Global Assessment of Biomass and Bioproduct Impacts on Socio-economics and Sustainability

Project No: FP7-245085

Global-Bio-Pact

Overview of Current Trading Regimes

for biomass/biofuels/bioproducts

WP 6 – D6.1

April 2012

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The Global-Bio-Pact project (Global Assessment of Biomass and Bioproduct Impacts on Socio-economics and Sustainability) is supported by the European Commission in the 7th Framework Programme for Research and Technological Development (2007-2013). The sole responsibility for the content of this report lies with the authors. It does not represent the opinion of the Community. The European Commission is not responsible for any use that may be made of the information contained therein. The Global-Bio-Pact project duration is February 2010 to January 2013 (Contract Number: 245085).

Global-Bio-Pact website: www.globalbiopact.eu

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Acknowledgements

The authors would like to thank the European Commission for supporting the Global-Bio-Pact project, as well as University of Campinas – Unicamp – and the Brazilian Bioethanol Science and Technology Laboratory – CTBE.

Abbreviations

CAFTA - Central America Free Trade Agreement

CBI - Caribbean Basin Initiative

CHP - Combined Heat and Power Plants

EBB - European Biodiesel Board

EIA-DOE - Energy Information Administration – Department of Energy

GHG – Greenhouse Gases

IWPB - Initiative of Wood Pellet Buyers

MTBE - Methyl Tertiary-Butyl Ether

VEETC - Volumetric Ethanol Excise Tax Credit

Preface

This report was elaborated in the framework of the Global-Bio-Pact project (Global Assessment of Biomass and Bioproduct Impacts on Socio-economics and Sustainability) which is supported by the European Commission in the Seventh Framework Programme for Research (FP7). Global-Bio-Pact is coordinated by WIP Renewable Energies and runs from February 2010 to January 2013.

The main aim of Global-Bio-Pact is the improvement and harmonisation of global sustainability certification systems for biomass production, conversion systems and trade in order to prevent negative socio-economic impacts. Thereby, emphasis is placed on a detailed assessment of the socio-economic impacts of raw material production and a variety of biomass conversion chains. The impact of biomass production on global and local food security and the links between environmental and socio-economic impacts are analysed. Furthermore, the Global-Bio-Pact project investigates the impact of biomass production on food security and the interrelationship of global sustainability certification systems with international trade of biomass and bioproducts, as well as with public perception of biomass production for industrial uses. Finally, Global-Bio-Pact focuses on socio-economic sustainability criteria and indicators for inclusion into certification schemes, and the project elaborates recommendations on how to best integrate socio-economic sustainability criteria in European legislation and policies on biomass and bioproducts.

A core activity of Global-Bio-Pact is the description of socio-economic impacts in different countries and continents in order to collect practical experience about socio-economic impacts of bioproducts and biofuels under different environmental, legal, social, and economical framework conditions.

This is the report "**Overview of Current Trading Regimes for biomass, biofuels and bioproducts**", which was elaborated by the research team of Unicamp engaged in the project.

1 Introduction

A strong public debate on sustainability aspects for biomass use for energy and products emerged in the last few years. This debate focused mainly on negative social and environmental impacts. In consequence, several initiatives were set up, which are engaged in developing tools to ensure sustainability of biofuels. One option to ensure the sustainability of biofuels is the application of certification systems.

The main aim of the Global-Bio-Pact project is the improvement of global sustainability certification systems for biomass production, conversion systems and trade in order to prevent negative and to promote positive socio-economic impacts. Thereby, emphasis is placed on a detailed assessment of the socio-economic impacts of feedstock production and a variety of biomass conversion chains.

This report "**Overview of current trading regimes for biomass, biofuels and bioproducts**" aims at providing an overview about international biomass/biofuels/bioproducts trade. Although currently 90% of world biofuel production is consumed domestically, international trade in biofuels is beginning to grow, as industrialized countries consider meeting the growing demand with imports from, for instance, Brazil, Argentina, Indonesia or Malaysia. It is predicted that in the future, international trade may also increase for bioproducts and involve other Latin American, Asian and African countries.

This report contains three main chapters, targeting on the assessment of liquid biofuels production and its trade (chapter 2), on the assessment of solid biomass – mainly wood pellets – consumption and trade (chapter 3) and on a preliminary assessment of the production of no-conventional bioproducts (chapter 4). Finally, a general overview and concluding remarks are presented in chapter 5.

2 Liquid biofuels production and trade

2.1 The growth of liquid biofuels production

Ethanol and biodiesel are the most important biofuels for the time being. Currently world production and consumption of fuel ethanol is dominated by the US and Brazil, which are responsible for about 88% of the world production, with about 77 BL (billion litres) out of 86 BL produced in 2010 (see Table 1); US is by far the main producer of fuel ethanol. Regarding biodiesel, it was in 2005 that its production began increasing significantly, spearheaded by the EU, which is currently responsible for more than 50% of the world production and about 60% of the world consumption. Table 1 shows some production figures of bioethanol and biodiesel in recent years.

Table 1: Biofuels production from 2000 to 2010, in billion litres (BL)

Country/Region	Fuel ethanol			Biodiesel	
	2000[a]	2005[b]	2010[c]	2005[b]	2010[c]
USA	6.2	15.0	49.0	0.25	1.2
Brazil	10.7	15.0	28.0	---	2.3
EU		0.9	4.5[d]	3.6	10.0[e]
China	NA	1.0	2.1	NA	0.2
Argentina	NA	NA	0.1	NA	2.1
Others	0.7	1.1	2.3[f]	0.05	3.2[g]
Total	17.6	33.0	86.0	3.9	19.0

Sources: [a] Walter et al., 2008; [b] REN21, 2006; [c] REN21, 2011
Notes: NA = information not available or no significant production;
[d] Main European producers: Germany, 1.5 BL, France, 1.5 BL;
[e] Main European producers: Germany, 2.9 BL, France, 2.5 BL, Spain, 1.1 BL, Italy, 0.8 BL;
[f] Other relevant producers: Canada, 1.4 BL, Thailand, 0.4 BL and Colombia, 0.4 BL;
[g] Other relevant producers: Indonesia, 0.7 BL, Thailand, 0.6 BL and Colombia, 0.3 BL;

Table 2 shows information on the main producer countries of fuel ethanol and biodiesel in 2010, and their annual average growth rates of production from 2005 to 2010. As can be seen, biodiesel production is less concentrated than ethanol. Due to the very low levels of production in 2005, the growth rates of biodiesel have further been faster. The average annual increase in biodiesel production indicates a rapid growth in the US, Brazil and Argentina, where the large share is based on soy, as well as in France and Spain (with the main raw materials being rapeseed and sunflower) (REN21 2010 and REN21 2011).

In relative terms, there has been rapid production growth of ethanol in Canada, France, Germany (mostly based on wheat) and in Thailand. In absolute terms, however, the bulk of the production growth has taken place in US. As for Brazil, the country with the longest tradition in fuel ethanol production, the sector was negatively affected by the financial constrains[1] and the unfavourable weather conditions in 2009; the ethanol production has also been impacted by high sugar prices in the international market. Moreover, in recent years the global economic crisis led to a considerable slow-down both in ethanol and biodiesel production in all the major producer countries (REN21 2011).

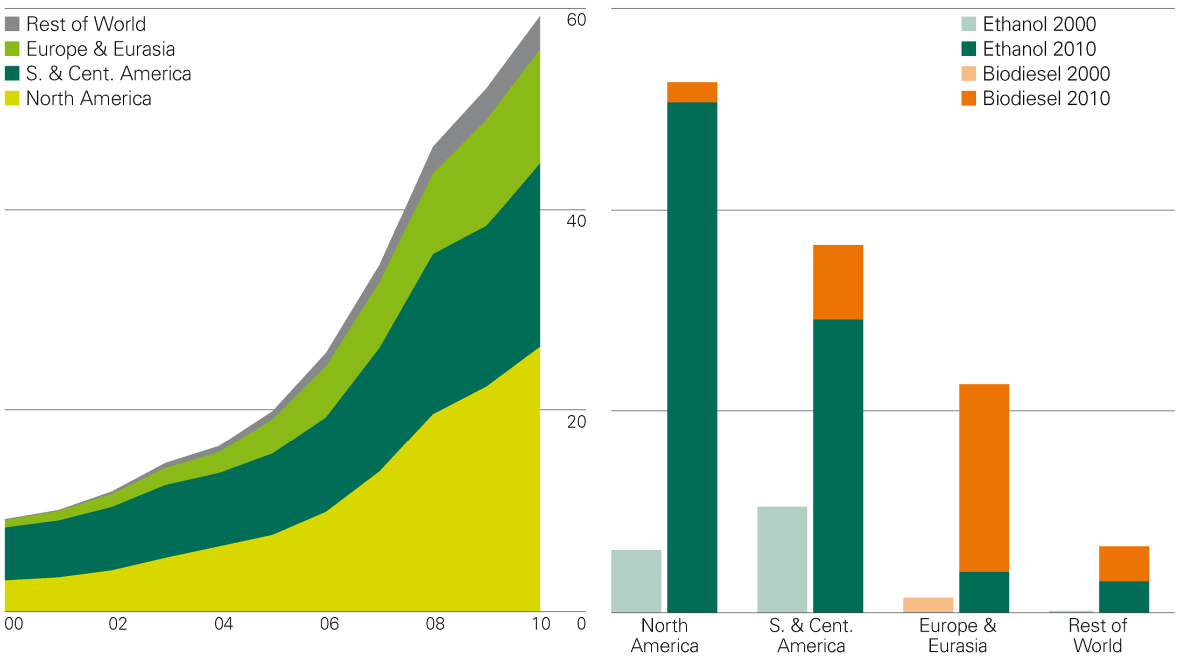
[1] And, consequently, low investment in the agricultural side. The low investment in agriculture was also due to changes in corporative governance, as companies were bought by new players. The growth of harvested area was reduced and yields decreased.

Table 2: Share of the production of the main country producers of fuel ethanol and biodiesel in 2010 and annual average growth of the production from 2005 to 2010 (%)

Country	Bioethanol		Biodiesel	
	Share of production (%)[a]	Annual growth (% per year)	Share of production (%)[b]	Annual growth (% per year)
US	57.0	26.7	6.3	36.9
Brazil	32.6	13.3	12.1	~400[1]
China	2.4	16.0	1.1[2]	NA
Canada	1.6	47.6	1.1	14.9
France	1.1	49.0	10.5	27.2
Germany	1.5	49.6	15.3	8.8
Spain	0.7	14.9	5.8	61.5
Thailand	0.5	39.8	3.2	NA
Argentina			11.1	153.7[3]
Others	2.2	12.1	33.7	47.1
Total		21.1		37.3

Sources: [a] BP, 2010; [b] REN21, 2006; REN21, 2011
Notes: [1] based on the production of 736 m^3 in 2005 (ANP 2010); [2] NA = information not available for 2005; [3] based on the production of 20 ML in 2005 (USDA 2009)

Figure 1 shows the evolution of biofuels production (ethanol and biodiesel) in the period 2000-2010. It can be seen that the growth was mainly in North America (mostly US) and in South America (mostly Brazil and Argentina). According to BP (2011), three quarters of biofuels production in 2010 occurred in the Americas.



Source: BP (2011)

Figure 1: Growth of biofuels production (in Mtoe) since 2000

An important driver in the biofuels boom has been public policies; about 30 countries have already introduced or are interested in introducing programs for biofuels. Their mandates vary from E2 to E25 (2% to 25% of ethanol blended with gasoline, volume basis) and from B2 to B8 (2% to 8% of biodiesel blended with mineral diesel, volume basis) (REN21 2010). Ethanol is also available as E85 blends in the US and Sweden, while pure hydrated ethanol is available in all Brazilian fuelling stations.

The production of bioethanol in 2010 (86 BL) was estimated to an equivalent of 3% (energy basis) of the gasoline consumption, considering a light distillates consumption of about 1,650 BL in the same year (mainly motor gasoline) (BP 2011). In the case of biodiesel production, also in energy basis, in 2010 its share was equivalent to 1% (19 BL) of the middle distillates consumption (1,820 BL) (BP 2011) (mainly diesel oil). Altogether, worldwide ethanol and biodiesel consumption represented in 2010 1.9% of the energy consumption of liquid fuels in the transport sector.

2.2 Liquid biofuels trade

2.2.1 Recent trends

The level of biofuels trade is small compared to typical agriculture and forestry commodities (e.g. in 2006, 19% for wheat and 22% for cellulose pulp) (Heinimö and Junginger 2009). It was evaluated that in 2005 ethanol trade represented about 10% of its world production and that biodiesel trade was negligible (Walter et al. 2008). Based on estimations from non-consolidated figures (data from FO Licht (2010), except for Brazil where data from MAPA were used) the total volume of ethanol exported (7.8 BL; all grades ethanol, not just fuel ethanol) was close to 10% of the worldwide production of fuel ethanol (76 BL). The exports of fuel ethanol – only – in 2009 were preliminarily estimated as 7.8% of the world production (Szwarc 2010).

General sense, data of biofuels trade are not accurate and shall to be used with caution due to many reasons, such as: (i) the different uses of ethanol, (ii) the fact that biodiesel can be produced on site from imported vegetable oils (this, indeed, often happens), (iii) the lack of proper codes for biofuels in trade data basis (Zarilli 2006), (iv) the fact that biofuels have also been exported as blends, to overcome trade duties, and (v) the fact that some countries with high export figures have, in fact, very small production (e.g. The Netherlands).

Table 3 shows imports, exports and the share of the resulting balance of biofuels trade compared with the domestic consumption of ethanol and biodiesel, in the US, EU, Brazil and Argentina in 2009 and 2010. It can be seen that a reasonable share of the biofuels consumption in the EU was covered by imports, while the opposite occurred in the US; in fact, in 2010 US was a net exporter both of ethanol and biodiesel. Two other aspects shall be highlighted: first, until 2010 the bulk of Argentina's production of biodiesel was for exports and, second, in case of Brazil the share of exports regarding the domestic consumption has decreased continuously.

Table 3: Trade figures of biofuels (ethanol and biodiesel) in 2009 and 2010 – net result is the difference between imports (+) and exports (-)

Ethanol (ML)	Imports	Exports	Consumption	(Net result/Consumption) (%)
US – 2009	1,095.6	528.0	42,315.1	1.3
US – 2010	484.5	2210.0	49,403.8	-3.5
EU – 2009	1,680.0	145.0	6,646.0	23.1
EU – 2010	1,506.1	93.5	7,849.0	18.0
Brazil – 2009		3,292[a]	24,423.1[a]	-13.5
Brazil – 2010		1,835[a]	23,300.0[a]	-7.9
Biodiesel (kt)	Imports	Exports	Consumption	Net result/Consumption
US – 2009	250.8	771.3	1,042.8	-49.9
US – 2010	72.8	284.0	770.0	-27.4
EU – 2009	1,947.2	66.0	10,150.0	18.5
EU – 2010	2,083.9	103.3	11,408.0	17.4
Argentina – 2009		1,149.7	0.5	~2,298.0
Argentina – 2010		1,366.1	496.7	175.0

Source: FO Licht 2011, except [a] EPE 2011

2.2.2 Trade regimes

Although growing, biofuels trade is still in a premature stage and the market has been distorted by trade regimes mainly imposed by the US and EU, besides unfair trade practices. Regarding ethanol, the US market – by far the largest – remains difficult to access for foreign ethanol producers, with an import tariff combined with the VEETC tax credit (the Volumetric Ethanol Excise Tax Credit) giving a rough 16 US$ cents/litre cost advantage to domestic US producers (REN21 2010). The EU also imposes a duty of 192 Euro/m^3 on undenatured alcohol (102 Euro/m^3 in the case of denatured alcohol)[2], but as production costs are higher in Europe and there is a high level of unsatisfied demand, there has been more room for imports[3].

Historically, US have imported large amounts of ethanol through Caribbean and Central American countries due to the existence of specific trade agreements. CBI (Caribbean Basin Initiative) is a trade agreement which allows up to 7% of the US ethanol demand to be imported duty free even if the ethanol was originally produced outside the CBI countries (e.g. Jamaica and Trinidad & Tobago have taken advantage of this agreement). The same occurs within the context of the USA Central America Free Trade Agreement (CAFTA), where Costa Rica and El Salvador have benefited from the duty free entry of a fixed volume of ethanol (Oosterveer and Mol 2010).

In Europe, considered unfair trade practices have had a deep impact on the biofuels industry recently. In 2007-2008, biodiesel was exported by the US to the European Member States blended with a tiny portion of mineral diesel (fuel known as B99). As in the US a federal tax exemption is granted to companies offering blends, European producers argued that the US was using unfair trade practices. As a result, in 2009, the European Commission imposed

[2] Denatured ethanol, used as fuel, to which a small percentage of foreign material has been added to render it undrinkable; remove it is difficult and expensive (Rosillo-Calle and Walter, 2006).

[3] The trade regime for bioethanol changed in US in January 2012. Details of what has been in force and an assessment of potential impacts on trade will be presented in the on-going report about the same subject, that deals with predictions up to 2020.

anti-dumping and countervailing measures. However, circumvention practices were soon observed, as the US biodiesel was shipped via other countries (e.g., Canada) where the production and trade of blends were not covered by the EU duties. More recently, European producers have also blamed Argentina of taking advantage of differentiated export taxes that incentivize exports of biodiesel rather than crude soy oil[4] (E-EnergyMarket 2010).

2.2.3 Fuel ethanol trade

The domestic market in the US is increasing saturated due to blending limitations. This, in combination with comparatively low production costs, has created opportunities for increased international sales and resulted in a sharp increase in US fuel ethanol exports, mainly to EU (Lamers et al. 2011).

Historically, US ethanol imports originate mainly in Brazil and the Caribbean, and to a lesser extent also Canada. The introduction of the VEETC also meant an increase in US market value for imported ethanol. Hence it became lucrative to import Brazilian ethanol despite US import tariffs (Lamers et al. 2011).

Until 2009, Brazil was the world's leading exporter of fuel ethanol. Its exports have risen continuously and are primarily destined for the EU and the US (to a large share via the Caribbean); to a lesser extent also to Japan and South Korea. Exports reached an all-time high in 2008, which was primarily supported by high international crude oil prices that made Brazilian ethanol cost competitive in export markets despite EU and US tariffs (Lamers et al. 2011).

As mentioned by Lamers et al. (2011), trade volumes have also been affected by (a) weather conditions, which influence harvests in exporting regions (e.g. reduction through adverse weather conditions in Brazil in 2009) as well as those in potential import destinations (e.g. floods in the US reduced corn harvests in 2008), and (b) thus the global supply and price of alternative feedstock - grains in particular. Since international grain prices were low in 2009, Brazilian ethanol imports to the EU and the US were less cost-competitive (under the given tariff levels) on these markets and export volumes shrunk. At the same time, a 'sugar gap' on the global market in 2009 lead to an increase of exports to other sugar producing nations such as India.

In 2011 net Brazilian exports of fuel ethanol were even lower due to the lack of sugarcane vis-à-vis the existing industrial installed capacity. It is estimated that it would be possible to process 700 million tonnes (Mt) of sugarcane but the production in the last harvest season was about 600 Mt. In fact, in 2011 Brazil imported large amounts of ethanol for the first time since the 1990s (1.14 BL), and mostly from US. However, at the same time, Brazil exported even more ethanol than in the previous year (1.96 BL) and also mostly to US. The reason is that fuel suppliers in US already need ethanol that is classified as advanced, and domestic (from corn) production is not classified as such[5].

Along the years, Brazilian ethanol exporters have been known to use the Caribbean free trade agreements of the US to import their ethanol duty free. This triangular trade seems to be used particularly in years in which other market prices (primarily grain) influence the competitiveness of Brazilian fuel ethanol (Lamers et al. 2011).

[4] The tax regime in Argentina is such that products like soy beans pay more taxes than soy meal and soy oil. The same occurs in case of exporting biodiesel and crude soy oil. Clearly, the tax regime aims at promoting the domestic industry.

[5] Advanced biofuels, according to the RFS2 – Renewable Fuel Standard 2 – is the one that allows reduction of at least 50% GHG emissions regarding the fossil fuel displaced. US-EPA recognizes that Brazilian ethanol allows 61% reduction, even taking into account emissions due to land use change (LUC) (both considering direct and indirect impacts).

Concerning the ethanol production at the European Union, a major limiting factor is feedstock costs. The traditional EU ethanol feedstocks are wheat and sugar beets, with increasing shares of corn, rye, barley, and wine ethanol surpluses.

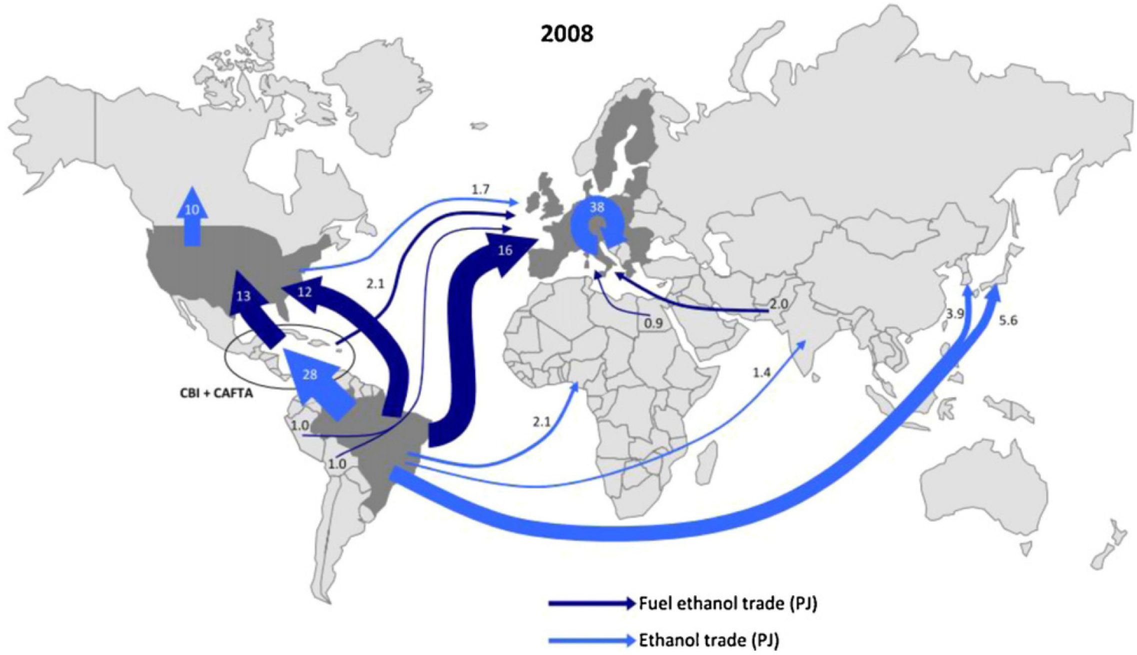
Rotterdam harbour already serves as the main entry gate of international ethanol imports to the EU (destined mainly for UK, Sweden, and Benelux). While the UK, the Netherlands and Sweden have been importing ethanol for several years, imports to other Member States (MS) – including France and Poland – have jumped from almost zero in 2007 to around 90 ML (1.9 PJ) each in 2008. This increase is exclusively attributed to high grain and crude oil prices that made international ethanol imports (in particular from Brazil) cost competitive with EU production despite import tariffs.

In most EU Member States, apart from the UK and the Netherlands, only blends of undenatured ethanol qualify for national biofuel quotas and this shields local production against cheap imports (mainly from Brazil) as tariffs for undenatured ethanol are almost twice those of denatured ethanol (192 Euro/m^3 versus 102 Euro/m^3). These tariffs are also comparatively higher than US ethanol import taxes. Since 2002, the vast majority (80–95%) of EU ethanol imports have been undenatured (Lamers et al. 2011).

Unsurprisingly, there have been efforts in the past to circumvent EU ethanol tariffs. The most prominent was the so-called 'Swedish loophole'; an effect triggered by the absence of specific fuel ethanol custom codifications as ethanol could be imported with lower duties under alternative tariff lines. By mixing ethanol with 12.5–20% gasoline just prior to customs declaration, ethanol for fuel blending was imported into Sweden under the 'other chemicals' tariff line thus reducing the tariff to 6.5% rather than 63% for undenatured or 39% for denatured ethanol. In addition, ethanol imported to Sweden this way was eligible for tax exemptions as a biofuel until 2006; legislative changes were made in 2007 that allowed only ethanol entering under the higher duty to benefit from the tax break (Lamers et al. 2011). Not coincidently, the exports of fuel ethanol from Brazil to Sweden started to decline in 2007.

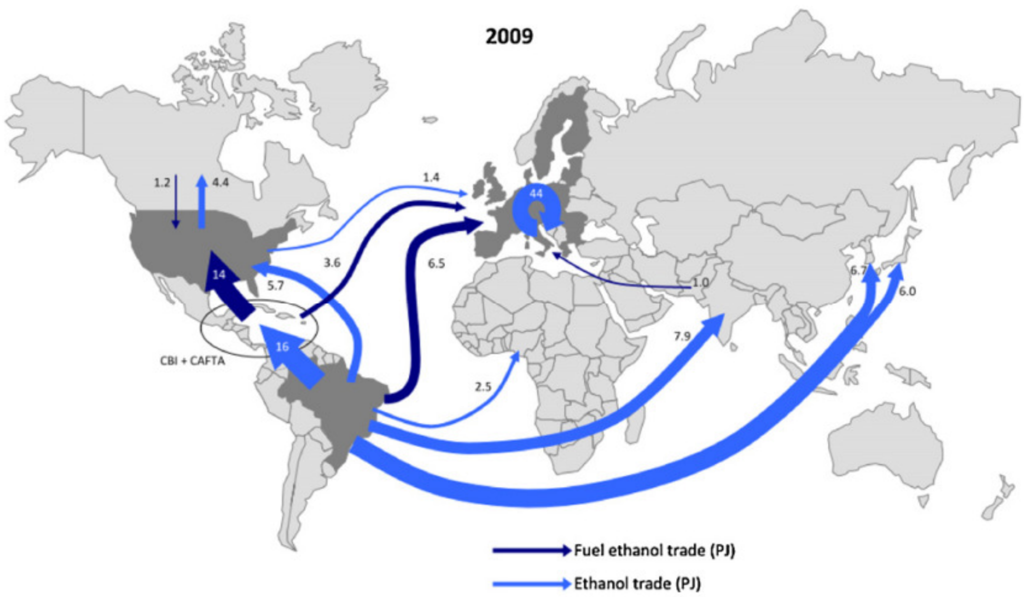
Brazil has been the main exporter of (fuel) ethanol to the EU while other nations subject to tariff preferences, in particular from Central and South America, have increased their shares in recent years. Imports of US corn based ethanol increased sharply in 2010, taking advantage of the production constraints in Brazil and the distortions of the existing trade regime. They are however likely to decline under the sustainability requirements of the EU Renewable Energy Directive (Lamers et al. 2011).

Figures 2 and 3 show a simplified scheme of the main ethanol trade streams in 2008 and in 2009 (as an illustration); values are presented in PJ, for estimated streams above 1 PJ. The authors of these figures have considered that only US, Brazil and EU were large consumers of fuel ethanol and that all ethanol shipments from Brazil to the Caribbean reached US. It can be seen the importance of Brazil's (up to 2009) in the international ethanol trade and the relevance of the trade within Europe, partially because most of the imports reach specific harbours, such as Rotterdam.



Source: Lamers et al. (2011)

Figure 2: Main global ethanol trade streams (fuel and other uses) in 2008. Data in PJ; 1 BL = 21.1 PJ



Source: Lamers et al. (2011)

Figure 3: Main global ethanol trade streams (fuel and other uses) in 2009. Data in PJ; 1 BL = 21.1 PJ

Table 4 shows results of an estimation done by Lamers et al. (2011) aiming at evaluating the share of fuel ethanol trade regarding the total production in recent years. According to the authors, the results are in line with data presented by FO Licht. It can be seen that the range of fuel ethanol traded is relatively low compared to the total production. By the time being, and based on data available, it is not possible to evaluate whether the results for 2009 represent a new tendency or were the exception along the recent years.

Table 4: Estimates of fuel ethanol trade in recent years (in ML)

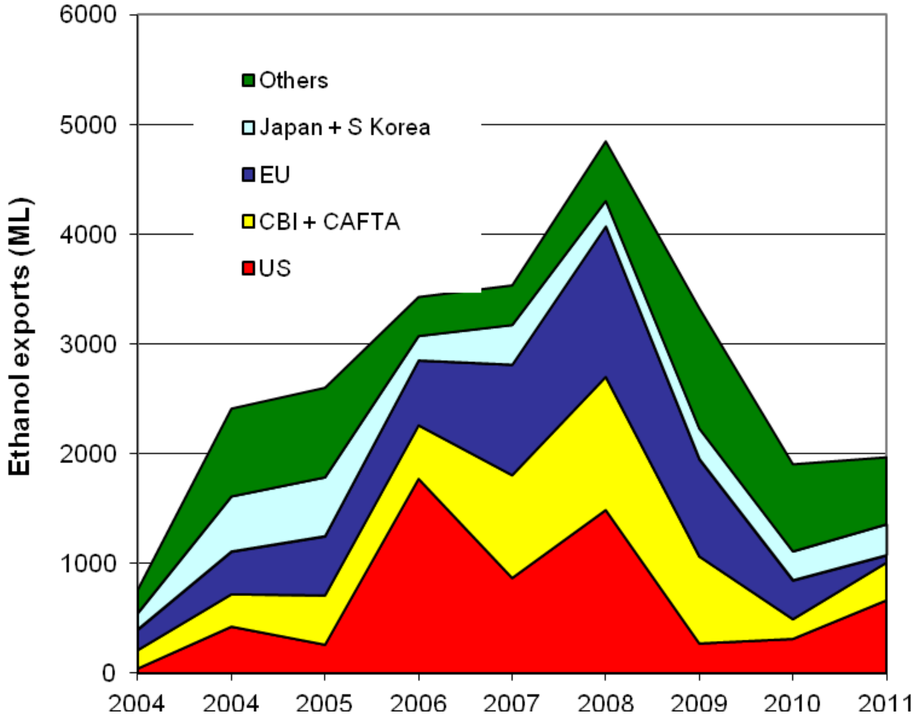
	2005	2006	2007	2008	2009
EU net imports	313	355	896	1,180	763
US net imports	517	2,773	1,668	2,009	735
Brazil's exports	649	2,540	2,517	3,886	1,735
World net trade	948-1,232	3,081-3,365	2,512-3,412	3,602-3,886	1,754-2,227
Share of global production	3-4%	8-9%	5-6%	5-6%	2-3%

Source: Adapted from Lamers et al. (2011)

In 2010, the US became a net exporter of fuel ethanol and a reasonable share was traded with Europe. There is a set of reasons for this, including the growth of production in the US, the decreased demand for gasoline in the US (and, as consequence, the ethanol demand for blends), the cap of 10% ethanol that can be blended to gasoline, and the lower competitiveness of the Brazilian industry. An important driver is also the tax credit (the Volumetric Ethanol Excise Tax Credit – VEETC) that companies receive for blending up to 90% ethanol to petrol even if the fuel is shipped overseas. In addition, these blends are eligible for lower import duties than those applied in Europe for denatured and undenatured alcohol. As can be seen in section 2.2.6, most of the exports by US in 2010 were as blends.

On the other hand, ethanol exports from Brazil fell dramatically in the last two years (from 5.1 BL in 2008 to about 1.9 BL in 2010). Besides the lower competitiveness due to the appreciation of the Brazilian currency against the US dollar and the raise of the international sugar prices, ethanol production was affected by adverse weather conditions in 2009. Yet, the main reason can be traced back to the rapid growth of domestic production in the US and the advantages given for export to Europe.

The drop in ethanol exports from Brazil to the US, as well as the drop of exports through Caribbean and Central American countries can be seen in Figure 4 (from about 1.5 BL in 2008 to 310 ML in 2010 and from 1.2 BL to 180 ML, respectively). The large exports to Caribbean and Central American countries can be explained by the existence of specific trade agreements, as previously mentioned.



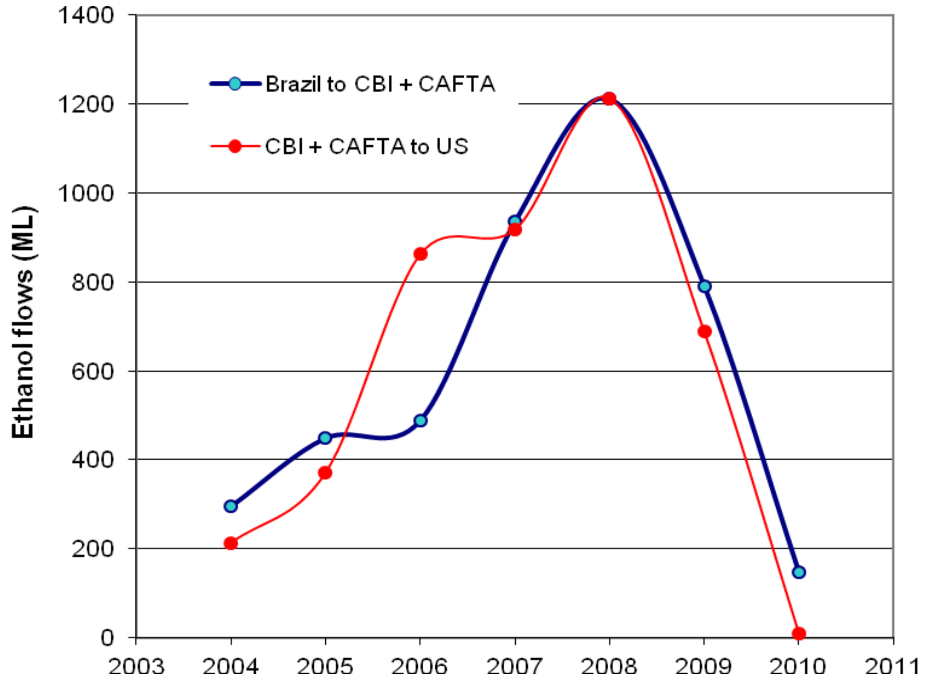
Source: MAPA, 2011 and MDIC (2012)

Figure 4: Evolution of ethanol exports by Brazil from 2004 to 2011

Similarly, the exports from Brazil to Europe were also reduced in the same period, from about 1.4 BL in 2008 to 350 ML in 2010. Traditionally, the main European markets for Brazilian ethanol were the Netherlands and Sweden, but straight flows to Sweden started to fall in 2005 and in case of the Netherlands a deep reduction occurred in 2009 and 2010. On the contrary, the imports to the UK have increased in recent years, but they are still relatively small (about 160 ML per year).

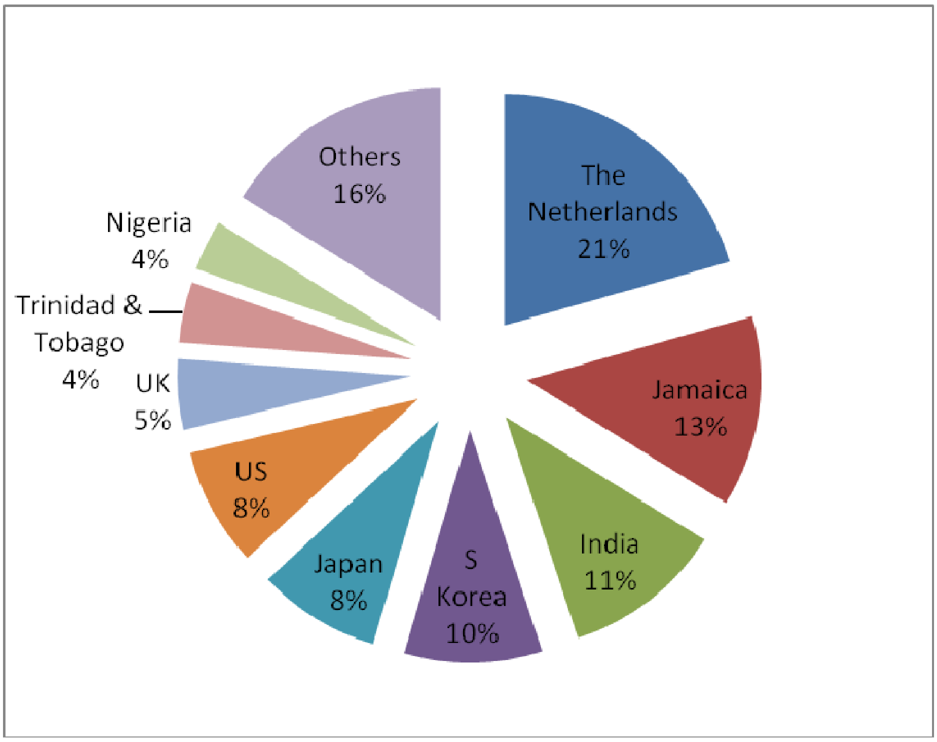
Figure 5 shows the evolution of ethanol exports from Brazil to CBI and CAFTA countries (mainly Jamaica, El Salvador, Costa Rica, Trinidad and Tobago and Virgin Islands) from 2004 to 2010, as well as the ethanol exports from these countries to the US in the same period. As can be seen, a strong correlation exists between the two series.

As an illustration, Figure 6 and Figure 7 show the main importers of ethanol from Brazil in 2009 and in 2011, respectively. It calls attention the big changes from one year to other, even in a market with very few large-scale suppliers; this volatility characterizes such an immature market.



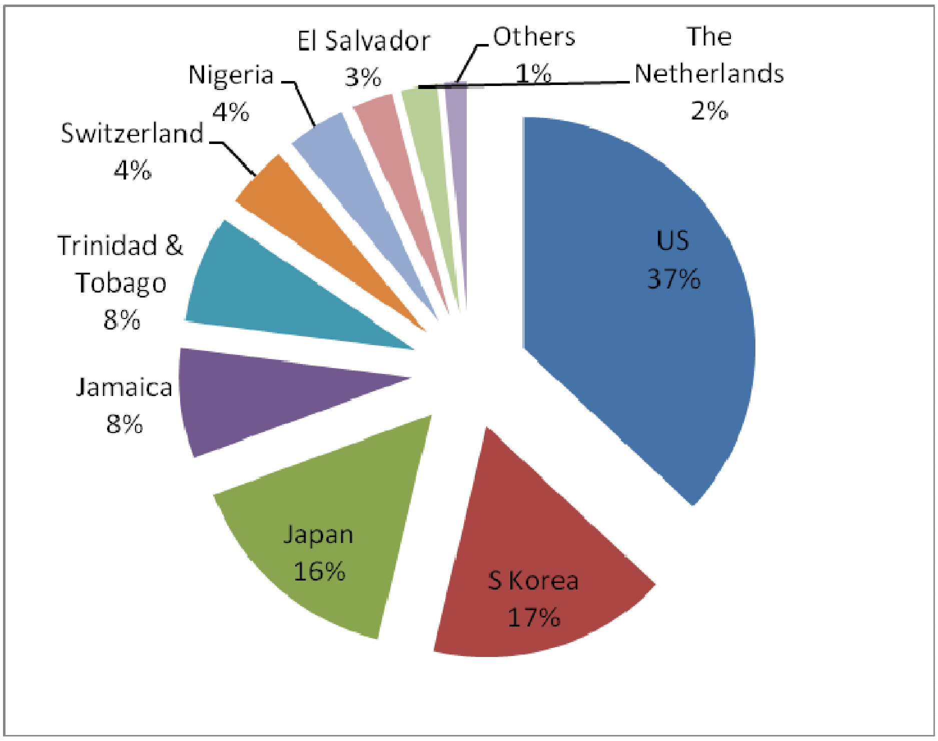
Sources: MAPA (2011) for Brazil and EIA-DOE (2011) for US

Figure 5: Ethanol exports from Brazil to CBI and CAFTA countries and from these countries to US – 2004-2010



Sources: MDIC (2012)

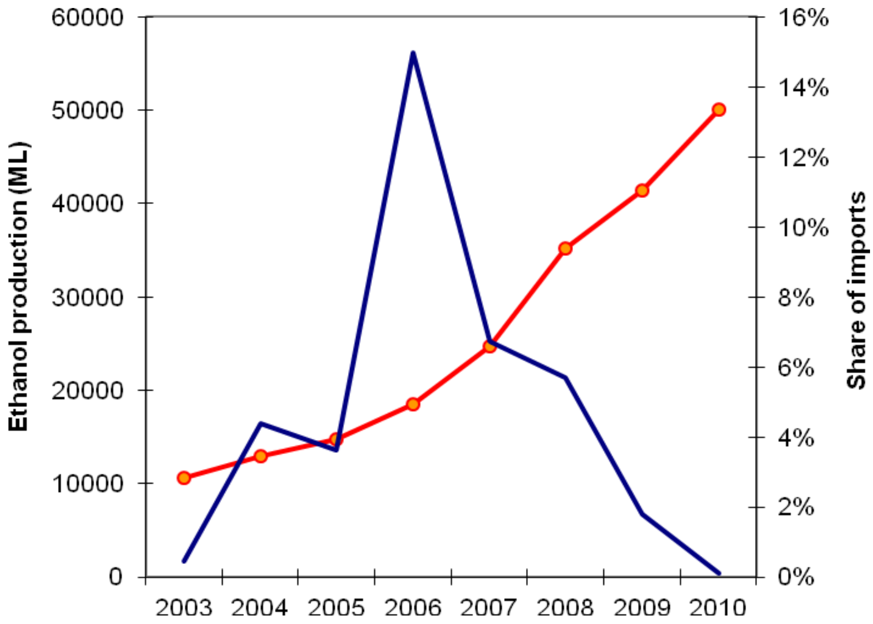
Figure 6: Main importers of fuel ethanol from Brazil in 2009 (total volume 3.3 BL)



Sources: MDIC (2012)

Figure 7: Main importers of fuel ethanol from Brazil in 2011 (total volume ~2.0 BL)

Figure 8 shows the evolution of ethanol production in US from 2003 to 2009. The information is combined with imports as share of the total domestic production in the same period. It reveals that except for 2006, the percentage of imported fuel ethanol was 6% or less and has been drastically reduced. Net imports of fuel ethanol in 2006 were relatively high since voluntary phase-outs of MTBE in several US states went into force that year. Since then, domestic production has kept up with the increasing demand and has led to an overall decline in net imports (Lamers et al. 2011). This may be explained by the US ethanol policies aiming at supporting local production that is more expensive than in some other countries (e.g. Brazil). According to data by the Energy Information Administration – Department of Energy (EIA-DOE 2011), since 2004, and except 2010, ethanol imports from Brazil and through the CBI and CAFTA agreements were never smaller than 90% of the total imports, but always targeting unsatisfied demand, rather than as a complement to domestic production.



Source: EIA-DOE (2010)

Figure 8: Ethanol production in US and the share of ethanol imports regarding the domestic production – 2003-2010

2.2.4 Biodiesel trade

The main market for biodiesel is EU and prior to 2008 the main consumer country was Germany due to the tax exemptions applied there. The picture changed dramatically with the new biofuel mandate introduced in 2007 that excluded tax exempted biofuels; as consequence, biodiesel lost competitiveness regarding mineral diesel oil.

According to Lamers et al. (2011), the EU biodiesel production capacity more than tripled since 2006, reaching about 20.9 Mt (788 PJ) in 2009, but the production itself didn't follow the same path. Three reasonable explanations are (1) that the investment decisions were taken at a moment the competition overseas was low, (2) a further relatively slower consumption increase partly related to concerns regarding the sustainability of biofuels and (3) the change of relative prices due to the lower prices of crude oil and higher prices of biodiesel feedstock.

The biodiesel trade balance varies across individual Member States. The EU-external imports to Germany remain marginal while they dominate the trade balances of the Netherlands and the UK (and also take large shares in France, Spain, Italy, and Austria). The reasons behind this are diverse. First, biodiesel prices differ across the MS varying mainly due to different tax levels and under lying biofuel policies. Secondly, some MS do not produce sufficient domestic feedstock (e.g. due to lack of suitable land or existing opportunity costs) and rather import oilseeds, vegetable oil, or biodiesel (Lamers et al. 2011).

Many harbours in EU (e.g., Rotterdam, Amsterdam and Antwerp) have become strategic biofuel hubs that deal with the import, crushing, production, blending and re-export of biofuels and their feedstock. It is obvious that these harbours are also European entrance gate for biofuels, and this explains the high trade volume registered by the Netherlands and Belgium. Apart from having access to a variety of feedstock, biofuel producers located in ports can also benefit from lower import tariffs for feedstock in comparison to the respective biofuel and its cleavage products. In addition, economic operators in ports can make use of a "custom's grey area" as they may handle commodities before or directly after declaring customs, thus further reducing/avoiding tariff payments (Lamers et al. 2011).

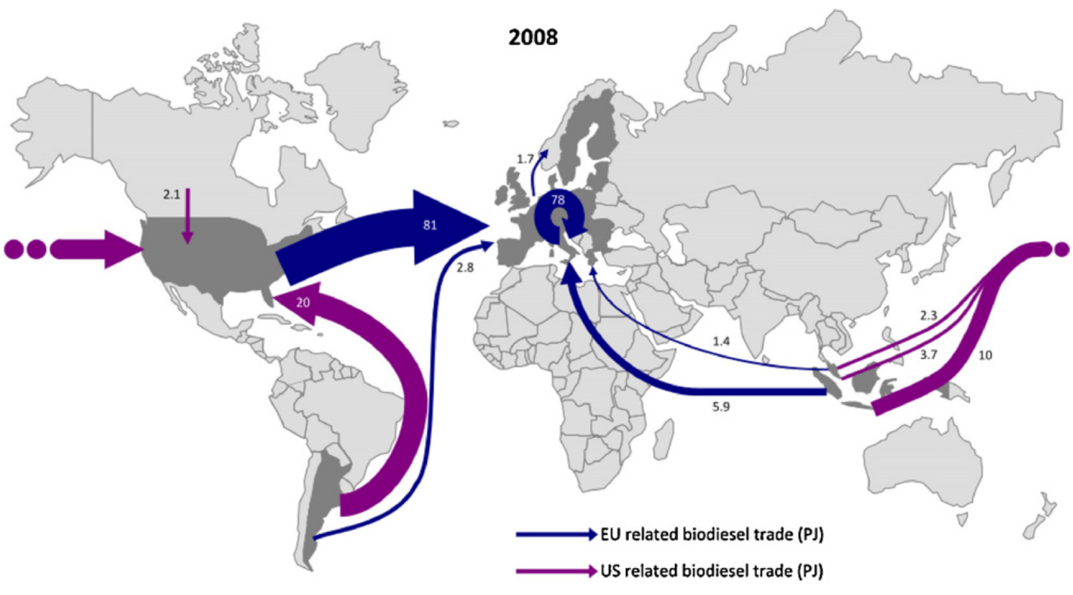
In recent years, international biodiesel imports into the EU varied according to tariff regimes. US imports dominated until early 2009 and were replaced by imports from Argentina, Indonesia, and Canada. US have faced anti-dumping and countervailing duties since March 2009 aimed at counteracting the so-called ‘splash-and-dash’ practice or ‘B99’ effect. It was based on the excise tax credit provided per volume of biodiesel blended with fossil fuel that was established in 2004 by the US Congress. The definition of ‘blending’ made it possible to receive the credit by adding only 0.1% of mineral oil. The resulting B99.9 biodiesel could be exported to Europe. It is important to notice that US imports to the EU already consisted to a large extent of Argentinean biodiesel (Lamers et al. 2011).

Similarly, part of the biodiesel exported from Canada to EU was originally produced in US, having received tax credits both in the US and in Canada. In mid 2010 the European Biodiesel Board (EBB) filed a complaint with the EC stating that US subsidized biodiesel still entered the EU market via triangular trade with third countries (as e.g. Canada and Singapore) or through blends at B19 (or lower) thus avoiding EU tariff lines for biodiesel (Lamers et al. 2011).

Since its early stages, the Argentinean biodiesel industry has mainly exported to the EU market. The production was expected to grow further and reach between 70 PJ and 86 PJ in 2010. Since Argentina has implemented a 5% biodiesel blending requirement in 2010, exports are assumed to be between 46 PJ and 56 PJ, i.e., about 65% of the total production.

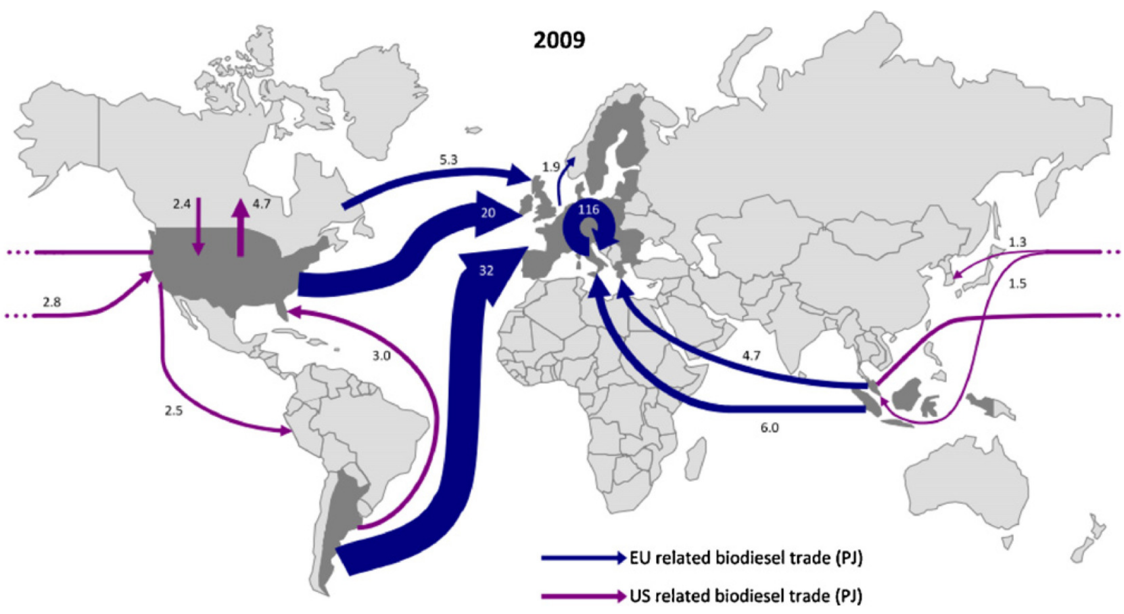
Indonesia and Malaysia, the two most important producer countries of palm oil, are playing an increasingly important role in international biodiesel trade. The production in both countries is mostly destined for export to the US and EU. Malaysian biodiesel production and exports have increased steadily in recent years, while Indonesian production seems to be fluctuating slightly.

Figures 9 and 10 show the major biodiesel trade flows in 2008 and in 2009; values are presented in PJ, for estimated streams above 1 PJ. The authors of these figures have considered that exports from Argentina, Malaysia, and Indonesia are exclusively dedicated to markets in the EU and the US. In addition, all US imports were assumed to be re-exported to the EU. From these figures it can be seen that EU is by far the main final destination of all biodiesel exports in recent years.



Source: Lamers et al. (2011)

Figure 9: Main global biodiesel trade streams in 2008. Data in PJ; 1 Mt = 37.7 PJ



Source: Lamers et al. (2011)

Figure 10: Main global biodiesel trade streams in 2009. Data in PJ; 1 Mt = 37.7 PJ

Table 5 show results of an estimation done by Lamers et al. (2011) aiming at evaluating the share of biodiesel trade regarding the total production, in recent years. It can be seen the (growing) trading tendency compared to the total production. Here it is also important to update the information in order to evaluate whether the results for 2009 really represent a new tendency.

Table 5: Estimates of biodiesel trade in recent years (in kt)

	2005	2006	2007	2008	2009
Net exports from Argentina, Malaysia and Indonesia		74	443	1,151	1,568
US net exports			438	1,207	629
World net trade	50	101	881	2,358	2,194
Share of global production	1%	2%	10%	18%	14%

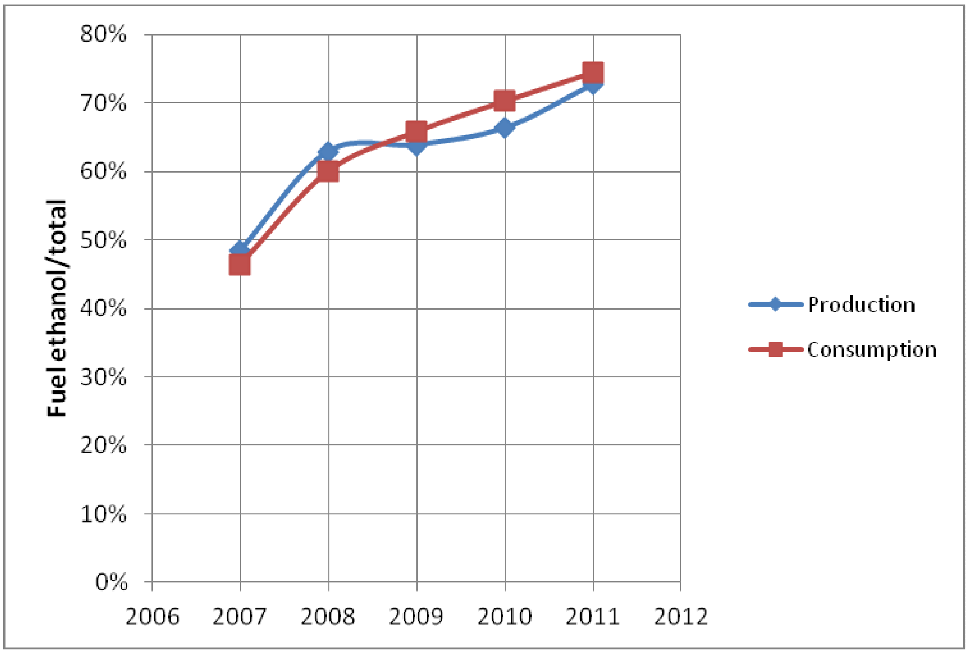
Source: Adapted from Lamers et al. (2011)

2.2.5 European Union

Ethanol

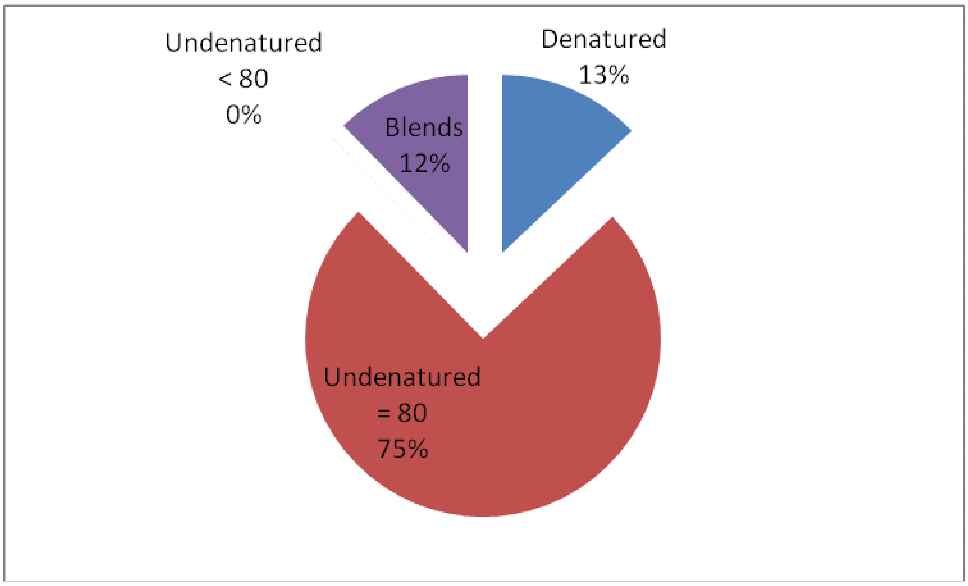
In this section details about biofuels trade in EU-27 are presented. The further information is based on FO Licht data for 2009 and 2010 (FO Licht 2011). FO Licht data is related with trade of all grade ethanol and, as it can be seen in Figure 11, the information for the last years can be considered good regarding fuel ethanol.

Figure 12 shows the profile of ethanol imports by EU-27 in 2009, and Figure 13 shows similar information for 2010. It can be seen that the bulk of imports in 2009 was as undenatured ethanol with degree equal or higher than 80%, mostly used as fuel. In 2010, the bulk of imports were of ethanol blended to gasoline, mostly exported by US (almost 620 ML) and taking advantage of duty exemptions; however, the same happened with Brazil, as 386 ML were exported as blends, and this represented 70% of the direct exports of fuel ethanol from Brazil to EU in 2010. The total volume imported by EU in 2009 was estimated at 1.34 BL while the total volume imported in 2010 was estimated at 1.51 BL.



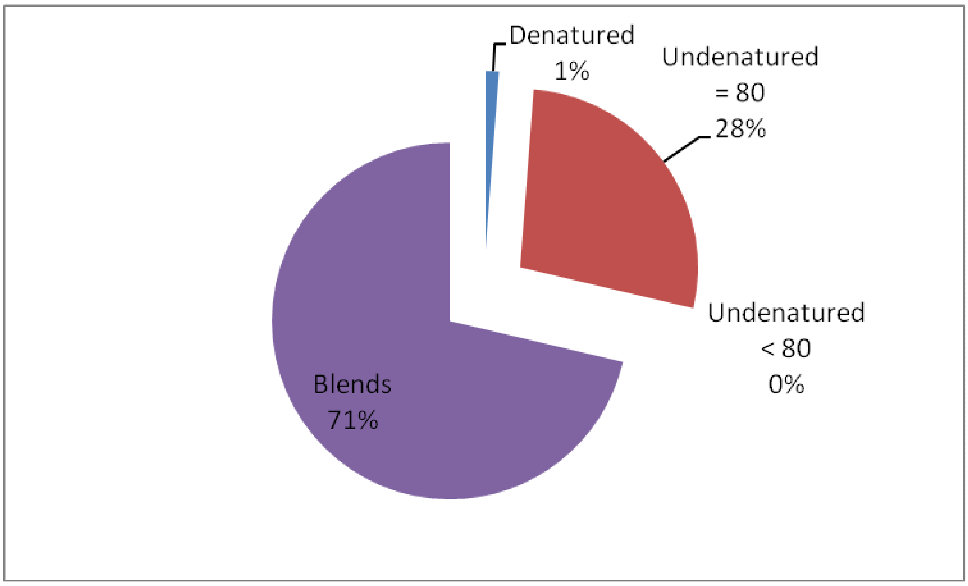
Source: FO Licht (2011)

Figure 11: Share of fuel ethanol regarding the information available of ethanol (total) production and consumption in EU-27



Source: FO Licht (2011)

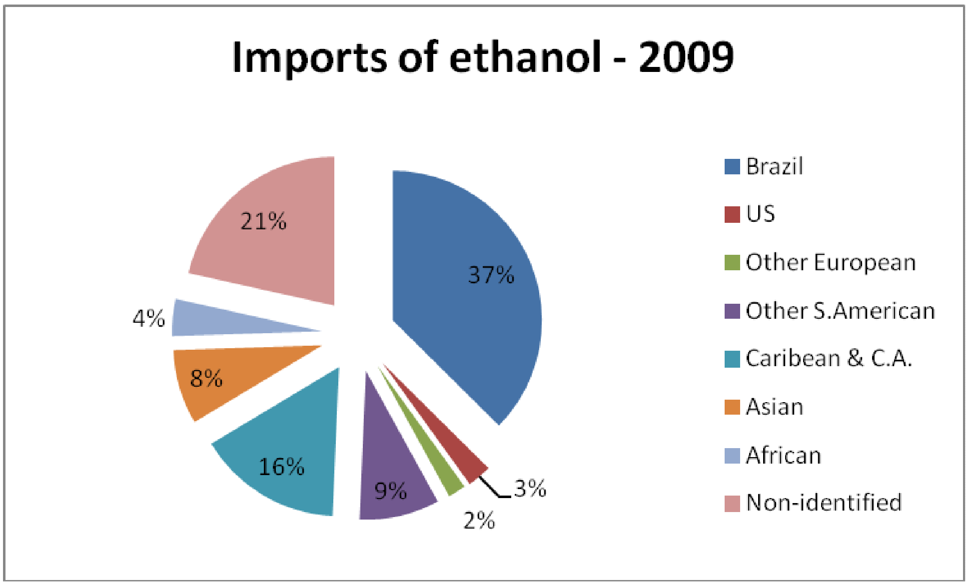
Figure 12: Profile of (net) ethanol imports by European Union, in 2009



Source: FO Licht (2011)

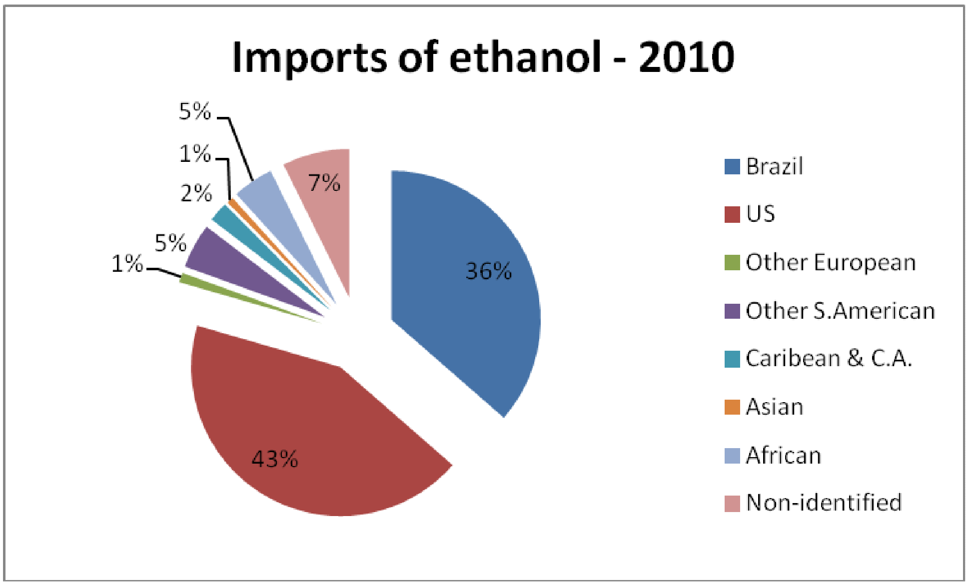
Figure 13: Profile of (net) ethanol imports by European Union, in 2010

Figures 14 and 15 show the share of different countries on the total imports of ethanol by EU-27 in 2009 and 2010, respectively. In 2009 Brazil still was the leading supplier country, with more than 500 ML exported, also with a significant amount exported through Caribbean countries, totalling 211 ML. In 2009 the exports from US were only 35 ML. The exports from Brazil to EU-27 grew to almost 550 ML in 2010, but its share among the suppliers was drastically reduced due to remarkable growth of ethanol imported from US (almost 650 ML in 2010, and mostly blended with gasoline; more than 95% of the total exports). The larger share of US negatively impacted other exporting countries of ethanol to EU-27, as it can be seen comparing Figures 14 and 15.



Source: FO Licht (2011)

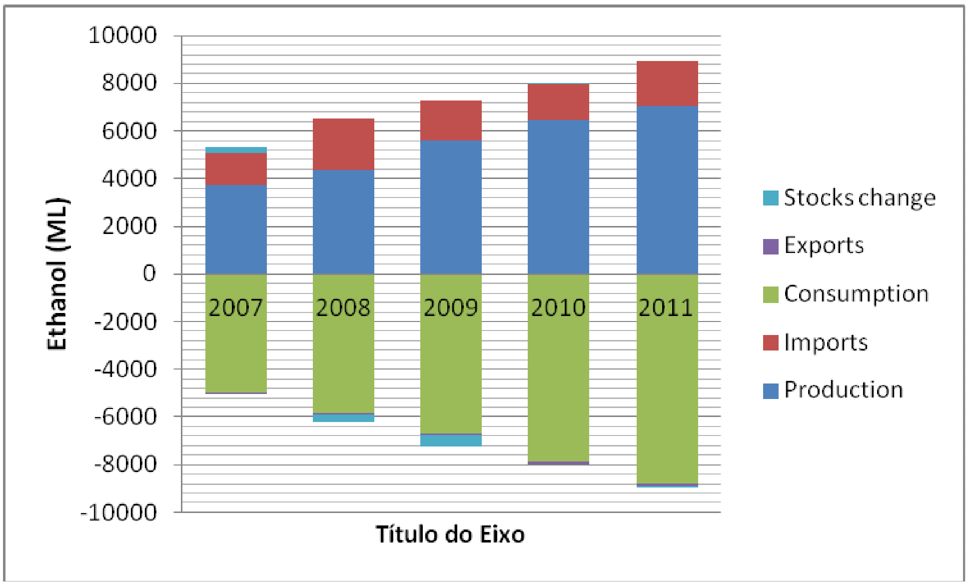
Figure 14: Imports of ethanol by European Union, in 2009; share of supplier countries



Source: FO Licht (2011)

Figure 15: Imports of ethanol by European Union, in 2010; share of supplier countries

Figure 16 shows the evolution of ethanol supply and the ethanol apparent consumption in EU-27 from 2007 to 2011 (estimates for 2011). The supply corresponds to the sum of domestic production, imports and reduction of stocks along the year. The apparent consumption corresponds to the sum of the consumption itself, exports, and net increase on stocks along the year. It is clear that consumption has continuous grown along the period. On average, imports represented about 25% of the annual total supply along the period, and are estimated at 21% in 2011.

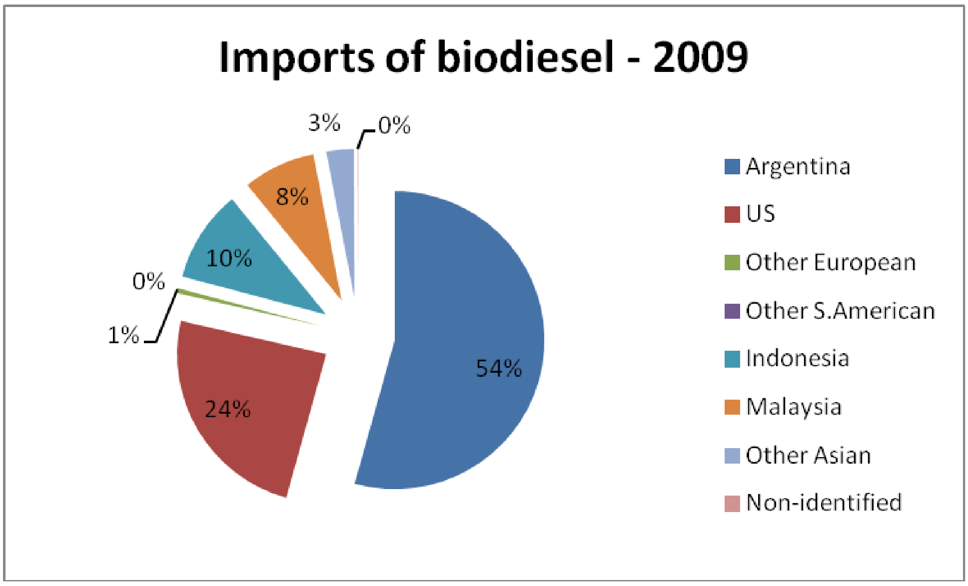


Source: FO Licht (2011)

Figure 16: Estimates of the total supply and of the apparent consumption of ethanol in EU-27

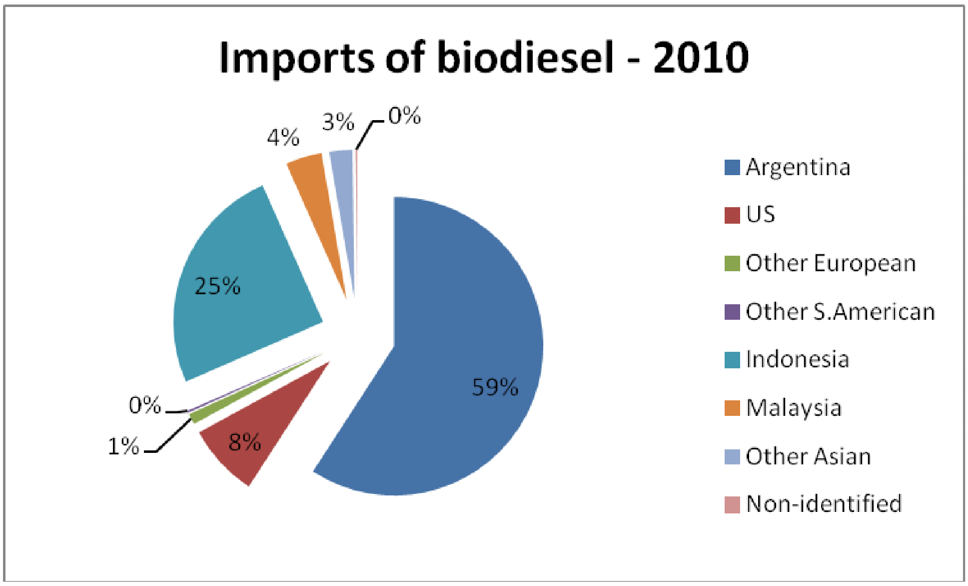
Biodiesel

Figures 17 and 18 show the share of different countries on the total imports of biodiesel by EU-27 in 2009 and 2010, respectively. Argentina was by far the main supplier in both years. The share of imports from US was drastically reduced from 2009 to 2010 due to the anti-dumping measures previously described. Mainly Indonesia took advantage of this reduction of imports from US as its exports more than doubled (157 kt in 2009 and almost 500 kt in 2010). The total imports of biodiesel by EU-27 were estimated at 1,711 kt in 2009 and 2,084 kt in 2010.



Source: FO Licht (2011)

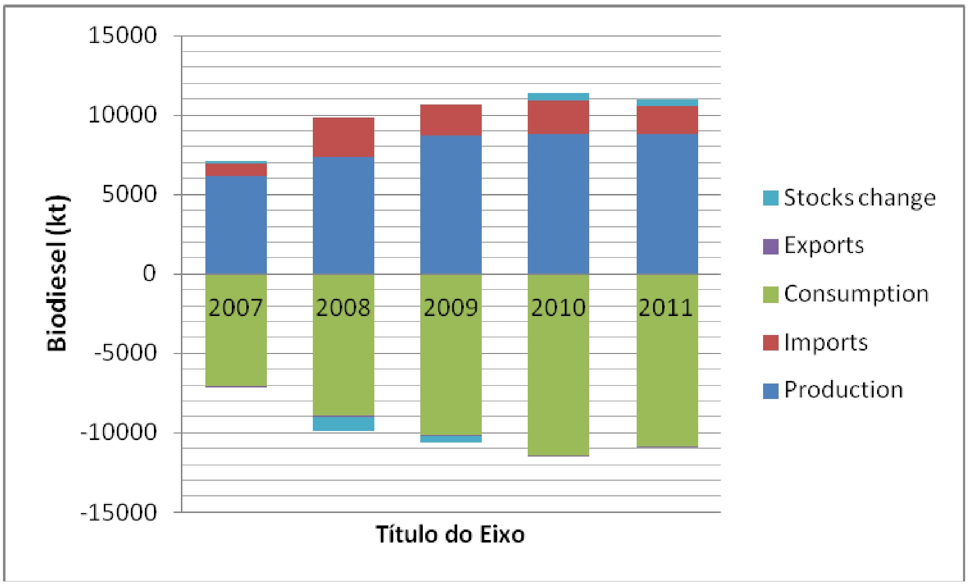
Figure 17: Imports of biodiesel by European Union, in 2009; share of supplier countries



Source: FO Licht (2011)

Figure 18: Imports of biodiesel by European Union, in 2010; share of supplier countries

Figure 19 shows the evolution of biodiesel supply and its apparent consumption in EU-27 from 2007 to 2011 (estimates for 2011). The supply corresponds to the sum of domestic production, imports and reduction of stocks along the year. The apparent consumption corresponds to the sum of the consumption itself, exports, and the net increase on stocks along the year. Domestic production has been roughly constant since 2009 and it is estimated a reduction of about 5% of biodiesel consumption in 2011 regarding 2010. It is clear that consumption has continuously grown along the period (except in 2011). On average, imports represented about 18% of the annual total supply along the period, and are estimated as 16% in 2011.



Source: FO Licht (2011)

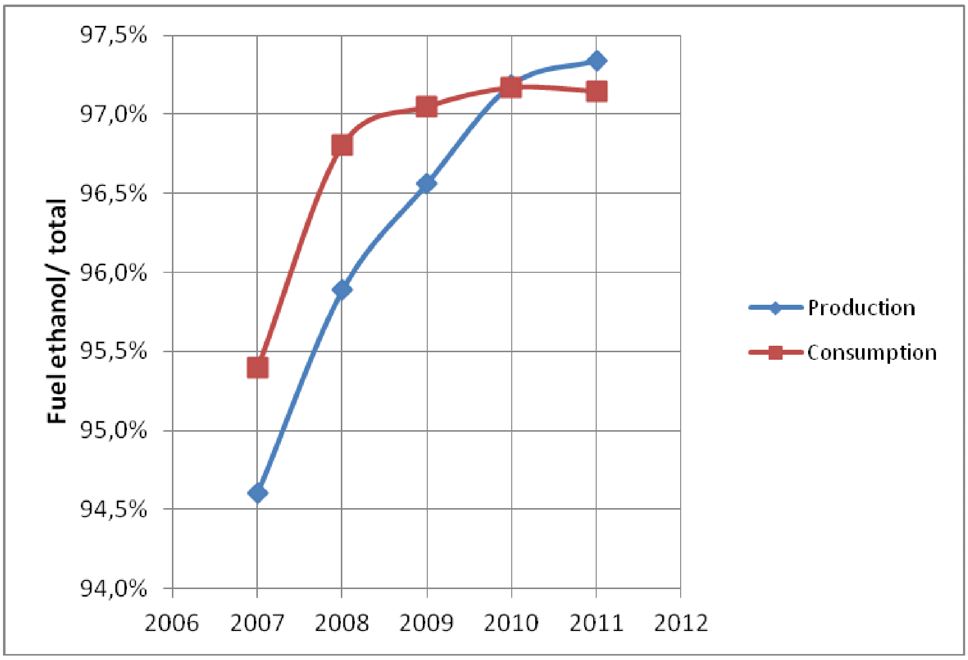
Figure 19: Estimates of the total supply and of the apparent consumption of biodiesel in EU-27

2.2.6 United States

Ethanol

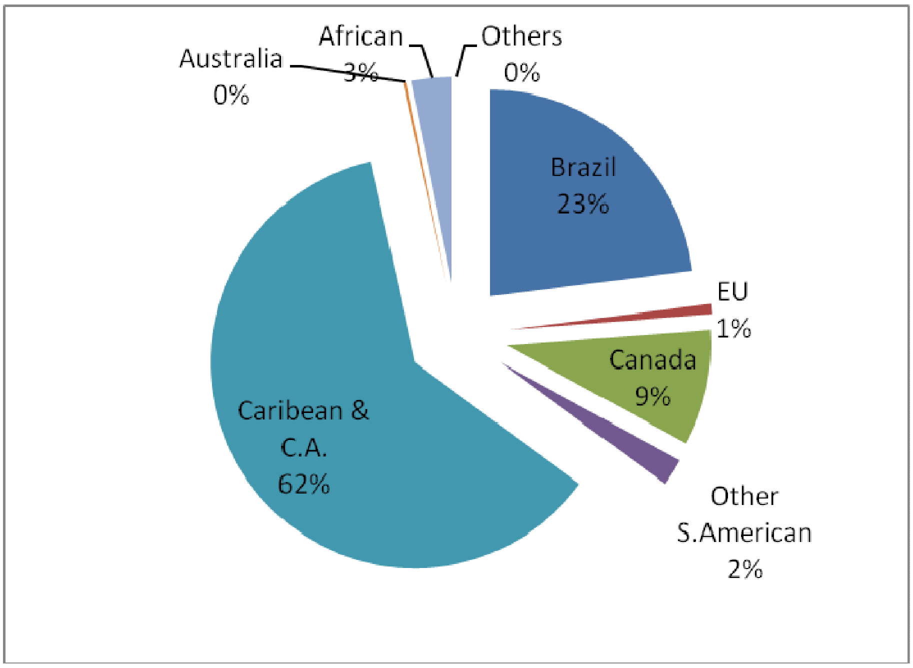
This section presents details of biofuels trade in US. The information is based on FO Licht data for 2009 (mostly) and 2010 (FO Licht, 2011). FO Licht data concerns trade of all grade ethanol but, in the case of US, as the share of fuel ethanol is by far the most important (see Figure 20) the further analysis can be considered very accurate regarding this product.

Figure 21 shows the shares of different countries/regions on the total ethanol imports by US in 2009 (1.1 BL). The bulk of the imports were from Central America and Caribbean countries, due to the specific trade agreements with such countries. In 2009 Brazil's share (directly importing to US) was much less than in previous years. It calls attention the small share of imports from other South American countries and also from African countries.



Source: FO Licht (2011)

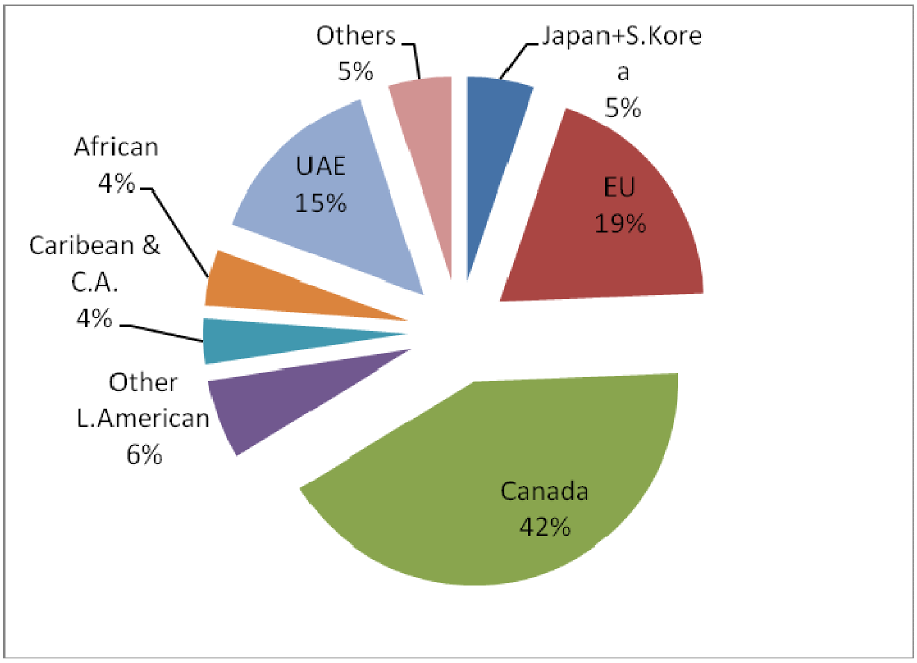
Figure 20: Share of fuel ethanol regarding available information of ethanol (total) production and consumption in US



Source: FO Licht (2011)

Figure 21: Profile of ethanol imports by US in 2009

Figure 22 shows the destinations of the ethanol exports from US in 2009 (542 ML exported). A significant share of the exports was to Canada, being EU the second most important destination.



Source: FO Licht (2011)

Figure 22: Profile of ethanol exports from US in 2009

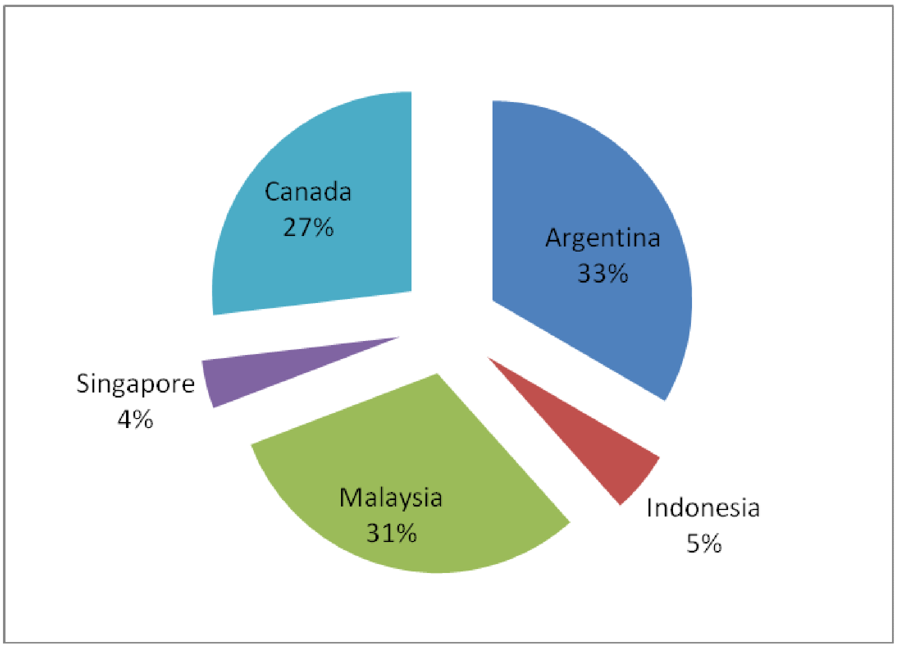
Figure 23 shows the evolution of ethanol supply (and, as proxy, fuel ethanol) and ethanol apparent consumption (fuel ethanol, basically) in US from 2007 to 2011 (estimates for 2011) (supply is the sum of domestic production, imports and reduction of stocks; apparent consumption is the sum of the consumption itself, exports, and net increase on stocks). Production and consumption have grown continuously in US in recent years and imports have had a small contribution on the total supply (just about 1% in 2010 and in 2011). On the other hand, US has become a net exporter of (fuel) ethanol since 2010, with more 2 BL exported in 2010 and an estimate volume of 2.4 BL exported in 2011.

Source: FO Licht (2011)

Figure 23: Estimates of the total supply and the apparent consumption of (fuel) ethanol in US

Biodiesel

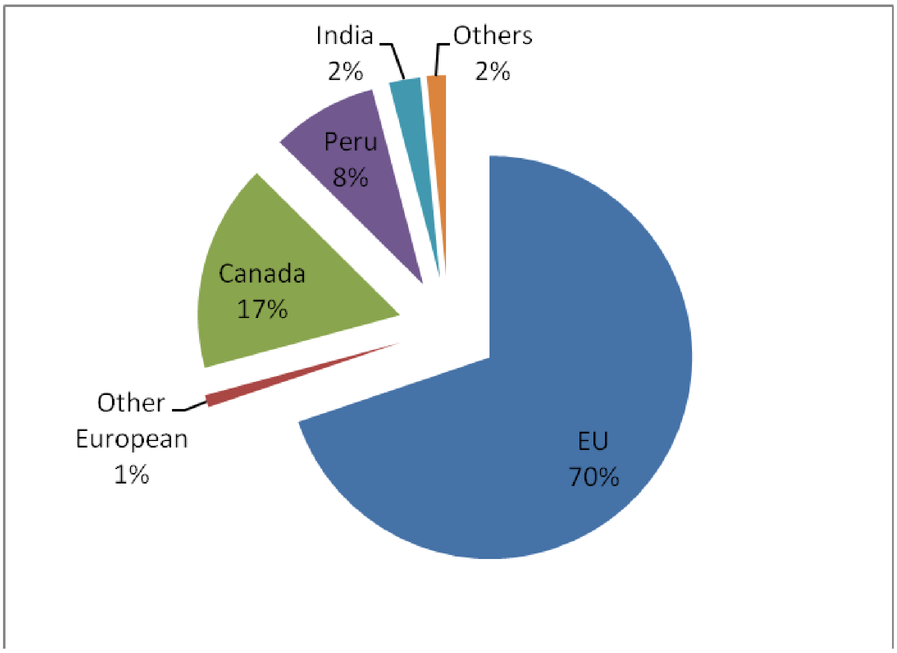
Figure 24 shows the contributions of the main exporters of biodiesel to US in 2009. Argentina, Malaysia and Canada covered more than 90% of the total imports, with almost similar contributions. The total amount imported bu US in 2009 was about 250 kt.



Source: FO Licht (2011)

Figure 22: Imports of biodiesel by US, in 2009; share of supplier countries

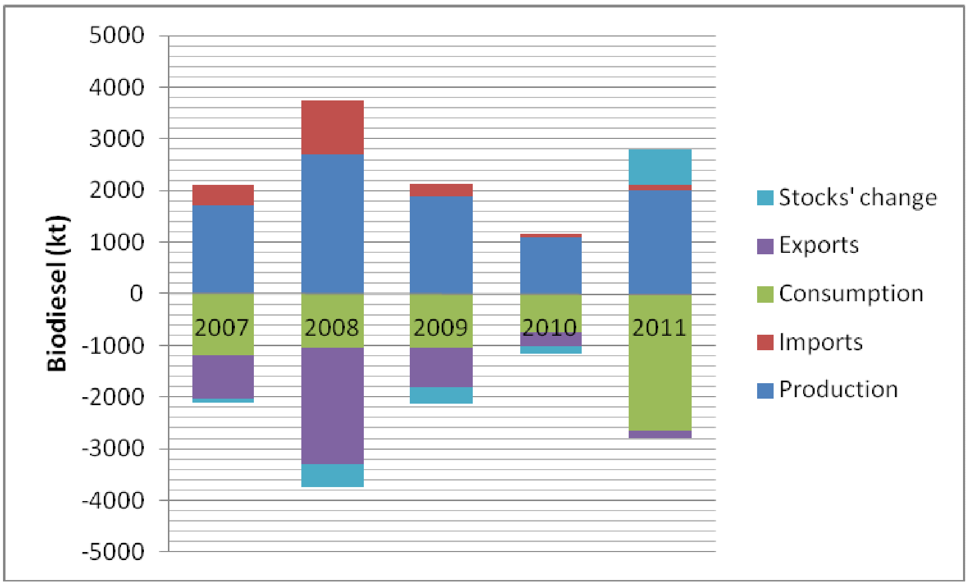
In 2009 US exported more than 770 kt of biodiesel and the main destination was EU-27, mainly to the Netherlands (about 300 kt), France (86 kt), Belgium (70 kt) and UK (67 kt). A significant share was also exported to Canada, as can be seen in Figure 25.



Source: FO Licht (2011)

Figure 25: Main destinations of the exports of biodiesel from US, in 2009

Finally, Figure 26 shows the evolution of biodiesel supply and its apparent consumption in US from 2007 to 2011 (estimates for 2011) (supply is the sum of the domestic production, imports and reduction of stocks; the apparent consumption is the sum of the consumption itself, exports, and net increase on stocks). Except for 2011, it is clear that the domestic consumption represented a small share of the total supply, and both the production and the imports were more targeted to exports.



Source: FO Licht (2011)

Figure 26: Estimates of the total supply and of the apparent consumption of biodiesel in US

3 Solid biomass trade

International solid biofuel trade has grown from about 56 to 300 PJ between 2000 and 2010. Wood pellets grew strongest, from 8.5 to 120 PJ. Other relevant streams by 2010 included wood waste (77 PJ), fuel wood (76 PJ), wood chips (17 PJ), residues (9 PJ), and round wood (2.4 PJ). Intra-EU trade covered two thirds of global trade by 2010 (Lamers et al., 2012). According to Junginger (2011), the main solid biomass traded worldwide are wood pellets, wood chips, wood briquettes, firewood, waste wood, straw and other residues. The main recent facts regarding solid biomass trade to and within Europe are described below.

Wood pellets: industrial wood pellets are used as fuel in power plants, co-fired with coal, and in Combined Heat and Power Plants (CHP). In Europe the main users as such are Sweden, Denmark, Belgium, the Netherlands and UK. These countries import pellets from Baltic countries, and also from Finland, Russia, Canada and USA. Within Europe, high-quality wood pellets – mostly used in households – are mainly imported by Italy from different countries (e.g., Austria, Germany, Slovenia, Portugal and Spain). Wood pellets are by far the main solid biomass traded in Europe.

Wood chips: according to Junginger (2011), in recent years wood chips have been exported by Latvia mainly to Denmark and Sweden. Other possible destinations are Belgium, Germany, UK and Lithuania.

Wood briquettes: have been traded in small amounts in Europe. Main exporters are Latvia, Lithuania and Slovakia.

Waste wood: i.e., used wood. According to Junginger (2011), waste wood has been traded across Europe, but there is not precise information regarding its end-use.

Other solid biomass: firewood has been traded by Norway and Greece, straw has been exported by Denmark to the Netherlands, Germany, France and Belgium, and agricultural residues (e.g., palm oil and olive residues, and sunflower pellets) have been used as fuel in UK (biomass has been imported from Indonesia, southern Europe and Africa).

3.1 International pellet trade

Due to the importance of wood pellets among all solid biomass, the text that follows is focused on this product. The market for wood pellets has grown strongly since late 1990s and the main consumer countries are in Europe; besides Europe, the consumption is also growing in US and in Asian countries, like Japan and South Korea (these are mainly importers of pellets, while US is a larger exporter). The consumption of industrial pellets in Japan and in South Korea tends to grow due to the priority given to the reduction of greenhouse gas (GHG) emissions, mainly promoting co-firing.

Global pellet production grew almost tenfold from 1.6 to over 15 Mt in ten years, i.e. up to 2010. Currently, the single largest producers are the USA, Canada, Germany, Sweden, and Russia. The industry has grown from small scale production units with capacities below 50 ktonnes and relying on surplus sawmill residues to large scale plants whose individual capacities reach almost 1 Mt and encompass chippers to allow flexibility in feedstock choice. Over the past decade, the leading consumer and importer of wood pellets has been the EU27; combusting more than two thirds of global production annually (Lamers et al., 2012).

Wood pellets are one of the largest internationally traded biomass commodities and are used specifically for energy purposes. The volume traded recently is comparable to biodiesel or bioethanol in energy terms. Compared with other solid biomass (e.g., wood chips and agricultural residues) their advantages are the storability and relative easy handling. Wood pellets also have a low moisture content and relatively high energy density (about 17.5 GJ_{LHV}/t). It is economically more feasible to transport wood pellets instead of wood chips above 9,300 km. As an energy source, wood pellets have been used for electricity and heating generation; in the future, could be used as a lignocellulose feedstock for the production of second-generation biofuels (Sikkema et al. 2011).

Global production grew from almost 8 million tonnes (Mt) per year in 2007 to more than 13 Mt in 2009. North America (US and Canada) produced about 6-7 Mt in 2009, of which almost 5 Mt were intended for exports to Europe. Leading countries in the consumption of pellets in Europe are Sweden, Austria and Finland; Germany, France and Italy have the largest market growth in both capacity and consumption of pellets. Russia is increasing its production capacity and may become a key player for exports in the near future (Pirraglia et al., 2011).

In 2009, the EU-27 produced about 8.8 Mt. The largest producers were Sweden and Germany, both producing about 1.6 Mt, and mainly using feedstock purchased from external sawmills. Italy was the third largest producer in Europe (almost 0.8 Mt) and has many integrated pellet plants (Sikkema et al., 2011).

North America has the largest pellet production facilities outside Europe; the production capacity has grown from 1.1 Mt in 2003 to 4.2 Mt in 2008 and 6.2 Mt in 2009. In 2009, a number of new plants were built in the United States to process chipped round wood for bulk pellets designated for export. Wood pellet production in the US in 2008 amounted to 1.8 Mt, which was 66% of capacity. In Canada, the estimated production was 1.4 Mt, about 81% of capacity (Sikkema et al., 2011). About 80% of US-produced pellets in 2009 (1.5 Mt) was consumed domestically for residential heating. By contrast, most Canadian pellets (90%) are transported as bulk and shipped overseas for power production in Europe.

The pellets production in US is located in the South and the industry has the ability to supply pellets for the European market at a competitive price because of enhanced production capacity due to a sustainable wood source from plantations. Considering exports to EU, in few years the production in Southern US has became competitive vis-à-vis Canadian production due to the location of ports, better road infrastructure and year-round harvesting. The US wood pellet industry was dominated by several small- to medium-sized factories (large factory produces about 100,000 tonnes per year) but, recently, several facilities in the Southern US have started operations, producing more than 500,000 tonnes per year (Pirraglia et al., 2011).

In 2009 the apparent consumption in Europe was estimated at about 9.8 Mt, of which 9.2 Mt was within EU-27 member states. Sweden is by far the largest user of pellets (2.0 Mt), followed by Italy (1.1 Mt), the Netherlands (0.95 Mt), Germany (0.94 Mt), and Denmark (0.89 Mt). The main markets in Belgium and the Netherlands are due to the utilization of pellets in large-scale power plants. Medium-scale consumers using bulk wood pellets for district heating and also for (larger) CHP plants are mostly important in Sweden, Denmark, and Norway (Sikkema et al., 2011).

In 2009, EU-27 imported about 1.8 Mt, being 0.54 from US, 0.52 Mt from Canada and 0.38 Mt from Russia. It is predicted that in 2010 2.5 Mt have been imported from outside Member States of UE (see Table 7). The main importing countries in EU are Sweden, the Netherlands and Belgium (Junginger, 2011).

In 2015, the consumption of pellets for power generation can surpass 8 Mt, being about 4.5 Mt only in UK; other large consumer countries for such purpose should be the Netherlands, Denmark, Belgium and Poland. According to the European Biomass Association, quoted by Pirraglia et al. (2011), it is expected that Europe will reach a total consumption of 50 Mt per year by 2020. Regardless of increased production, European countries will have a lack of production capacity to satisfy the internal demand, mainly due to the scarce availability of sustainable sources of raw material in the EU. The predications presented by Sikkema et al. (2011) are even higher: in 2020 the demand for woody biomass varies from 105 Mt, based on market forecasts for pellets in the energy sector and a reference growth of the forest sector, to 305 Mt, based on maximum demand in energy and transport sectors and a rapid growth of the forest sector.

Outside Europe, the production capacity shall be enhanced in the following years, considering that Canada shall enlarge its production capacity in 2 Mt, US in 3 Mt and Brazil plans to start the production of pellets from eucalyptus for exports with 3 Mt (Junginger, 2011).

Table 6 presents estimates of the world wood pellets production from 2000 to 2010. It can be seen that in 2010 the production in EU-27 plus US and Canada represented 87% of the world production.

Table 6: World wood pellets production from 2000 to 2010 – 1,000 tonnes

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
USA	460	587	776	723	927	1,062	1,090	1,180	1,800	2,800	3,000
Canada	356	401	499	533	727	936	1,145	1,485	1,335	1,300	1,320
Brazil							25	25	20	20	20
Argentina							7	7	7	9	10
Chile							20	60	20	20	20
Australia									5	5	125
New Zealand							20	20	50	100	110
South Africa										42	21
Japan	2	2	2	2	4	9	23	33	38	50	60
China									75	75	75
South Korea										20	170
EU27	840	1,205	1,360	1,754	2,278	3,100	4,696	6,072	7,507	8,764	9,286
Norway				20	34	42	51	45	35	68	193
Switzerland							35	70	74	112	112
Russia		2	4	8	30	50	350	550	550	840	800
Belarus							20	40	40	88	88
Ukraine							30	60	65	77	90
Bosnia H.									19	38	38
Croatia							21	41	41	77	77
Serbia									40	38	38
TOTAL	**1,658**	**2,197**	**2,641**	**3,040**	**3,999**	**5,199**	**7,533**	**9,687**	**11,721**	**14,542**	**15,652**

Source: Lamers et al. (2012)

Table 6 presents estimates of the imports of wood pellets by EU in 2010. It can be seen that almost 80% of the imports are due to Canada, US and Russia, and in the three cases the main product is industrial pellets.

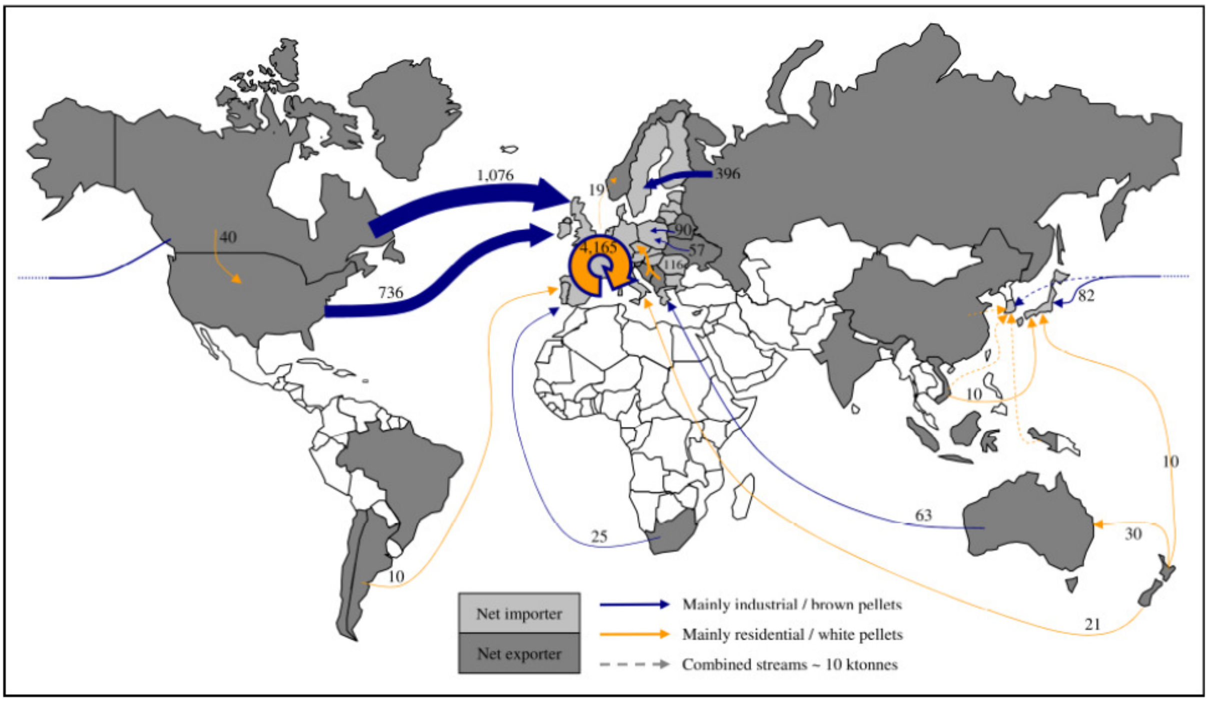
Table 7: Imports of wood pellets by European countries in 2009 and 2010 – 1,000 tonnes

Country	2009	2010	Main type[a]	Main destination[b]
Canada	520	926	Industrial	NL, UK, BE
USA	535	736	Industrial	NL, UK, BE, DK
Russia	379	396	Industrial	DK, SE
Croatia	73	95	High quality	IT (partly via SI)
Belarus	75	90	Industrial	DK, DE, LI
Bosnia and Herzegovina	54	44	High quality	IT (partly via SI), SI
Ukraine	30	57	Industrial	PL, DK
Australia	9	63	Industrial	NL (partly re-export to EU)
South Africa	42	25	Industrial	UK, BE, NL
Serbia	18	26	High quality	IT, SI
New Zealand	0	21	High quality	NL, IT
Switzerland	6	15	High quality	IT, DE, AT
Other	31	27		
World	**1,771**	**2,523**		

a: Observations based on the predominant market in the importing countries
b: Trade route information based on interviews and [20]

Source: Lamers et al. (2012)

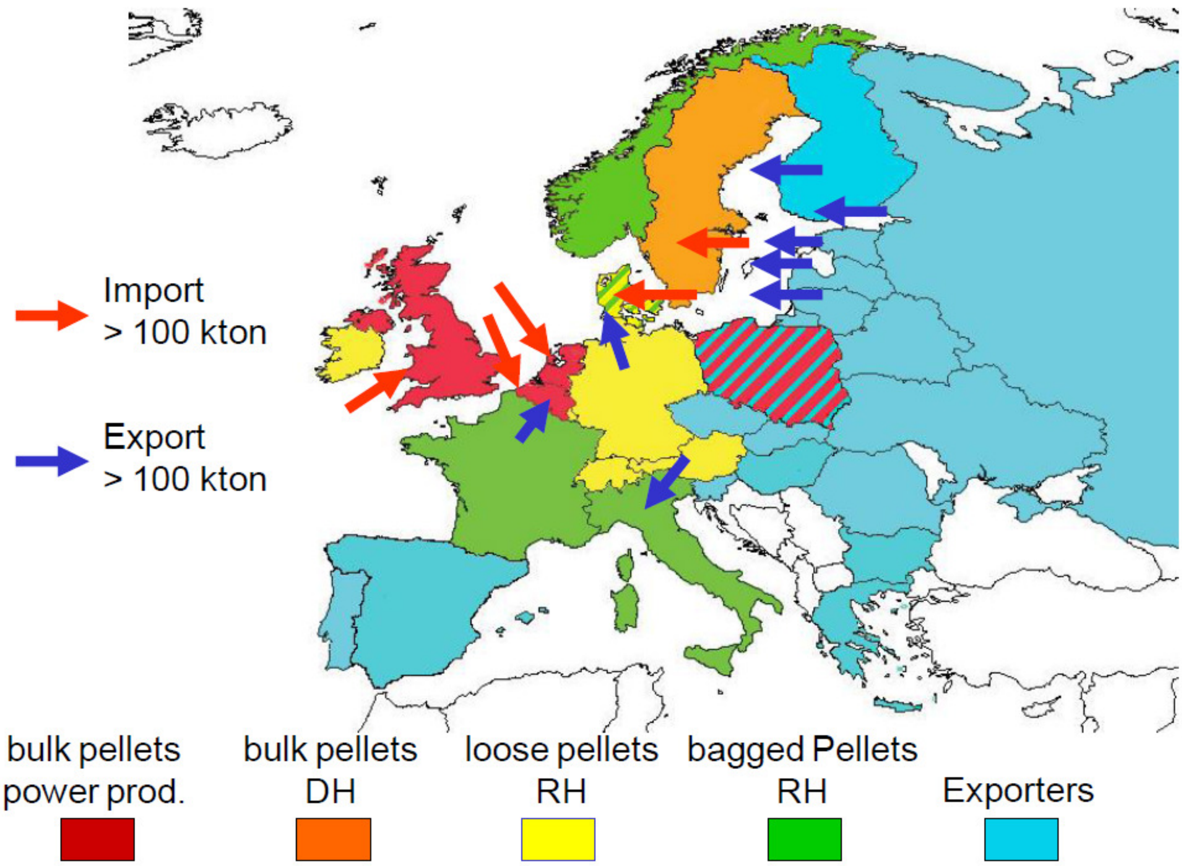
Figure 25 shows the main world trade routes of wood pellets in 2010. It can be seen that the main flows to Europe are from Canada and US (and in this case large-scale exports started just in 2008). The flow from Australia and South Africa to Europe is still relatively small.



Source: Lamers et al. (2012)

Figure 25: Main trade streams (kt) of wood pellets around the world in 2010

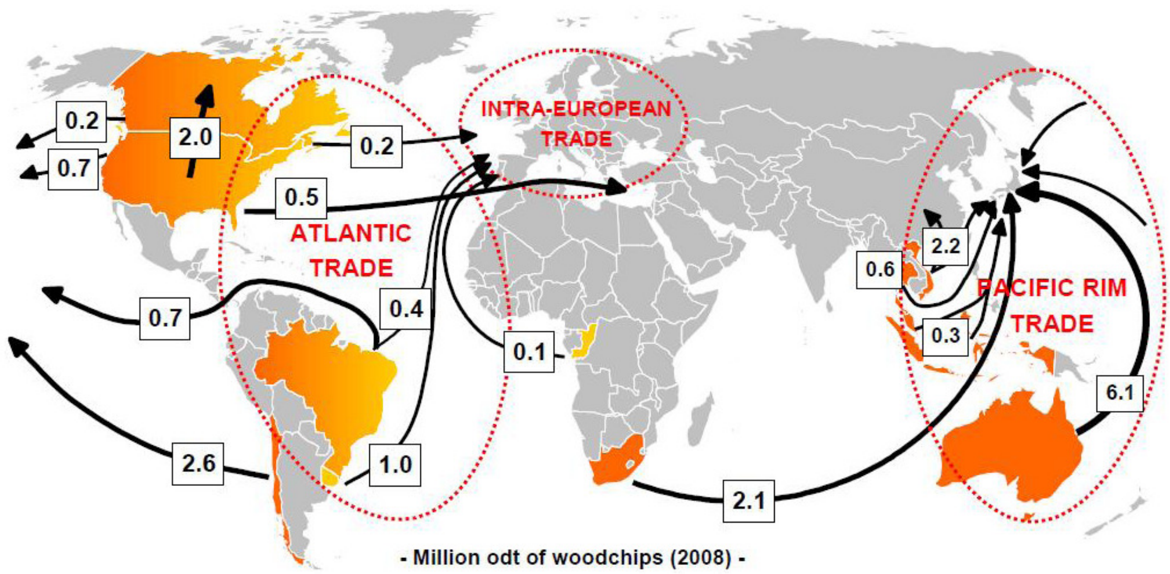
Details of the European pellet market and of the main markets in Europe in 2009 are presented in Figure 26. In the Figure, DH means “District Heating” and “RH means “Residential Heating”. As previously mentioned, the use of pellets in power plants mainly occurs in Belgium, the Netherlands, UK and Poland.



Source: Sikkema et al. (2011)

Figure 26: European pellet market and the main markets in each country in 2009

The trade of wood chips in 2008 was estimated at 19.4 Mt (odt, i.e., oven dry tonne – absolutely dry), being Japan the destination of 77% of the total flows. The main exporter countries are identified by colours in the Figure 27, presented here as an illustration of the market size for wood chips. Table 8 presents data of production, imports and exports of wood chips in different countries, in 2007, 2008 and 2009; data are presented in 1,000 tonnes.



Source: Junginger (2011)

Figure 27: Trade of wood chips around the world

Table 8: Main producers, importers and exporters of wood chips in 2007-2009 (ktonnes)

	Production			Imports			Exports		
	2007	2008	2009	2007	2008	2009	2007	2008	2009
Australia	4,725	5,412	4,968	1	1	1	6,051	6,113	4,759
Chile	2,384	2,583	2,293	0	0	0	3,065	4,059	3,695
USA	1,513	1,925	1,650	214	98	57	2,996	2,861	2,849
South Africa	3,561	3,561	3,561	0	1	0	3,593	3,268	2,122
Latvia	751	1,024	783	20	80	7	1,693	1,557	1,449
Russia	3,273	2,420	2,035	4	3	2	850	932	1,377
Germany	821	776	860	489	341	395	1,794	1,613	1,278
Thailand	572	572	572	1	0	6	359	882	1,253
Brazil	2,405	1,921	1,921	1	0	0	1,419	1,414	1,025
Uruguay	352	628	315	0	0	0	959	1,697	860
Japan	1,280	1,430	1,556	14,337	14,722	10,478	0	7	0
China	2,680	2,752	3,536	1,140	1,056	2,766	215	73	7
Finland	2,579	2,188	1,596	1,661	2,432	1,908	110	143	227
Turkey	234	234	234	1,228	1,014	1,542	0	0	0
Sweden	4,840	4,538	4,263	1,545	1,547	1,345	518	577	293
Canada	20,725	20,725	20,725	2,051	1,975	1,312	721	551	443
Austria	1,510	1,472	964	1,017	992	1,007	440	313	166
South Korea	0	0	0	829	1,057	741	0	0	0
Italy	146	146	116	1,011	617	691	1	2	9
Norway	0	0	0	616	741	619	28	85	77
Other	7,566	7,533	7,429	4,047	4,430	3,429	3,980	3,657	3,307
World	**61,916**	**61,839**	**59,374**	**30,211**	**31,109**	**26,305**	**28,792**	**29,806**	**25,194**
						Data gap	1,420	1,303	1,110

Source: Lamers et al. (2012)

In 2009 the main producer was by far Canada, with almost 35% of the total world production. The main importer has been Japan, but the 2009 figures presented in Table 6 indicate that its share was about 40% of the total traded in 2009 (less than 50% in the previous years). In these three years, more than 50% of the total amount traded was exported by Australia, Chile, United States and South Africa (Lamers et al. 2012).

According to Ekstrom (2012), Vietnam is worldwide the largest supplier of hardwood chips, followed by Chile. In 2011, Latin America's hardwood chip export volumes accounted for approximately 50% of globally traded wood chips, a share that has grown from 34% five years ago. Historically, between 80-90% of the exported wood chips from Latin America have been destined for Japanese pulp mills, but there has been a diversification of consumers over the past few years; pulp mills in Europe have been buying much more Eucalyptus chip, particularly from Chile and Uruguay.

The vast majority of global trade refers to high quality chips for pulp and paper production. Global wood chip trade has been partly cross-border (e.g. Finland-Russia, Canada-US) but also heavily driven by Japan (increasingly also China). Across the past decade, Japan has been attracting on average 35%, but in some years over 50% of all globally traded wood chips. It is estimated that 3% of the total Japanese wood chip supply (of which more than 70% is imports) ends up in combustion plants (Lamers et al. 2012).

Regarding the database on wood pellets production and trade, at least in Europe the information currently available is reliable. Since 2009, export and import figures on pellets have been published by Eurostat using a new product code, defined as 'sawdust and wood waste and scrap, agglomerated in pellets. Before that time, only global estimations could be made based on expert opinions and more generic statistics. However, world statistics will be available in short-term: further embedding of the specified pellet code in the Harmonised System (HS) nomenclature of the World Customs Organisation will take place no earlier than 2012 (Sikkema et al., 2011).

So far, the only branch of the European market for pellets that is dominated by exports is the one of bulk industrial pellets that is consumed by large-scale users. The main aspects related with trade in this market are listed in Table 9.

Table 9: Synthesis of trade conditions for large-scale users in Europe (bulk pellets)

Trade operators	International operating traders (with one main European office)
Way of transport	Inter-continental shipping, in vessels with freights between 10,000 to 100,000 tonnes
Contracts	Both long-term contracts (up to 3 years) and purchase from short-term markets, e.g. within one month deliveries
Demand players per country	Few, internationally operating utilities (e.g., in 2009, the Netherlands had four power companies that co-fired wood pellets in six existing units)
Quality requirements	Company-specific criteria. Implementation of a flexible, pan European EN 14961-1 standard for industrial pellets since April 2010. Feedstock may exist of woody biomass, herbaceous biomass, fruit biomass or blends and mixtures.
Sustainability requirements [a]	There is no imposition by EC, but there are voluntary schemes adopted by the main consumers (e.g., Drax, in UK, Laborelec, in Belgium and Green Gold Label, in the Netherlands

Source: Sikkema et al., (2011), except for [a] (Ryckmans, 2011)

3.2 Sustainability certification of pellet trade

Regarding sustainability requirements, a decision by EC is that by the time being specific criteria are not necessary for solid biomass (EC, 2010). This decision is based on the fact that the bulk of solid biomass is produced inside Europe, but the main consumers have decided to adopt their own criteria. Then, pushed by the main consumers, EC launched a consultation on sustainability criteria for solid biomass and a report was predicted by the end of 2011 in order to decide whether or not sustainability criteria for solid biomass are needed. It seems possible that EC will decide for a uniform sustainability criteria for wood pellets consumed by power plants above 20 MW of net capacity (Ryckmans, 2011).

At this moment, Belgium is in favour of extending the pre-standard EN 16214 on “Sustainably produced biomass for energy applications - Principles, criteria, indicators and verifiers for biofuels and bioliquids” for liquid biofuels to solid biomass. On the other hand, UK and Sweden would prefer solid biomass be only treated by future ISO 13065 on “Sustainability criteria for bioenergy”. Some countries argue that this will not necessarily be in line with the requirements made by EC. So far, the decisions is that trade of wood pellets between Belgium, the Netherlands and UK will only be possible if evidence of sustainability can be brought to the buyer (the final consumer, i.e., the power plants). Belgium has a system in place related to grant of green certificates that only covers raw material by country report and GHG balance through audit of processor, while UK and the Netherlands are developing mandatory systems for biomass co-firing that include a verification scheme for the whole supply chain (Ryckmans, 2011).

From the consumer’s side, one main initiative is the Europe's Initiative of Wood Pellet Buyers (IWPB) that has been working on standards for sustainability criteria. The organization, which came together at the invitation of Vattenfall in Berlin, includes all major European power firms that fire biomass – and mainly wood pellets – in power plants: Dong Energy of Denmark, Drax International of the UK, Germany's Eon, Laborelec/GDF Suez of Belgium, RWE/Essent, and Sweden's Vattenfall. Collectively, the IWPB members make up 70% of the European biomass market and also represent an estimated 6 to 8 Mt of demand for wood pellets – roughly half of global production (Ryckmans, 2011).

Currently, each firm has its own sustainability criteria for the procurement of biomass for power production, with image playing a major role. The firms would also, however, like to sell wood pellets to each other, and doing so would then require standardised sustainability criteria. The IWPB plans to take into account biodiversity, soil protection, water conservation, air pollution, competition with local food production, and social standards. The label would then be a voluntary agreement within industry (Koop and Morris, 2011).

The initiative in place in Belgium does not specifically address socio-economic aspects; the initiative of Drax Power has as principles that the biomass production and the supply management should contribute to the local prosperity and that the social well being of employees and local population should be enhanced. On the other hand, the future IWPB should focus on local welfare, respect of rights and on work conditions (Ryckmans, 2011).

4 Conventional and non-conventional bioproducts

The so-called bio-based economy is related to the production of different materials from biomass feedstock, including (a) energy vectors such as liquid biofuels, pellets, chips and biogas, (b) classical products such as food ingredients, pulp and paper and pharmaceuticals, and (c) innovative products like bio-plastics, fine and specials bio-chemicals. The integrated production of diverse products using biomass as source of carbon has been called biorefinery and the effective development of feasible, efficient and sustainable production processes is worldwide the current challenge of many research and development projects.

Statistics Canada (2010), in its Bioproducts Production and Development Survey 2009, used the following definition for industrial bioproducts: products made from renewable biological inputs, often referred to as biomass feedstock. In that study, industrial bioproducts exclude food, feed and medicines and focus was put mainly on non-conventional industrial bioproducts such as liquid biofuels, organic chemicals (e.g., biopolymers), pesticides, non-conventional building/construction materials and composites.

Current global bio-based chemical and polymer production (excluding biofuels) is estimated to be around 50 Mt. Notably examples of bio-based chemicals include non-food starch, cellulose fibres and cellulose derivatives, tall oils, fatty acids and fermentation products such as ethanol and citric acid. However, the majority of organic chemicals and polymers are still derived from fossil based feedstocks, predominantly oil and gas. Global petrochemical production of chemicals and polymers is estimated at around 330 Mt (IEA Bioenergy, 2010).

In the petrochemical industry primary output is dominated by a small number of key building blocks, namely methanol, ethylene, propylene, butadiene, benzene, toluene and xylene; further, they are mainly converted to polymers and plastics, but also converted to a number of different fine and specialty chemicals. From a technical point of view almost all industrial materials made from fossil resources could be substituted by their bio-based counterparts (IEA Bioenergy, 2010).

Bio-based products (i.e. chemicals and materials) can be produced in single product processes; however, the production in integrated biorefinery processes producing both bio-based products and secondary energy carriers (fuels, power, heat), in analogy with oil refineries, probably is a more efficient approach for the sustainable valorisation of biomass resources in a future bio-based economy. Biorefining can also be integrated with food or feed production, as is the case with first generation ethanol production (IEA Bioenergy, 2010).

The current main driver in biorefinery development, i.e. efficient and cost effective production of transportation biofuels, is to increase the biofuel share in the transportation sector, while the co-produced bio-based products provide additional economic and environmental benefits. The platforms (e.g. based on C5/C6 sugars, syngas, or biogas) are intermediates which are able to connect different biorefinery systems and their processes. The number of involved platforms is an indication of the system complexity. The two biorefinery product groups are energy products (e.g. bioethanol, biodiesel, and synthetic biofuels) and material products (e.g. chemicals, materials, food and feed). Feedstocks can be grouped as either energy crops from agriculture (e.g. starch crops, short rotation forestry) or biomass residues from agriculture, forestry, trade and industry (e.g. straw, bark, used cooking oils, waste streams from biomass processing) (IEA Bioenergy, 2011).

Concerning conversion processes, the classification system identifies four main groups, including: biochemical (e.g. fermentation, enzymatic conversion), thermo-chemical (e.g. gasification, pyrolysis), chemical (e.g. acid hydrolysis, synthesis, and esterification) and mechanical processes (e.g. fractionation, pressing, size reduction) (IEA Bioenergy, 2011).

The previously mentioned report by Statistics Canada (2010) characterizes a new bioproducts industry in a country with considerable production potential. It is worth to mention that two most important conclusions of this report were that the bulk of the existing companies are involved with research and development processes and subsidies were required by most of the production chains.

Another assessment of the status of bioproducts industry was presented for US, based on data of 2007. At that year, the bio-based industry had only 159 facilities in US and less that 4% of the chemical sales were bio-based; the potential in 2025, according to US Department of Agriculture, is 20-25% (Singh, 2010).

Statistics about the production of non-conventional industrial bioproducts are not easily found and it's even more difficult to get accurate information about its trade. What has been possible to get at the time being was information for production and trade of forestry products, such as round wood, sawn wood, chips and others.

According to Heinimö and Junginger (2009), forestry commodities with the highest potential energy application are industrial round wood, chips and particles and sawn timber. Figures of world production and international trade are presented in Table 10. In energy terms, the indirect trade of round wood was four times larger than the volume trade of ethanol in 2006 while the indirect trade as wood chips and particles was equivalent to the energy amount traded as ethanol plus biodiesel in the same year.

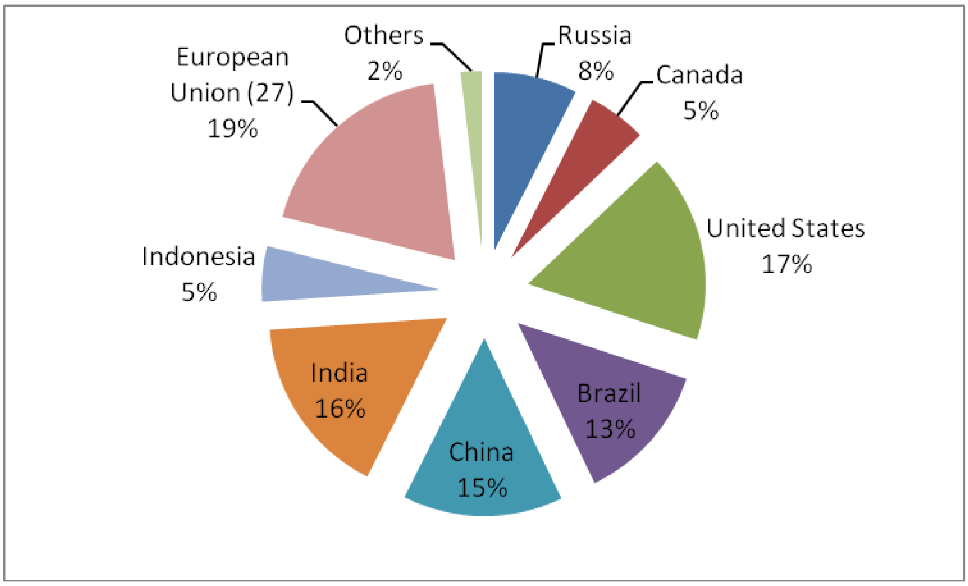
Table 10: Estimated production and trade volume of the main forestry commodities (Mm^3)

Products	Production	International trade	Trade share
Industrial round wood	1,684	129	7.7%
Wood chips and particles	232	44	19.0%
Sawn timber	427	133	31.1%

Source: Heinimö and Junginger (2009) (2009)

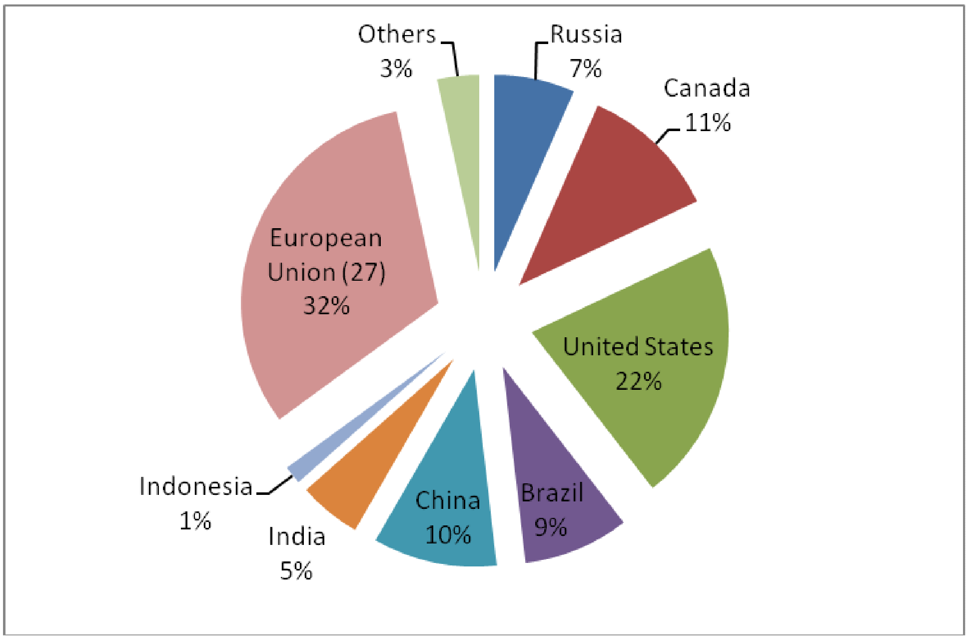
In this sense, as long as second generation biofuels and bioproducts can be produced in industrialised countries using forestry feedstock produced overseas, it is worth assess recent figures and tendencies of production and trade for forestry products.

Figures 28 and 29 illustrate the main producers of industrial round wood (round wood is wood removed from the forest and other wooded land during certain period of time) and sawn wood (wood produced either by sawing lengthways or by a profile-chipping process) in 2009, respectively. The production of round wood worldwide was estimated at about 2,000 Mm^3 in 2009, while the production of sawn wood was estimated as almost 290 Mm^3 in the same year. For both products, besides European Union and United States, the main producers are China, Brazil, Russia and Canada; potentially, the last four countries are the main exporters.



Source: EUROSTAT (2011)

Figure 28: Main producers worldwide of industrial round wood in 2009



Source: EUROSTAT (2011)

Figure 29: Main producers worldwide of industrial sawn wood in 2009

According to FAO (FAOSTAT, 2011), regarding industrial round wood European Union was a net importer in 2009, and imports represented about 12% of the production; for US, the country was a net exporter in the same year, and exports represented 3% of the total production. Regarding sawn wood, and according to the same data source, in 2009 European Union was by far a net exporter, (50% of the production was exported) while the opposite was verified to US: a net importer, with imports representing almost 40% of the domestic production. It is worth noting that this analysis is presented here as a guideline, as production data from FAOSTAT and EUROSTAT have significant differences.

These figures will be assessed in details in the next report, when predictions about trade of biofuels and bio-products will be presented for 2020.

5 Final remarks

This report is an overview of current trading regimes for biofuels and bioproducts. Emphasis has been given to ethanol, biodiesel, pellets and forest products. The production of non-conventional bioproducts, such chemicals, is still very small and detailed information is not available for the time being.

The main conclusions of this report are that trade of ethanol, biodiesel and wood pellets are growing, but the volumes traded are still low regarding other energy and agriculture commodities. Mainly regarding liquid biofuels, international trade has been strongly influenced by trade regimes imposed by US and EU, that are by far the main markets for ethanol and biodiesel, respectively. There was an important change on trade regimes for biofuels in early 2012 but, so far the information available is not enough for an analysis of the ongoing impacts. In the case of pellets, the main consumer market has been EU and the main exporters have been US and Canada. Trade regimes have been much less restricted for pellets regarding liquid biofuels.

Sustainability requirements and certification schemes will have a strong influence on trade regimes both for liquid biofuels and pellets. In case of liquid biofuels, sustainability requirements have already been imposed by EU and US; in the pellets case, is the consumer market that has been imposing sustainability requirements.

As these initiatives are very recent, it’s not possible to evaluate impacts over trade. An exercise on assessing these impacts in short to mid-term will be done in the next report about the same subject.

In what concerns the production of other bio-products (e.g. chemical and materials) this industry is yet its infancy and no example of large-scale production can be presented. One of the most important appeals for such products is its potential benefits to the environment and to the society; thus, sustainable production will be an essential condition for reaching the most important markets. Obviously that the production of bio-products shall be based on sustainable and feasible supply of feedstocks, and a strategy that has been developed is the concentration of the conversion units close to the consumer markets, and the diversification of the biomass supply.

The current report will be complemented by an on-going study on perspectives of biofuels/bioproducts trade, taking as horizon 2020. The impacts of sustainability requirements and certification schemes on trade will be addressed with particular emphasis.

In the same on-going study it’ll be highlighted the perspectives of biofuels/bioproducts production and trade in some selected countries, for those specific case studies have been developed in the Global Bio-Pact project. These countries are Mali and Tanzania, Indonesia, Argentina, Brazil and Costa Rica, as potential producers and exporters, and US and EU, as producers and, mainly, as the most important consumer markets in 8-10 years.

References

ANP (2010) The Brazilian National Agency for Oil, Natural Gas and Biofuels. Information available at www.anp.gov.br.

BP (2010) Statistical Review of World Energy. Information available at ww.bp.com. 2010

BP (2011) Statistical Review of World Energy. Avalianle at bp.com/statisticalreview. 2011

COMPETE – Competence Platform for Bioenergy in Arid and Semi-Arid Ecosystems in Africa. Reports of the project, available at www.compete-bioafrica.net..

E-EnergyMarket (2010) Information available at www.e-energymarket.com.

EIA-DOE (2010) U.S. Energy Information Administration / Department of Energy. Information available at www.eia.doe.gov.

Ekstrom, H. (2012). Wood Resource Quarterly. Available at www.woodprices.com. Wood Resources International LLC.

European Commission (2010) Report from the commission to the council and the European parliament. on sustainability requirements for the use of solid and gas. Available at http://ec.europa.eu/energy/renewables/transparency_platform/doc/2010_report/com_2010_0011_3_report.pdf

EUROSTAT (2011). Data available at www.epp.eurostat.ec

FAO (2011) Food and Agricultural Organization of the United Nations. Data available at www.faostat.org

FO Licht (2010) World Ethanol & Biofuels Report.

FO Licht (2011) World Ethanol & Biofuels Report.. Different issues.

Gardiner, N. (2009) Chemical Forecaster 3Q09. Drewry Publishing; Drewry Shipping Consultants Ltd. London, United Kindom...

GTZ (2009)– Deutsche Gesellschaft für Technische Zusammenarbeit. International Fuel Prices. Available at www.gtz.de/en/themen/29957.htm. 2009

Heinimö, J., Junginger, M. (2009). Production and trading of biomass for energy – an overview of the global status. Biomass and Bioenergy:. 1310-1320..

Hoogwijk, M., Faaij, A, deVries, B, Turkenburg, W. (2009) Exploration of regional and global cost – supply curves of biomass energy from short-rotation crops at abandoned cropland and rest land under four IPCC SRES land-use scenarios, Biomass and Bioenergy , 26–43.

IEA-Bioenergy. (2011) Bio-based Chemicals - Value Added Products from Biorefineries. Report of IEA-Bioenergy Task 42.

IEA-Bioenergy. (2012) IEA Bioenergy Task 42 Biorefinery. Report of IEA-Bioenergy Task 42.

Janssen, R., Rutz, D, Helm, P, Woods, J, Chavez, R-D. (2009) Bioenergy for Sustainable Development in Africa – Environmental and Social Aspects. Paper available at www.unido.org..

Jumbe, CBL, Msiska, FBM, Madjera, M. (2009) Biofuels development in Sub-Saharan Africa: Are the policies conducive? Energy Policy, 4980–4986.

Junginger, M. 2009. Around the world in 12 years (2009) An overview of the global wood pellet trade. Trade activities and opportunities for liquid and solid biofuels in the SE Asian region and implications for policy. Presentation at the Joint Task 40 / ERIA workshop, Tsukuba Japan, .

Junginger, M. 2011. International trade of wood pellets (2011) prices, trade flows and future trends. Presentation at the EUBIONETIII workshop: Biomass trade – focus on solid biomass. VTT, Espoo, Finland.

Koop, D, Morris, C. (2011). Global sustainability criteria for wood pellets. Available at http://www.renewablesinternational.net/global-sustainability-criteria-for-wood-pellets/150/515/32395/.

Lamers, P., M. Junginger, C. Hamelinck and A. Faaij (2012). Developments in international solid biofuel trade – an analysis of volumes, policies, and market factors. Renewable & Sustainable Energy Reviews.

Lerner, A, Matupa, O, Mothlathledi, F, Stiles, G, Brown, R. (2010) SADC Biofuels State of Play Study. An assessment of the Biofuel Sector Development in the Southern African Development Community. SADC Biofuel Taskforce. http://www.probec.org/fileuploads/fl11092010040316_SADC_BIOFUELS_STATE_OF_PLAY_STUDY.pdf..

MAPA (2010) Ministério da Agricultura e Pecuária. Information available at www.agricultura.gov.br..

MDIC (2010) Ministério do Desenvolvimento, Indústria e Comércio Exterior. Information available at www.mdic.gov.br (exports of commodities)..

Mitchell, D. (2011) Biofuels in Africa. Opportunities, Prospects, and Challenges. Washington: The International Bank for Reconstruction and Development , The World Bank..

Oosterveer, P, Mol, APJ. (2010) Biofuels, trade and sustainability: a review of perspectives for developing countries. *Biofuels, Bioproducts & Biorefi*ning, 66–76..

Pirraglia, A, Gonzalez, R, Saloni, D. 2011. Wood Pellets: An Expanding Market Opportunity. Biomass Magazine. Available at http://biomassmagazine.com/articles/3853/wood-pellets-an-expanding-market-opportunity/.

REN21 (2006) Renewable Energy Policy Network for the 21st Century. Renewable 2006 – Global Status Report..

REN21 (2010) Renewable Energy Policy Network for the 21st Century. Renewable 2010 – Global Status Report..

Robertson, B, Pinstrup-Andersen, P. (2010) Global land acquisition: neo-colonialism or development opportunity? Food Security, 271–283.

Rosillo-Calle F, Walter A. (2006) Global market for bioethanol: historical trends and future prospects. Energy for Sustainable Development X(1),18–30.

Ryckmans, Y. (2011). Initiative Wood Pellets Buyers Sustainability criteria for solid biomass in large scale power plants. Presentation at the IWPB Meeting, Rotterdam.

Sikkema, R, Steiner, M, Junginger, M, Hiegl, W, Hansen, MT, Faaij, A. (2011) The European wood pellet markets: current status and prospects for 2020. Biofuels, Bioproducts & Biorefining. 250–278.

Smeets, E, Faaij, A. (2009) Third Periodic Activity Report; Annex 5-3-1: Synthesis report on international trade opportunities in Africa. Available at www.compete-bioafrica.net.

Singh, R, (2010) The U.S. Industry Perspective on Assessing Sustainability of Bio-based Products. Presentation at the The World Congress on Industrial Biotechnology & Bioprocessing, June 29.

Szwarc, A. (2010) Bioethanol: production, use and trade. Presentation at the 33rd IAEE Conference. Rio de Janeiro.

USDA – United States Department of Agriculture. (2009) Gain Report – Global Agricultural Information Network. Argentina Biofuels Annual. Report number AR9018.

Zarilli S. (2006) The emerging biofuels market: regulatory, trade and development implications. In: UNCTAD—United Nations conference on trade and development, Geneva

Walter, A, Rosillo-Calle, F, Dolzan, P, Piacente, E, Cunha, KB. (2008) Perspectives on fuel ethanol consumption and trade. Biomass and Bioenergy.730–748.