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Fuel Ethanol Trade: Current Barriers and Perspective

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Abstract – *Fuel ethanol consumption has grown rapidly in recent years but both production and consumption are still mostly concentrated in US and Brazil. Due to the size of their potential markets, the US and the European Union – EU – will have a crucial role on international biotrade, inducing or constraining fuel ethanol production in developing countries. However, both US and EU have trade regimes based on tariffs that offset the comparative advantages of some producer countries. This paper analyses current trade regimes on fuel ethanol and the perspectives in short- to mid-term. It is shown that fuel ethanol trade can significantly reduce the supply cost in the main markets (US and EU) and also induce the development of the ethanol industry in emerging producing countries. Without imports it seems very difficult to reach the targets recently set in US and EU; besides physical constraints for local production based on conventional feedstocks, the supply cost would be very high if large-scale production was to take place based on corn and wheat, for instance. Some short- to mid-term term tendencies in the fuel ethanol market are identified and analysed, including: (i) how US and EU tend to preserve their traditional domestic production until second generation of biofuels becomes commercially available, (ii) the impact of quotas in US and EU on fuel ethanol imports, to induce production in other countries, (iii) requirements for certification of biofuels production – primarily in the EU – to insure the adoption of the main sustainability practices.*

***Keywords* –** Bioenergy, biofuels, fuel ethanol, international trade.

1. INTRODUCTION

Recently, many countries have set mandates for fuel ethanol and, as consequence, the consumption has grown rapidly. In general, the main priorities of developed countries are their agricultural issues (e.g., high subsidies maintaining living standards in the country side), improving energy security through diversification of their energy matrix and the reduction of GHG emissions. On the other hand, developing countries have their focus on rural development, jobs creation and foreign currency savings.

Despite the recent growth, both the production and the consumption of fuel ethanol have been concentrated in US and Brazil (almost 70% of the whole production of ethanol [1] – all grades – by 2006, and 85% of the estimated consumption as fuel [1], [2]). Fuel ethanol trade is still very small representing about 10% of the world consumption in 2005 [3].

US and European Union (EU) are the world largest consumer markets, being estimated that their consumption could reach 40% of the worldwide consumption in a hypothetical scenario in which ethanol could displace 7% of the predicted gasoline consumption (52.2 PJ) by 2020 [3]. Currently US and EU have trade regimes based on tariffs that offset the comparative advantages of some producer countries (e.g., Brazil). On the other hand, due to the size of their markets and to their capacity of investment, US and EU would have a crucial role on trade, inducing or constraining fuel ethanol production in developing countries.

This paper analyses fuel ethanol trade, with focus on the current situation and on perspectives up to 2020.

2. CURRENT FIGURES ON FUEL ETHANOL PRODUCTION AND TRADE

Ethanol Production

Fuel ethanol consumption in 2006 was estimated as about 40 Gl, being the total ethanol production evaluated as 51 billion litres (Gl) [1]. Since 2005, US is the main world producer and in 2006 its production was estimated as 18.4 Gl, while the consumption as fuel was estimated as 20.4 Gl; in 2007, from January to October, the production raised 32% in comparison to the same period in 2006, while the demand grew 26% [1]. Brazil has been for many years the world's largest producer and consumer of fuel ethanol; in 2006 its production was 17.7 Gl, while the domestic consumption as fuel was 13.4 Gl. These figures for 2007 are estimated as: production 20 Gl and domestic consumption 16.5 Gl [4]. Besides US and Brazil, other important producers of ethanol (all grades) in 2006 were China, India, France, Germany, Russia, Canada and Spain that altogether produced more than 9 Gl [1].

Figure 1 shows the fuel ethanol production from 1982 to 2007. Figures for 2007 (just US and Brazil) are estimates. Production figures prior to 2000 are inaccurate due to the inconsistencies of statistical information. From 2000 to 2006 the average annual growth rates of fuel ethanol production were 14.6% in the world and 20% in US; in Brazil this figure was 9%.

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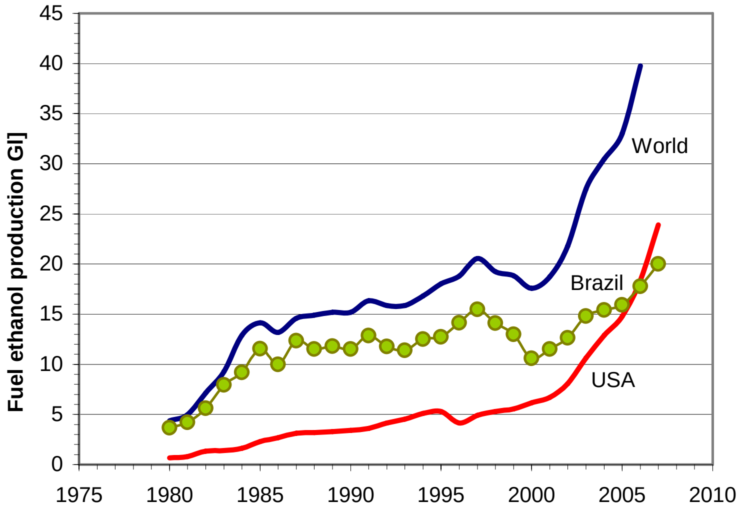


Fig. 1. Fuel ethanol production in the world – 1982-2007
Sources: [5] for the world, [1] for US and [2] for Brazil

Fuel ethanol production in EU was estimated as 1,590 Ml in 2006 [6]. The production is still small in comparison with US and Brazil, but the annual growth rates have surpassed 70% in recent years.

As of 2006, fuel ethanol covered almost 3% of the US automotive fuel demand [7] while in EU this figure was smaller than 1% [3]. Conversely, in Brazil ethanol covered more than 30% of the automotive fuel demand (energy basis) [2]; in Brazil all gasoline is blended with anhydrous ethanol (currently 25% ethanol, volume basis) and hydrated ethanol is used in neat-ethanol vehicles.

Large-scale production in Brazil started in 1976 but it has been since 1999, after the full deregulation of the industry, that the consumption has raised steadily. The main driving force was the launch of flex-fuel vehicles (FFVs) in early 2003. In Brazil, FFVs can run with any fuel mix between gasohol (E25) and pure hydrated ethanol (E100). The relative low price of ethanol regarding gasoline and the quality of the FFV technology are the main reasons why currently almost 90% of the new cars in Brazil are FFV.

In US fuel ethanol demand has been stimulated by the phasing-out of methyl tetrabutyl ether (MTBE) as octane enhancer (MTBE was banished in 23 US states by 2005). More recently, high oil prices and external oil dependency have been the main drivers. Even after the creation of a Renewable Fuels Standard (RFS) that set targets of 28.4 Gl for the transport sector by 2012 (the majority fuel ethanol), by January 2007 much more ambitious targets were set: by 2017 the US production of biofuels (mostly ethanol) would reach more than 130 Gl.

On the other hand, EU has a strong policy for promoting the use of alternative fuels and a special interest is put on biofuels, but the results reached so far are modest. It was established that by 2005, 2% of the total transport fuel consumption (on energy basis) should be covered by biofuels, while the target for 2010 was set at 5.75%. However, in 2005 the average biofuel contribution was minimum (less than 1%); Germany (3.75%) and Sweden (2.23%) were the two countries with higher proportions in 2005 [8]. Biodiesel consumption in EU is more important than ethanol. As consequence of the current trends, in early 2007 the EU has adopted a more conservative estimate for 2020 – 10% rather than the 20% previously suggested.

In Brazil ethanol production is based on sugarcane and its production costs are the smallest worldwide: 0.21 to 0.29 Euro/litre [9]. In US ethanol production is most based on corn and actual production costs (without subsidies) are more than twice higher than in Brazil [10]: 0.33 to 0.50 Euro/litre, with subsidies [9]. On the other hand, ethanol production in EU is mostly based on cereals (e.g., wheat) and sugar beet, with production costs almost three times higher than in Brazil: 0.41 to 0.66 Euro/litre [9]. Henniges and Zeddies [10] have studied the cost structure of ethanol production in Brazil, US and Germany (from wheat and sugar beet) and concluded that feedstock represents the bulk of the costs (68% in Brazil, 53% in US and 50-59% in Germany – cheaper for the production from wheat). Considering the production costs in Euro/litre (2004), feedstock is twice more expensive in US than in Brazil, and 2.8-3.6 times higher in EU. There is also a large difference considering the operational costs (including fuel and electricity) that are 5 times higher in US than in Brazil and 7-8 times higher in Germany. In this regard the advantage is mainly because sugarcane bagasse (a fibrous by-product of the sugarcane plant) is used as fuel in cogeneration systems; sugarcane mills in Brazil are self-sufficient regarding fuel and electricity and some mills sale surplus electricity to the grid. Net production costs are impacted by the sales of by-products in Germany and both by the sales of by-products and government subsidies in US. Table 1 compares production costs of anhydrous ethanol in Brazil to the costs in USA and Germany.

An important issue regarding fuel ethanol use is the avoided emissions of greenhouse gases (GHG), and a common analysis is the comparison (regarding fossil fuels) of total emissions of CO_2 equivalent in a “well-to-wheel” basis (i.e., considering the life cycle of each fuel). Depending on the feedstock, production conditions and land-use change, emissions from biofuels could be as high as those from gasoline or biodiesel, whereas other combinations of feedstock and conversion processes can reduce "well-to-wheel" CO_2 emissions to near zero [11]. It is mostly accepted that using bioethanol produced from sugarcane, according to the Brazilian conditions of production, 80-90% of the GHG emissions can be reduced regarding to the use of gasoline. Avoided emissions regarding the production of ethanol from starches (e.g., corn and wheat) are evaluated as 15-40% [11], [12]. Due to the combining effect of lower costs of production and higher avoided GHG emissions, ethanol from sugarcane (considering Brazilian conditions of production) is the best economic alternative for the reduction of GHG emissions with biofuels (less than 50 Euro/$tCO_{2\ eq}$ vis-à-vis about 500 Euro/$tCO_{2\ eq}$ for the production from corn and more than 700 50 Euro/$tCO_{2\ eq}$ for the production from wheat [11].

Table 1. Production costs of ethanol in Brazil, USA and Germany (cents Euro/litre), Source: [10]

	Brazil	USA	Germany	Germany
Feedstock	Sugarcane	Corn	Wheat	Sugar beets
Building	0.21	0.39	0.82	0.82
Equipment	1.15	3.40	5.30	5.30
Labour	0.52	2.83	1.40	1.40
Insurance, taxes and others	0.48	0.61	1.02	1.02
Feedstock	9.80	20.93	27.75	35.10
Other operation costs	2.32	11.31	18.68	15.93
Total production cost	14.48	39.47	54.97	59.57
Sale of by-products	-	6.71	6.80	7.20
Government subsidies	-	7.93	-	-
Net production cost	14.48	24.83	48.17	52.37

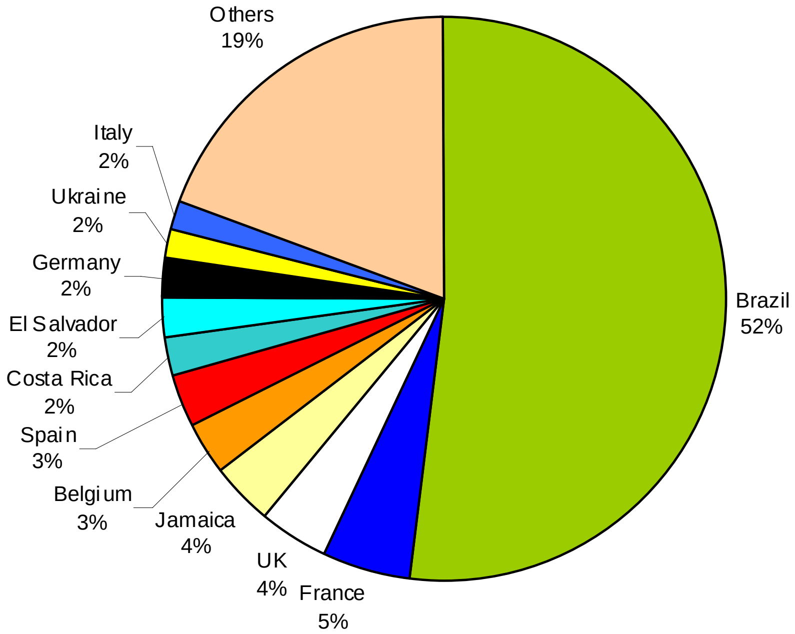


Fig. 2. Main exporter countries of ethanol in 2006
Sources: [1] for US, [4] for Brazil, and [13] for other countries

Ethanol Trade

Data about fuel ethanol trade are imprecise due to two main reasons: the various potential uses of ethanol (i.e., as fuel, industrial or for beverage use) and the lack of proper codes for the statistics on biofuels trade. Estimates provided by [13] indicate that ethanol trade (all grades) has almost steadily grown from about 3 Gl in 2000 to 6 Gl in 2005 (i.e., about 13% of the world production, estimated as 45 Gl that year). As the rise in recent years was mostly due to the fuel ethanol it is reasonable to estimate that trade covered about 10% of the fuel ethanol consumption in 2005.

Figure 2 shows the main exporting ethanol countries in 2006, when the total volume traded was estimated as 6.5 Gl [14] (almost 13% of the whole production). Export figures presented in Figure 2 correspond to about 96% of the total volume traded. Sixty-three countries exported ethanol in 2006, but only 10 exported more than 100 Ml and the 15 most important exporters covered 90% of the whole trade. US have imported almost 2.5 Gl in 2006 [1], EU about 690 Ml [13], while the imports of Japan were estimated as about

600 Ml. These three economic blocks represented about 80% of the net imports of ethanol in 2006.

Brazil has exported more than 2 Gl of ethanol/year since 2004 (see Figure 3), taking advantage of its low production costs and the existing flexibility in its domestic market: firstly, the share of anhydrous ethanol blended to gasoline can vary from 20 to 25% and secondly, most of hydrated ethanol is consumed in FFVs.

Except in 2006, when more than 50% was directly sold to US, ethanol exports from Brazil have been roughly well distributed among 10-12 countries. Figure 4 shows the evolution of ethanol exports from Brazil to the most regular buyers in the period 2003-2007. Sales to US grew very fast in 2004 and 2006 but, as a tendency, as long as local producers are able to enlarge their output, imports were reduced. In addition, it can be seen from the figure that the general tendency is the reduction of ethanol sales to Sweden and South Korea, the stabilization of the sales to Japan and the growth of trade with Netherlands and CBI countries. Caribbean Basin Initiative (CBI) is an agreement between US and Central America and Caribbean countries that allows that up to 7% of the US ethanol demand may be imported duty-free, even if the production itself occurs in another country [15]. In 2006 US imports of fuel ethanol from Jamaica, El Salvador, Costa Rica and Trinidad Tobago summed up 628 Ml [1]. In the same year these four countries imported 480 Ml from Brazil (about 75% of the total sold to US); most of the ethanol exported to US from Central America and Caribbean countries is only dehydrated there. From 2006 to 2007 the sales from Brazil to these four countries grew 80% [4].

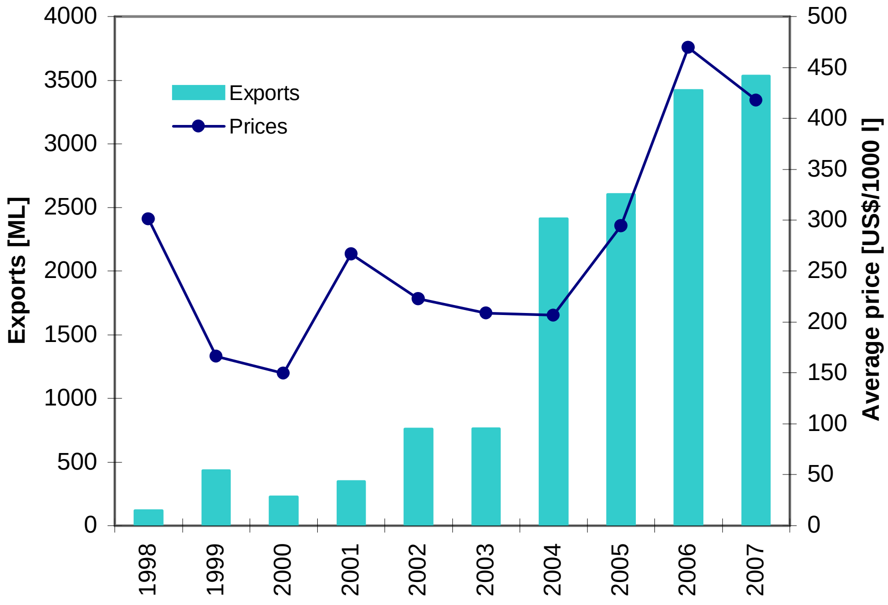


Fig. 3. Brazilian exports of ethanol (all grades) since 1998
Sources: [16], [4]

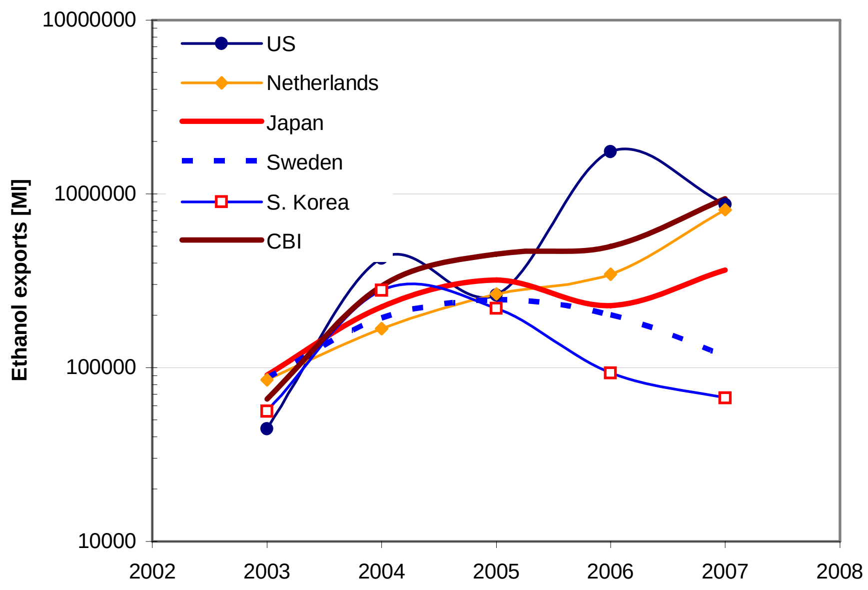


Fig. 4. Main destinations of Brazilian ethanol – 2003-2007
Source: [16], [4]

Historically, imports of fuel ethanol from US have been very small in comparison to the demand (e.g., 2% to 4.5% from 2002 to 2005). In 2006 imports covered 12% of the US demand but, due to the fast growth of local production capacity, it is estimated that imports shall be reduced to about 7% of the demand in 2007. Direct exports from Brazil to US reached almost 8% of the demand in 2006, but except that year the highest figures were 3-4% (in 2004 and 2007 – estimated). It is clear that so far, the US policy regarding the supply of ethanol is to maximize the domestic production.

It is estimated that the ethanol production in EU in 2006 was almost 1.6 Gl [6]. According to [13], EU imported 688 Ml in 2006 and exported almost 65 Ml, corresponding to a net flow evaluated as 623 Ml. Thus, it can be estimated that about 30% of ethanol demand in EU is covered by imports. Also contrary to US, EU imported from about 30 different countries outside the Union in 2006 [13]. Brazil was the main supplier, with more than 330 Ml, i.e., almost 48% of the total imports and about 15% of the demand.

Conversely, all ethanol used as fuel in Japan is imported. According to the last figures available [13], more than 60% of the ethanol consumed in 2005 was imported from Brazil, which explains the partnership on investments of Japanese companies in Brazil aiming at improving logistics and reducing costs [17].

3. BARRIERS ON ETHANOL TRADE

According to the traditional trade theory, economies gain from trade by specialising in products where they have a comparative advantage [18]. In this sense, those who produce at lower costs and with higher quality should have advantages on trade but, in practice, this is not what occurs in many markets as countries impose trade barriers in order to protect local production. Trade barriers are traditionally applied to agricultural products and, more recently, to biofuels. Most common trade barriers comprise high import duties – higher than the practice for most goods – and can also include a set of other mechanisms such as high internal subsidies, rigorous technical specifications and sanitary rules.

On the other hand, the lack of widespread accepted technical specifications can also act as a trade barrier. Indeed, in case of fuel ethanol an important trade constraint is the lack of a single specification regarding the product, as different countries and some organizations have their own standards (e.g., regarding maximum water content, aldehydes content, flash point, explosion limits, pH, etc.). Currently there are multilateral initiatives and an important effort involves the governments of US and Brazil.

Subsidies have also been applied to ethanol production both in US and in EU. In US it is estimated that federal and state governments give more than 200 different subsidies. Henniges and Zeddies [10] estimate that subsidies sum-up almost 80 US$/m^3, that is about 20% of the evaluated production costs; recently, The Economist [19] has estimated government subsidies as 72 US$/m^3 of ethanol from corn. Brazil is the only country where ethanol production is currently feasible regarding the prices of oil derivatives but its production was also subsidized for many years. Full deregulation of the supply chain and phase-out of subsidies only happened in 1999, almost 25 years after the beginning of large-scale production of ethanol.

Most important, US and EU have trade regimes based on specific rules. However, in practice these trade regimes almost exclusively impact Brazilian production. US impose MFN (most-favoured nations) import duties of 142.7 US$/m^3 (54 ¢US$/gallon) plus a 2.5% *ad valorem* tariff on ethanol. The exemption is applied to least-developed countries beneficiary with the GSP (Generalized Systems of Preferences) status, CBI agreement, ATPA (Andean Trade Preference Act) countries, Canada, Israel, and Mexico. Actually, however, there is just a small but regular flow through CBI countries to USA, as previously mentioned. In USA the argument is that import duties ensure that the benefits of the domestic US ethanol tax credit do not accrue to foreign producers [20]. Partial Federal tax exemption of 137.4 US$/m^3 (52 ¢US$/gallon) is applied for ethanol that is derived from renewable resources and used as fuel. Thus, the additional tax on imports aims at offset the domestic Federal tax exemption to foreign production [21].

Even the US International Trade Commission [21] recognizes that, in practice, the US ethanol trade policy discourages imports beyond the free-duty quotas already defined in agreements and almost prohibits imports from countries non-treated with exemption of import duties. Conversely, US producers argue that there is a fair trade environment and that no specific barrier is posed to, for instance, the Brazilian ethanol [7].

According to the European Commission [22] about 50% of the ethanol imported by EU in 2005 was under normal MFN regime and almost equal shares corresponded to imports under reduced duty regimes and to imports with no duties al all. Under MFN regime EU imposes a duty of 192 Euro/m^3 on undenatured alcohol and a duty of 102 Euro/m^3 in case of denatured alcohol. All exports from Brazil to EU are under MFN rules and European Commission recognizes that Brazil is the only country capable of exporting large quantities as MFN. Reduced duty and duty-free regimes correspond to preferential trade arrangements between EU and developing and less developing countries. Many countries of Africa, South and Central America and Asia are included in these preferential trade arrangements that aims at drug diversion, sustainable development and good governance. In 2006 EU imported relatively small volumes from, for instance, Pakistan (59 Ml), Bolivia (28 Ml), Malawi (20 Ml) and Swaziland (16 Ml) [13].

Other countries, such Australia and Canada, have MFN duties on ethanol imports. Even Brazilians, who often claim against the trade duties imposed by USA and EU, impose a tariff of 60 Euro/m^3 on imported ethanol.

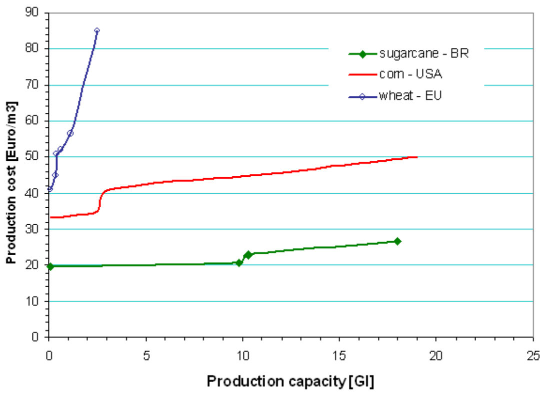
4. POTENTIAL BENEFITS OF FUEL ETHANOL TRADE

Trade barriers can be imposed in the short-run in order to encourage the development of biofuels production in countries where it is more expensive. In mid- to long-run trade barriers imposed in wealthy markets tend to retard the growth of the production in developing countries, which potentially have comparative advantages. Learning effects and scale-effects induce cost reductions, as it was demonstrated in the case of ethanol production in Brazil [23], and domestic markets in most developing countries are not large enough to accelerate the learning process. Thus, the final long-term result of trade barrier policies shall be a constrained production, at a higher cost.

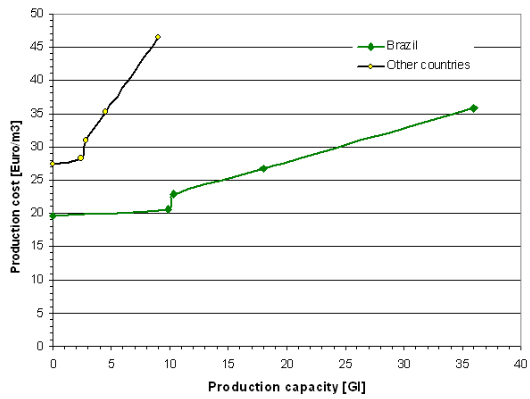
A good is a commodity if it can be traded in large extent. International trade of fuel ethanol is essential to ensure competitiveness at lower cost. The main reasons for developing ethanol trade were presented by [24]: (i) it is important to have alternative sources of supply in case of problems with the domestic production; (ii) the possibility to form planned stocks; (iii) it is important to balance prices to consumers in case of high domestic production costs; (iv) subsidies should be progressively reduced over the years and it is convenient to foster higher efficiency; and (v) fuel ethanol programs should be implemented in non-producing countries.

In order to illustrate the economic benefits of ethanol trade a hypothetical exercise was developed. Figure 5(a) shows estimates of ethanol supply curves in Brazil, in US and in the EU. These curves are based on [25] and were adjusted to reflect the range of production costs in these three countries/regions [9]: 210-290 Euro/m^3 in Brazil (considering installed capacity 18 Gl and average cost equal to 220 Euro/m^3), 330-500 Euro/m^3 in US (supposing installed capacity 19 Gl and average cost estimated as 437 Euro/m^3) and 410-850 Euro/m^3 in Europe (considering installed capacity 2.5 Gl and average cost equal to 615 Euro/m^3).

On the other hand, Figure 5(b) represents an estimated supply-curve of a hypothetical country that would produce ethanol from sugarcane at a cost 60% higher than Brazil. As an illustration, it was considered that the maximum production capacity is 9 Gl/year and that the average production cost is 354 Euro/m^3. Except US and Brazil, currently no country has such large capacity of ethanol production.



(a)



(b)

Fig. 5. Ethanol supply curve – (a) traditional producers and (b) hypothetical producer (production from sugarcane)

Extrapolating the Brazilian supply curve to more than 35 Gl/year, as indicated in Figure 5(b), it is estimated that the production cost of 24 Gl of ethanol would reach 275 Euro/m^3 in short-term (vis-à-vis 267 Euro/m^3 on average for the production of 18 Gl). Transport costs (domestic and maritime) would sums-up about 50-70 Euro/m^3 in the short-term, leading the CIF cost in Europe and US to about 320-340 Euro/m^3 in case no duties were applied. Based on the estimates presented in Figure 5(a) it is clear that the European production would not be competitive with imported ethanol from Brazil in a free trade scenario. On the other hand, in a free trade scenario only about 2-3 Gl of the US production would be competitive with exports from Brazil.

In 2006 the ethanol sold from Brazil to US had an average FOB price equal to 394 Euro/m^3, or an estimated average CIF price close to 420 Euro/m^3, without duties and taxes. Only about 5 Gl of the US production would be competitive under theses conditions. On the other hand, considering current trade regime, 15-16 Gl of the US production are competitive with imported ethanol from Brazil – that would be sold in US for no less than 480 Euro/m^3 (based on the average cost of production in Brazil). Thus, in a hypothetical free trade scenario about 10 Gl would be exported from Brazil to US, in comparison with 1.7 Gl directly sold in 2006. In this simplified analysis these factors that would impact the market were not taken into account, such as: (i) the entrance of other producer countries in the US market, and the sales through countries that have preferential trade regimes with US, and (ii) the tendency of higher prices and costs in Brazil due to the higher demand and also due to the increased production in less productivity areas.

In case of EU, the 192 Euro/m^3 duty on undenatured alcohol implies that imported ethanol from Brazil costs no less than 660 Euro/m^3. Under these conditions, about 1.5-1.6 Gl of the European production are competitive vis-à-vis Brazilian imports. Coincidently, in 2006 Brazil has exported about 580 Ml to EU country states, i.e., close to the maximum that is possible to export under current trade regime. Nevertheless, in 2007 exports to EU were just 330 Ml.

The analysis presented above is based on the simplified hypothesis that only Brazil could be competitive in the main ethanol markets. However, other ethanol producer countries would be competitive in the international market, even in case of higher costs regarding Brazil. Taking as reference the supply curve presented in Figure 5(b), a hypothetical producer country (production based on sugarcane) with a domestic consumption of 2 Gl could sell other 2.5 Gl in US and in EU, even in case of higher transportation costs: considering 353 Euro/m^3 as the marginal production cost for 4.5 Gl/year and 122 Euro/m^3 as the transportation cost (i.e., twice the estimated cost in the Brazilian case), the supply of ethanol from this country would be competitive in US and EU markets as long as local production costs are higher than 475 Euro/m^3.

From this analysis it can be concluded that the reduction of trade barriers would deploy the development of the ethanol industry in countries with good potential but with small domestic markets. As previously mentioned, the enlargement of the production would induce cost reductions and, as consequence, the industry would be even more competitive in the short- to mid-term. The main benefit for consumer countries (e.g., US and EU) would be lower costs of supply. In contrast, trade barriers would constrain the development of ethanol production in other countries and impose higher prices to consumers, with possible negative impacts in mid-term. Due to the size of their potential markets, the role of US and EU (and Japan, as well) will be vital on the development of a sustainable international market for biofuels, with more producers and continuous reduction on costs.

5. PERSPECTIVES OF FUEL ETHANOL TRADE

One of the main driving-forces of biofuel policies is enhancing security of energy supply, being a second important driving-force, the preservation of living standards in rural areas of developed countries. From the results shown in the previous session it is clear that in a free trade scenario both the US and the European (mainly) ethanol industry would be non-competitive and barely would survive in mid- to long-term. In this context, it is naive to consider that these countries would accept a free trade environment in the years to come. Indeed, it is illustrative the fact that both US and EU opposed late 2007 to the Brazil's proposal for classifying ethanol as an environmental good in future international trade rules.

On the other hand, it is possible to conclude from the previous session that without imports it would be difficult and expensive to match the predicted demand in the next 10-15 years. For instance, the potential market in 2020 was evaluated by [3] as 37 Gl and 27 Gl in US and EU, respectively, in a moderate scenario, and as 163 Gl and 39 Gl, respectively, in case of an optimistic scenario. In addition, there is a growing concern with the rise of food prices, partially caused by the rapid growth of ethanol production from corn in US [19]. It seems clear that such pressures will occur if large-scale biofuels production is based on food crops such as maize, wheat and soybeans. Even considering the possibility that the second generation of biofuels could reach a commercial stage in such period of time, trade should have a special role [3].

It seems that a balanced approach is the strategy that should be followed by US and EU, keeping certain room for the local producers but also allowing imports. In this sense, a trade system based on quotas is a possible solution. Certainly that the share of the market that will be devoted for imports and which countries will have priority, if any, would be crucial issues. As it was previously showed, EU already covers a reasonable share of its ethanol market (still very small) with imports, but this has not been the case of US.

It seems probable that a reasonable share of the biofuel market will be deserved to less developing countries, as biofuels production has been identified as a good strategy in order to overcome endemic poverty. A second important reason for such policy is that good business opportunities (e.g., providing equipment and services) would be created for developed nations due to the early stage of the biofuels industry and to the lack of infrastructure in poor countries. Inducing biofuels production in some selected countries is a policy that has been applied by EU and that has been recently followed by US.

On the other hand, there are increasing requirements for certification of biofuels production in order to assure that sustainability principles are adopted along the production chain. The tendency is that certification will focus mainly on aspects such (i) reduction of greenhouse gases emissions, (ii) biodiversity protection and preservation of sensible biomes, (iii) minimum or even no-pressure on food supply and (iv) protection of the essential rights of workers [26]. An important issue, however, it to ensure that certification will not become a new trade barrier as it has been blamed by some developing countries. In this sense, sustainability criteria should be developed through transparent negotiations between consumer and producing countries. A very important issue, and also a big challenge, is that criteria and indicators should be at the same time clear, simple and accurate.

Despite some criticisms because of the predicted difficulties to implement an efficient certification system, it is logical that in mid-term incentives supporting biofuels should be proportional to the actual benefits they offer [27]. In this sense, the precise evaluation of the biofuels contribution to the reduction of GHG emissions will have a central role. Methodologies able to evaluate the life-cycle emissions of different feedstocks and different conversion process need to be developed and tested.

6. CONCLUSION

It is unlikely that the targets set by US and EU on fuel ethanol consumption would be reached without trade in a large extent. Besides physical constraints, supply costs would be very high if production is based on feedstocks like corn and wheat.

So far, both in US and EU high duties have been applied over the imports from most competitive countries but, in practice, only Brazil has been deeply impacted. Such policy has been effective in order to protect domestic production but should be revised in mid-term. Production of biofuels, in general, and of fuel ethanol, in particular, should be deployed in developing and emerging countries. In most of these countries local consumption is not large enough to induce learning effects in short-term and, in this sense, exports would be essential. Large-scale production of biofuels in less developing countries also has the potential to improve economic and social conditions, and this should be a target in itself. In this paper it was demonstrated that even a country with high production costs could be competitive in the international market in short-term. However, the implementation of a biofuel production program should be carefully assessed in order to avoid disruptions in the food market.

Sustainability is one of the main drivers of large-scale biofuels production – and probably will be the main issue in mid- to long-term. It seems obvious that sustainability needs should be assured, for which certification of biofuels production would be essential. However, the ways to induce the adoption of sustainable practices and to check the results should be discussed among all stakeholders. In the bottom-line the wishes of the main consumer markets will be fulfilled, first because of its power, and second because sustainability principles tend to be common sense within some years. However, long-term sustainability also requires legitimacy and, in this sense, a wide discussion of – eventually – different points of view is the only way to go.

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