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BIOFUELS POLICY IN EUROPE UNDER THE DIRECTIVE 2003/30: AN ANALYSIS OF GOALS, HINDRANCES, INSTRUMENTS AND EFFECTS

Augusto Ninni[1] – Pietro Lanzini[2]

Abstract. Up to 2008/2009, biofuels were considered one of the best alternatives to oil consumption in a captive market like transports, being one of the pillars of the 20-20-20 initiative in Europe. Improvement of security of supply through partial substitution of imported oil; reduction of GHGs emissions; improvement of income and employment in the agricultural and rural sectors were the main drivers of the promotion of biofuels in Europe, as well as in the United States and in Brazil.

In the European Union biofuels policy was supported through Directive 2003/30. However its effects proved to be disappointing: the consumption of biofuels was expected by the Directive to account for 5.75% share of road fuels in 2010 in the European MSs, but it came early clear that such a target could not be met. Above all, consensus about biofuels decreased sharply when their ability to strongly decrease overall GHGs emissions was questioned, and when they were blamed of being the main responsible of the 2007-2008 food price increase. Finally, a new Directive was approved on April 23rd, 2009, including the request of various certifications to prove the sustainability of biofuels.

The paper deals deeply with the biofuel experience in Europe, providing a general analysis of the 2003/30 Directive. It includes an evaluation of the difficulties met in satisfying the requested targets, an assessment of the MSs policies to support biofuels, and a discussion about the main features of the (failed) birth of a new industry.

Keywords: Renewable energies; biofuels; biomass.

JEL Codes: Q 42; Q 48; Q 57.

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Introduction

Biofuels such as ethanol and biodiesel hold the promise of playing a relevant role in the renewable energy sources panorama, ensuring the achievement of multiple goals such as:

1) security of supply,
2) reduction of greenhouse gas (GHG) emissions,
3) development of business opportunities in the agricultural and rural sectors.

However, a number of issues fuel the debate over the real benefits of a steady development of biofuels, at least first generation biofuels: concerns the range of increase in agricultural prices to high production costs, from competition for land to achievable environmental benefits.

The European Commission, notwithstanding the increasing uncertainties surrounding biofuels, decided to confirm its support in December 2008 by approving the Climate Change Package, envisaging the target of 10% renewable sources energy in the transport sector by 2020: the previous targets, proposed by the Directive 2003/30, were 5.75% in the transport sector in 2010.

The Climate Change Package was finally approved on April 23rd, 2009 as Directive 2009/28/EC on the promotion of the use of energy from renewable sources, amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

The aim of the paper is to discuss, with reference to the EU: a) the recent performance of production and consumption of biofuels (Section 1); b) the main concerns regarding the feasibility and the advantages of the biofuel option, i.e. availability of land, benefits in terms of GHGs emissions, competition for food (Section 2); c) shapes and costs of the policy support (Section 3); d) the economic consequences of the biofuel option: the birth of a new industry and some hints of the macroeconomic consequences in Italy (Section 4); e) the general conclusions are presented in Section 5.

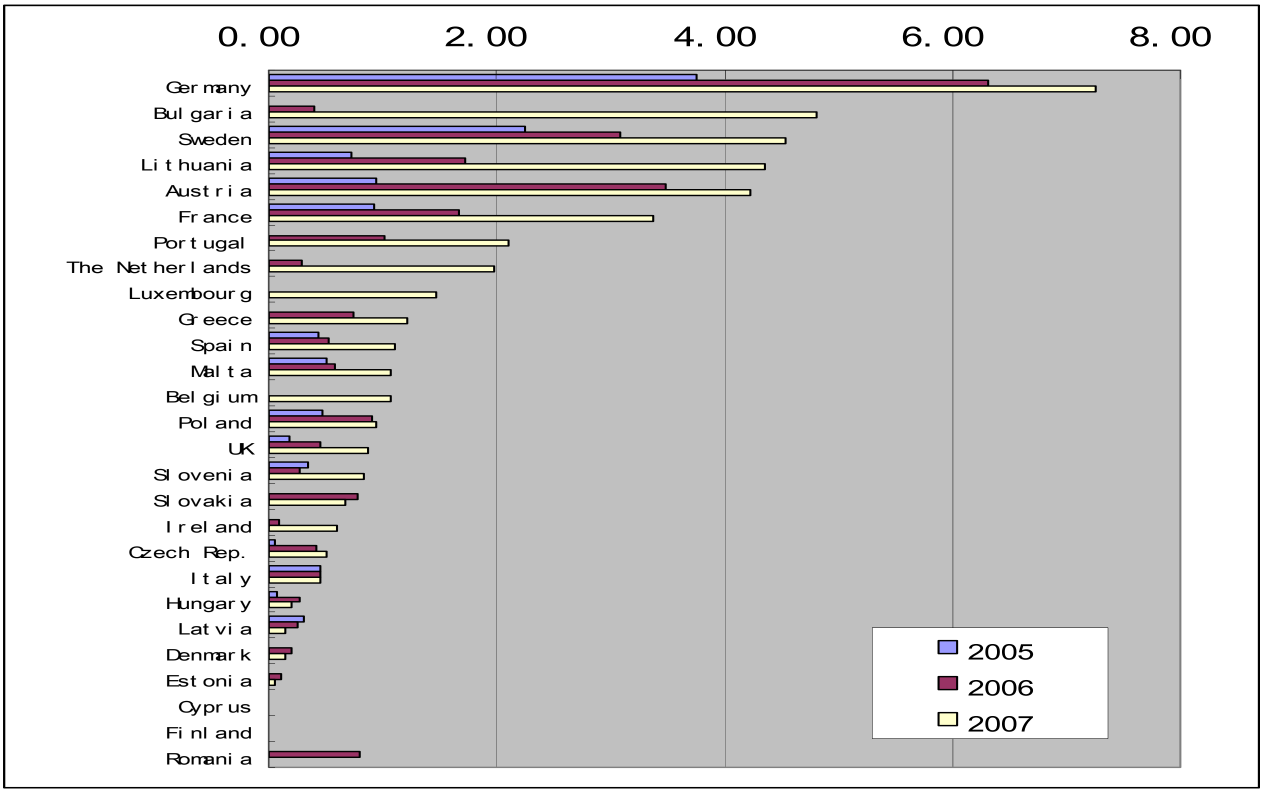
1. THE PATH OF PROGRESS IN THE USE OF BIOFUELS

Biofuels have experienced a steady development in Europe over the past few years. Currently, the European Union (EU27) is by far the main producer of biodiesel worldwide, and the ethanol industry is rapidly growing, as well.

However, most MSs and the Union as a whole are lagging behind as far as biofuels placed on the market are concerned. Notwithstanding steady increases in the amount of both biodiesel and ethanol placed on the market, it is very unlikely that the 5.75% target proposed for 2010 will be met.

Biofuels in 2006 accounted for 1.8% of all fuels; the percentage rose to 2.6% in 2007: given current trends a percentage of more than 4.2% in 2010 is unlikely to be achieved. Figure 1 illustrates the degree of penetration of biofuel in all MSs over the 2005-2007 time period:

Figure 1, Biofuel % shares in the transport sector: EU27 MSs



Source: MS Reports 2005, 2006, 2007 meeting the requirements laid down in Article 4(1) of Directive 2003/30/EC to report to the Commission the measures taken to promote the use of biofuels or other renewable fuels to replace diesel or petrol for transport purposes.

Germany is the biggest player, with over 7% biofuels placed on the market in 2007[3]. Many MSs experienced a steady increase (eastern Countries such as Bulgaria and Lithuania, but also France and the Netherlands), while others are lagging behind with no change of catching up in sight.

The total consumption of biodiesel in 2007 reached 6.8 Mtoe (25.8% of which imported), while the total consumption of bioethanol neared 1.28 MToe (31% imported). Table 1 summarises the progress of the biofuel market in Europe, both in physical and percentage terms:

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[3] In 2008, German domestic consumption decreased 16% from previous year. However, according to the estimates of the European Biodiesel Board, the whole EU production of biodiesel increased 35 % thanks to a strong increase of production in France and in other EU Member States.

Table 1, Fuels in Europe (2005-2007)

	Fossil fuel (Ktoe)	Biodiesel (Ktoe)	Vegetable oil (Ktoe)	Bio-ethanol (Ktoe)	Biofuel (Ktoe)	Share (%)	Total fuel (KToe)
2005	292876	2277	182.4	552	3011	1.02	295901
2006	303125	4082	648	881	5611	1.82	308751
2007	306295	6091	768	1246	8105	2.58	314400

Source: MS Reports

The biofuel market is very geographically concentrated, with a limited number of MSs (Germany, France, Spain, Sweden, Austria) representing over 80% of EU27 consumption.

EU27 is a net importer of both ethanol and biodiesel (since 2006): indeed, in 2007 the US implemented an aggressive policy with heavy subsides to exports, so that the so-called B99 (a blend with 99% biodiesel and 1% diesel) was placed on the European market at a very competitive price. This led to a formal anti-dumping investigation in June 2008, which eventually led to the imposition of punitive tariffs on B99 imports from the United States.

Little changed over the past few years in the Italian context: biofuels represent around 0.5% of fuels placed on the domestic market (0.46% in energy content, as of 2007). Only biodiesel is placed on the Italian market, while all of the ethanol produced is exported abroad, mainly to Sweden.

2. FACTORS AFFECTING THE PROGRESS OF BIOFUELS

2.1 The agricultural issues: available and needed arable land

Focusing on the hypothesis of achieving the past 10/20/20 EU targets, how much land would be needed in Europe? Many studies[4] have been carried out on the issue, providing a wide set of outcomes.

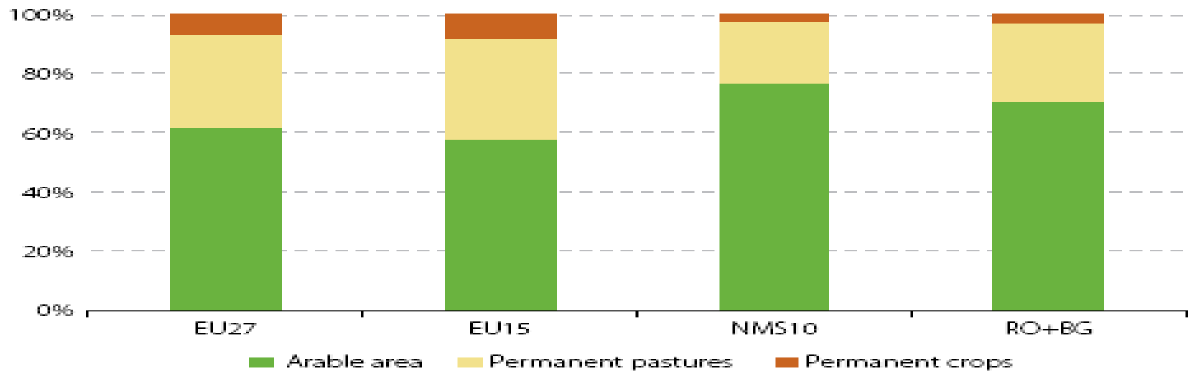
Indeed, actual European Agricultural land can be declined as follows (Figure 3):

[4] According to Frondel-Peters (2005) the target of the Directive 2003/30 (5.75 % of overall road fuel consumption in 2010) would have required, if completely met with Communitarian feedstocks, to use more than 11 millions ha, i.e. 13.6 % of total arable land. EEA (2006) achieves similar results in terms of arable land but as it considers wastes as well its conclusions are more favourable. EC DG Agri study (2007) stresses how about 17.5 million hectares would be needed, assuming: technological improvements and increases in agricultural yields (30% of biofuels coming from the *second generation*); oil prices around 48 USD per barrel; the exploitation of areas previously under the set aside regime

- arable land
- pastures
- permanent crops (vineyard, olive trees etc)

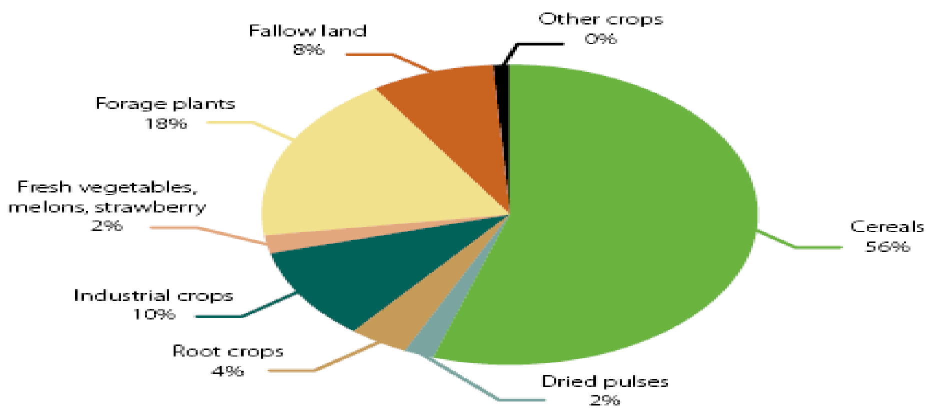
EU27 stretches over 432 million hectares. Around 160 million are agricultural land, of which just over 100 million are arable land (Eurostat 2008)[5].

Figure 3, EU Agricultural land



Cereals play a relevant role if we focus on arable land (Figure 4), with around 58 million hectares, 19 million hectares are cropped with forage plants and other cultivations play only a marginal role:

Figure 4, EU arable land



On an available arable area of around 100-105 million hectares, 15% should be devoted to energy crops, according to the previously mentioned EC study, as to provide the feedstock necessary in order to comply with Bruxelles targets.

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[5] Agricultural Statistics. Main Results 2006-2007. EUROSTAT 2008

Given current figures (around 4 million hectares dedicated to energy crops), this would imply a steady development of biofuels' feedstock cropping, with further pressure on European agriculture.
Such overstretching of feedstock demand is expected to impact on both the availability and prices of alimentary goods. It is the so-called *competition for land* issue, where an increase of biofuel production would imply a shift to an agro-energy of land before it is cropped for traditional purposes.

2.1.1 Agricultural areas dedicated to energy crops

Table 2 summarises the area dedicated to energy crops in Europe in the past few years

Table 2, Land dedicated to energy crops (mio ha)

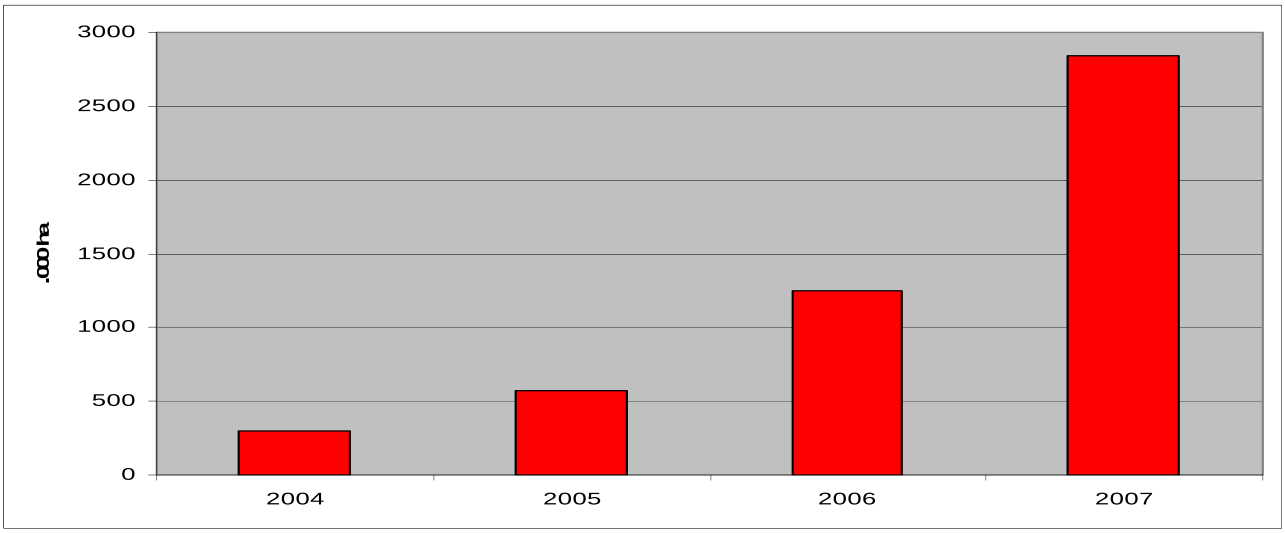
	2004	**2005**	**2006**	**2007**
On set aside area, of which	0.5	0.9	1.0	1.0
- oilseeds	0.5	0.7	0.8	0.8
(rapeseed)	0.4	0.7	0.8	0.8
- cereals	0.0	0.1	0.1	0.1
On "Energy crop premium" area, of which	0.3	0.6	1.3	2.8
- oilseeds	0.2	0.4	0.9	2.0
(rapeseed)	0.2	0.4	0.8	2.0
- cereals	0.0	0.1	0.2	0.3
On areas without incentives, of which	0.8	1.6	1.4	0.2
- oilseeds (rapeseed)	0.8	1.3	0.9	0.1
- cereals	0.0	0.3	0.4	0.0
TOTAL	1.6	3.1	3.7	4.0

Source: DG Agri, 2008

The set-aside regime has been introduced in the late 1980s in order to balance cereal supply excess; while at first the percentage of area to be set aside varied on a yearly basis, it has been set to 10% in 1992 and never changed until last season, when the set-aside regime was (temporarily, and later permanently) suspended to increase cereal production.
On the other hand, the supporting tool of the Energy Crop Premium (45 € per hectare where energy crops are grown) swiftly developed, covering 1.2 million hectares in 2006 and almost 3 million

hectares in 2007 (Figure 5). It has therefore been necessary to adopt a coefficient (around 70%), in order to comply with the Communitarian budget of 90 million €.

Figure 5, Energy Crop Premium in EU



2.1.2 The Italian case

Focusing on the Italian context, 35.500 hectares benefit from the Energy Crop Premium scheme. This is a modest result, if compared to that of other European Countries (646.000 in Germany, 718.000 in France and 182.000 in Spain).

Set-aside area figures are illustrated on Table 3:

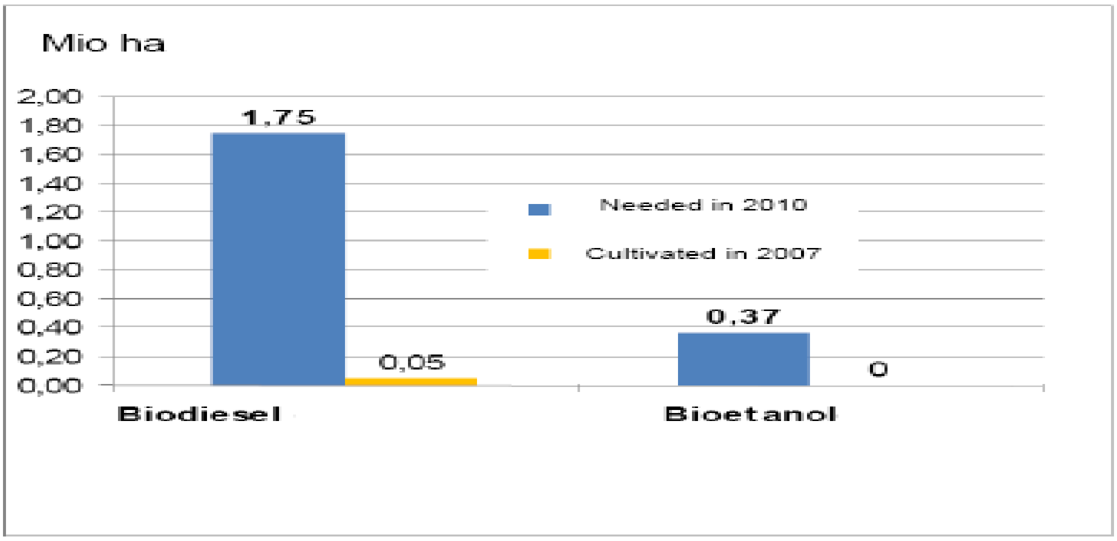
Table 3, Set aside in Italy (000 ha)

	2007-08	2008-09	Difference
Obligatory set-aside	217	0	-217
Voluntary set-aside	125	283	+158
Total of idle land	342	283	-59

The situation reflects what happened at the European level, with a partial shift from idle to cultivated land, leaving 59.000 hectares set aside.

As far as the cropping area is concerned, Italy needs to fulfil communitarian targets; Nomisma Energia provides the following results (referring to the indicative goal of 5.75% biofuels by 2010):

Figure 6, Arable land needed in Italy



Source: Nomisma Energia

To achieve the 5.75% target, more than 2.1 million hectares would be needed, where the theoretical potential is only 600.000 hectares. In 2007, only 35.000 hectares were dedicated to energy crops in Italy (77% sunflower, 23% rapeseed). As a consequence, it appears necessary to recur heavily on imports in the future.

2.1.3 Feedstock production

The trend of the European production of energy crops is difficult to track. Rapeseed alone experienced a fierce increase from 11 to 16 million tons. Figure 7 shows the production trend of typical energy feedstocks in the past few years

Figure 7a, Feedstock production in Europe 2001-2007

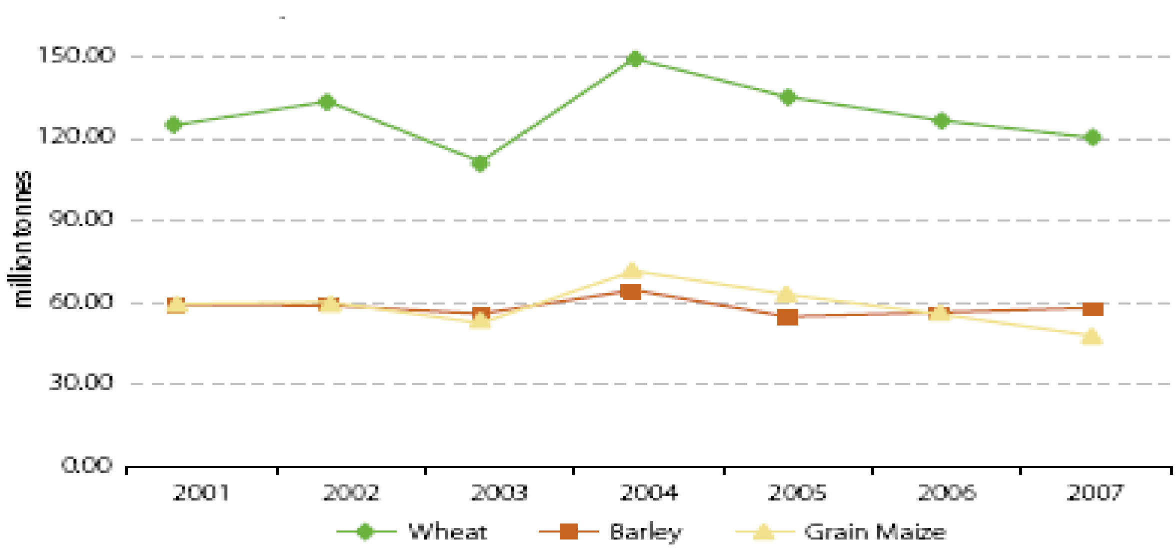


Figure 7b

Source: Agricultural Statistics. Main Results 2006-2007. EUROSTAT 2008

The data available for Italy shows that current trends are favorable for grain, while other crops such as soybean or some oilseeds are losing ground (Table 4).

Table 4, Change of feedstocks in Italy, 2007/08 vs. 2006/07

Feedstock	**Variation 2007-08 / 2006-07 (%)**
Soft wheat	8.9
Durum wheat	20.1
Barley	11.3
Corn	3.8
Sorghum	18.1
Other cereals	0.2
Sugarbeet	-16.6
Rapeseed	38.1
Sunflower	-16.8
Soybean	-14.5

Source: ISTAT

There has been an increase in the land cultivated with cereals (durum wheat above all) and a decrease in other biofuel feedstocks such as sugarbeet, sunflower or soybean.

The increase in wheat production reflects its higher profitability spurred by an increase in prices deriving from the shrinking of European stocks as well as the exploitation of areas previously dedicated to set aside, while the decrease in sugarbeet cultivation has its roots in the sugar reform limiting the amounts of sugar to be produced.

Oilseeds in general decreased in favor of more profitable crops (wheat), with the relevant exception of rapeseed (+38.1%), which anyhow plays a marginal role in the Italian agricultural framework.

2.1.4 Agricultural yields

Productivity is clearly linked to agricultural yields, which vary significantly depending on a number of variables such as:

- Geographical location and characteristics of the arable land
- Weather conditions (rainfall, draughts etc)
- Cropping techniques

Average yields for cereals in Europe are around 5 t/ha for grain and 6.5 t/ha for corn, but with strong differences among Member States, as Romania and Bulgaria have a far lower productivity per hectare compared to other EU Countries. The same applies for biodiesel feedstock.

Furthermore, yields vary not only according to different Member States, but also within a given Country. In Italy, for instance, cereals show yields varying significantly from region to region (Table 5).

Table 5, Cereal yields in Italy

Feedstock	Min (t/ha)	Max (t/ha)
Grain	1.27	6.46
Barley	1.26	6.21
Corn	3.18	12.25

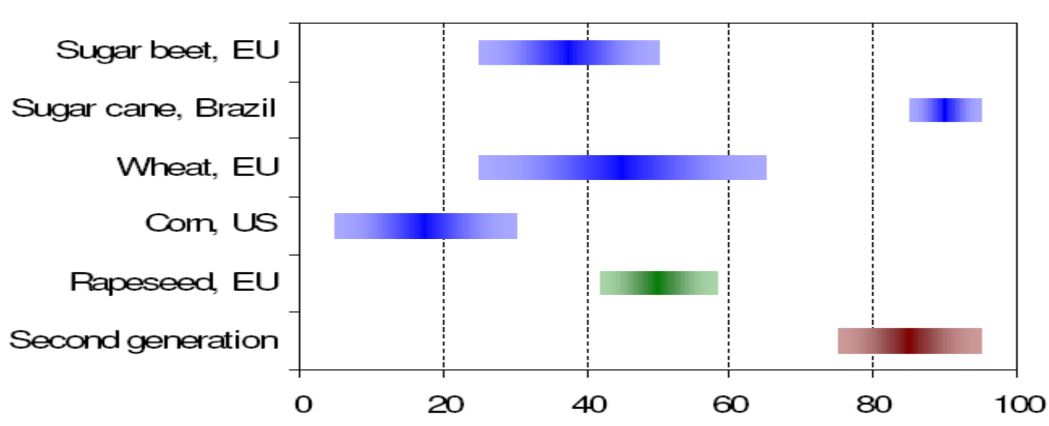
Source: Venturi & Venturi, 2005

2.2 GHG EMISSIONS

A crucial issue in the debate over the real benefits of biofuels is represented by the reduction of polluting emissions in the atmosphere.

It is difficult to simplify the answer stating that either biofuels *do* or *do not* lead to a decrease in GHG emissions in comparison with their fossil fuel counterparts. Indeed, biofuels vary significantly in terms of the feedstock used, land used for its cropping, agricultural techniques, production processes, logistics, and so on. Figure 8 illustrates how the range varies not only from feedstock to feedstock, but also (and significantly) within a given category.

Figure 8, GHG emissions reduction (%)



Source: GBEP 2008

Second generation biofuels represent a great opportunity to further strengthen the environmental benefits of biofuels. However, to date some specific fuels such as Brazilian ethanol from sugarcane are already highly competitive from such perspective, with a decrease in GHG emission of 85%-95%. US corn, on the other hand, ensures a considerably smaller saving of polluting emissions, within the 5%-30% range. European biofuels seem to stand in the middle, with rapeseed (RME) biodiesel in the 40%-60% range, wheat ethanol 25%-65% and sugarbeet ethanol (25%-50%).

If we focus on the European context, it is possible to assess the effective GHG savings that have been achieved thanks to ongoing policies. Moreover, assuming that both current consumption patterns and the mix of feedstock used for producing biofuels remain constant, it is possible to evaluate the savings that could be achieved in the (unlikely) event of reaching the target of 5.75% by 2010.

It is indeed possible to build a matrix of both current and future GHG savings by applying a coefficient of such savings – shown in Table 6 - to each type of biofuel chain, then *weighting* the results as to obtain the saving of a given MS.

Table 6, Percentage of CO2 reduction by type of feedstock

Biofuel	**% of CO2 reduction (typical values)**
Ethanol from sugar beet	61
Ethanol from Maize (heat from methane in cogeneration)	56
Ethanol from wheat (heat from straw)	69
Ethanol from sugar cane	71
Ethanol from barley	62*
Ethanol from rye	62*
Ethanol from triticale	62*
Biodiesel from rapeseed	45
Biodiesel from sunflower	58
Biodiesel from oil and/or fat recycled	88
Biodiesel from soybean	40
Biodiesel from palmoil (process not specified)	36

** : In absence of accurate data on the GHG savings achievable from the pathways of such cereals, we use an estimated coefficient of 62%, which is the average of the savings achievable from other cereals (e.g: wheat, maize)*

Such coefficients can be applied to the biofuel placed on the market in each MS, disaggregated by feedstock, on the assumption they are completely met by domestic production, which is known.

Based on the available data and literature (EBB, Assocostieri etc), we can assume the following breakdown of feedstocks:

- 70% RME
- 20% soybean
- 10% sunflower

GHG savings among biofuels: 45,30%

Overall GHG savings: 0,4530*0,46%= 0,21%

GHG savings if the 5.75% target is met: 2,60%

Table 7 summarises the findings of the above analysis.

Table 7, Biofuel-led GHG savings in Europe (all data in percentage points).

MEMBER STATE	Biofuel share	GHG savings among biofuel	Overall GHG savings	GHG savings (5.75% scenario)
Austria	4.23	47.59	2.01	2.74
Belgium	1.07	45	0.48	2.59
Bulgaria	4.82	62.41	3.01	3.59
Cyprus	-	-	-	-
Czech Rep.	0.50	45	0.22	2.59
Denmark	0.14	62	0.09	3.70
Estonia	0.06	45	0.03	2.59
Finland	0.02 (2006)	36	0.0072	2.07
France	3.37	48.84	1.65	2.81
Germany	7.26	46.68	3.39	N.A..
Greece	1.21	58	0.70	3.33
Hungary	0.20	62.36	0.12	3.59
Ireland	0.59	45	0.27	2.59
Italy	0.46	45.30	0.21	2.60
Latvia	0.14	45	0.06	2.59
Lithuania	4.35	51.46	2.24	2.96
Luxembourg	1.46	45	0.66	2.59
Malta	1.07	66.5	0.72	3.82
Poland	0.94	60.71	0.57	3.49
Portugal	2.10	58	1.22	3.34
Romania	0.79	52.64	0.48	3.03
Slovakia	0.67	56	0.38	3.22
Slovenia	0.83	45	0.37	2.59
Spain	1.11	56.39	0.63	3.24
Sweden	4.53	58.44	2.65	3.36
Netherlands	1.98	52.05	1.03	2.99
UK	0.87	49.71	0.43	2.86
EU 27	**2.6**	**49**	**1.27**	**2.82**

Then EU 27 has a biofuel share of 2.6% in road fuels, and an average GHG saving of 49%. Current overall savings are hence around 1.27%, which could reach 2.82%, in the case of meeting the 5.75% target.

To date, only 6 MSs are above the European average in terms of both the biofuel share and GHG emission savings, but given their importance (e.g: Germany), they counterbalance the vast majority of MSs with lower biofuel shares, and hence lower GHG emission savings.

Focusing on the physical savings in terms of CO2, more than 11.6 billion Kgs of CO2 have been saved by shifting to biofuels. More specifically, we notice how the emissions associated to traditional fuels are the following:

- gasoline: 2,38 kg CO2 per litre
- diesel: 2,65 kg CO2 per litre

In 2007, the use of biofuels replaced the following amount of fossil fuels:

i) 1593,1 million litres of gasoline

ii) 7729,9 million litres of diesel

If we apply the above mentioned coefficients, we understand that 24.28 Mtons CO2 that would have been emitted in the atmosphere have been partially saved. We say partially because the figure represents the gross savings achieved, as biofuels, even if are less pollutant, cause some emissions in the atmosphere, as well. The net saving can be calculated by multiplying the gross savings for the average percentage of emissions saved by biofuels (49%).

We hence obtain the net savings achieved in the EU in 2007, thanks to the biofuel placed on the market and consumed:

11.9 Mtons CO2

If the current split between gasoline and diesel are maintained (with similar disaggregation of pathways, as far as biofuels are concerned), the achievement of the 5.75% target would ensure savings of 26.32 Mtons CO2 (if current levels of consumption remain constant).

2.3 Competition with food

The past sharp increase of food prices was likely to be the major driving force that reduced collective consensus on biofuels in 2007-2008.

Of course, competition for land is only one of the issues which weakened the evaluation of the worth of the 1st generation biofuels. It is however curious that there is no agreement among international organizations and other institutions or single scholars about the amount of responsibility of biofuels on food inflation occurring in 2007-2008.

In the EU Countries as a whole, biofuel policy was launched by Directive 2003/30. As required, it was followed by an impact analysis of its major requirements (CEC, SEC(2006) 142)[6] : should the requirements (5.75%) in terms of 2010 biofuel consumption share in the road transport be met, real[7] oilseeds prices are expected to increase by 5-12 or 15% in 2010 with respect to 2005, without remarkable difference on whether the increase of consumption had to rely more on European production (rapeseed oil, sunflower oil) or import from abroad (palm oil, soya oil). Cereals prices are expected to increase by 6-11% in case of predominant domestic provision of feedstocks, while a decrease is expected (-15 or -20%) in the case of predominant imported provision. As a whole, the expected food price effect would be rather negligible.

Different evaluations of the role of biofuels in food inflation occurred in 2008. In June 2008, Bodman and Schafer[8], who were US Secretary for Energy and US Secretary for Agriculture respectively, claimed that the growth of the US biofuel (mainly ethanol) production was responsible for less than 10% of the increase of global food prices from April 2007 to April 2008, and more directly responsible for 23%, 31%, 26% and 24% respectively for corn (maize), soybeans, soybean meal and soybean oil. In the same period IMF estimates that increased demand for biofuels account for 70% of the increase in corn prices and 40% of the increase in soybean prices[9].

The toughest evaluation came from World Bank[10]: in the Mitchell words "the remaining 70-75% increase in food commodity prices was due to biofuels and the related consequences of low grain stocks, large land use shifts, speculative activity and export bans" (p. 17 of the Mitchell paper).

What is surprising in this discussion is that there is a mutual agreement that there were a large number of causes that triggered off the increase in prices, and everyone agrees in quoting the real causes; but there is no agreement about the weight of the single contribution.

The factors behind the 2007-2008 increase in food prices can be summarized in table 8.

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[6] CEC, SEC(2006)
[7] I.e. over the overall inflation rate
[8] S.W. Bodman – E.T. Schafer, 2008,
[9] J. Lipsky , 2008
[10] D. Mitchell, 2008

Table 8, Causes of the price increase of food products, 2007-2008

	Supply	Demand
Low variance (high predictability)	Technology Total harvested area Climate change Productivity	↑ population ↑ purchasing power Dietary changes and tastes Meat and livestock economy
High variance (low predictability)	Drought and natural disasters Plant diseases Crop-specific harvested area Oil price Fertilizer cost	Exchange rates Speculation Government trade and inventory policies Hoarding Biofuels (predictable when driven by government policies; unpredictable when driven by the increase of oil price)

Source: Timmer 2008

According to Timmer's analysis, it is possible to split the food price increase factors in two groups, depending on their level of predictability (which is strictly correlated with variance). When the degree of predictability is low, demand and supply are able to adjust in volume terms, without strong and sharp tensions on prices. The latter occurs when changes in demand or in supply are difficult to foresee, such as: droughts, plant diseases, changes of cultivation areas, oil prices as well as fertilizer prices on the supply side; while on the demand side the factors are exchange rates, speculation, stock policies driven by Governments, hoardings, plus an additional demand coming from biofuels: its effects can be predicted when they derive from government policies, but are not easy to predict when their demand is caused by the increase in oil price.

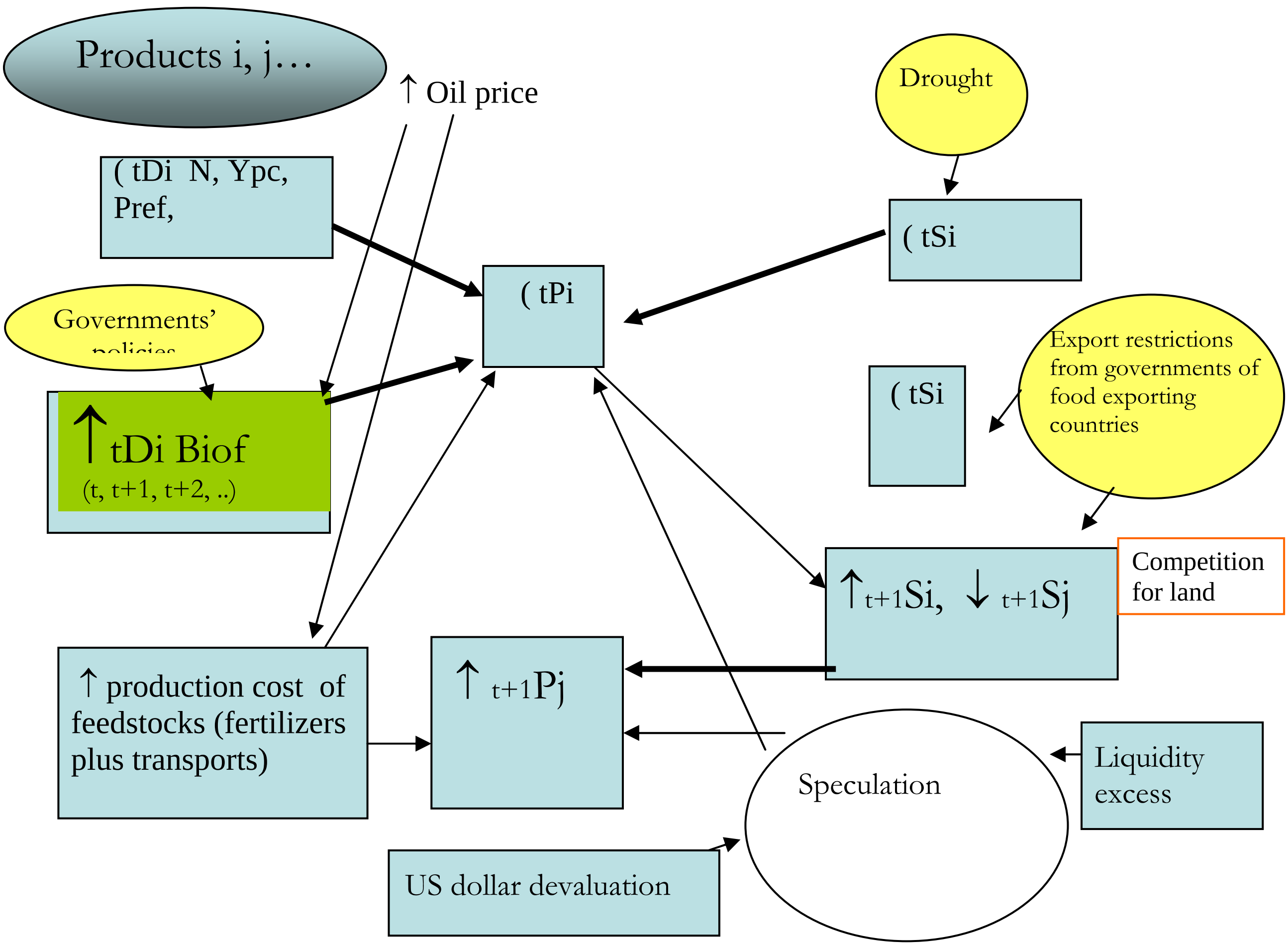
A better picture of the factors increasing food prices, emphasizing the causes of transmission of price increases from a product to another, is provided in figure 9, where seven single causes (or bundles of causes) are specified.

The increase in food prices is a complex factor, which gathers:

1. Reduction of the supply of the product **i**, caused by droughts and other natural causes, plus India's decision to build back strategic stocks (sharp, unforeseeable);

2. Increase of the demand of the product **i,** caused by the growth of income per capita, population and by the changes in consumer tastes in China and India (continuous, predictable);
3. Increase of the demand of the product **i,** used as a feed-stock for biofuels (sharp, unpredictable);
4. Increase of the cost of production of the product **i,** directly caused by the increase of the price of oil, which is a component of fertilizers and affects costs of transport (sharp, unpredictable);
5. Increase of the demand of the product **i,** for purposes not linked to the consumption of the product but for speculative reasons, due to the excess of liquidity and partially connected to the devaluation of the dollar vis-à-vis euro (which prompts financial investors to buy raw materials priced in dollars) (sharp, unpredictable);
6. Reduction of the availability of the product **j,** because the amount of field previously bounded to **j** diminishes, to the benefit of cultivation of **i** **(competition for land**): a higher availability of **i** can be obtained only by removing (the utilization of) land to **j** (sharp, predictable);
7. Reduction of the international availability of **i** and **j**, because of restrictions to exports caused by the Government of the exporting Countries, due to (possible and already occurred) riots for lack of domestic food (sharp, unpredictable).

Figure 9, Main factors behind the increase of prices of the various food products



As a matter of fact, feed for livestock is the major outlet of cereals, and biofuels explain a small percentage of oils consumption (except for Europe) (table 9).

Table 9, Outlets of feedstocks with respect to domestic production, 2006 (%)

	Food	Feed	Fuel
Maize (US)	15	62	24
Four oils (World)	95	←	5
Four oils (EU 25)	78	←	22
Four oils (US)	92	←	8

Note: Four oils → rapeseed, sunflower, soy, palm
Oils: figures for food include percentages for feed
Source: USDA, DGAGRI, World Oil

However, biofuels did represent a major outlet in dynamic terms, as for US maize, domestic demand for biofuels increased by 794 bln bushel between 2004/05 and 2006/2007, while domestic demand for feed decreased by 560 during the same period.

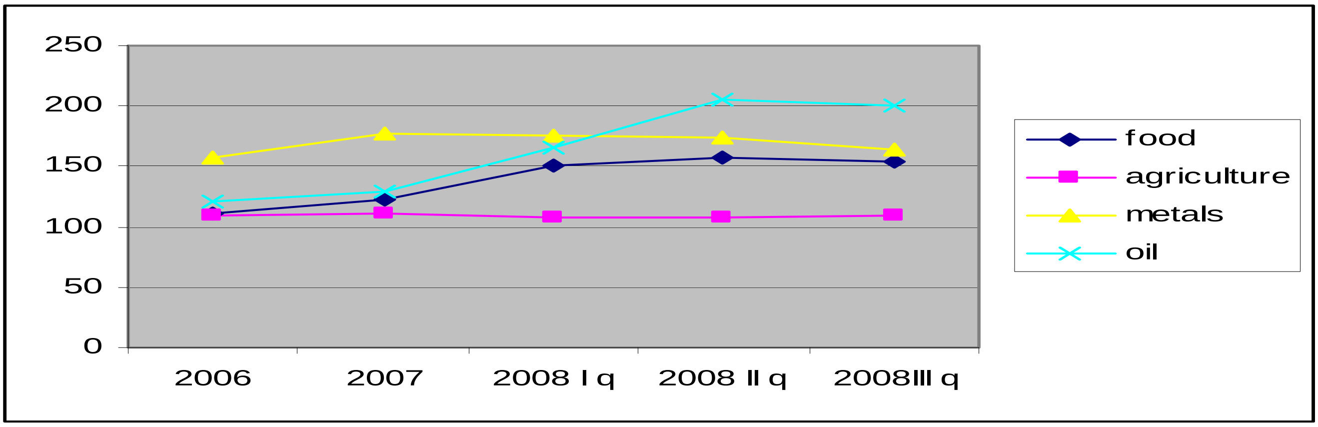
Then maybe the direct responsibility of biofuels for the food increase exists, but it has been overemphasised. The indirect responsibility must still be ascertained, given the existence of many interconnected causes. Finally, the responsibility of speculative reasons is methodologically difficult to point out: there is however some agreement that they are important (Gilbert, 2009).

The differences between the phases of the period are stressed when attention is focused on graphs (Figure 10).

At the peak of the price rise (summer 2008, i.e. between second and third quarter of 2008), the higher increase with respect to 2005 was reached through oil price, metals being the second one.

The increase of metal price is the greatest between 2005 and 2006, but later it became stagnant or even decreased. Oil price strongly increased between 2007 and 2008, and within 2008, up to second quarter; it decreased slightly in the third quarter of 2008. At the end of the period it marked the highest price level. Food price strongly increased between 2007 and 2008, like oil, but unlike oil its price does not increase significantly between the first two quarters of 2008. Non-food agricultural product prices stagnated throughout that period.

Figure 10, Dynamics of price levels for food, non food agricultural products, metals and oil (2005=100)



Source: IMF

The connection between food-oil is rather simple to explain, considering their parallel increase in the period 2007- 1st quarter 2008. However, the correlation is less clear in 2008.

3. POLICIES TO SUPPORT BIOFUELS

3.1 Reasons for Government involvement

Of course, in absence of supporting policies the biofuel industry cannot develop in a spontaneous way, as the costs of production of the various kinds of biofuels are higher than those of the fossil fuels they are substituting, the Brazilian ethanol from sugarcane being the only exception. However, even in Brazil, the government's support in various times has been historically fundamental in order to push the industry.

The recent crisis told us that this statement is true even when the oil prices soar to more than $ 130/bbl, as also prices of biofuel feedstocks increase. This is one of the most important truths learnt after the 2007/08 crisis, as it denies past analysis claiming the achievement of the competitiveness of biofuels reached when oil price should have been able to touch a certain amount of dollars per barrel.

Of course not every production which is not competitive in the market should be stimulated by Government intervention. Only one kind of production should be promoted: outstanding industries providing remarkable externalities[11].

In the case of EU, the recognized external economies stemming from biofuels were three:

- reduction of external emissions of GHGs, in order to slow down the climate change;
- security of supply, in order to reduce and differentiate EU energy supply channels from abroad;
- improvement of the rural income and conditions, in order to reduce existing gaps within EU, and to create new outlets to the farm production.

According to an Oecd questionnaire submitted to 17 Countries (Figure 11)[12] (Oecd, 2008):

- support policies are given more for a bundle of priorities rather than for a specific objective;
- however, GHGs' emission reduction appears to be among top priorities for most Countries;
- the reduction of energy import dependence is one of the main objectives for some Countries (especially in Europe) but not for all (e.g: Brazil);

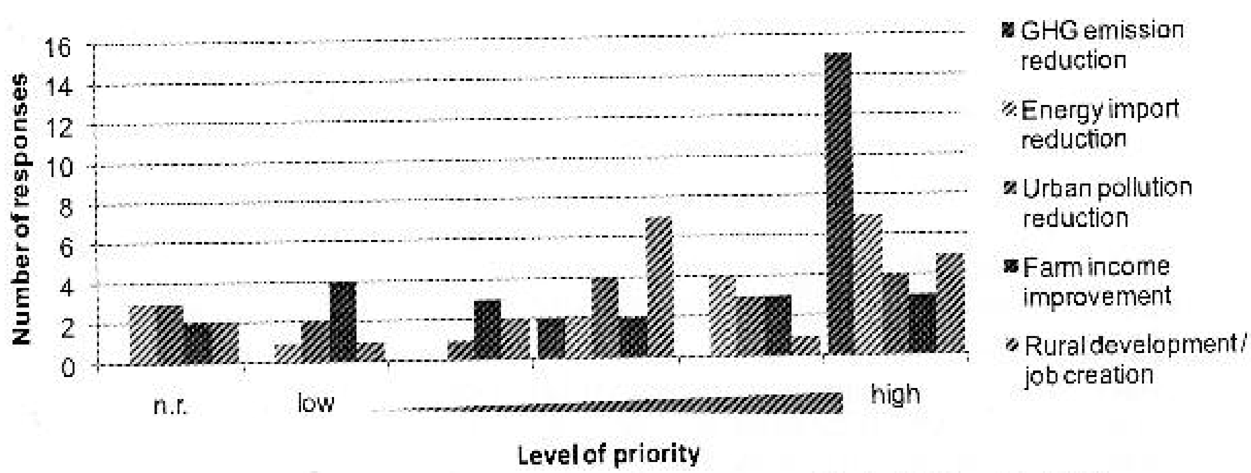
[11]. Here is room for the Odagiri approach, where the State acts traditionally as a social planner. Let us suppose a case where the domestic market for the i-goods does exist, but they are satisfied only by imports. A private domestic supplier will not enter the market, because it should bear huge sunk costs. The credit market (or the finance centre of a multinational firm) will not finance its entry: even if the new production will turn off profitable after the production start, because of the triggering off of scale economies, its discounted profits should reveal lower than the costs charged at the entry (the Negishi condition). If however the production of the new industry should be able to generate relevant positive externalities on the rest of the system, reversing the before mentioned welfare losses, the State could finance the entry. This occurs because the State is expected to maximize the collective welfare, while private entities maximize their own individual welfare (Odagiri, 1986; Ninni-Silva, 1997).

[12] Oecd does not list the countries which replied to the questionnaire.

- for some Countries, rural development and the creation of additional jobs is another top priority.

Figure 11, Objectives of policies supporting biofuels: Oecd questionnaires

Figure 1.8. Indications of priority of various objectives behind biofuel/bioenergy support policies



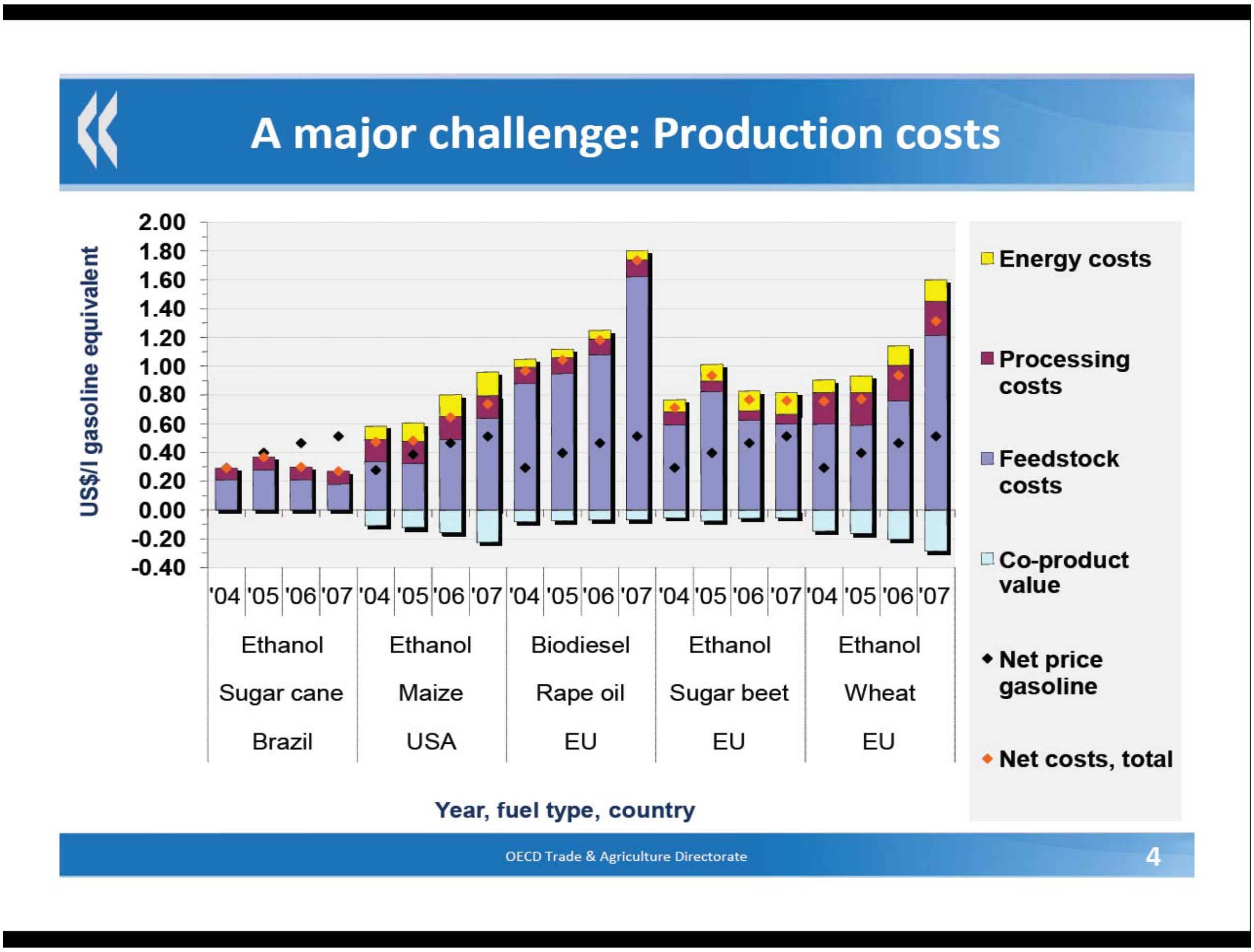
Source: Data from questionnaires provided to the OECD Secretariat between October 2007 and April 2008.

The first reason for supporting policies is of course the lack of cost competitiveness with respect to oil (net price of gasoline in Figure 12).

According to Figure 12:

- Brazilian ethanol from sugar cane is by far the cheapest biofuel;
- its cost of production decreased from 2005 to 2007, because of a reduction in the price of feedstock (which represents a large part of the cost of the biofuel)
- as its cost of production decreased while the price of gasoline increased, its competitive advantage with respect to oil widened;
- on the ther hand, the gap with respect to oil products increased in the case of the European biodiesel and European ethanol, made from wheat;
- the pattern of prices of raw materials sets the prices of biofuels, and partially their competitiveness: EU ethanol produced by sugar wheat is less costly than both EU ethanol produced by maize and US ethanol produced by maize, even if it is still more expensive than Brazilian ethanol.

Figure 12, Inter-country cost comparison of 1st generation biofuels, 2004-2007



Source: Oecd

3.2 EU involvement

The involvement of EU as an institution materialized for the first time in 1997, through the White Paper "Energy for the Future: Renewable Sources of Energy".

The European Council in Goteborg (June 2001) focused on the strategy for sustainable development. Through it, in 2003, a specific strategy for biofuels was set through the Directive 2003/30, which posed "indicative" targets of 2% (to be reached within 2005) and 5.75% (to be reached within 31st December, 2010).

As analyzed at the beginning of our article, it was clear already in 2006 that nearly all Countries wouldn't be able to meet the targets, Germany; Austria and Sweden being the only exceptions. EU Commission launched a first Public Consultation in April 2006, where the main questions posed were a) is the biofuel promotion policy still a valid objective? b) For which reason were targets not met?

According to the replies of the governments[13], to promote 1st generation of biofuels was still considered a worthwhile aim[14], provided that economic, environmental and energy costs were assessed: only Denmark, among EU governments, opposed the 1st generation temporary step suggesting passing directly to the 2nd generation.

The quoted reasons for the failure to meet targets were manifold: clashes with the Fuel Quality Directive, reductions of the level of incentives and rigidity of the domestic supply of feedstocks (all subject to the high costs of production of biofuels) were considered to be the major hindrances to the development of biofuels.

In view of a revision of the Directive 2003/30, the European Council in Brussels (March 2007) proposed a different goal for the strategy of biofuels: the percentage share of biofuels with respect to road fuels became 10% instead of 5.75%, aiming to reach this in 2020 instead of 2010; it should be a binding target, instead of being an indicative target.

However, meeting this target is subject to three provisions:

- the production of biofuels should be sustainable in an environmental and social perspective;
- 2nd generation biofuels should reach the level of commercialization;
- Fuel Quality Directive should be emended in order to attain suitable levels of blending.

All the provisions were furthermore conditional to a general clause: biofuels should be expected to reach cost competitiveness.

A second Public Consultation [15] was launched on April 2007, concerning the definition of 2nd generation biofuels, sustainability and certification.

As far as the definition issue is concerned, the Commission proposes the choice between a new technology or a new raw material (or part of it) with respect to 1st generation biofuels. The bulk of replies are divided between a) to suggest “other raw material” as major feature characterizing the 2nd generation biofuels (in order to reduce competition for land with respect to food products: note that the big food inflation was not yet started) and b) the choice between technology or raw material is unimportant, what is important is that the new biofuel allows a minor level of emissions of GHGs.

According to the 2007 public consultation, the additional sustainability conditions suggested by the UK, Dutch and German Governments include: a) a positive GHG balance of the production chain of the biomass; b) biomass production must not be at the expense of important carbon sinks in the vegetation and in the soil; c) the production of biomass for energy must not endanger the food

[13] The replies came only from Denmark, France, Germany, Ireland, Latvia, Netherlands, Slovakia, United Kingdom.

[14] The officially recognized reasons were: energy security of supply (above all), reduction of GHG emissions and rural development.

[15] The consultation paper is at http://ec.europa.eu/energy/renewables/consultations/doc/2007_06_04_public_consultation_biofuels.pdf

supply; d) biomass production must not affect protected or vulnerable biodiversity and will, where possible, has to strengthen biodiversity; e) in the production and processing of biomass the soil and the soil quality are retained or improved; f) in the production and processing of biomass ground and surface water must not be depleted and the water quality must be maintained or improved[16].

The bulk of these sustainability conditions and criteria fit into the set of proposed directives on 23 January, 2008. It states that "each Member State shall ensure that the share of energy from renewable sources in transport in 2020 is at least 10% of final consumption of energy in transport in that Member State" (art. 3).

But it requires also:

- mandatory requirements to biofuels about 35% minimum GHGs saving with respect to oil products;
- prohibition to utilize (for the production of biofuels) grounds with high carbon stock (wetlands and continuously forested areas);
- prohibition to utilize (for the production of biofuels) areas characterized by recognized high values of biodiversity, like forests undisturbed by significant human activity, areas designated for nature protection purposes, highly biodiverse grassland.

The sanctions which cannot fulfil these requirements proposed for biofuels are the following:

- they cannot be accounted for in the 10% target;
- they do not reserve special treatment for State aids and incentives.

The bulk of these requirements remains in the official Directive 2009/28/EC

3.3 The national measures

3.3.1 The general measures: tax exemptions and blending obligations

Historically, the main measures at the national level to fulfil the target requirements imposed by the Commission were: the (partial or total) exemption by excise and obligations to mixture.

The rationale for these measures is quite simple, and it starts from the gap between the market price of biofuel (because of the cost of the feedstock) and the market price of oil products. As the market price of the oil products is usually formed by the sum of its cost of production plus the

[16] It is interesting to make reference to a particular point of view, which underlines how the issue of biofuels is politically difficult to manage: according to the Government of Malaysia, assessment of the sustainability is an issue which has to be managed by the country producing feedstock, where its Government is the only entity able to provide certification.

margin of distribution plus VAT plus the indirect tax (excise), the latter accounting in many European countries for more than half of the market price of oil product, a good solution is to (make similar or) equalize the price of the two fuels by reducing or removing the charge of the excise for the biofuel, while keeping (or even increasing) it for the oil products. In this case, it i the partial or total exemption from the excise.

This measure is a powerful support to biofuel development. However, it reduces the fiscal revenues going to the States. It has correctly justified the debate on the excessive cost of the biofuel support. Furthermore, this measure ensures that the required mixture target is reached (as 10%) only by chance.

To protect their own fiscal revenues and to head directly towards the target, many Governments – Germany first of all – have recourse to the "obligation to mix": oil distributors and retailers are required to refuel customers at petrol pumps with a pre-specified mixture of oil and biofuels. Often the mixture is increasing with time within a time span of four to five years.

Obligations are theoretically less expensive for Governments than tax exemptions, as there is no reduction in tax revenues, but are riskier, because by causing a (admittedly light) increase in prices[17] they can involve a demand reduction (and then in fiscal revenues as well)[18].

3.3.2 The time evolutions of tax exemptions and obligations to blend

Before 2006, tax exemptions were the most frequently used measures in 2005-2006. All European countries adopted it in 2005-06, except Finland[19].

In contrast, obligations to blend were far less frequent: only Austria, France[20], Lithuania, Slovakia, Slovenia and Sweden adopted it in 2005-2006.

Most of the Governments of EU countries replying to the First Public Consultation in 2006 claimed that a way to overcome this unsuccessful performance could be the imposition of the obligation to blend.

Maybe for this reason, in 2007-2008 more countries pass to adopt the obligation to blend, keeping excise exemptions however, albeit less generous.

Some countries utilize the quota mechanism (Belgium, France, Italy, Ireland, Portugal): the States established a yearly amount of biofuels which is shared among different suppliers from different European countries through calls for proposal. Of course, this mechanism allows Governments to

[17] If pre-tax costs of provision of biofuels remain higher than pre-tax costs of provision of traditional fuels.
[18] Comparsions of the two sets of measures are provided by De Gorter-Just (2007).
[19] Finland grants partial relief from excise duty only for biofuels involved in R&D projects.
[20] Where the success of TGAP (Taxe General sur les Activités Polluantes) is told to be high.

decide the amount of biofuels that has to be supplied each year, so that a more dirigistic approach prevails. No country decided to modify this approach during that period.

The current (2007/2008) situation is the following:

- Belgium; Bulgaria; Hungary; Ireland; Latvia; Lithuania and Romania adopt exemptions;
- Czech Republic; Germany; Luxembourg and Netherlands adopted the obligation to blend;
- Austria; France, Italy, Portugal, Slovakia, Spain, Sweden and United Kingdom adopted both the measures.

According to a very naïve evaluation, based on the average of the rates of growth of biofuel consumption linked to the different combinations of measures, to keep on tax relieves or, in this case, the obligation to keep them adding to blend appear the most successful measures. The reasons seem obvious: continuous tax relief build up a habit for customers, who like to go on purchasing biofuels without paying higher prices, which reflect the persistency of a gap in the costs of production between fossil fuels and biofuels. A passage to the obligation to blend is probably needed to reach the required target, but it should be strongly sustained by tax relief; in absence of this, it seems more difficult to reach target (because it is more expensive for the consumers, who can react by reducing the overall demand for fuels).

According to a SWOT approach, benefits and drawbacks of the two sets of measures are compared in Figure 13.

Figure 13, Tax exemptions vs. blending obligations: a standard SWOT analysis

Policy measures (direct impact on agricultural production)	**Strengths**	**Weaknesses**
Tax exemptions (the agricultural produce increases, according to variations in relative prices)	• Easy to implement; • Few market risks; • Incentive to innovation; • Suitable for the early stages of development	• Loss of fiscal revenues; • Risks of overcompensation (proposal of to high tax reduction); • Strongly dependent on the initial levels of the excise: it is effective where these levels are significantly high
Blending obligations (the agricultural produce increases, independently from variations in relative prices)	• It injects certainty in the agricultural sector; (unless the subsequent increase in prices significantly penalize the agricultural supply) • It does not involve additional costs for public budget; • Suitable for the more advanced stages of development	• Higher prices for taxpayers; • Less incentive to innovate; • Higher prices variability; • Difficult to implement and monitor

Source: Refuel (2008)

3.3.2 Other, more specific measures

Finally, the support to biofuels also occurs through specific measures.

Agriculture measures include set-aside areas and energy crop premia. Even if both instruments are largely used for the creation and diffusion of the biofuel industry, they are different. The Energy Crop Scheme has been planned and used for this purpose (together with providing biomass for heat and electricity). The Set Aside scheme has been planned and used for other purposes: farmers are paid independently on what they produce, so the incentives to direct yields towards different outlets depend on prices which the farmers are able to obtain on the market through contracts, rather than from upstream support to the farmers tying the direction of their products.

Other specific measures focused on agriculture have been introduced by single Countries (for example Belgium, Greece, Ireland, Lithuania and Poland).

Excluding R&D policies, measures for industry refer above all to the current transformation localised in the agro-industry (Cyprus, Czech Republic, Latvia, Lithuania and Poland).

Besides the contributions many Governments make to Small and Medium Enterprises operating in poor regions or in rural countries, some aid is provided through regional entities. For example, in the UK, the Scottish Executive and the Regional Development Agencies continue to offer support to operators in the sector.

Measures for the distribution sector are provided in few cases, like Sweden and the UK.

Interventions helping to purchase and maintain specific cars able to run on biofuels with a higher content than the accepted one by the car manufactures are adopted in different Countries, (Cyprus and Ireland, plus Sweden, where the reference is "the new eco-friendly car").

Finally, programmes for public procurement, as well as programmes for granting public awareness, are common in many Countries. However they refer to very little quantities of "clean" vehicles and often no room is left for purchasing biofuels through continuative long term contracts. Of course, they occur only for demonstrative reasons, as the size of the market involved by these purchases is too small to provide a substantial outlet for the production of biofuels, and to trigger off scale economies in the industry, as well[21].

3.4 The cost of the support

Considering only (partial or full) exemptions from excises and payments for Energy Crop Premia, it is possible to assess the cost for the public budget of the policies for the support of biofuels in EU 27 (Table 11).

We found overall figures very similar to those evaluated by Kutas-Lindberg—Steenblik[22] (KLS). The total (i.e. for both ethanol and biodiesel) cost of support for the biofuel industry in the form of reductions in the excise tax is estimated at € 2.978 million in 2006 in EU 25, a figure very close to that proposed by KLS (€ 2960 million). Curiously, this similarity stems from differing results for some countries, depending on more updated information available to us than to KLS; rather surprisingly, the single different country figures balance in the total sum.

In 2007 however the total cost decreases, because some countries, first of all Germany, adopted provisions for mandatory blending, and other countries reduced the levels of exemption of excises.

[21] More active policies are pursued by Sweden and Poland.

[22] Kutas-Lindberg—Steenblik, 2007

Then the total cost of the support for 2007 is smaller than for 2006: € 2.124 million, quite a sharp reduction (29%).

Furthermore, payments for energy crops have to be added: for 2006, amounting to € 58.5 million (10 more than the figure estimated by KLS), while the estimate for 2007, in want of official figures, is 90 million euros (row n. 2). This is because the total space allowed receiving these payments (2 million ha, while the agreed support is € 45/ha) was already surpassed in September, so that a coefficient of reduction (0.7034) was used: in absence of official figures, we suggest the maximum sum *compatible* with these data (row n. 2).

Note that the political agreement reached by the EU agriculture ministers on 20/11/2008 about the "Health Check" of the Common Agricultural Policy involves, among other matters, the abolition both of set-aside schemes and the energy crop premium. This – besides other issues - will reduce the cost of the promotion of biofuels [23] from 2009 onwards.

Considering partial or full) exemptions only (from excises and payments for Energy Crop Premia, it is possible to assess the cost for the public budget of the policies for the support of biofuels in EU 27 (Table 11).

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Note that the political agreement reached by the EU Agriculture Ministers on 20/11/2008 about what the "Health Check" of the Common Agricultural Policy involves, among others, the abolition

[23] KLS evaluated € 261 million the support to biofuels coming from crops grown on set-aside land, both in 2005 and in 2006.

[24] Kutas-Lindberg—Steenblik, 2007

both of set-aside schemes and the energy crop premium. This will reduce the cost of the promotion of biofuels [25] from 2009 onwards.

Table11, Assessment of the costs of EU 25 promotion policies for biofuels (2006, 2007)

		2006	2007
1	Support cost, € millions	2978	2124
2	Energy crops € millions	58.5	90
3	Total support € millions	3036	2214
4	Consumption of biofuels (mill. Litres)	7652	10905
5	euro/ consumed litre of biofuels	0.397	0.203
6	Avoided oil products (mill Lit) (petrol+gasoil)	6562	9323
7	Average industrial price of petrol, EU 25, euro/1000 l	472.3	484.5
8	Average industrial price of gasoil, EU 25, euro/1000 l	511.6	512.4
9	Value of displaced oil products € millions	3312	4733
10	support/avoided value of imported oil (euro)	0.917	0.468
11	State Aids, EU 25, € millions (at current prices)	66723	62999
12	Support for biofuel/State Aid %	4.55	3.51
13	Support for biofuels/tCO2 eq avoided (€/tonne)	0.23775	0.119853

Including the energy crop contribution, the total support estimated for biofuels in 2006 is € 3036 million, 1.6% more than the value estimated by KLS: the difference has to be attributed to the energy crop premium. In 2007 the total value is € 2214 million, i.e. a 27% reduction (row n. 3).

The efficiency of these supports is strongly increased: if in 2006 each litre of consumed biofuels required € 0.397 in the form of State Aid, in 2007 it requires € 0.203, or nearly 50% less. Such an improvement is due, of course, to the absolute decrease of State support and to the increase of biofuel consumption (row n. 5).

A larger consumption of biofuels means a larger avoided amount of imported oil products (42.1%, as compared to the 42.5% increase in the consumption of biofuels, the difference being accounted for by the different energy content, but also by the fact that EU 25 MSs mostly produce and consume biodiesel, which replaces gasoil whose energy content is higher of that of petrol.

The oil import avoided may be estimated: taking into account the EU 25 (not weighted) averages of the average (not weighted) monthly industrial prices of the single MSs, it is possible to define

[25] KLS evaluated € 261 million the support to biofuels coming from crops grown on set-aside land, both in 2005 and in 2006.

average industrial prices for petrol and diesel oil in EU 25. These may be used to determine the value of oil product imports avoided (row n. 9).

The outcome of this calculation is interesting: each euro of oil import avoided, required 0.9 Euros of public support for biofuels in 2006, but less than 0.5 Euros in 2007. This offers another perspective of viewing the achieved improvement in efficiency.

Even the weight of biofuels in terms of EU 25 State Aids has improved, as its incidence on total Aid figures (excluding railways) in 2007 vs 2006 has diminished by one percentage point (now it is nearly 3.5%).

Finally, even the support for the tCO2 equivalent was half in 2007 of the value in 2006.

Conclusions are obvious: passing from 2006 to 2007 the expenditure for promotion of biofuels has improved, while their consumption increased.

It meant that EU 25 MSs were able to save Euros for each litre of consumed biofuels, for each litre of avoided oil, for each euro of reduced dependence from imported oil, finally for each tonne of CO2 equivalent saved.[26].

<u>4. THE BIRTH OF A NEW INDUSTRY: THE BIOFUEL SECTOR IN EUROPE</u>

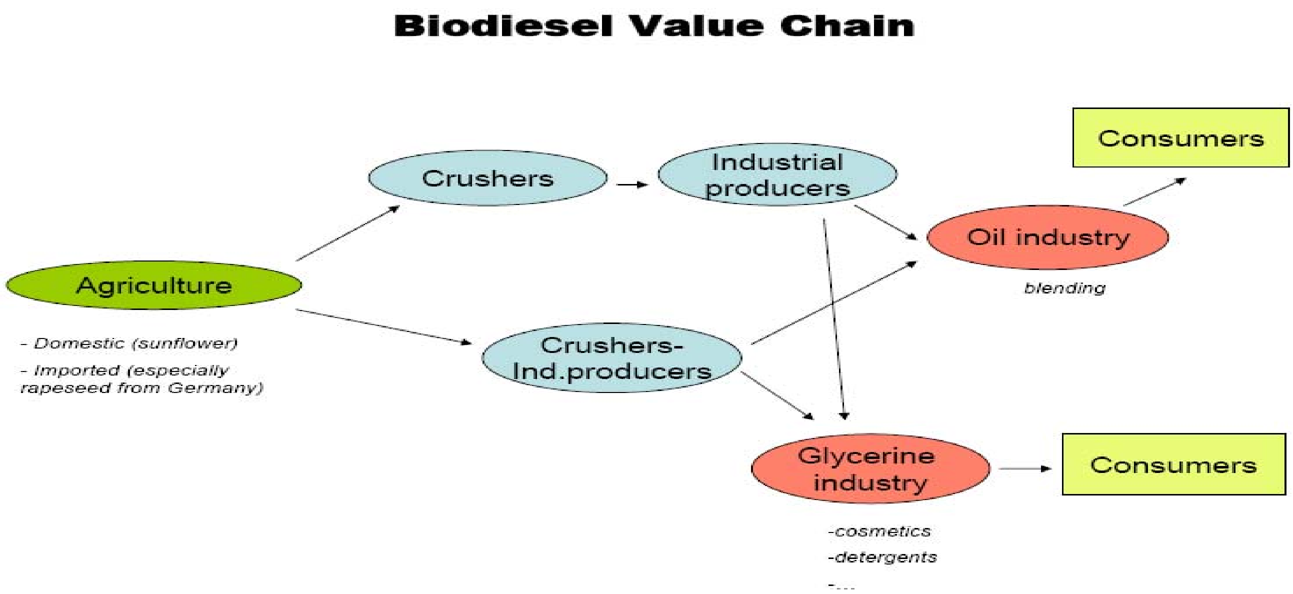
<u>4.1 Biodiesel</u>

<u>4.1.1 Key-players and value-chain in the biodiesel case</u>

The value chain of biofuels (here, biodiesel, Figure 14) is characterised by the interactions of different groups such as farmers in the agricultural world, oilseed crushers, industrial producers and oil companies.

[26] The value of avoided oil products should not be completely a saving in foreign currency, as a part of the value of oil product goes to the refining industry, that is for the majority of production localized within Europe.

Figure 14, the Biodiesel Value Chain



Upstream, the agricultural world provides the feedstock that will undergo multiple transformation activities downstream, to obtain both biodiesel and by-products to be exploited commercially. Hence farmers who are specialised in the cropping of rapeseed, sunflower and soybean play an important role, by interacting with oilseed crushing companies through supply relationships which can take different degrees of complexity, durability and exclusivity.

Oilseed crushers carry out a number of operations on raw material ranging from pre-treatment of the latter to crushing and oil extraction, obtaining raw oil that has to be refined (by degumming, neutralisation and other such activities) to be used downstream by biodiesel companies.

In larger organisations the two categories (crushers and industrial producers) can coincide with large industrial groups internalising upstream activities (oilseed crushing), while smaller companies tend to externalise such activities, due to lack of economic and organisational resources.

The typical feedstock supply relationship between industrial producers and the agricultural world upstream is represented by spot contracts. This is due to the great uncertainties surrounding the demand of biodiesel (e.g: B99) that make producers afraid of binding themselves to long-term contracts that might lead to unsold production. Only larger organisations exploit their structure to integrate activities within the value chain. For instance, ADM and Cargill exploit their activity as agricultural commodities' traders, while Diester has its own agricultural land to grow energy feedstocks.

Downstream, after biodiesel producers convert refined oil into biodiesel through a process known as transesterification, glycerine is obtained as a by-product, to be sold to operators of the pharmaceutical, chemical and cosmetics industries (above others) after purification and distillation activities.

Oil companies buy the end-product from biodiesel companies, blend it with traditional gasoline to obtain a blending that complies with the legislative framework and applicable standards and sell it to consumers. Indeed, while a blend with up to 5% of biodiesel can fit any type of car and engine, higher percentages require specific, up-to-date engines, so that old cars might face problems when using such blends.

Most of oil companies enter the biodiesel value chain only in the very last steps, carrying out the final distribution to consumers. It is interesting hence to note how key players in the biodiesel industry make a different family from that of key oil companies (with some exceptions, such as Neste Oil). It is however important to stress how most major oil companies are very active in R&D activities on so-called *second generation biofuels*, so that in the years to come they will probably play a bigger role within the biofuel value chain.

4.1.2 The biodiesel players

Industrial producers represent a heterogeneous world: companies differ in scale, geographical coverage and broadness of activities carried out or externalised.

Table 12 summarises some features of main biodiesel players in the European context:

Table 12, Biodiesel producers in Europe

	Structural info	Origin	Dimensions (employees; turnover)
Diester Industrie International 2005	DII derives from a Joint Venture between Diester Industrie and KBBV, at 60% and 40%, respectively. It is the only key-player operating in Italy, with the brand Novaol (plant in Livorno, and soon in Ravenna, as well)	Agriculture (oilseeds)	n.a. ; 5,735,000 € (Diester Industrie turnover: 1,281,000,000 €)
Verbio AG 2006	Verbio operates through 6 subsidiaries: one (Verbio STS) deals with raw material and distribution, two with actual biodiesel production and three with ethanol production	Biofuels	326 employees ; 423,000,000 €
ADM 1920	US-based multinational with operational plants and offices in 4 continents, it has strong links with the agricultural world, it deals with all relevant phases along the value chain (transport, production and distribution) of products such as food, feed and recently biofuels	Agriculture (food & feed)	27.000 employees; n.a.
EOP Biodiesel 2000	EOP operates through the subsidiaries EOP Beteiligungs (controlled at 100%, for raw material acquisition), Abid (controlled at 56%, for biodiesel production) and Baltic Holding Company, temporarely closed in October)	Biofuels	121 employees; 132,276,000 €
Neste Oil 1948	Multinational operating in the oil sector (and now biodiesel as well) especially in North America and the Baltic region (biodiesel refinery in Finland). The company is structured in 5 divisions: Renewable fuels, Oil refining, Oil retail, Specialty products e Shipping.	Oil	4.810 employees; 12,224,000,000

It is interesting to stress the variety as far as the origin of companies is concerned. While only two firms actually started their activities within the business (the smaller firms, employing few hundred people), other have their roots either in the agricultural world or the traditional oil sector, being part of a much larger organisations employing several thousand people.

Taking into account all main producers in key-Member States such as Germany, Italy, France, Poland, the Netherlands, Spain and the UK, the main areas are (Table 13): biofuel itself (usually, but not always, the case of smaller organisations), chemical industry, agricultural world (agriculture, oilseeds, food etc) and the traditional oil industry. Other sectors (engineering or alcohol, which is far more important in the case of ethanol) are present only marginally. Most firms have capacities not exceeding the 300,000 tons threshold; only 7 producers of those investigated are bigger, and they come either from the agricultural world (in 4 cases) or the biofuel sector itself (3 cases). Chemical and oil companies only have smaller plants, as the biodiesel is perceived as a promising opportunity for differentiation, but not as a core-business.

Table 13, Sector of origin of biofuel producers

	Capacity < 300 000 tons	Capacity > 300 000 tons	tot
Biofuels	√√√√√√√√√	√√√	12
Agriculture	√√√√√	√√√√	9
Chemicals	√√		2
Oil industry	√√		2

Moreover, there seems to be some correlation between the national context and the sector from where biodiesel producing companies come. For instance, in the United Kingdom all the companies considered are new companies that have their roots in the biofuel sector, and the situation is similar in Spain (3 out of 4 companies being investigated). On the other hand Italian producers often have their roots in the agricultural world.

In a sort of specialisation vs integration trade-off, maybe the direction is towards an ever increasing integration upstream, internalising agriculture-related steps where larger profits can be obtained.

European biodiesel industry is hence a well developed structure, where different agricultural and industrial firms cooperate and interact, while traditional oil companies only play a marginal role, placing the final product on the market. Given the interests at stake and the investments in R&D, it is likely, as previously mentioned, that in years to come oil companies will play an ever increasing role. To date, most oil companies are heavily investing in second generation technologies, as highlighted by Table 14 which summarizes the area of investment on second generation biofuels (both biodiesel and ethanol) by major world oil companies:

Table 14, Oil companies and second (or third) generation biofuels

Oil Company	**Branches of investment**
BP	Jatropha, cellulosic ethanol
Neste Oil	Hydrotreated vegetable oil
Shell	Algae27, cellulosic ethanol
Eni	Algae[28], Fischer Tropsch
Total	Hydrotreated vegetable oil, cellulosic ethanol
Petrobras	Cellulosic ethanol
Chevron	Cellulosic ethanol

It will be interesting to see how these will interact with incumbents; will the new structure of the industry be based on joint ventures or even acquisitions of companies operating in the biodiesel industry, or will oil companies privilege sheer competition with incumbents?

Table 15 furthermore summarises some features of Italian crushers, such as the type of relationship with the biodiesel industry or the feedstocks being crushed:

Table 15, Oilseed crushers in Italy

Company	*Feedstock*	*Biodiesel*	*Contracts*
Bunge Italia	Sunflower, rapeseed, soybean	Supplier of Novaol (partner)	8-12 months
Casa Olearia Italiana	Sunflower, soybean	Supplier of Gruppo Marseglia companies	
Cereal Docks	Soybean	Biodiesel producer	
Italcol	Sunflower	Supplier of around 10 different subjects	Single, *spot* contracts
Oleificio Medio Piave	*Sunflower, soybean*	*no*	*no*
Paoil	*Sunflower*	*no*	*no*

[27] Sometimes R&D investments in algae are referred as “third generation”. However there is no agreement about definitions.

[28] See note before.

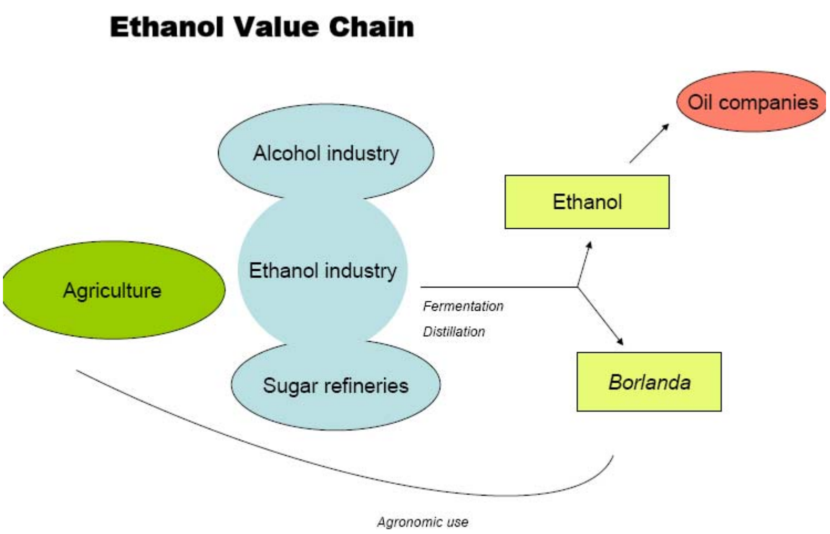
Italian oilseed crushers are focused on privileging Italian feedstocks through the stipulation of contracts with local suppliers, but given the scarcity of arable land, it is often necessary to import raw material from other Countries.

4.2 Ethanol

4.2.1 The value-chain in the ethanol case

The key players in the value chain of ethanol (Figure 15) are, on one hand, the agricultural world providing feedstock, and on the other the ethanol industry, with the latter overlapping with other sectors such as distilleries and sugar refineries. If biodiesel provided glycerine as a by-product to be exploited commercially in different markets, ethanol production processes provided as a by-product of a fertilizer, in Italian *borlanda*, to be exploited for agricultural purposes.

Figure 15, the Ethanol Value Chain



The European ethanol industry is far less structured than that of biodiesel, as Europe is, historically, mainly a relevant biodiesel producer.

Moreover, the ethanol sector is much harder to monitor in comparison with biodiesel, as ethanol producing companies overlap with firms operating in other industries (namely alcohol and sugar) while biodiesel companies emancipated themselves from original sectors (such as agriculture), enjoying now a much higher visibility and *independence*.

The production trend resembles the one experienced by biodiesel somehow: a steady increase up to 2006, and then a slowdown in 2007 with a growth rate of 11% compared with rates of 70% characterising previous years.

From 2007 onwards, the European Union produced around 1,731 million litres of ethanol, resulting in a European market share much smaller than those of world leaders such as the US and Brazil.

Table 16 summarises some features of the ethanol players, providing structural info and stressing the sector of origin:

Table 16, Major ethanol players

Company	Structural info	Origin	Dimensions (employees; Turnover)
Abengoa *1941*	Spain-based multinational, it operates in 5 Continents (especially Latin America) with 6 business units, one (Abengoa Bioenergy) specifically dedicated to ethanol	Technology company	**17,245 employees; 3,562,000,000 €** (Abengoa Bioenergy has 527 employees and 497,000,000 € turnover)
Sudzucker *1926*	Germany-based multinational, divided in three segments: Sugar, Fruit and Special Products (like ethanol)	Sugar refinery	**18.642 employees; 6,172,000,000 €** (Sudzucker bioethanol has 65 employees and 146,000,000 € turnover)
Verbio *2006*	Six subsidiaries: one (Verbio STS) deals with raw material and distribution, two deal with biodiesel production and three with ethanol production	Biofuels	**326 employees; 423,000,000 €**
Sekab *1985*	Swedish company born in 1985 from the merger of MoDo and Berol, active in the production and distribution of ethanol, and on research on second generation ethanol	Chemical company	**100 employees; 204,000,000 €**
Tereos *1932* (Origny)	The company gathers (cooperative-style) 12.000 farmers guaranteeing raw material supply. The plants are located in Europe, Brasil and Africa.	Distillery and sugar refinery	**1,691 employees; 1,247,000,000 €**

Only Verbio has been specifically established for the production of biofuel, while other companies have their roots in different businesses (sugar, chemical, distillery etc).

The sector with strongest links with the biofuel industry is perhaps that of sugar refineries, with companies developing the innovative market of bioethanol to exploit over-production of sugar (we can mention, as far as sugar refineries entering the biofuel market are concerned, companies such as Hellenic Sugar and British Sugar).

In Italy, the ethanol industry has started developing only recently. Until 2004, no ethanol was produced, and even nowadays the numbers are still limited. 60 million litres were produced in 2007 (78 million in 2006), and the production was entirely exported (mainly to Sweden).
Table 17 summarises the production capacity and the feedstock used by the Italian producers:

Table 17, Italian ethanol producers

Company	*Prod. capacity Mio l*	*Ethanol from:*
Silcompa	60	Alcohol
Alcoplus	42	Cereals
IMA	200	Alcohol
Grandi Molini	*130*	*Cereals*

4.3 Conclusive remarks on the biofuel strategy and industry

The adoption of a biofuel strategy has largely failed until now: most of the European countries were not able to reach the required targets of penetration. Some large country (Germany and in more recent times France) developed domestic production of biofuels, but anyhow at very high costs. The other countries were waiting for sensible reductions in the cost of production of biofuels, which should have reduced their financing efforts as well. However, the production of biofuels seemed not to be characterized by meaningful economies of scale (everywhere, with the only exception of Brazil).
Of the three main, traditional goals of a biofuel policy – to reduce GHG emissions, to improve security of supply, to provide income and jobs to the rural world – the third seems the most unlikely. The bulk of the assessments agree in claiming that a large increase of utilization of biofuels could be met in Europe, realistically, only by large imports, due to the lack of suitable cultivable areas within the continent. Then it should benefit the income and jobs of the rural world mainly in the developing countries: benefits for the EU rural world are more difficult to get.
Biofuels are able to reduce GHG emissions: the extent of this reduction depends on the success of the certification effort, required by the Directives. As they are the only current alternative to oil in all the transports (excluding current devices which utilize electrical energy, like railways) at the current level of technologies, the first goal is met.

The success in terms of enhancing the security of supply is limited by the scarce use of biofuels, which can substitute for relatively small amounts of oil. The scarce use of biofuels is partially due to the high cost of the support policies. Then the second goal of the biofuel policy, to reduce security of supply, is currently met only in a very partial way. Furthermore, it has to be stressed that domestic production in Europe is unlikely to be obtained, because of lack of suitable areas and competition with food, oil imports would be substituted by biofuel imports.

The cost of the support policy is decreasing, thanks to the German change of policy, however it still remains expensive. There are doubts that it can be confirmed in a period of difficulties like this: no Government emphasized it in the economic stimulus packages.

The worst incident that occurred regarding the biofuel policy, is however the concomitance with the increase of the prices of food products in 2007-2008. Of course, 1st generation biofuels do contribute to the increase of prices: but the extent to which they were directly and indirectly responsible for the past increase is still unknown[29]. Above all, it is uncertain if the increase of the price of food products will reappear, when the financial and economic crisis will disappear, and when demand for biofuels returns and whether international liquidity will increase as fast as during those years.

What is clear however is that the increase of food prices strongly reduced the consensus for biofuels, even if biofuels were not completely responsible for the increase in food prices.

Finally, there is some proof that a new biofuel sector is forming in the European agroindustry. Some new firms were created, even if a large part of the new production originated by diversification of existing companies.

While the ethanol industry is still in its infancy, and due to the overlaps with other industries (sugar, alcohol) it cannot be precisely depicted yet, the biodiesel industry is now growing independently from the oil industry. The main producer is the industrial world, with some producers of relevant dimensions capable of internalising upstream activities such as oilseed crushing, and a number of smaller organisations that resort to spot contracts with agricultural suppliers in order to receive the feedstock they need to process.

In years to come, two dimensions will play a relevant role in determining the outcome of competition within the sector: the management of logistics on one hand, and the R&D activities for advanced biofuels, that might lead to direct competition with oil companies, also heavily investing in the second generation.

[29] Mitchell attributes the bulk of the increase in the price of other agricultural raw materials to the price increase of biofuels.

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APPENDIX I: EU PLAYERS IN BIODIESEL

Undoubtedly, **Diester Industrie International** **(DII)** has to be included in such definition, with a 1 million tons of production capacity in France (as of 2007) and other plants under construction for a further 750.000 T.

DII (the only among top European players to operate in Italy) is a joint venture between the Diester Group, leader company in the French sector of biodiesel and Bunge, world-class leader in the agro-alimentary sector and the production of vegetable oils. The mission of DII is to develop the biodiesel industry in Europe, through plants and offices stretching over many Member States (e.g: France, Germany, Italy, Austria and Portugal).

DII operates in Italy through Novaol, which has a fully operational plant in Livorno, and a plant in Ravenna due to start production in 2009. The early roots of Novaol (then acquired by Bunge in 2001) date back to the early 90s, as it has been established as a spin-off company of Novamont (Montedison group) to be focused on the emerging biodiesel industry. The first years of activity are based on the 60,000 tons plant of Livorno, later expanded in 2004 in order to reach current capacity of 250,000 tons. The Ravenna plant should guarantee further 200,000 tons a year, while Novaol expanded abroad in the meantime, with investments in France (Verdun) and Austria (Bruck).

German company Verbio has a capacity of 400,000 T, with plans located in East Germany.

The **VERBIO** group is indeed among leading producers and suppliers of biofuels in the world, and the only industrial-scale producer of biodiesel and bioethanol in Europe, as well.

The nominal capacity currently amounts to around 450,000 tons of biodiesel and 300,000 tons of bioethanol per year. The company has developed its own processes and innovative technologies for the production of biodiesel and bioethanol, supplying its products directly to European mineral oil corporations, mineral oil traders, independent gas stations and haulage companies.

VERBIO also markets high-quality pharma glycerine for the consumer goods and cosmetic industries, as to commercially exploit the byproduct obtained from biodiesel production.

As regards the corporate structure, the group’s operating business is run by its subsidiaries: VERBIO Diesel Bitterfeld, VERBIO Diesel Schwedt, VERBIO Ethanol Zörbig, VERBIO Ethanol Schwedt and VERBIO STS.

One of the few companies that have their very roots in the biofuel sector, it employs (as of 2007) 385 people, with sales for about 415 million €.

ADM is an American multinational operating in Europe, where it has 3 plants operating in Germany for an overall production capacity of around 1 million tons.

Its business spans the whole agricultural value chain, from sourcing crops to cleaning, storing and transporting them, then processing crops into biofuels but also food and feed, then distributing the end product on a global stage. Biofuel production streams hence derive from a well-organised structure, a top-diversified agribusiness with scale and expertise in corn and oilseeds processing.

ADM is also involved in R&D activities on advanced biofuels. In August 2008, for instance, it embarked on research collaboration with Monsanto Company focusing on the logistical hurdles of harvesting, storing and transporting corn stover to be processed as to obtain lignocellulosic ethanol.

EOP Biodiesel is one of the few key players active in the biodiesel sector that actually dealt with such market right from their establishment. EOP actually operates in many EU Countries (Germany, Austria, Serbia, Romania, Poland and Latvia), and has set a goal of reaching the production capacity of 500,000 T by 2010 (the feedstock used is mainly rapeseed).

EOP sells its core product to the petroleum industry, exploiting at once biodiesel production by-products such as rapeseed expeller (which can be used for high-grade animal feed), glycerine (pharmaceutical industry) and potassium sulphate (fertilizer).

EOP employs around 130 people and had a group revenue of 131 million € in the 2007/2008 financial year.

Finnish company **Neste Oil** is a refining and marketing company focused on advanced, clean traffic fuels, with a strategy that prioritizes growing its refining and premium-quality renewable diesel businesses. It has a production capacity of just over 200,000 tons, but a plant of 800,000 tons is currently under construction in Singapore. It employs almost 5,000 people, and has a 12,103 million € turnover.

The Italian industry replays the European trend somehow, with a steady increase in biodiesel production from 2003 to 2006, followed by a sensible contraction in 2007.

In Italy, the feedstocks used for biodiesel production are mainly rapeseed (70%, imported from Germany, Austria, France and Spain) and soybean. On the other hand, feedstock actually grown on Italian soil and used for energy purposes is sunflower.

Most of the Italian plants and facilities are located in northern regions. However, the presence of biodiesel production sites stretches along the whole peninsula.

The average dimension of the plants ranges from 150,000 to 200,000 tons, with few larger plants (e.G: Ital Green Oil in Verona) and some smaller, under the 100,000 tons threshold.

As far as Italian oilseed crushers are concerned, only two have no contact or interaction at all with the biodiesel industry (Paoil and Oleificio Medio Piave), while others are integrated in the biofuel value chain at different degrees: some are only suppliers of third party firms (e.g: Italcol), while others are part of a company or a group which is active in the biodiesel production industry.

Bunge operates in Italy with three crushing and refining facilities and bottling plant. The facilities are located in Ravenna, Ancona and Venice. Its joint venture biodiesel producer (Novaol) operates in Livorno.

On a broader scale, Bunge is a large multinational linking the world's agricultural producing regions with the largest and most promising markets for grains, oilseeds and other food products.

Casa Olearia Italiana (COI) is part of the Marseglia Group, with plants in Bari and Verona. As much as 1 million tons of oils a year are transported and distributed by COI, both by road and by ship. As far as biodiesel is concerned, COI supplies its refined oil to Ital Bi Oil, which proceeds with the operations of processing and transformation into biofuel.

Cereal Docks has, as a core business, the processing of cereals and oilseeds for the production of flour and oils to be used in different markets such as food, cosmetics and pharmaceutical. Cereal Docks recently broadened its activities thanks to technological research and innovation, entering the biofuel sector and becoming a relevant player in the Italian biodiesel industry. Cereal Docks is hence an oilseed crusher and a biodiesel producer at once, with the Vicenza plant capable of producing up to 150,000 tons a year.

Italcol is a Tuscany-based company that, through close relationships with local farmers, processes around 80,000-100,000 tons a year of oilseeds, mainly sunflower and olive oil. Its products range from alimentary oil to flour for animal feed, to refined oil to be processed into biodiesel.

Italcol has multiple commercial relationships with a number of different producers (around 10), with single, spot contracts.

On the other hand, Olificio Medio Piave and Paoil are not currently interested in the biofuel sector

APPENDIX II: EU PLAYERS IN ETHANOL

Abengoa is a technological company that applies innovative solutions for sustainable development in the infrastructure, environment and energy sectors. It is present in over 70 countries where it operates through its five Business Units (Solar, Bioenergy, Environmental Services, Information Technology, and Industrial Engineering and Construction). Abengoa Bioenergy is the unit that specifically focuses on ethanol, selling its products to most major oil companies such as Shell, Texaco, BP and Total.

Sudzucker is Europe's leading supplier of sugar products. The company has established a key market position in the special products segment (such as ethanol), employing almost 4,000 people in that specific unit. It implements a strategy based on close relationships with farmers, as sugar beet farmers indeed represent the main shareholders of the company (via Süddeutsche Zuckerrübenverwertungs-Genossenschaft eG (SZVG), holding 55% of the share capital).

The **SEKAB** Group is a relevant firm in the European biofuel panorama, producing and distributing bioethanol fuel and green chemical products.

Established in 1985 as Svensk Etanolkemi, from the merger of Berol (50%) and MoDo (50%), developed into the new SEKAB group in 2006: Etek and Svensk Etanolkemi AB have been re-named SEKAB E-Technology and SEKAB BioFuels & Chemicals, becoming part of the SEKAB Group. Sekab has great interest in advanced biofuels, carrying out thorough R&D activities on lignocellulosic ethanol.

The France-based multinational **Tereos** has a cooperative organisation focusing on strong relationships with the agricultural world (12,000 farmers in France alone).

The only key-player operating in Italy, Tereos has 32 industrial facilities, employing over 13,000 employees. Core business is the processing of 930,000 ha of beet**,** cane and cereals into sugars, starch products, alcohol, and ethanol.

Tereos operates in three Continents: Europe (France, Spain, Italy, Belgium, England and the Czech Republic), South America (Brazil) and Africa (Mozambique and Ile de la Réunion), achieving production numbers such as 2.830 million tonnes of sugar, 1.8 million tonnes of starch products and 1.5 million m3 of alcohol/ethanol. Moreover, Tereos produces many co-products for animal feeds and recycles bagasse from cane into electricity.

Only few Italian operators are currently active, mainly players of the alcohol industry which diversify their business by entering the biofuel sector.

Silcompa is a company of the Finagrin group, established in 1925, which diversifies the destination of its core product (alcohol) to different sectors such as the pharmaceutical and biofuel industry.

Alcoplus has its roots in the 2005 joint venture between Alc.Este (40%) and Caviro (60%), and aims at becoming a reference firm in the development of integrated agro-energy systems for the exploitation of agricultural feedstock such as cereals and sugarbeet for the processing of bioethanol.

IMA (Industria Meridionale Alcolici, Bertolino Group) is partner of SIBE, an Italian bioethanol society, and has a capacity of around 200 million litres a year.

Moreover, its current work in progress is the project for the construction of two plants dedicated to ethanol by **GMI** (Grandi Molini Italiani). The first plant (due in 2009) will operate in Porto Marghera, processing corn and grain into ethanol, while the other will be built in Trieste, and it will process corn.

TECHNICAL APPENDIX

Second generation biofuels: where are we at?

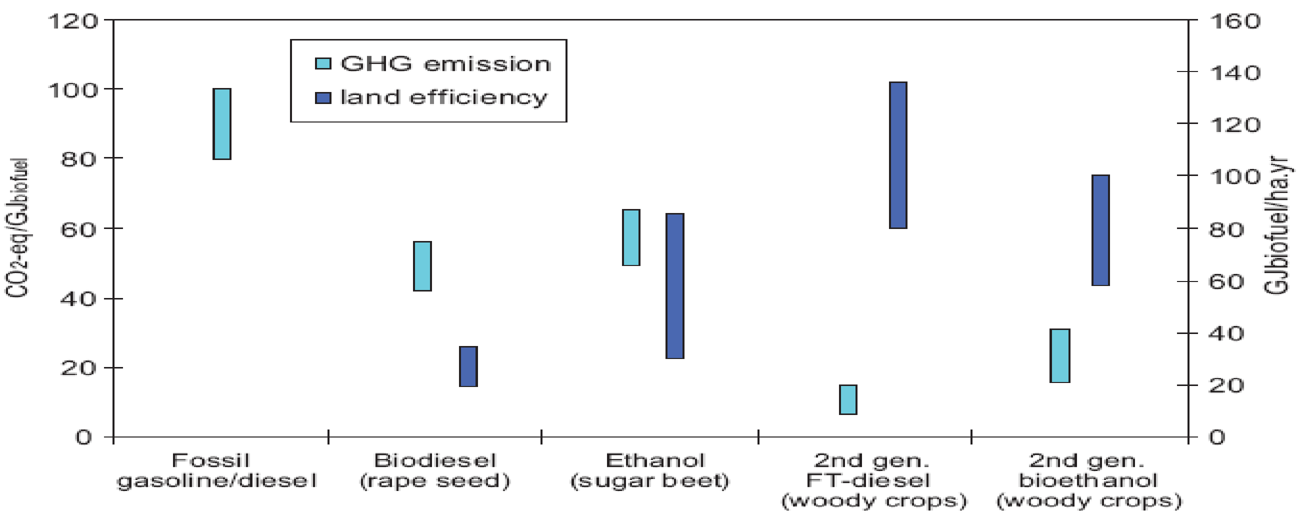
The amount of arable land needed to grow energy feedstocks and the need not to exacerbate competition with food make it clear that traditional biofuels alone are not able to provide a strong support to Italian or European energy needs. This is why research and development activities on the 2^{nd} generation of biofuels are gaining more and more importance. Even if there is no universally accepted definition of the second generation.

Usually, however, people refer to those advanced biofuels as regards to the following dimensions (or a combination of both):

- feedstocks being used (e.g: Jatropha, Miscanthus, forestall residues, etc)
- production process (e.g: Fischer Tropsch)

Figure 15 well illustrates the advantages of 2nd generation biofuels in terms of both land efficiency and GHG emissions:

Figure 15, Second-generation biofuel benefits



Source: REFUEL project, 2008

Compared to fossil fuels, traditional biofuels (rapeseed biodiesel or sugarcane ethanol) and second generation biofuels, the latter turn out largely preferable. Greenhouse Gas emissions are reduced compared to fossil fuels, while traditional biofuels achieve modest results (especially due to the massive use of pesticides and other pollutants at the cropping stage).

Nowadays, the main hurdles on the way of an effective exploitation of advanced biofuels are relevant and broad in nature:

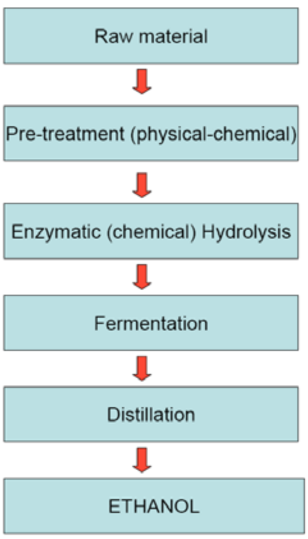
- high costs of dedicated raw materials
- high costs of plants and machinery that are still largely under development
- technological issues (e.g: still much to be done in connection to the technology for the pre-treatment of materials to enter the Fischer Tropsch reactor)
- inefficient enzymes in the case of lignocellulosic ethanol.

The main typologies of advanced biofuels are two, even if the situation is very fluid and ever-changing given the broad activity of R&D currently ongoing: lignocellulosic ethanol and synthetic biodiesel obtained through the Fischer Tropsch process.

The main advantage of lignocellulosic ethanol is the possibility of exploiting the sugars entrapped in the molecules of cellulose and lignin, as they break free thanks to the use of specific enzymes before being fermented to produce ethanol as in the traditional process. In other words, the whole crop is exploited (leaves, stover etc), and not only a part of it (like the cob for corn). This has clear and positive implications for both the yields (given a certain arable land, the quantity of feedstock increases significantly) and the avoidance of competition for land (for instance, by using only those parts of the crop that are not edible).

Chemically identical to traditional ethanol, the only difference regards the production process that can be synthesised by the following figure:

Lignocellulosic ethanol



Raw material can be either agro-forestry residues, organic waste, or dedicated energy crops.
The first step consists of a pre-treatment (e.g: milling), in order to adapt raw material for the following steps. Then, the enzymatic (or sometimes chemical) hydrolysis takes place, where sugars are freed from cellulose (which is composed of molecules of glucose as starch or, indeed, sugar) through the use of enzymes. Then, a traditional step of fermentation of sugars takes place, followed by distillation in order to obtain ethanol.
Llignocellulosic ethanol holds promises of ensuring economical and environmental advantages, thanks to low production costs, once the whole process is developed and an efficient value chain is established (5 to 10 years from now, experts predict) and polluting emissions are reduced up to 85%.
Some plants for the production of this advanced biofuel are indeed already operative; it is the case of Iogen, a Canadian company with a small-scale plant in the pre-commercial scale (capacity: 3 million litres / year). The plant is aimed at giving insights of hurdles and hindrances that can be fixed before building a larger, commercial-scale one.
Italy is active in the field of lignocellulosic ethanol as well. The Mossi & Ghisolfi group, while about to activate the first ethanol-dedicated plant in Italy in 2009 (200,000 tons / year), is carrying out the PRO.E.SA 5-year research programme on advanced biofuels. The project, in cooperation with MIT and DuPont, is aimed at building and testing a pilot plant (20,000 tons / year), then converting the bigger plant on the basis of the experience acquired through the smaller one.
Another type of advanced biofuel is represented by synthetic biodiesel obtained with the Fischer Tropsch process. The core of the technology, the Fischer Tropsch reactor, reflects a well developed technology. However, there are still a number of technological issues to be solved, especially in the upstream operations which are necessary in order to *prepare* the material entering the reactor, which causes the costs to still be very high and not as yet competitive.
The production process begins with a pre-treatment of raw material (biomass), with milling and drying operations before the gasification step, in order to obtain a so-called syngas. Syngas is hence purified from dirt and slag, and conveyed in the Fischer Tropsch reactor, for the production of biodiesel.
Even if there are few Fischer Tropsch plants, we can mention Choren, a German company with 1,000 tons / per year demonstration plant in Freiburg which is currently building a larger plant (15,000 tonnes / year) in a joint venture project with Shell and Wolksvagen.

Jatropha

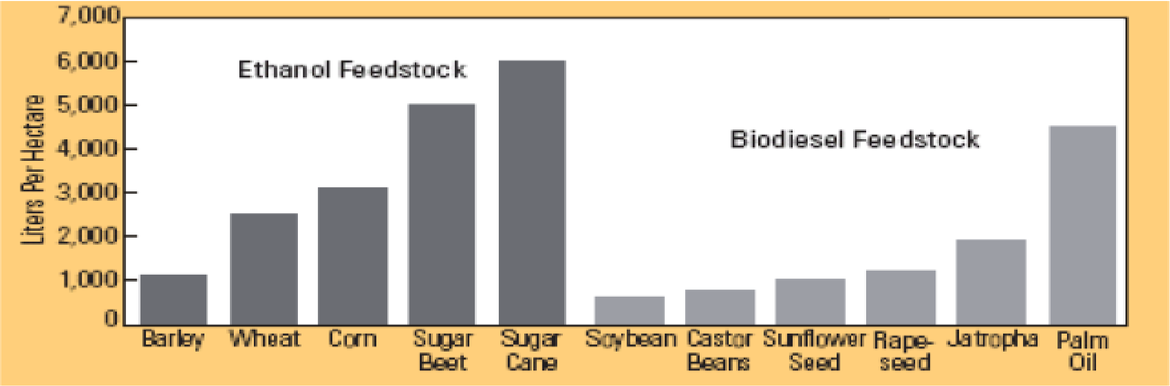
Jatropha is considered by some as the answer to drawbacks of traditional biofuels.

Originally from Central America but now common in India and Africa as well, Jatropha holds the advantage of growing on semi-arid or even waste land, where other crops would perish (hence avoiding any competition for land). Its ideal habitat consists of mild areas, with temperatures between 20 and 28 degrees Celsius all year long. It has great adaptability to hostile environments, growing with as low as 300 mm of yearly rainfall, so that it is suitable for cropping in many semi-arid areas of Central America, India and Africa.

So far, Jatropha has received little attention and has been scarcely cultivated. Its yields vary significantly on a case-by-case basis, given the *wild* nature of the crop whose cultivation techniques haven't experienced many improvements and developments, so far.

However, yields themselves seem to be very promising, if compared to those of other biodiesel feedstocks[30]:

Figure 16, Biofuel feedstock yields



Moreover, Jatropha is not edible, given its toxicity, and is not attacked and eaten by animals. If this appears as a modest advantage in the European context, the picture changes in Africa or India, where one of the most dangerous *enemies* of crops and plantations is the risk of raids of roaming animals looking for food.

Moreover, Jatropha helps in preventing desertification, and this explains why many experts consider this crop as an effective solution for specific geographical areas, with immediate great potential for creating employment in developing Countries' rural communities.

However, we have to stress how some inaccurate information has been spread about Jatropha, growing excessive hopes for what has to be considered an option with great potential, but also with certain question marks:

[30] Biofuels for transportation, WorldWatch Institute 2006

- existing Jatropha plantations are part of experimental, government-funded projects
- cropping and harvesting techniques are still labour intensive
- Jatropha is still to be considered a wild crop
- most of the numbers being publicised about Jatropha are simply incorrect (the 5 million hectares in India, or the million hectares in Myanmar, just to give a couple of examples). Regarding initiatives that are actually taking place for the development of Jatropha plantation, we can mention:
- Senegal: national programme of the Agriculture Ministry for the cropping of 330,000 hectares (so far, however, only 500 hectares are actually being cultivated)
- Mozambique: Government-led programme, in partnership with private and national firms as well as international investors, for the cultivation of 200,000 hectares (state-of-the-art: 500 hectares)
- Brazil: national programme for the development of Jatropha plantations (state-of-the-art: few hundred hectares).

The African continent is undoubtedly an area of great potential for the development of Jatropha plantations. However, it is in India that the best results have been achieved so far. A demonstration project on 400,000 hectares is currently underway, and the trend is towards a gradual increase of such an area, with a partnership between the Government (which is to pay 30% of the costs for the implementation of the programme) and private firms.

Given its features, Jatropha is not suitable for the European climate, too rigid even in its southern, Mediterranean Regions. Indeed, only some areas in Greece, Spain and Italy might be suitable; there are currently some experimental plantations going on in such areas, but the results are pretty scarce as Jatropha is able to grow but not to provide adequate yields in terms of fruits, thus oil to be converted into biodiesel (probably it is too rigid for better cropping outputs, given the temperatures).

Notwithstanding unsuitable climatic conditions, Europe is focusing on Jatropha by shifting its attention on investments in tropical and sub-tropical Countries.