Energy efficiency, environmental benefits and cost competitiveness of EU biofuels

PRELIMINARY DRAFT, WORK IN PROGRESS, DO NOT QUOTE

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Abstract: In the EU, the biofuels policy now has a significant impact on some sectors, such as the oilseeds, and future targets are likely to affect also the grains and sugar market. The paper provides a background information regarding the EU policy on biofuels. The purpose is to assess whether this policy may lead to an increase use of European agricultural products for energy, or whether it is more likely that the EU will shift towards imports of biofuels. We first describe the EU policy of support to energy crops, i.e. tax exemption for biofuels and mandatory incorporation targets in some member states, the impact on demand and supply of biofuels. We then focus on the prospects for the production and utilization of biofuels in the EU. We address the three related issues of energy efficiency, environmental benefits and cost competitiveness of EU biofuels and we present simulations regarding the competition between food and non food use of agricultural products and the consequences on the competitiveness of biofuels.

INTRODUCTION

Modeling EU agricultural trade is now made particularly difficult given the interactions between the food and non food markets. Indeed, the production of biofuels may interfere a lot with the food market. Because the biofuels production, in the EU, is largely driven by public intervention, and in particular by policies at the Member states level, it is necessary to account for these public policies even in models of the agricultural sector. In this paper we provide a background analysis regarding the prospects of the developments of biofuels. We first provide a description of the EU biofuel policy. We then attempt to assess the costs and benefits of this policy, so as to gauge whether EU countries are likely to pursue in the present direction, or either reduce or expand their support to biofuels. We then provide some elements on the interaction between the utlisation of agricultural products for energy and food purposes.

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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% of transport fuel). The European Commission (EC) must 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 (European Commission, 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. The combination of the EU policy and 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 (European Commission, 2007).

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 has varied a lot across MS. Only Germany and Sweden had met the European interim target of 2% in 2005. 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 in the future. The cost of production may therefore be different in the past, given that this land could soon be used for alternative production. 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. This raises concerns about whether an ambitious support policy should be maintained. 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 due to their budgetary cost.

In most EU countries, the most energy efficient as well as cost competitive EU first- generation biofuel is biodiesel. In 2005, biodiesel amounted to 1.6% of the diesel market while bioethanol represented 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 of transport fuel). There is now an open debate on whether the EU should rely more on imported biofuels.

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 biofuels production would certainly be much more limited. The CAP provides incentives for producing crops for 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. This includes freedom to promote different crops and technologies. 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.

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. It is estimated that this restricts oilseed supply for energy purposes on set-aside land to a maximum of around 0.7 million hectares (USDA, 2005).

[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 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 not to produce anything. They are nevertheless 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, i.e. 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%. 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" (European Commission, 2006c). Despite this uncertainty, one can reasonably assume that the increase in EU imports of alcohol, from 151 000 tons in 2002 to 555000 tons in 2006, is largely due to the bioethanol demand. (see section 2) Ethanol 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 (code 220710) and 10.2 euros per hectoliter on denatured alcohol (code 220720).

Thanks to the various preferential agreements in force in the EU large quantities of alcohol can enter into the EU at a zero or reduced tariff. The agreements that allow such duty free imports include:

- the EU Generalized System of Preferences (GSP) for the Least Developing Countries, sometimes called the "Everything But Arms" initiative,
- the GSP+ granted to 14 countries including all Latin American countries (except Argentina, Brazil, Chili, Paraguay and Uruguay),
- A special agreement with Egypt
- The Cotonou Agreement with 77 African, Caribbean and Pacific (ACP) States.

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

- Norway has been granted duty-free access to the EU under the system of tariff rate quotas.

The regular GSP regimes provided a 15% reduction relative to the MFN tariff for most other developing countries, but this reduction ended in 2006. Large producers such as Brazil were already "graduated", i.e. excluded from this preference.

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, even though we will see in section 2 that this growth has so far been limited, in particular due to the exclusion of Pakistan from this scheme.[4]

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 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 CO2 emissions by at least20% 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.

[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.

Policies at the MS level. The various MS 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].

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 oil is 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. In order to reduce budgetary costs, measures that impose a mandatory percentage of biofuels incorporation are emerging. In most cases, command and control as well as incentive measures are used simultaneously (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, 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. 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. 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 a strong incentive to do so and pass 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 who 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. 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 stations must supply either ethanol of biogas to car drivers. The obligation will be extended to medium gas stations in 2009. In addition, some imported biofuels 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

[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.

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. 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. Energy independence is another one. However, several MS seem also particularly motivated by providing farmers with an extra outlet for their crops, as a way to ease the adjustments of the future reforms of the CAP.

Environment. The EU has been 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. 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 is 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.

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-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. It is almost certain that income support will be reduced in the future. At best, the current payments 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.

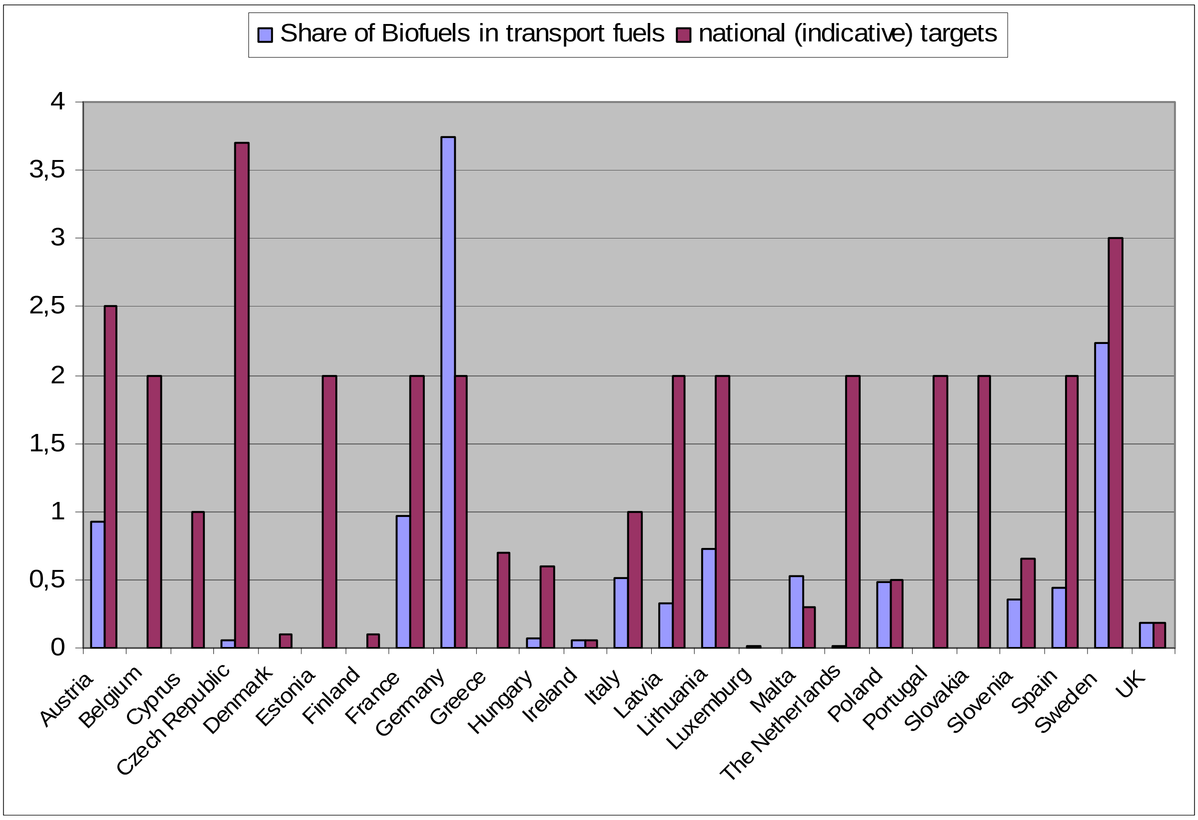
2. Demand and supply of biofuels in the EU

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%. 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 this rate by 2010.[6]

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



Source: use of EU Commission figures, Eurostat

It is noteworthy that the situation is changing rapidly. Over the last few months, the use of biofuels has increased dramatically in several MS. Austria, Latvia, Lithuania, Slovenia and the UK are examples. Let us consider the case of Austria: after introducing a mandatory

[6] 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).

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% at the end of 2006.

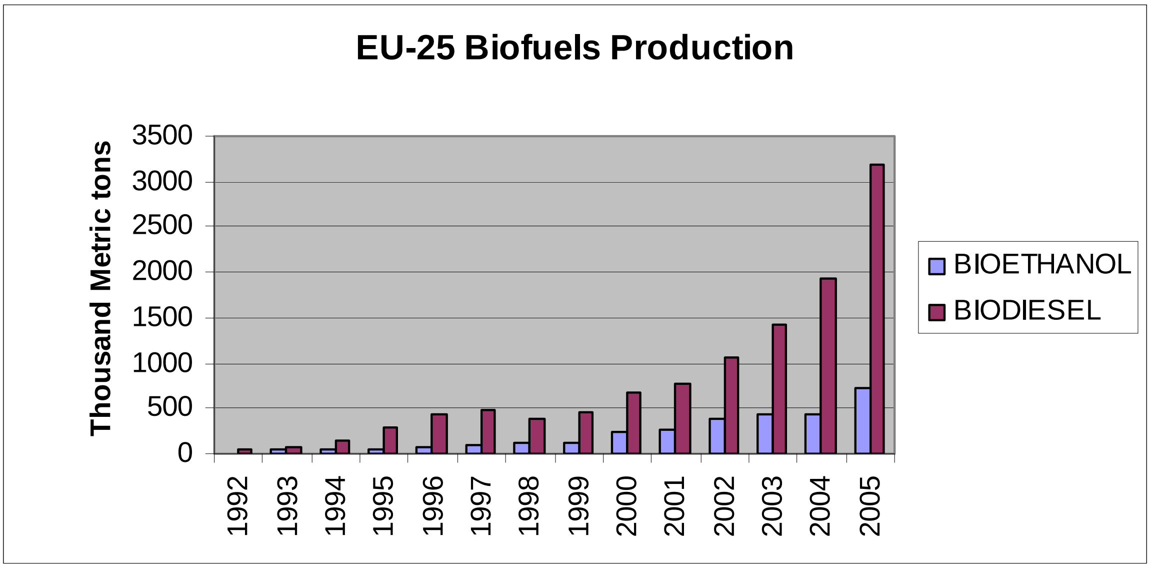
The high use of biofuels in 2005 in percentage terms in Germany and Sweden results from the generous tax exemption policy in place. These countries have encouraged the use of biofuels under different forms (pure or mixed), without quantitative ceilings. This also reflects the fact that both Germany and 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 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 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. 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. Roughly 90% of the world production of biodiesel is produced in the EU (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



Source: EurObserv'ER (Biofuel Barometer)

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

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

	Production					Production capacity			
	2002	**2003**	**2004**	**2005**	**2006**	**2004**	**2005**	**2006**	**2007**
Germany	450	715	1035	1669	2662	1088	1903	2681	4361
Italy	210	273	320	396	447	419	827	857	1366
France	366	357	348	492	743	502	532	775	780
UK	3	9	9	51	192	15	129	445	657
Spain		6	13	73	99	70	100	224	508
Czech Rep.	69	70	60	133	107		188	203	203
Poland				100	116		100	150	250
Lithuania			5	7	10		10	10	42
Portugal				1	91		6	146	246
Austria	25	32	57	85	123	100	125	134	326
Slovakia			15	78	82		89	89	99
Denmark	10	41	70	71	80	44	81	81	90
Sweden	1	1	1.4	1	13	8	12	52	212
Estonia				7	1		10	20	35
Slovenia				8	11		17	17	17
Greece				3	42		35	75	440
Belgium				1	25		55	85	335
Netherlands					18				115
Romania					10				81
Bulgaria					4				65
Latvia					7		5	8	20
Other countries				8	8		4	17	41
Total UE-25	**1134**	**1504**	**1933**	**3184**	**4890**	**2246**	**4228**	**6069**	**10289**

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

Germany is by far the EU main producer. 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. Germany now has 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).

EU bioethanol. 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.[7]

Spain was the main EU producer (240 000 metric tons in 2005), but should soon be taken over by Germany. Other suppliers are progressively entering the market (Sweden, France, Poland). The 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 exhibit a significant increase in the French production with larger contingents benefiting from tax exemptions and the building of new plants. Overall, EU-25 bioethanol production capacity was estimated to 1.2 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	2006
Spain	176	160	202	240	317
Sweden		52	57	130	58
Germany		60	20	120	316
France	91	82	81	100	234
Poland		60	38	68	104
Finland			4	37	0
Hungary				12	5
Netherlands			11	6	
Lithuania				6	14
Italy					102
Czech				1	13
Netherlands					12
Latvia				1	10
Other countries			10	3	1
Total EU-25	**383**	**424**	**423**	**722**	**1185**

Source: EurObserv'ER (Biofuel Barometer) and UEPA

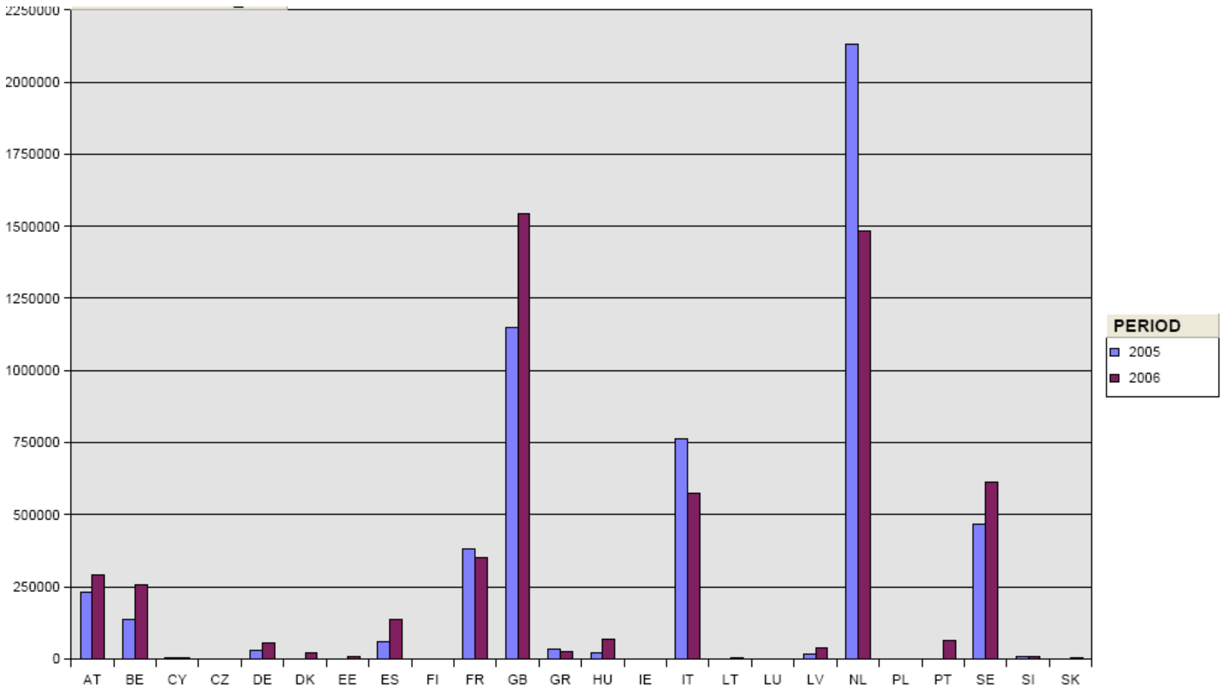
2.3. Evolution of Extra-EU trade in biofuel

Ethanol. In 2006, the EU-25 imported 474 000 tons of undenatured ethanol (code 220710) and 81230 tons of denatured ethanol (code 220720, source Comext). Roughly 10% of this volume was imported under the regime of inward processing, involving subsequent reexportation.[8] The overall imports represent 295 million euros.

[7] 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)

[8] "Inward processing" means the customs procedure under which the good is brought into the EU conditionally relieved from payment of import duties and taxes, on the basis that such goods are intended for manufacturing, processing or repair and subsequent exportation.

Figure 2.3. Imports (origin extra-EU25) of ethanol in 2005 and 2006 (100kg)



Source: Comext, categories 220710 and 220720. Countries with extra-EU imports of less that 5000t are not represented. Figures on the left hand side axis are in 100kg.

Figure 2.3 shows that the United Kingdom is now EU member states that imports the largest quantities of ethanol from outside the EU-25, even if the Netherlands was a largest importer in 2005.[9] Because we focus on extra-EU trade, this might nevertheless reflect primarily the fact that ethanol imports simply enter the EU through Dutch ports.

The generalization of the preferential access through the GSP+ and the Cotonou and Everything But Arms regimes were seen as creating some significant opportunities for imports. However, while in 2004 imports under preferential regimes accounted for 55% of all imports (i.e. the preferential imports were 155000 tons at the time), in 2006, the imports under preferential regime only account for 20% of imports.[10] One explanation of the decreasing share of imports under preferential regimes might be that Pakistan was no longer eligible to the GSP+, which replaced the special "drug" GSP for those countries that fought drug trafficking. Pakistan had taken advantage of its brief eligibility to the GSP drugs to export significant quantities of ethanol. Another explanation is that, because of the eligibility of ethanol to special import regimes in the United States, some Central American countries have recently found an outlet there.[11] This might explain that the exports of Guatemala under the GSP+ to the EU tend to go down. However, the

[9] Note that temporary imports under another classification that took place in Sweden are not accounted here. All imports of ethanol for biofuels normally take place under the 2207 subchapter in the EU.

[10] These figures, coming from the new decomposition of Eurostat regarding the flows under preferential regimes must be taken with caution. Eurostat has warned us about some fragile allocation of the imports between the various regimes, which rely on the declaration of importers.

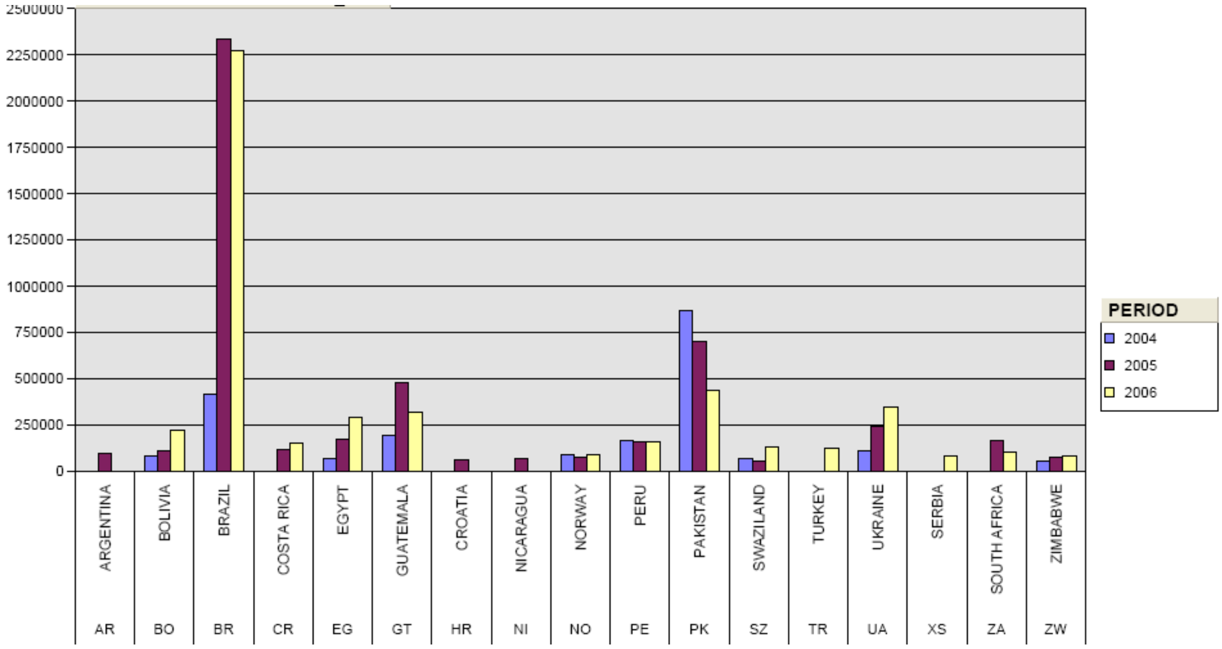
[11] It seems that a significant activity is the re-export of Brazilian ethanol from countries such as Salavador.

main explanation of the fall of preferential imports in percentage terms seems to be the growth of imports from Brazil under the MFN regime. Indeed, according to the recent Eurostat figures mentioned above, in 2006, 67% or the EU ethanol imports were subject to the MFN tariffs (Figure 2.4).

Figure 2.5. for the year 2006 shows that the largest imports come from Brazil, Pakistan and Ukraine and that they take place under the MFN regime (Figure 2.5 and Figure 2.6 excludes imports under inward processing, but it is noteworthy that Brazil and Pakistan also export large quantities under a zero tariff for reexporting after processing). Egypt, Bolivia and Guatemala export significant quantities under preferential regimes and, at least in the case of Egypt, Bolivia and Costa Rica, their exports have been growing steadily over the last few years. In the future, it is expected that Swaziland and Zimbabwe, who are supposed to have very low production costs, similar to the Brazilan ones, could become significant exporters. While imports from Swaziland have increased in 2006, those from Zimbabwe are limited by the poor political situation in this country.

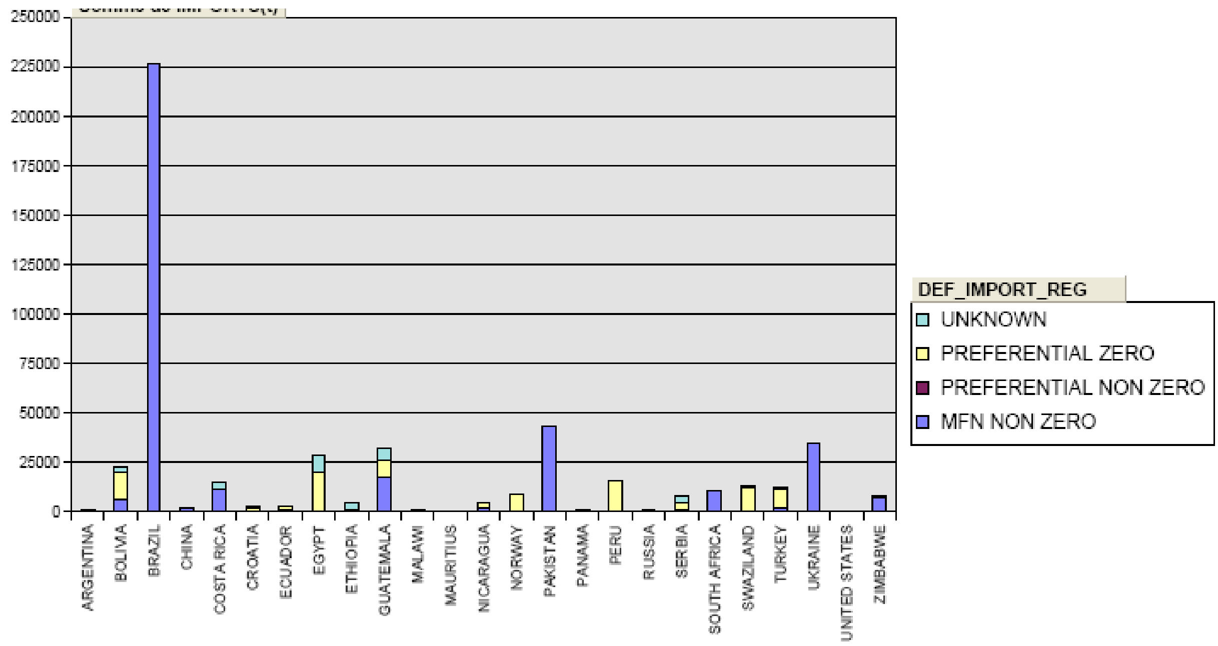
It is forecasted that preferential imports could grow considerably (see EC Commission, 2006c, USDA 2006). However, the Figures 2.5 and 2.6 suggest that this has not yet happened. Overall, Figure 2.6 shows that there is only a limited growth of duty free imports. Indeed, if we exclude ethanol imported for reexportation, the exclusion of Pakistan from the GSP+ has led this country to reduce its exports to the EU. Except a significant share still imported under the inward processing regime, Pakistan exports now face the MFN tariff, and as a result, its exports to the EU have gone down dramatically. Preferential imports have been increasing mainly from Egypt and some GSP+ countries such as Bolivia and Costa Rica. However, so far exports from other GSP+ countries such as Peru, Ecudaor and Guatemala have not increased significantly in 2006, and those from ACP countries have remained low. It remains to see whether the erosion of their sugar rent could lead ACP exporters of sugar such as Mauritius, Tanzania or the Dominica Republic to export ethanol to the EU in the future. LDCs could also increase their exports significantly, in particular by using raw material from low cost producers such as India (Nepal) or Thaïland (Cambodia).

Figure 2.4. Origin of ethanol imports in the EU-25 (2004-2006)



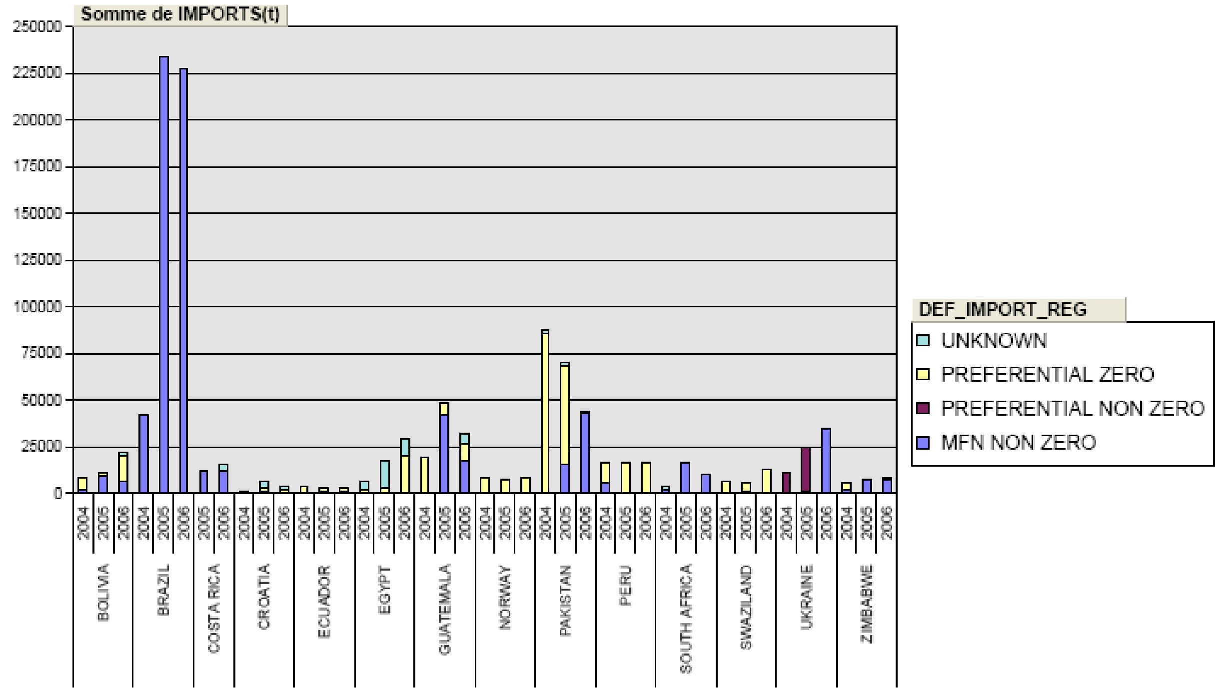
Source: Comext, categories 220710 and 220720. Countries with exports to the EU of less that 5000t are not represented. Figures on the left hand side axis are in 100kg. Figures include imports under inward processing.

Figure 2.5 Import regime and origin, ethanol 2006



Source: Comext, categories 220710 and 220720. Countries with exports to the EU of less that 2000t are not represented. Figures on the left hand side axis are in tons. These imports do not include imports under inward or outward processing (subject to a zero tariff). Year 2006

Figure 2.5. Changes in import regimes, main suppliers, ethanol (2004-2006)



Source: Comext, categories 220710 and 220720. Main suppliers only. Figures on the left hand side axis are in tons. These imports do not include imports under inward or outward processing (subject to a zero tariff). Year 2006.

Biodiesel. Assessing the EU external trade for biodiesel is difficult. Indeed, there is only limited trade in this product per se, even thought EU imports seems to have been booming recently. The EU is the world's largest producer. In addition, it makes little sense to focus on trade in the final product, while there are important possibilities of trade in the various raw materials, from seeds to vegetable oil. There are some significant imports of rapeseed from the Black Sea region, soybean oil from Argentina, Brazil and the US, and palmoil coming from Malaysia in addition to booming imports from the US.

3. 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 have 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, 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.

3.1. 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, including 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. 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 outputs 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.

3.2. 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 3.1. provides an estimate of the findings of the main studies on the EU.

Table 3.1. 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 of an increase in arable crops acreage on conservation programs. 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.

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.

3.3. 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 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.

3.4. 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.

4. The prospects for EU production of biofuels

4.1. 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.

4.2. 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 programs 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.[12] 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.[13] 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

[12] COM(2006)34, 08/02/2006.
[13] 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.

(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 fulfill 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.

5. IMPACTS OF BIOFUELS ON EU AGRICULTURE

5.1. 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 large 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 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. In the 1990s, the EU was a major exporter of rapeseed oil. 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 there is no longer any significant export (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.[14]

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

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

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 5.1. 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)

5.2. 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. 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 would be binding (see Subsection 1.1.). 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.

5.3. Competition between food and non-food use

Even though biofuels represent today roughly 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. Gohin (2007) 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 relies on the assumption 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 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.[15]

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 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.

[15] 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.

Table 5.2. 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

5.4. Simulations of the impact of EU targets : an illustration for France

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). One of the objectives here is to assess under which condition EU incorporation objectives could be reached by relying on domestic production.

The reference year is 2015. We assume that the 2003-2006 reforms of the CAP are fully implemented, including the sugar reform, but that no other policy change has taken place. The energy crop subsidy of 45 euros per hectare is maintained, with the present threshold regarding eligible surface (434000 hectares for France, 2 million hectares for the EU). The 10% set aside is also maintained. 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.

The reference scenario (S-1%) corresponds to an incorporation of 1% of biofuels in transport fuel, which is the one observed when the model is calibrated (year 2004). Two scenarios are investigated: The one corresponding to a 7 percent target (S-7%) set by the French government for 2010 and one corresponding to a 9% target called S-9%.

The model determines the price of oilseeds that is necessary to reach the target production of biofuels, given the production function of the sample of farmers, which includes agronomic and technical constraints. Here, we assume that the production of rapeseed and sunflower oil for food purposes remains unchanged. Other prices are set endogenously in the micro economic model, but they come from the simulation output of a larger general equilibrium model, GOAL (Gohin, 2007). The total consumption of fuel of 45.6 tep comes from the outlook by the French Industry Ministry. The relative percentage of diester / biodiesel (75%) and ethanol (25%) is assumed.

Under these assumptions, the farm sector is required to meet the demand for biofuels in 2015 that amounts to 382000 tons of biodiesel and 133000 ethanol under the S-1% scenario, 2.673 million tons of biodiesel and 0.929 million tons of ethanol under the S-7% scenario, and 3.435 million tons biodiesel and 1.19 million tons ethanol in the S-9% scenario. 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).

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 a 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 or/and 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*

Energy crops in crop rotations. In the reference scenario S-1%, 3% of the surface of the sample is used for energy crops. Most production takes place on set-aside land (97%). The remaining production benefits from the energy crop payment. In the S-7% scenario, energy crops represent 17 % of the total acreage of the sample. The ratio becomes 23% under the S-9% scenario. The production of energy crops on set aside land only amounts to 32% and 24% of the total acreage devoted to energy crops, respectively. Note that under the S-7% and S-9% scenario, 49% and

51% of the land under set aside programs are used to grow energy crops, against 24% under the S-1 scenario. This suggests that there is a limit to the capacity of using set aside land for energy crops once agronomic constraints are taken into account.

The three scenarios have a very different impact according to crops. The mandatory targets do not appear to lead to a much larger area devoted to sugar beets and wheat, even though the fulfillment of the 9% mandatory target results in a significant demand for both products. It has, overall, a rather minor impact on the acreage devoted to these crops. However, the demand for oilseeds in the energy market is considerable. Under the S-1% scenario, 12% of the rapeseed and 16% of the sunflower is used for biofuels. Not only the increase in the incorporation rate results in a shift from the use for food purposes to biofuel, but the overall oilseed production increases dramatically. In many farms of the sample, the S-9% scenario leads to hit was is considered in the model as an agronomic constraint, with cases where oilseeds are grown on 40% of the arable land.

Table 5.3. Changes in the surface devoted to energy and food crops

		S1% 1000 ha	**S7% 1000 ha**	**S9% 1000 ha**
Rapeseed	Total	1273	1312	1683
	Including Energy crops	*12%*	*78%*	*83%*
Sunflower	Total	291	397	489
	Including Energy crops	*16%*	*26%*	*40%*
Wheat	Total	3263	3449	3217
	Including Energy crops	*0.4%*	*6.5%*	*8.6%*
Beet	Total	261	260	237
	Including Energy crops	*3%*	*6%*	*9%*

Source : simulations, OSCAR model, INRA Grignon

The model provides the opportunity costs of growing energy crops the different scenarios. 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 when the incorporation rate increases, 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 5.4. Opportunity costs of energy crops (€/t)

€/t	S-1%	S-7%	S-9%
Rapeseed	158.3	246.8	330.4
Sunflower	164.4	268.6	359.5
Wheat	65.3	117.9	117.9
Sugar beet	9.15	10.9	11.33

Source : simulations, OSCAR model, INRA Grignon

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.

Table 5.5. Competitiveness of biodiesel under the baseline (S0) and the S1 scenario

Crude oil en $/barrel	S-1% Gap in €/litre between crude oil and biodiesel cost of production	S-7% Gap in €/litre between crude oil and biodiesel cost of production	S-9% Gap in €/litre between crude oil and biodiesel cost of production
20	-0.23	-0.44	-0.64
30	-0.17	-0.38	-0.57
40	-0.11	-0.32	-0.51
50	-0.05	-0.26	-0.45
60	**0.02**	-0.19	-0.39
70	**0.08**	-0.13	-0.32
80	**0.14**	-0.07	-0.26
90	**0.20**	-0.01	-0.20
100	**0.27**	**0.06**	-0.14
110	**0.33**	**0.12**	-0.07
120	**0.39**	**0.18**	-0.01
130	**0.45**	**0.25**	**0.05**
140	**0.52**	**0.31**	**0.11**
150	**0.58**	**0.37**	**0.18**

Source : simulations, OSCAR model, INRA Grignon. Results for France.

Because the agricultural good is the largest cost component of the biodiesel, the price of the agricultural material affects the competitiveness of the biodiesel compared to crude oil in a considerable way. Under the assumption of a price for rapeseed cake of 110€/ton (a price of 180€/ton for glycerin and 300€/t for methanol) the cost of producing 100 litres of biodiesel would amount to 37€ under the scenario S-1%, to 57€ under the scenario S-7% and to 77€ under the S-

9% scenario. These costs are compared to different oil prices in Table 5.4, under the assumption of an exchange rate of 1.2€/US$.

Under the S-1% scenario, that roughly represents the present situation, biodiesel is competitive with a price of oil at 60$/br without any exemption or subsidies. That is, the present level of public support (tax exemptions) in France overcompensates the actual extra cost of including biofuels made from oilseeds. However, with the 7% target, biodiesel is competitive with fossil oil without subsidies if oil price exceeds 80$/br. The present level of public support, i.e. 0.25€/l wuld no longer be sufficient to make biofuels competitive if the price of oil is 60$/br.

Even though these results are obtained under restrictive assumptions and are valid in the case of France only, they suggests that, at today's price of oil, biodiesel would not need any subsidy or tax cut. 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 higher levels of support because the way production costs of biodiesel increase with the mandatory target (under the assumption that imports are kept out).

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 5.4. 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.

6. CONCLUSION

The EU has set ambitious targets for the development of biofuels. Both the consumption and production of biofuels have grown dramatically over the last two years, even though they still represent less than 2% 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.[16] In order to reduce further GHG emissions, they committed 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 valorization of co-products (rapeseed cake and glycerine in the case of biodiesel) will go down with larger quantities of biodiesel produced, and this will result in a higher break even point for the latter. 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 organizations have investigated carefully the energy balance of EU biofuels, and have questioned 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,

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

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 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 organizations 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.

References

ADEME/PWC (2002). Bilans énergétiques et gaz à effet des serre des filières de production de biocarburant. Rapport technique, novembre, Agence française pour la Maitrise de l'Energie, Paris (Price Waterhouse Coopers).

Ballerini D. (2006), Les biocarburants : état des lieux, perspectives et enjeux de développement. Institut Français du Pétrole.

Bioenergy NoE (2006), Bioenergy in Europe: opportunities and barriers. Network of Excellence, DG Research project, European Commission.

Biofuel Research Advisory Council (2006), Biofuels in the European Union, A vision for 2030 and beyond.

USDA (2006). Global Agriculture Information Network, GAIN Report Number: E36122, Date: 7/11/2006, United States Department of Agriculture, Foreign Agricultural Service.

Colonna P. (Editeur) (2005). La chimie verte, Edition Tec Lavoisier 560p

Cormeau J., Gosse G. (2006), La filière lignocellulosique, Biofutur n°269.

Dronne Y., Gohin A. (2006), Le développement des utilisations non alimentaires de l'huile de colza dans l'UE : quels impacts sur les marchées et prix mondiaux ? OCL Vol. 12 n°5-6 septembre-décembre 2006

EEA (2006), How much bioenergy can Europe produce without harming the environment?, n°7/2006.

Ericsson K., Nilsson L.J. (2006), Assessment of the potential biomass supply in Europe using a resource-focused approach, Biomass and Bioenergy, 30 1-15.

EuObserv'ER (2006), Biofuels Barometer, Systèmes solaires, n°173, mai 2006 juin 2006.

European Commission (2005), Biomass Green energy for Europe, Brussels.

European Commission (2006a), Biofuels Progress Report - Report on the progress made in the use of biofuels and other renewable fuels in the Member States of the European Union, COM(2006) 845 final, January 2007

European Commission (2006b) Commission Staff Working Document, Accompanying document to the Biofuels Progress Report - Report on the progress made in the use of biofuels and other renewable fuels in the Member States of the European Union, COM(2006) 1721 final, January 2007

European Commssion (2006c). Impact Assessment. Annex to the Communication from the Commssion, "A EU Strategy for biofuels", SEC (2006) 142, Brussels.

European Commission (2007), Prospects for Agricultural Markets 2006-2013, January 2007

Gagnaire N., Gabrielle B., Da Silveira J., Sourie J.C., Bamière L. (2006), Une approche économique, énergétique et environnementale du gisement et de la collecte des pailles et d'une utilisation pour les filières éthanol, Rapport final du projet AGRICE.

Gohin (2007). Impacts of the European bio-fuel policy on the farm sector : a general equilibrium assessment. Paper presented at the conference “Bio-Fuels, Food and Feed Tradeoffs” sponsored by Farm Foundation and USDA, April 12-13, 2007, St Louis, Missouri.

Graveline N et al. (2006). Integrating economic with groundwater modelling for developing long term nitrate concentration scenarios in a large aquifer. Bureau de Recherches Géologiques et Minières, Montpellier. (*International symposium Darcy 2006 - Aquifer Systems Management)*

IEA (2004). Biofuels for transport. An international perspective international perspective coordinated by Lew Fulton and Tom Howes. International Energy Agency, Paris, 203 p.

Mortimer N., Cormack, Elsayed Horne R.E. (2002). Evaluation of the comparative energy, environmental and socio-economic costs and benefits for biodiesel. Report for the Department for Environment, Food and Rural Affairs.

OCDE (2006). Incidences de la croissance de la production de biocarburants sur les marchés agricoles AGR/CA/APM(2005)24/FINAL

Oil World (2006) , “EU-25 Update 2006/07, December 2006

Price Waterhouse Cooper (2005): Biofuels and other renewable fuels for transport. A study commissioned by the Federal Public Service of Public Health Food Chain Safety and Environment, Brussels, Belgium.

Prieur Vernat, A. His, S., Bouvart F., (2007) Biofuels and their environmental performances , Panorama 2007, Institu Francais du Pétrole.

Prieur Vernat, A. His, S (2007), Biofuels in Europe, Panorama 2007 , Institut Francais du Pétrole.

RAC-F. (2006). Les biocarburants, quelle perspective ? Réseau Action Climat-France, Etude réalisée par EDEN, Normandie.

Rainelli P. (2007), Concurrence des terres pour les usages alimentaires et énergétiques. Discussion paper, Notre Europe, Paris.

Schmidhuber J. (2007). Impact of an increased biomass use on agricultural markets, prices and food security: A longer-term perspective. Discussion paper, Notre Europe, Paris and Food and Agriculture Organisation, Rome.

Sourie J-C, Tréguer D., Rozakis S. (2005). L'ambivalence des filières biocarburants INRA Sciences Sociales N°2 Décembre 2005.

UFC (2007). Les biocarburants. Union Fédérale des Consommateurs-Que Choisir?, Paris.

VIEWLS (2005). Environmental and economic performance of biofuels.: VIEWLS (Clear Views on Clean Fuels, Data, Potentials, Scenarios, Markets and Trade of Biofuels), Directorate for Energy and Trasnsport, European Commission.

WTW (2005). Well-to-Wheel analysis of future automotive fuels and power trains in the European context. Concawe, Eucar, JRC Ispra (http://ies.jrc.cec.eu.int/WTW).