in the EU price of rapeseed. Unless oil prices increase in the same proportion, this means that public support will be higher than the results presented in Table 5.5. to make the locally grown biofuels competitive with fossil fuel. Given the large quantities required to meet the 7 % target, if the French government maintains its policy of favouring local production over imports, the burden on public finances might become significant.

Table 5.4. Competitiveness of biodiesel under the baseline (S0) and the S1 scenario

S0	**40$/br**	**60$/br**	**80$/br**
Raw material cost (€/L)	0.340	0.340	0.340
Biodiesel cost * (€/L)	0.346	0.346	0.346
Biodiesel price equivalent** (€/L)	0.269	0.399	0.529
Minimum tax cut (€/L)	0.076	-0.053	-0.183
Current tax cut (€/L)	0.250	0.250	0.250
Difference	0.174	0.303	0.433

S1	**40$/br**	**60$/br**	**80$/br**
Raw material cost (€/L)	0.483	0.483	0.483
Biodiesel opportunity cost * (€/L)	0.489	0.489	0.489
Minimum biodiesel price** (€/L)	0.269	0.399	0.529
Minimum tax cut (€/L)	0.220	0.090	-0.040
Current tax cut (€/L)	0.250	0.250	0.250
Difference	0.030	0.160	0.290

* Assumptions: prices of rape meal 110€/t, glycerin 180€/t and methanol 300 €/t
** Gazole / ester energy content ratio: 1.088, exchange rate: 1.26 $/€

6. Conclusion

The EU has set ambitious targets for the development of biofuels. Both the consumption and production of biofuels has grown dramatically over the last two years, even though they still represent less than 2 percent of transport fuel. Support to energy crops is provided under the CAP, but as far as the actual biofuel policy is concerned, the practical implementation and the funding are left to MS. This has resulted in a rather heterogeneous development of production between EU countries. Germany and France are now significant producers of biodiesel.

The EU motivates its policy mainly by environmental concerns and the need to reduce GHG emissions, as well as the reduction of energy dependence on imports, particularly given the recent threats on the supply of Russian oil and gas. However, those member states that have set ambitious national targets for biofuels (France has set a 7% target, to be compared to EU wide target of 5.75% in transportation fuels in 2010) seem particularly motivated by providing new outlets for farmers. They see biofuels as an important source of income for farmers, directly or through cross price effects with the food sector, and as a way to make it easier for farmers to accept future CAP reforms (which are likely to result in a strong reduction in EU agricultural budgets).

Recently, EU authorities have given a new impetus to biofuel policy.[13] In order to reduce further GHG emissions, they committed to a have 20% of the EU's overall energy consumption coming from renewable fuels by 2020, and as part of the overall target, to achieve at least 10% of their transport fuel consumption from biofuels. Note, however, that the binding character of this target is "subject to production being sustainable" and to "second-generation biofuels becoming commercially available", which represent an important conditionality to the whole decision.

If the biofuels production in the EU has increased in an impressive way, at least in percentage terms, uncertainties persist regarding the sustainability of such a development. Indeed, one should keep in mind that a large share of the initial development of biofuel production took place on land (set aside under mandatory CAP provisions) that could not be used for other purposes. The simulations provided in the French case by the OSCAR model show that the opportunity cost of growing energy crops when they compete with food crops is much different.

A key variable in the development of EU production of biofuels is obviously the price of oil. Estimates suggest that EU biofuels are competitive without subsidies with a price of oil of roughly 80 dollars a barrel. It is expected that they will become competitive with a barrel of oil at 60-70 dollars in the coming years, and second generation biofuels might drive costs of production down after 2020. However, the cost of production of biofuels is not exogenous, and the interactions with the food market must be taken into account. The EU biofuel production still covers a very small percentage of the transportation fuel, but in the rapeseed sector, the consequences on markets are already apparent. Tensions on food market prices, should the EU attempt to rely mainly on local fuels, would interact with cost of biofuels and their competitiveness compared to fossil fuels. Because of the limited availability of land in the EU, and the low production per hectare of the EU biofuels (rapeseed and sunflower based biodiesel) this is a serious limitation to the production. It is unlikely that the 10% target could be met by domestic supply without serious tensions on the food markets.

If the price of oil remains at rather low levels, EU member states willing to support the production of biofuels will need to provide subsidies. The generous tax cuts that have been given to the initial development of biofuels would draw considerable resources from member states budgets if the consumption of biofuels was large enough to meet the 10% target. This should be kept in mind when assessing the future development of EU biofuel production.

Finally, the initial ambitious biofuel policy was largely supported by the society as a whole. Indeed, the reduction in GHG emissions was seen as a legitimate reason to subsidize the use of biofuels. However, recently, an intensive debate has taken place regarding the actual positive externalities of biofuels. Many non governmental organisations have investigated carefully the energy balance of EU biofuels, and have question the actual level of reduction in

[13] EU heads of states Council in Brussels on 8-9 March 2007

GHG emissions. Others are now questioning the side environmental effects of an ambitious policy promoting biofuels, i.e. the water problem, the nitrates and pesticide pollution, and the risk that subsidized biofuels offset the positive environmental impacts of other EU (subsidized) policies, in particular the ones that promote setting land aside for conservation and biodiversity management. This is likely to play a significant role in the future, since major organizations have become critical of biofuel promotion policies. Consumers also fear the impact on food as well as transportation fuel prices and have started to express their dissatisfaction. Consumers groups favour imports of cheaper biofuels. On the environmentalists' side, it is acknowledged that the GHG emission reduction achieved by using imported ethanol is larger than the one achieved by using EU biofuels. However, environmental organisations fear that imports of palm oil accelerate the destruction of rainforest worldwide (they imposed to some MS governments to remove some incentive to use palm oil and are likely to press for an environmental certification of imports).

Overall, there are many reasons to curb the enthusiasm of those who believe that the production of EU biofuels is bound to reach very high levels in the EU. The limited availability of land will raise the issue of competition with food use, which will in turn reduce the competitiveness of biofuels regarding fossil fuels. The rate of present public support will not be sustainable given the large quantities at stake, should biofuels represent 10% of transportation fuel. And the public opinion is no longer a strong supporter for an ambitious policy in the EU. If the EU production of biofuels is likely to keep growing, it is likely that a larger share of the consumption will be met by imports. Member states are divided regarding import liberalization. Some argue that the EU should encourage consumption, not production, and in particular should make it easier to import ethanol made from sugar cane, which has a better energy balance. Others keep opposing large tariff reductions, and already worry about the new provisions allow developing countries (Africa, Caribbean, Pacific, Central American and Andean countries) to export ethanol duty free to the EU. However, ongoing trade negotiations and the pressure on food and fuel prices are likely to have the EU move towards more liberalization in the future. In such a case, the EU would become a significant importer of biofuels.

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