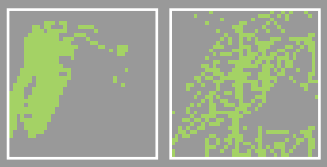


International Biofuels Policies

Adriano Pires

Rafael Schechtman

Global biofuels production is growing, reaching approximately 80 billion liters in 2008, of which 67 billion was ethanol. Supply increased by 18.6% per year between 2000 and 2008 for ethanol, and 37.3% for biodiesel. This is a market where the most important producers of ethanol are the United States (34 billion liters in 2008) and Brazil (27 billion liters); the two countries together accounting for about 80% of world production.

Despite the increase in production, experience in several countries shows that in general the use of biofuels is not yet competitive with petroleum products, and depends on public policies. These policies do not tend to succeed where petroleum derivatives are subsidized or where the tax burden does not include the costs of the externalities of fossil fuel production and use.

All countries (except Brazil, in the case of ethanol) have policies to encourage biofuels consumption. These are justified by a number of factors, including greater energy security, reduction of environmental impacts and the creation of new markets for agricultural products.

Three main instruments exist to promote the use of biofuels: command and control mechanisms (regulatory standards, including mandatory consumption); economic measures (financial incentives, differential taxation, tradable certificates); and import restrictions.

The United States, for example, applies both regulatory standards and financial incentives, establishing mandatory volumes for renewable fuels. It is important that regulations take into account the rate of emissions reduction attributable to replacing fossil fuel with biofuel. Today, a 10% blend of ethanol in gasoline is mandatory in some U.S. states. In addition, there are tax incentives to promote the use of U.S. corn-based ethanol and tariff barriers to imports from Brazil.

The European Union uses much more biodiesel and accounts for two thirds of world production of this fuel, which receives strong incentives. In the medium term, given the restrictions on domestic supply, the EU is likely to import larger quantities of ethanol to meet growing consumption. Today, Brazilian ethanol faces tax barriers to enter the EU.

This study also analyzes biofuels policies in Sweden, Britain and Germany. In Sweden, where ethanol use is promoted compulsorily, half of new light vehicle models were offered in flex versions in 2008. The UK, which until 2010 promoted biodiesel and ethanol via tax incentives, will introduce increasing mandatory quotas for biofuel sales. And Germany, which in 2008 produced 17% of the world's biodiesel from canola, ended tax breaks for the majority of cases, preferring to impose quotas.

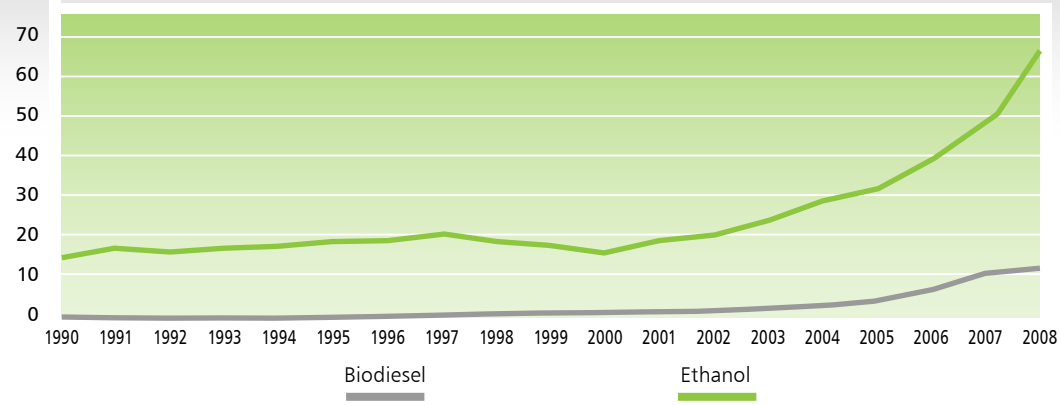
▶ Introduction

The global biofuels market grew at surprising rates during the last decade. As can be seen in **Graph 1**, between 2000 and 2008, the annual growth of ethanol production averaged 18.6%, while for biodiesel growth averaged 37.3%.

As shown in **Table 1**, 67 billion liters of ethanol and 12 billion liters of biodiesel were produced in 2008, a volume equivalent to approximately 920,000 barrels/day of petroleum, or 1.1% of the global production of fossil fuels. The United States leads the global production of ethanol, followed by Brazil. Together, these countries were responsible for nearly 90% of global ethanol production. Germany was the largest producer of biodiesel, with its 2.2 billion liter output representing 17% of global production. Production of biodiesel has been dominated by member-states of the European Union (EU), which together produced 8 billion liters, or two-thirds of global production.

The performance of the biofuels market reflects both the implementation of policies in several countries to promote its production and use, and its improving competitiveness compared to fossil fuels. This stems from falling production costs, due to technology gains, as well as the rising petroleum price until 2008. Even so, production costs for biofuels are greater than those for petroleum derivatives. Biofuels are not competitive with fossil fuels at market prices, except in a few cases such as Brazilian ethanol. Hence, the majority of promotional policies are justified on the grounds that biofuels bring non-market benefits.

Graph 1 **Annual growth of global ethanol and biodiesel production** *In billions of liters*



Source: Prepared by the authors from Fulton, L. et al. (2004) for 1990–2000 data; EIA (2009a) for 2001–2007; and REN21 (2009) for 2008.

These benefits include:

a *Increase in national security of energy supply*

Petroleum has finite reserves and highly volatile prices. Seeking to minimize dependence on this fuel is therefore crucial for many countries. Biofuels have great potential for directly substituting petroleum derivatives in the short term and without great investments in infrastructure or technological changes in vehicle motors. Ethanol can be used when mixed with gasoline in proportions of up to 15%[i] without significant alterations to vehicle engines, and in greater proportions in modified vehicles. Modern diesel engines can run on mixtures of up to 100% biodiesel, while older models accept up to 20% biodiesel with small modifications. Unlike other candidates to substitute petroleum derivatives, such as natural gas (CNG), hydrogen and electricity, the biofuels distribution and retail chain can more easily use the existing infrastructure for oil derivatives. In addition, biofuels can be produced domestically; if imported, they can come from diverse regions that do not manifest the instabilities that currently plague several oil producing countries.

b *Reduction of global and local environmental impacts*

The substitution of oil derivatives by biofuels is positive for local air quality. Biodiesel emissions, for example, contain less carbon monoxide, sulfur oxides and particulate matter than diesel emissions. Biofuels are less toxic than fossil fuels and their production processes are less aggressive to the environment, while waste material from their production can be recycled and even used to generate electricity, as in the case of Brazilian sugarcane ethanol.

Global production of ethanol and biodiesel in 2008 *In billions of liters* **Table 1**

	Ethanol	Biodiesel	Total
United States	34.0	2.0	36.0
Brazil	**27.0**	**1.2**	**28.2**
France	1.2	1.6	2.8
Germany	0.5	2.2	2.7
China	1.9	0.1	2.0
Argentina	0.0	1.2	1.2
Canada	0.9	0.1	1.0
Spain	0.4	0.3	0.7
Thailand	0.3	0.4	0.7
Others	0.5	2.7	3.2
Global Total	**67.0**	**12.0**	**79.0**

Source: Prepared by the authors from REN21 (2009).

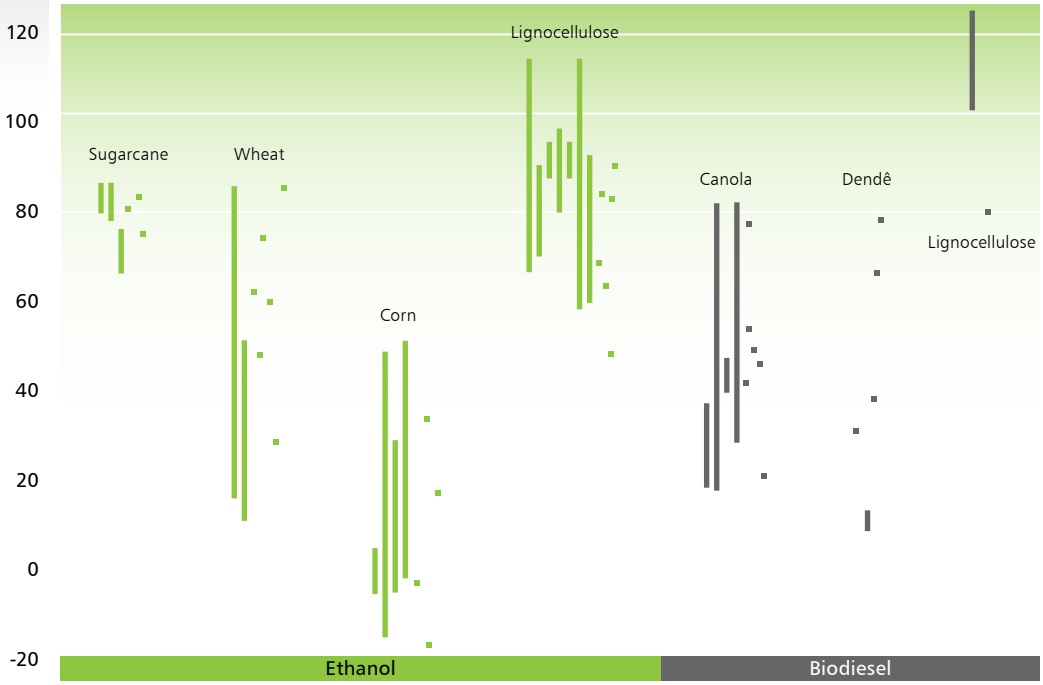
Because they produce less greenhouse gas (GHG) emissions than gasoline and diesel, ethanol and biodiesel are important options for mitigating climate change. This is particularly true for countries that need to reduce their emissions to comply with the Kyoto Protocol. According to a 2008 study by the OECD looking at lifecycle emissions[ii] of GHG from various biofuels produced by different technological paths, sugarcane ethanol emits, on average, 85% less GHG than gasoline (see **Graph 2**). This can exceed 100% if the use of byproducts of the sugar-ethanol industry is considered, for example the generation of bioelectricity. Wheat ethanol offers more modest results, reducing emissions between 30% and 50%, while corn ethanol provides an average reduction of 20%.

Studies show differing results for biodiesel produced with existing technologies in Europe, using canola vegetable oil. However, the OECD study indicates probable emission reduction values of between 40% and 55%. According to the OECD, research data on Dendê biodiesel is scarce. Some cases point to reductions of up to 80%, although in other cases where the crop has been grown in areas where tropical forest was burned down, there may be an increase of emissions.

Graph 2

Less greenhouse effect *Reduction in (%)*

Reduction of net greenhouse gas emissions for technology paths for biofuels production compared to gasoline and diesel (with no change in land use)



Source: REN21 (2009).

For the second-generation technology paths, the production of both ethanol and biodiesel from biomass lignocellulose can lead to emission reductions greater than 100%. However, these paths are not yet commercially available.

c *Creation of new markets for agricultural products*

Biofuels production creates new demands in agriculture and brings benefits to rural areas by improving product prices and increasing regional income. Other benefits include the development of new agricultural and production technologies and the possibility of exporting new items, for example new technologies and renewable products. There is, however, great concern that crops destined for biofuels production may occupy or dislocate areas destined for food production. These crops may even be diverted to biofuel production. This is particularly true when fiscal incentives for biofuels distort the relative market prices.

d *Stimulus for regional and national development*

Biofuels production can also promote economic activity, development and job creation, especially in rural areas that are generally less developed than urban areas. Other benefits can also be created for the country, such as the technological development of agricultural sectors and biofuel production. Also, the country can expand its range of export options, adding new technologies and renewable fuels.

This study analyzes international policy experiences for promotion and use of biofuels in an attempt to identify the barriers and opportunities for exporting Brazilian ethanol. In item 1, we analyze automotive fossil fuel prices in several countries with the aim of identifying space within pricing policies to adopt financial incentives for biofuels. Item 2 evaluates policies to promote production and consumption in selected countries, seeking to identify the dimensions of the ethanol market in these countries and the barriers to Brazilian ethanol. Finally, item 3 summarizes and complements the main considerations and results of this paper.

▶ 1 Analysis of international automotive fuel prices

An analysis of the internal pricing policies of automotive fossil fuels used in different countries is essential for an understanding of the impact of policies aimed at promoting biofuels.

Consumer prices for petroleum derivatives include several cost factors, profit margins and taxes incurred along the supply chain from the wells to the gas stations. These include the costs of petroleum prospection, production, transportation and refining, then the cost of distribution and retail sale of derivatives, plus companies´ profit margins and taxes in both the oil producing and derivative consuming countries.

In general, international gasoline and diesel prices follow the price of a barrel of petroleum. With the elevation of petroleum prices until the middle of 2008 and its subsequent decline, it would be logical that consumer prices followed a similar pattern, at least to a certain extent. However, it can be seen that in some countries the prices did not follow the variation of the international price of petroleum. The explanation for this lies in the different policies of countries to set domestic prices and taxes.

Three basic mechanisms are used in policies to establish domestic prices: (I) *ad hoc* decisions; (II) automatic adjustments determined by formulas; and (III) market prices. The first mechanism is what occurs when prices are adjusted by the government or by oil companies that are directly or indirectly controlled by the government, as a function of political or macroeconomic concerns. Readjustments are usually made at irregular intervals of time, using non-transparent criteria, and this leads to prices that move out of step with international ones. China, India and Indonesia are examples of countries that use such a mechanism. Under Brazilian law, gasoline and diesel prices are free, but in the last few years diesel and gasoline price adjustments made by Petrobras have used this mechanism, either for political interests of the government or for the economic interest of the government-controlled corporation.

The second mechanism – used for example in Malaysia and Vietnam – is based on formulas that are predefined by the government or the national petrol company. These formulas readjust prices automatically, at pre-defined periodic intervals, based on the behavior of international prices. Compared with an ad hoc system, readjustment by this mechanism has the advantage that domestic prices follow the international market, albeit with some delay, in addition to being transparent and predictable.

Finally, under the third mechanism, adopted in the majority of countries that are members of the Organization for Economic Cooperation and Development (OECD)[iii], prices are a consequence of the interplay of market forces. In these countries, the role of the government is restricted to taxing fossil fuels.

Generally speaking, two types of taxes are levied on automotive fuels in consuming countries: specific tributes for fuels (excise taxes or duties, and transportation taxes), for example Brazil's federal fuel levy known as the CIDE (literally, the Contribution of Intervention in the Economic Domain); and value added taxes (VAT), which also apply to the sale of other products – the Brazilian ICMS state-level tax is an example. The specific taxes have fixed values and apply to volumes sold, while VAT is fixed as a percentage of the final price of fuels, and therefore impacts the selling price. There are also taxes on the ownership and use of vehicles, such as Brazil's IPVA, and the congestion taxes that are used in some European countries, but these do not affect the final price of fuels.

In a comparison between fuel prices – with and without taxation – in OECD countries, the Institut Français des Relations Internationales (IFRI) showed that tax-free prices do not reveal significant variations, given that oil derivatives are commodities (Davoust, R., 2008). The IFRI thus demonstrated that the differences between consumer prices are caused mainly by national tax policies, while differences in costs and margins have little influence compared to taxes.

This same conclusion was reached by GTZ (now GIZ) in a series of studies of consumer prices and tax levels for diesel and gasoline in several countries since 1991 (GTZ, 2009). Based on the level of tax in final consumer prices for gasoline and diesel, GTZ (GTZ, 2009) grouped countries in four categories, as shown in **Graph 3** and **Graph 4**[iv]:

Category **1** – countries with high tax incentives[v]: These are countries where consumer prices for derivatives are below the international oil price. In other words, product prices do not cover the opportunity cost of oil and the costs of derivatives production. In general these are oil-producing countries where the cost of derivatives production is subsidized by the national oil industry and fuel prices are used to control inflation and avoid public dissatisfaction. Examples include Venezuela, Libya and Saudi Arabia. Biofuels penetration in such countries is practically impossible. Given their abundant low-cost oil, only non-market objectives such as local and global environmental questions could motivate any biofuel promotion policy.

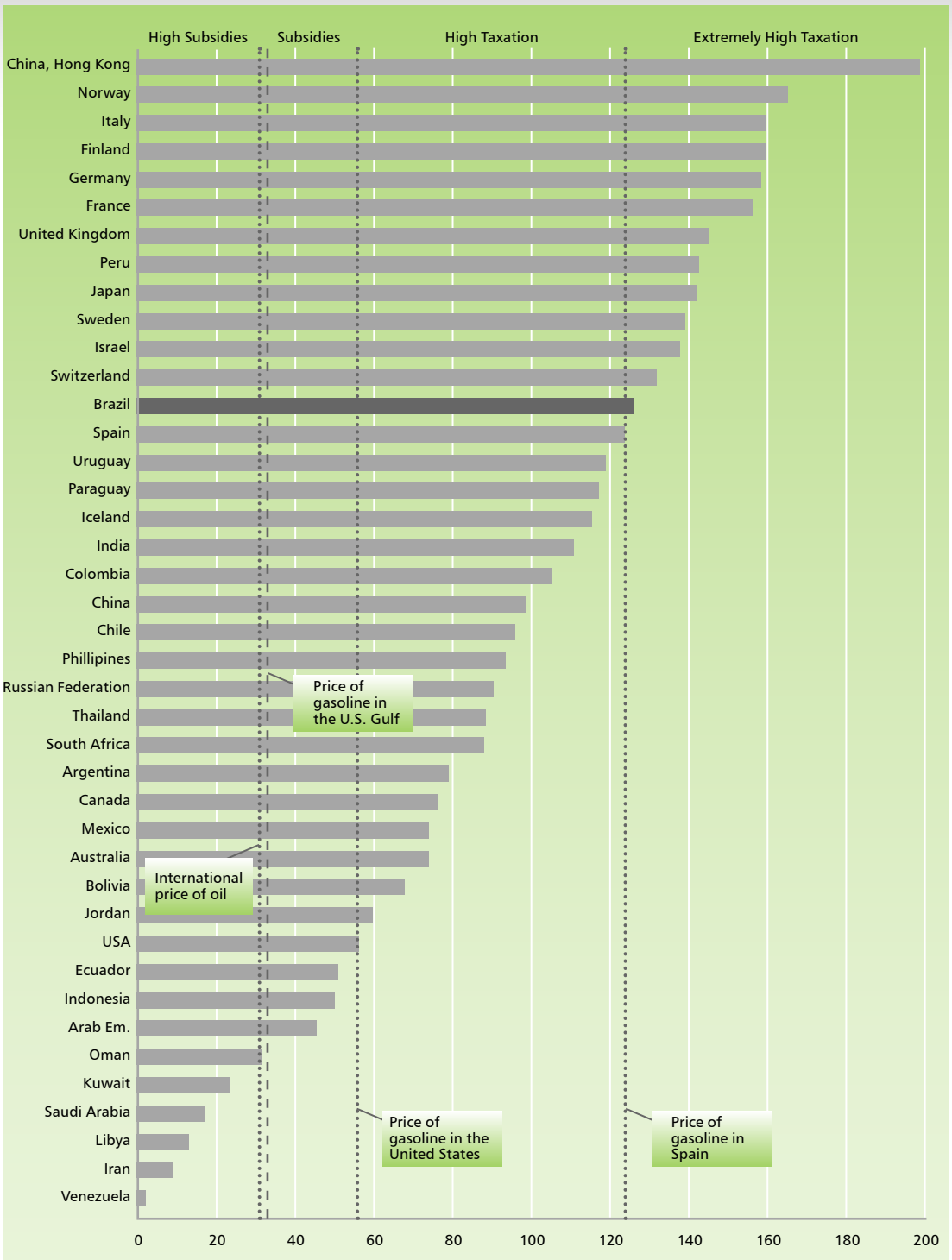
Category **2** – countries with tax incentives: These are countries where diesel and gasoline consumer prices are above international oil prices but below the selling price in the United States[vi], which is a country that practices market prices for derivatives with a minimum of tax. Fuel prices in these countries cover the raw material costs but receive tax incentives to cover other costs in the supply chain. As shown in **Graph 3** and **Graph 4**, in some of these countries gasoline and diesel prices are below market prices practiced in the Gulf of Mexico. As in Category 1, this group also includes oil-producing countries where significant tax incentives would be necessary for biofuels promotion, which would only be justified by non-market objectives.

Category **3** –countries with high taxation[vii]: These are countries where prices lie between the U.S. and those practiced in Spain, which in November 2008 had the lowest derivatives prices of countries in the EU-15[viii]. In addition to Spain's own taxes, fuel prices in that country are impacted by the mandatory minimum values of VAT and the specific taxes on fuels that apply to every EU member. Taxation in countries within this category exceeds US$0.10/liter and has other purposes in addition to road construction and maintenance. In some countries in the category, fuel prices are not a result of market forces; rather they are established ad hoc by the government or an oil company controlled by the government. In this case, derivatives sales generate more income than is required to cover production and distribution costs. Appropriation of this income by the government has the same role as taxation. Concession of tax incentives would be necessary for biofuels to be viable in these countries.

Category **4** –countries with very high taxation: These are countries where prices are above the level in Spain. In these countries, fuel taxation has many objectives such as constructing and maintaining roads, generating income, encouraging efficiency in the transportation sector and internalizing the environmental costs of the production and use of fuels and vehicles. These countries offer high potential for the introduction of biofuels without requiring elevated tax incentives.

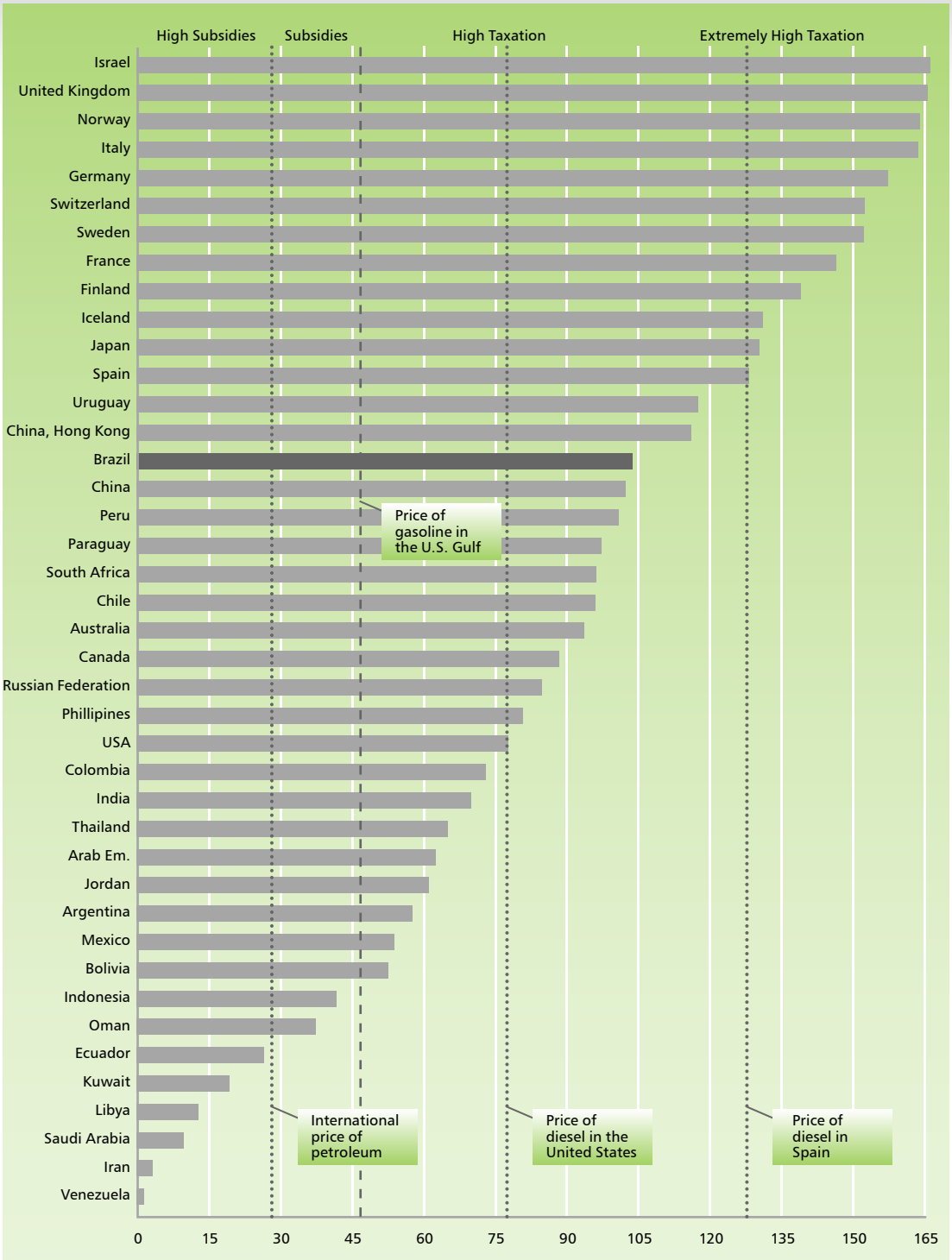
The last survey of gasoline and diesel prices in 172 countries undertaken by GTZ in November of 2008 (GTZ, 2009) indicated that, in the case of gasoline, eight countries fell into category 1; 12 into category 2; 86 into

Graph 3 **Comparison of consumer prices for gasoline** *US cents/liter; November 2008*



Source: Prepared by the authors from GTZ (2009).

Comparison of consumer prices for diesel *US cents/liter; November 2008* Graph 4



Source: Prepared by the authors from GTZ (2009).

category 3; and 66 into category 4. Diesel, on the other hand, saw 12 countries in category 1; 30 in category 2; 81 in category 3; and 49 in category 4. In that month, Brazil fell into category 4 for gasoline and category 3 for diesel. It must be remembered, however, that the GTZ survey was conducted after the beginning of the global economic crisis, when free-market prices of these derivatives were in free fall around the world, but Petrobras had not made any adjustment to domestic prices.

▶ 2 Analysis of international policies for biofuels promotion

Many countries have in recent decades found that using biofuels for automotive purposes represents a contribution to the solution of important issues, such as: (**I**) increasing energy efficiency and flexibility, and diversifying available energy sources; (**II**) improving the country's ability to rapidly respond to emergency situations that affect fuel supply, such as price shocks or temporary interruption of supply for security reasons; (**III**) promoting the use of energy sources that are renewable and less harmful to the environment, especially with respect to GHG emissions; and (**IV**) exploiting the country's comparative advantages, promoting development and the exportation of new technologies and products.

Governments have adopted three main instruments to promote the use of biofuels: instruments of command and control; economic instruments; and import restrictions. Instruments of command and control have been applied since the 1980s, and are regulatory standards that imply, for example, a requirement for biofuel mixtures or the production of vehicles for its use. This category also includes vehicle emission standards, fuel specifications and minimum efficiency standards for vehicles.

Economic instruments include financial incentives, special tax structures and negotiable certificates for biofuel mixtures. Financial incentives and special tax structures have been used in several countries since the beginning of the 1990s as a way to achieve environmental goals. They can take the form of tax credits, government tax incentives or loans with special conditions, and their purpose is to reduce the cost of producing alternative fuels and acquiring vehicles that run on them. In general, financial incentives and regulatory standards are applied together.

Special tax structures are conceived to place a greater tax burden on fossil fuels. They are usually applied via policy changes that create or increase taxes on pollutant sources and agents, according to the externalities that these produce. Environmental taxes differ from financial incentives in two ways. First of all, they do not imply cost for the government; on the contrary, they generate funds that can be used to reduce other taxes or to finance environmental and social programs. The second difference relates to the signal sent to consumers about the externalities involved in vehicle use, which are internalized by the tax. Faced with higher prices, the consumer adjusts his demand or chooses to use less pollutant technologies or fuels.

The use of certificates has been adopted in environmental programs in the United States and European countries, together with regulatory standards. These standards require, for example, that electricity distributors or generators or, alternatively, consumers themselves, use a minimum percentage of renewable

fuels to meet the demand of electricity. The imposition of standards is accompanied by the introduction of negotiable certificates that are supplied to the agents according to their fulfillment of the required standards. This means that agents who can acquire renewable energy more cheaply can sell their surplus certificates to others that face higher costs in meeting their targets.

Import restrictions are geared to protecting domestic biofuel producers, in particular via the introduction of import tariffs or restrictions on the concession of financial incentives for imported products. This barrier has low economic efficiency because it imposes greater costs on the consumer by creating a market reserve and limiting competition among suppliers. The fact is that if there were no restrictions on international commerce, there would be a faster fall in biofuel costs and economic efficiency would increase, so helping speed up the reduction of fossil fuel use.

In the following pages, we discuss the application of these policies in the United States and the European Union. The United States was chosen because of the size of its market for vehicle fuel, both fossil and renewable, especially in the case of ethanol. The country also represents a good example of the application of regulatory standards and financial incentives to promote the production and use of biofuel.

Policies in effect in the European Union are discussed via the analysis of the situation in three member states: Sweden, the United Kingdom and Germany. While Sweden does not have a large fuel market compared to the other countries analyzed, it has one of the most ambitious biofuel promotion policies, especially for ethanol. Thanks to its relatively small fuel market – together with its high level of economic and social development, and the environmental awareness of its population – this country has introduced innovative policies to reduce, if not eliminate, the use of fossil fuels.

The United Kingdom, on the other hand, is a relevant example of the use of a biofuels program supported by the introduction of blend certificates.

Germany was selected because of its incentive policies for biodiesel. These place Germany first among biodiesel producers and consumers. The country's programs initially provided heavy subsidies for biodiesel use, but have now entered a new phase with the use of regulatory standards and economic instruments.

Finally, we discuss the history of Brazilian policies for ethanol promotion and indicate the necessary requirements for implanting a new national biofuel policy.

2.1 Biofuel policies in the United States

The United States has since 2005 occupied first place in the global production of ethanol, followed by Brazil. American ethanol is produced almost entirely from corn and is consumed domestically, above all as an oxygenator mixed with gasoline in proportions up to 10%. In 2009, ethanol consumption in the U.S. was 40.7 billion liters, representing almost 8.5% of the fuel market for Otto cycle vehicles.

The United States is a good example of the combined application of regulatory standards and financial incentives to promote biofuels. The 2005 Energy Policy Act (EPAct 2005) constitutes extensive legislation on energy, and establishes in Section 1501 a mandate for refineries, blenders, distributors and importers to add renewable fuels to gasoline. The Renewable Fuel Standard (RFS1) provided that the use of renewable fuels – which began in 2006, at four billion gallons or approximately 15 billion liters annually – should progress to 7.5 billion gallons by 2012. The regulation and implementation of this mandate is the responsibility of the Environmental Protection Agency (EPA), which must also define the percentage renewable fuel blend in gasoline, based on the gasoline demand in the country each year.

In December of 2007, the U.S. Congress passed the Energy Independence and Security Act (EISA), creating a new program which became known as RFS2. Once again, the EPA was given the responsibility of regulating the alterations. On May 26th, 2009, the agency submitted for public hearing a document entitled Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program. The hearing deadline was September 25th 2009, but the EPA only officially published the final version of the RFS2 regulation on March 26th, 2010, over two years after Congress created RFS2. This delay was caused by the great controversy generated about how to calculate emissions associated with biofuels production.

One important change introduced by RFS2 was the increase in mandatory volumes of renewable fuels. As shown in **Graph 5**, the new program extended the timeline for increasing the use of renewable fuels to reach 136 billion liters in 2022. RFS2 also establishes that a growing proportion of the annual volume of renewable fuels consumed must be advanced biofuels, and they must include minimum volumes of cellulosic biofuel and biodiesel produced from biomass. Although there is a significant increase in renewable fuel volumes, RFS2 allows for the possible substitution of all types of fuels in all types of vehicles including locomotives, vessels and aircrafts, as well as fuels used in stand-alone engines, whereas RFS1 provided only for the substitution of gasoline.

In order to be classified as a renewable fuel, advanced biofuel, cellulosic biofuel or biomass biofuel, and thereby qualify for inclusion in the respective annual volumes, the fuels must achieve minimum percentage lifecycle reductions of GHG emissions compared to the gasoline and diesel used in the United States in 2005. According to EISA, renewable fuels produced in mills whose construction was started after December 19th, 2007 must achieve minimum emission reductions of 20%, while advanced biofuels and biodiesel must reach 50% and cellulosic ethanol 60%.

To determine the emission reductions generated by biofuels, the EPA relies on its own analysis and also the best available scientific models. It has incorporated many changes to the model initially proposed, based on public comments and the formal revision process undertaken by the agency. EPA analyses consider emissions throughout a fuel's lifecycle. This includes emissions caused by direct and indirect land use change (ILUC) in other countries that are caused by the production of renewable fuels in the United States. Because a fuel's lifecycle GHG emissions occur over the course of time, the EPA presented two proposals to take account of the temporal nature of emissions: analysis for a 30-year horizon, without weighting present and future emissions; and an analysis for a 100-year horizon, in which future emissions are discounted at

an annual rate of 2%. In the end, however, the EPA decided to only use the 30-year horizon, without any discount.

Final regulations for RFS2 were announced in February 2010 and the EPA designated sugarcane ethanol as an advanced biofuel, capable of reducing greenhouse gas emissions by at least 50% compared to gasoline. The EPA also confirmed that Brazilian ethanol achieves GHG emission reductions that exceed the minimum requirements for all categories. The EPA's calculation shows an average reduction of 61% when compared to gasoline, using a 30-year period to compensate emissions related to indirect effects of land use (ILUC). Corn ethanol reduces emissions by 21% using best industry practices (i.e. electricity generated with natural gas), but the American average is still well below that, as shown in **Graph 6**.

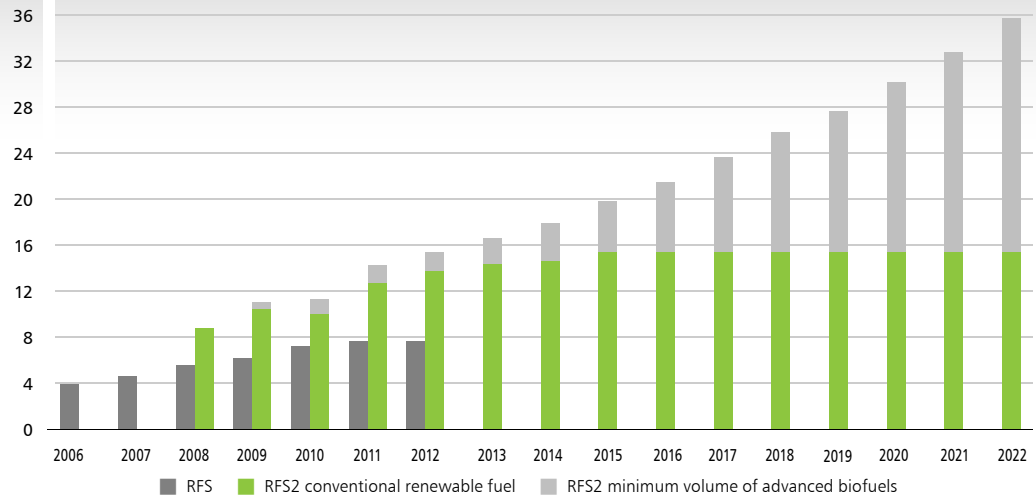
The status achieved by Brazilian sugarcane ethanol undoubtedly opens windows of opportunity for this biofuel, given the uncertainties that surround the ability of the United States to produce advanced biofuel on a commercial scale in the short term.

This means that the criteria for emission reductions established by the EPA to classify biofuels, if maintained, open a window of opportunity for Brazilian ethanol, given that the deficit of American ethanol would lend weight to the argument of those people – including many in several U.S. states – who defend the reduction or even elimination of the current import taxes on the Brazilian product.

Graph 5

Comparison between required volumes of renewable fuels in RFS and in RFS2

*In billions gallons**



Source: Prepared by the authors from EPA (2009) and RFA (2009a). • *one gallon = 3.791 liters

In addition to RFS2, U.S. federal and state laws dealing with air quality and fuel specifications also have played a determinant role in the country's use of ethanol. At the federal level, the 1990 Clean Air Act (CAA 1990) mandated the use of oxygenated gasoline (reformulated gasoline) in some regions of the country, aiming to reduce emissions of carbon monoxide. Gasoline suppliers initially opted for the addition of methyl tert-butyl-ether (MTBE) to gasoline as an oxygenator because it is cheaper than U.S. ethanol, until evidence showed that MTBE poses a risk of groundwater contamination and is carcinogenic. Several U.S. states therefore banned its use, leading to a rapid acceleration in the use of ethanol as a substitute.

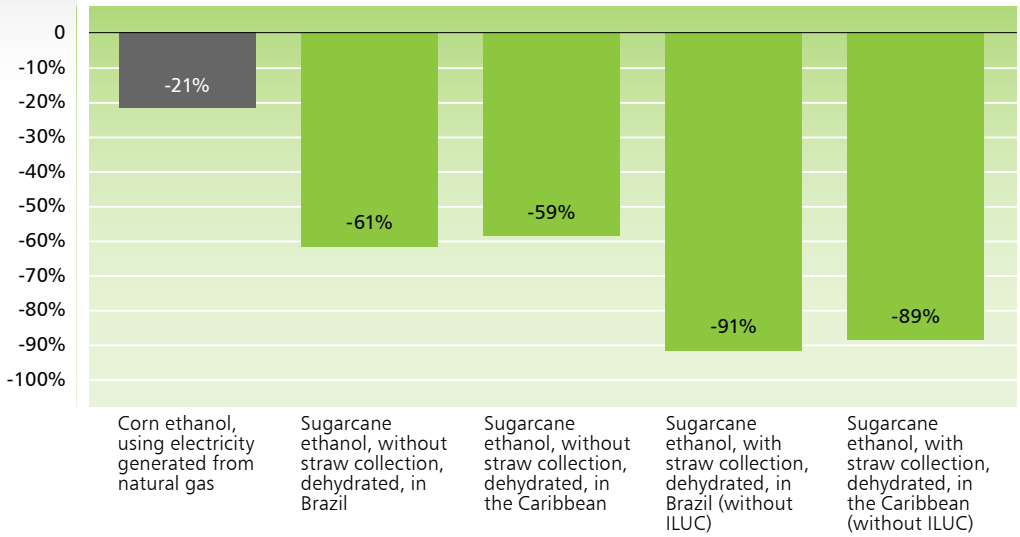
Thanks to environmental legislation, the addition of 10% ethanol in gasoline (E10) has now become mandatory in several U.S. states[ix], and is optional in all others. The blend of up to 10% is found at regular fueling stations. A voluntary 85% ethanol blend (E85) is also used, but is found in a few stations, in part because very few vehicles have the compatible technology to use it. On the other hand, the biodiesel blend with diesel in proportions from 2% to 100% is optional in all states.

To support the mandatory measures established under U.S. law, federal programs provide tax credits to fuel blenders and biofuel producers, as summarized in **Table 2**. Incentive values are significant. According to Koplow (2009), tax incentives applicable to conventional ethanol could add up to US$0.60 to US$0.79 per gallon in April 2009, while the amount for cellulosic ethanol was US$2.26 to US$2.46/gallon. As for

Graph 6

Lower greenhouse gas emissions

Average reduction of greenhouse gas emissions in the lifecycle of corn ethanol and sugarcane ethanol, including emissions from direct and indirect land-use change (LUC and ILUC), with 0% discount and a 30-year horizon



Source: U.S. Environmental Protection Agency (March 2010), prepared by the authors.

biodiesel, the sum of tax incentives could reach US$2.22 to US$2.65 per gallon. By way of comparison, the average price of U.S. gasoline in April 2009 was US$2.049 per gallon and diesel US$2.225 per gallon, including federal and state taxes that on average totaled US$0.47 to US$0.514 per gallon.

Although the incentive given to gasoline blenders (VEETC) does not discriminate the source of ethanol, the U.S. product is favored by the application of customs taxes on imports. An *ad valorem* tariff of 2.5% is levied on imported ethanol, which is low when compared to the rates prevailing in other countries, but in addition there is an extraordinary tax of US$0.54 per gallon, which exceeds by 20% the US$0.45 per gallon VEETC credit. Only the ethanol from countries that have concluded bilateral trade agreements with the United States is excluded from this tax; such countries include members of the North American Free Trade Agreement (NAFTA) and those included in trade preference programs created by Congress, such as the Caribbean Basin Initiative and the Andean Trade Preference. Ethanol imported from Brazil does not fit into any of these situations, and is therefore fully taxed.

In April of 2009, the Energy Information Agency of the United States published the Updated Annual Energy Outlook 2009[x] (Updated AEO 09). The document provides a reference scenario for the country's energy sector, taking into account the new global economic situation, together with the effects that the American Recovery and Reinvestment Act of 2009 (ARRA 09) may have on the U.S. economy and its energy market.

Enacted in February of 2009, ARRA 09 includes a package of measures from the U.S. government to stimulate the U.S. economy and minimize the effects of the crisis. Among the various measures are several aimed at increasing energy efficiency, reducing carbon emissions and increasing domestic energy production. Examples include improvements in buildings heating systems, setting minimum consumption standards for manufacturers and importers of motor vehicles, encouraging the acquisition of electric and hybrid vehicles, the use of renewable fuels and the use of light diesel vehicles. On the supply side, ARRA 2009 aims to increase domestic production of petroleum and natural gas, both onshore and offshore.

According to the updated projections of the AEO 2009, presented in **Table 3**, there would be a drop in gasoline consumption in the United States in 2009 due to the global economic crisis. The growth trajectory would resume in 2010 and 2011, with the return of economic growth. In 2012, however, the measures contained in ARRA 09 could impact the transportation sector, resulting in a drop in gasoline consumption which remains through the end of the analysis horizon. Ethanol consumption in the country, however, receives a positive impact from ARRA 09, caused by the increase in the volumetric percentage of the ethanol blend in gasoline, which grew from 7% in 2008 to 10% in 2010, remaining at that level until 2030.

The measures contained in ARRA 09 also have a positive impact on domestic production of ethanol. The increase in production of this biofuel will reverse the present deficit, which is met by imports, and generate an exportable surplus. This surplus will prevail through 2015, when domestic production again becomes insufficient to meet demand, causing a new cycle of ethanol imports that increase in the period 2015 – 2030 and reach 7.8 million m3, or 16% of ethanol demand, in 2022.

Table 2 **Main federal incentives for biofuels in the United States**

Incentives	Commentary	Value
Volumetric Ethanol Excise Tax Credit (VEETC). Promulgated by the America Jobs Act (2004). Replaced the partial exemption of automotive fuels established in the Energy Tax Act of 1978.	Credit for blenders when paying the excise tax on fuels. Calculated on the volume of ethanol of any origin, including imported, mixed to gasoline. There are no restrictions as to the size of the factory, market prices or social or environmental impacts for the production of methanol.	US$0.45 per gallon since January 1st, 2009 (it was US$0.51 per gallon until then). Values in introductory programs varied between US$0.40 and US$0.60 per gallon from 1978 to 2004.
Volumetric Biodiesel Excise Tax Credit (VBETC). Promulgated by the America Jobs Creation Act (2004). Most recent modifications included in the Emergency Economic Stabilization Act of 2008 (EESA).	Credit for blenders when paying the excise tax on fuels. Excludes biodiesel that is not produced or sold in the United States, or produced by co-processing in refineries. Includes biodiesel produced by any process and not only by etherification of vegetable and animal oils, except by co-processing in petroleum refining.	US$1.00 per gallon for every source. Originally, US$1.00 per gallon for vegetable and animal grease and US$0.50 for recycled oils.
Renewable Biodiesel Tax Credit. Promulgated by the American Jobs Creation Act (2004).	Credit for the producer on the payment of income tax. Originally, a tax credit parallel to the VBTEC for producers who, for whatever reason, could not reclaim the specific tax credit for fuels. In April 2007, its application was extended to include biodiesel produced by thermal depolymerization, which was not covered by the VBTEC.	US$1.00 per gallon for every source. Originally, US$1.00 per gallon for vegetable oils and animal grease and US$0.50 per gallon for recycled oils.
Small Producer Tax Credit. Initially authorized by the Omnibus Budget Reconciliation Act (1990). The Energy Policy Act (2005) doubled the annual production capacity of plants eligible for fiscal incentive from 30 million to 60 million gallons.	Credit for the producer on the payment of income tax. Any type of ethanol and biodiesel. Applicable only to factories with annual capacity of up to 60 million gallons.	US$0.10 per gallon for the first 15 million gallons per year. Producers of cellulose ethanol can claim credit on all 60 million gallons.
Production Tax Credit for Cellulosic Ethanol. Authorized by the 2008 Farm Bill.	Applicable only to the production of cellulosic ethanol.	US$1.01 per gallon, discounting VEETC if the production is destined to a gasoline blend and the Small Producer Tax Credit in case of small producers.

Source: Prepared by the authors from DOE (2009), RFA (2009b) and Koplow (2009).

This scenario, if it occurs, represents an opportunity for Brazilian ethanol exports, in particular if one considers that the EIA study does not take into consideration the sustainability criteria established by RFS2, which restrict the use of much of the ethanol currently produced in the United States.

2.2 Biofuel policies in the European Union

The group of member states in the European Union (EU) constitutes the world's greatest producer and consumer of biodiesel. The trade bloc began using biodiesel in the 1990s, in the transportation sector, motivated by the rise in oil prices. Biodiesel production later made great progress driven by the Blair House Agreement[xi] of 1992 and by strong fiscal incentives, principally in Germany.

In 2003, as a response to concerns about climate change and energy security, the EU approved Directive 2003/30[xii]. This laid out non-compulsory goals for fossil fuel substitution by biofuels to be pursued by the member states through 2010. As shown in **Table 4**, while biofuel participation has grown rapidly in the EU, it was not enough for the bloc to achieve the goals defined in the guidelines. This happened mainly because the goals were non-compulsory, with each state being responsible for deciding which measures it would adopt to meet those goals.

Faced with the EU's poor performance in combating GHG emissions, not just in transportation but in other sectors of the economy, on April 6th, 2009 the European Union Council approved the Energy and Climate Change Package (CCP), containing a new strategy to deal with the issue of energy and climate change. The section of this package that sets policy for renewable energy is called The Renewable Energy Directive (RED); it was published on June 5th, 2009 and came into effect 20 days later. RED policies must be implemented by EU member states in an 18-month period following its publication – in other words, by November 2010 – when they should be incorporated in member states' domestic legislation. Member states were also required to submit their national action plans by June 2010.

The CCP establishes the so-called "20/20/20" landmarks to be achieved by 2020:

I A 20% reduction in GHG emissions compared to 1990 levels.
II A 20% improvement in energy efficiency compared to current projections for 2020.
III A 20% participation of renewable energy in the EU's energy consumption matrix. It is mandatory for every member state that part of this renewable energy participation be obtained through the minimum level of 10% renewable energy consumption in transportation.

It is important to note that, while the 20% participation of renewable energy in total energy consumption is an overall target for the EU, different objectives were set for each member state in light of their current economic situation and potential for economic growth. Hence, some states should reach goals higher than 20%, while others may reach lower targets. The goal for renewable energy participation in Sweden, for

Table 3 **Ethanol and gasoline in the United States**

Consumption of gasoline; consumption, production and importation of ethanol in the United States; in millions of m³, according to EIA projections

Year	Consumption of gasoline with ethanol	Consumption of ethanol mixed with gasoline	Percentage of ethanol in gasoline	Consumption of ethanol as E85	Domestic production of Ethanol	Net importing of Ethanol
2006	537.0	21.1	4%	0.0	18.5	2.7
2007	538.9	25.9	5%	0.0	24.7	1.3
2008	520.2	36.0	7%	0.0	34.9	1.2
2009	514.1	39.6	8%	0.0	39.9	-0.3
2010	547.4	49.0	9%	0.1	49.7	-0.6
2011	560.8	55.1	10%	0.1	56.2	-0.9
2012	559.4	55.0	10%	0.1	55.2	-0.1
2013	555.6	54.7	10%	0.1	54.8	-0.1
2014	550.2	54.1	10%	0.1	54.3	-0.1
2015	542.1	53.4	10%	2.3	55.5	0.1
2016	533.1	52.5	10%	5.4	57.8	0.2
2017	525.9	51.8	10%	7.3	58.9	0.2
2018	516.9	50.8	10%	11.5	61.0	1.3
2019	510.9	50.1	10%	16.1	63.3	2.9
2020	502.9	49.6	10%	22.1	69.2	2.5
2021	497.3	49.7	10%	25.8	73.5	2.0
2022	486.8	48.1	10%	35.2	79.4	3.9
2023	487.1	48.2	10%	35.0	81.3	1.8
2024	489.2	48.9	10%	33.5	80.6	1.8
2025	488.7	48.4	10%	35.0	80.7	2.7
2026	488.9	48.0	10%	36.2	81.3	2.9
2027	482.1	47.9	10%	44.3	87.8	4.4
2028	481.8	47.8	10%	46.3	88.8	5.3
2029	476.6	49.5	10%	50.3	92.0	7.8
2030	478.1	48.2	10%	51.7	93.4	6.5

Source: Prepared by the authors from EIA (2009b).

example, is 49%, while in Malta it is just 10%. The goals in Germany, France, the United Kingdom and Italy, the largest European economies, are 18%, 23%, 15% and 17%, respectively.

The special attention given by the CCP to transportation is due to projections indicating that the sector will be responsible for the greatest share of growth in energy consumption. It thus requires the greatest discipline.

One important topic within RED refers to the sustainability criteria of biofuels that are used to reach the 10% goal. The three main criteria are:

I From the autumn of 2010 onwards, lifecycle GHG emissions of biofuels should be at least 35% lower than those of the fossil fuels they replace. GHG emissions reduction should be at least 50% from 2017 onwards, increasing to 60% when biofuels are produced in new installations.
II Biofuels should not be produced from raw materials obtained in areas of high biodiversity, such as primary forests and areas with native vegetation.
III Agriculture raw materials produced in the EU should be produced according to correct agricultural and environmental practices established by the EU's Common Agricultural Policy (CAP)[xiii].

Transportation fuel consumption in the European Union *In thousands of TPE* **Table 4**

Fuel	2006[r]	2007[r]	2008[e]	2009[p]	2010[p]
Total biofuels	5,910	7,940	9,320	10,340	12,650
Biodiesel	4,110	5,900	7,160	8,170	9,980
Pure vegetal oil	920	660	370	100	100
Ethanol	880	1,380	1,790	2,070	2,560
Conversion biomass – liquid (BtL)	-	-	-	2	8
Total fossil fuel	293,531	295,667	297,900	300,160	302,470
Diesel	183,702	189,596	192,250	194,940	197,670
Gasoline	109,829	106,071	105,650	105,220	104,800
Total fuels	299,440	303,610	307,220	310,510	315,120
Biofuels participation	1.97%	2.62%	3.03%	3.33%	4.00%
Target in Directive 2003/2030	2.75%	3.50%	4.25%	5.00%	5.75%

Notes: r- revised; e- estimated; p- projected. • *Source:* Prepared by the authors from Flach, B. (2009).

Given the technological preference for diesel motors in the EU and the longstanding tradition in the production of biodiesel, ethanol accounted for just 19% of biofuel consumption within the bloc in 2008. As shown in **Table 5**, ethanol consumption in the EU in 2008 was approximately 3.71 million m^3, of which 3.55 million m^3 was destined for the transportation sector and the remainder to stock formation. Countries with the greatest consumption of ethanol were France (1.1 million m^3), Germany (0.75 million m^3), and Sweden (0.43 million m^3). In fourth place were the United Kingdom and the Benelux bloc, with 0.28 million m^3 each. As shown in **Table 5**, consumption in the EU is projected to grow by an average of 16% per year between 2008 and 2010.

Ethanol production in the EU totaled 2.66 million m^3 in 2008, with the main producers being France (0.80 million), Germany (0.58 million), Spain (0.30 million) and Poland (0.22 million). The main raw material used in the production of ethanol was wheat (3.2 million tonnes), followed by sugar (1.0 million tonnes), corn (1.6 million tonnes) and barley and rye (0.5 million tonnes). According to the estimates presented in **Table 5**, ethanol production in the bloc should grow, on average, by 20% per year between 2008 and 2010.

In 2008, the EU's deficit between ethanol consumption and production required imports totaling 1.1 million m^3. Main importers were the United Kingdom, Sweden and the Benelux counties, acquiring the fuel from Brazil, Argentina, Costa Rica, Venezuela, Peru and Guatemala. Even though production grew by more than consumption between 2008 and 2010, ethanol imports will still be necessary and are projected to grow by 7% per year, on average, reaching 1.27 million m^3, or 25% of the product's consumption, by the end of the period.

It can be forecast that, in the medium term, the EU is likely to import growing quantities of ethanol due to two factors: (I) growth in demand to meet the goals for renewable fuel use imposed by CCP; and (II) limitations on domestic supply, given the biofuels sustainability criteria imposed by the RED. These criteria are unlikely to be met by the ethanol produced from the raw materials used in the EU. This creates a window of opportunity for Brazilian ethanol exports, at least until technologies for production of cellulosic ethanol reach maturity.

Table 5 **Supply and demand of ethanol in the European Union** *In thousands of m^3*

	2006[r]	2007[r]	2008[e]	2009[p]	2010[p]	Average annual growth
Installed capacity	2,220	3,800	5,960	6,720	8,870	41.4%
Production	1,635	1,840	2,660	3,040	3,800	23.5%
Exports	38	44	51	57	63	13.5%
Imports	230	1,000	1,105	1,115	1,270	53.3%
Consumption	1,825	2,795	3,715	4,100	5,010	28.7%

Notes: r - revised; e - estimated; p - projected. • *Source:* Prepared by the authors from Flach, B. (2009).

However, Brazilian ethanol currently faces tax barriers to enter the EU. The bloc establishes two import tax rates for ethanol: €0.192 per liter for non-denatured ethanol and €0.102/liter for denatured ethanol. These taxes, however, do not apply to countries included in the "Everything But Arms" initiative for Least Developed Countries nor to those African, Caribbean and Pacific nations covered by the Cotonou Agreement, which are exempt from any taxation. The Brazilian product therefore faces the higher of the two taxes, given that Brazil exports mainly non-denatured ethanol and the majority of EU member-states allow only this type of ethanol to be blended with gasoline.

Concern about biofuel imports to meet goals for GHG emission reductions in the transportation sector has been expressed by the European Commission (EC) in a series of policy documents. In the documents "An EU Strategy for Biofuels" (EC, 2006) and "Renewable Energy Road Map" (EC, 2007), the Commission proposes a search for the "appropriate development of both domestic production as well as the increase for importation opportunities". In the latter document, the EC declares that "if it becomes clear that the EU's supply of sustainable biofuels becomes restricted, the EU must be prepared to examine if greater access to the market should be an option to aid development of the market". According to these documents, the Doha Development Round and the free trade agreement between the EU and Mercosul will have impact on the additional opening up of the ethanol market. (Flach, B., 2009).

However, some factors may reduce the forecast importation into the European market. The preference that EU consumers have shown in the last two decades for diesel vehicles indicates an obstacle to the growth of gasoline consumption, which would stimulate an increase in ethanol consumed in the bloc. There is also competition from the growing biofuel production in countries favored by EU custom tax exemption programs.

Taxes on automotive fuels in Sweden in 2009 Table 6

Fuel	Consumption tax (SEK/l)	CO_2 (SEK/l)	SO2 (SEK/l)	VAT (%)
Conventional Gasoline	3.08	2.44	0	25
Diesel	1.33	3.01	0	25
Ethanol and biodiesel	0	0	0	0

Notes: SEK 1 = US$ 0.14, average exchange rate in August 2009. • *Source:* Prepared by the authors from Dahlbacka, B. (2009).

2.3 Biofuel policies in Sweden

Sweden was one of the first countries in the EU to adopt economic instruments in its environmental policies. As far back as 1991, the country introduced environmental taxes on all types of energy, including automotive fuels. As shown in **Table 6**, in addition to VAT Sweden targets gasoline with a specific consumption tax and a CO_2 emissions tax. Diesel faced yet another tax on SO_2 emissions but this became inoperative when the country began using diesel with ultra-low sulfur content (below five ppm). At the same time, ethanol and biodiesel enjoy total tax exemption, without which their prices would not be competitive.

Ethanol is used in Sweden as a compulsory additive to gasoline in an E5 blend. There is also an optional E85, which in winter months can be reduced to E75. Ethanol can also replace diesel in the form of optional ED95[xiv]. Biodiesel has been allowed since 2006 in a diesel blend up to 5%.

Sweden is Europe's greatest promoter of the use of E85 and flex-fueled vehicles. In the last few years, the government has granted incentives for the acquisition of flex-fuel vehicles, including a purchase bonus of SEK10,000 (approximately US$1,400), discounted insurance, lower licensing fees, free parking places in most major cities and exemption from the traffic congestion tax charged in Stockholm[xv].

In 2008, 50% of new light vehicle models were offered in flex-fuel versions and 25% of vehicle sales were flex-fuel. The Swedish government expects that the flex-fuel fleet will reach 300,000 units by the end of 2010, and that E85 will represent 10% of the country's automotive fuel market by 2012 (Christiansen, R.C., 2009).

In addition to the tax incentives for ethanol, the country's flex-fuel fleet is served by an infrastructure of approximately 1,400 stations offering E85, with that number predicted grow to 2,000 by the end of 2009. The Swedish government has already spent €69 million (US$91 million) setting up this infrastructure (Christiansen, R.C., 2009).

Even with tax exemption, the insufficient production volume and the high cost of European ethanol have undermined its competitiveness compared to traditional fuels. To supply the market and reduce the cost of the product, the European Commission has since 2008 been authorizing Sekab to import Brazilian ethanol with a reduced import tax. To make this possible, Brazilian ethanol used in the E85 blend is classed as a chemical, so attracting a lower import tax. However, this concession is being renewed yearly, and the fear that it could be cancelled at any moment creates insecurity for car buyers. This fear is aggravated by the fact that European ethanol producers oppose the concession given to Sweden. If European producers succeed in ending the tax reduction for Brazilian ethanol, placing it back in the agricultural product category, ethanol would cease to be competitive in Sweden and consumers would go back to using gasoline and diesel, or would at least reduce their consumption of biofuels.

Sweden is looking for alternatives to importing ethanol from Brazil. One option is supporting ethanol production projects in countries that benefit from tax-free entry into the EU through the "Everything But Arms" initiative for Least Developed Countries and the Cotonou Agreement with African, Caribbean and

Pacific countries. An experiment is taking place in Ghana, where a 150,000 m^3 capacity plant will be built by Brazil's Constran S /A group. The Brazilian Development Bank (BNDES) will concede partial financing of US$260 million, out of the project's total US$306 million investment (Energy Daily, 2008).

2.4 Biofuel policies in the United Kingdom

The United Kingdom started promoting biodiesel in 2002, to be consumed pure or in a diesel blend. Biodiesel was granted a reduction of £0.20 per liter (US$0.30 per liter) in the specific automotive fuel tax (£0.5035 per liter in 2008). Taking into account the 15% VAT, the reduction implies an advantage for the consumer of almost £0.24 per liter. In 2005, the reduction was extended to ethanol used in E85 or blended with gasoline in any proportion.

In 2008 the government announced that this reduction would end in April 2010, as of when biofuels will be taxed like other automotive fuels. Replacing the tax reduction policy, the Renewable Transport Fuel Obligation (RTFO) Order 2007 constitutes one of the UK's main policies for reducing GHG emission in the transportation sector. RTFO took effect on April 15th 2008, and seeks to reduce by 2.6 to 3.0 million tonnes per year the carbon gas emission of the transportation sector.

Inspired by a similar program that promotes the use of renewable sources in UK electricity generation, RTFO requires the larger agents (those supplying more than 450,000 liters of fossil fuels per year) to sell a minimum quota of ethanol and biodiesel. During the first year when RTFO was in force, from April 15th 2008 to April 14th 2009, the mandatory quota was set at 2.5%, rising to 3.25% between 2009 and 2010, 3.5% between 2010 and 2011, 4.0% between 2011 and 2012, 4.5% between 2012 and 2013, and 5.0% between 2013 and 2014[xvi].

Companies participating in the program were separated into two groups: those that supply more than 450,000 liters of fossil fuels per year, and are therefore required to participate by registering in RTFO; and those that supply volumes below this yearly limit, or which supply only biofuels. These can participate voluntarily by registering with the RTFO.

The Renewable Fuels Agency (RFA) was created to manage the RTFO. It supplies companies registered with the RTFO, either compulsorily or voluntarily, with Renewable Transport Fuel Certificates (RTFC) corresponding to the volume of biofuel they sold, substantiated by the payment of the relevant specific fuel tax. Companies are allowed to negotiate certificates between themselves.

Each annual period runs from April 15th of one year to April 14th of the next. At the end of each period, companies must prove to the RFA that they possess a number of certificates corresponding to the mandatory quota of that period. Companies that do not prove ownership of these certificates will have two options: (I) pay a fine (a buy-out penalty); or (II)) acquire RTFCs from other companies. Collected fines will go to a buy-out fund. Companies that are obliged to participate in the RTFO and have excess certificates can sell these to the RFA, while companies that participate voluntarily will be able to sell the agency all their certificates. The RFA buys these certificates at a price that depends on the amount accumulated in the buy-out fund. The value of the buy-out penalty was set at £0.15 per liter of non-supplied biofuel, increasing to £0.30 starting April 15th 2010.

To replace the tax incentive of £0.20/liter (extinct as of 2010), the UK government plans to set up a system to compensate biofuels according to the carbon emissions avoided in their production and use. Starting April 15th 2011, this system would reward only those biofuels that are produced from raw materials that meet sustainability standards deemed appropriate.

2.5 Biofuel policies in Germany

Germany is currently the world's largest producer and consumer of biodiesel. In 2007, it had installed capacity to produce 4.2 million tonnes a year, mainly from canola oil, and was responsible for 17% of global production. However, in that same year Germany produced just 0.54 million m^3 of ethanol, a tiny fraction of the worldwide production of 52 million m^3.

The country began using biodiesel in 1991, when the first production plant was built in Aschach, Austria. Because biodiesel was so much more expensive than diesel, its sale became feasible only with a favorable tax structure that exempted it from taxes on fossil fuels, such as the eco-tax (Ökosteuer) that is applicable to all energy sources, and the specific tax on mineral oils (Mineralölsteuer).

Initially, biodiesel was sold only in its pure form (B100). Filling station pumps had two nozzles, one for diesel and one for biodiesel, so allowing the consumer to decide his own mixture. This strategy could be implemented immediately thanks to the coincidental prohibition in the country of leaded gasoline sales, which freed up the distribution and retail infrastructure of the banned gasoline for use by the new fuel, so avoiding major investments. In addition to B100, biodiesel mixtures with percentages between 2% and 20% are common in Germany, while ethanol is blended into gasoline in a 5% proportion. E85, on the other hand, has a very small market, with just 30 filling stations offering it in 2007.

The government began encouraging the use of biodiesel in 1999, increasing the specific tax on fossil fuels. Petroleum prices began to rise in the same period, making biodiesel more and more competitive. This led to a consumption boom, with biodiesel sales growing by an average of 24% per year between 2000 and 2003. In 2002 there were 1,500 filling stations selling B100, about 10% of the country's fuel outlets. Biodiesel sales in 2003 totaled 755,000 m^3, representing 2.3% of total fossil diesel consumption in Germany,

then about 33 million m^3 (Wittke, F. and Ziesing, H., 2004). In 2005, biodiesel could be found at 1,900 retail outlets and it enjoyed 3.75% participation compared to total diesel sales; almost twice the level required in Directive 2003/30. German biodiesel consumption in 2007 was 3.9 million m^3, representing 35% of worldwide biodiesel consumption and almost 10% of diesel consumption in the country (Federal Ministry of Economics and Technology, 2009).

With the rapid growth in consumption, fiscal exemption granted to biofuels[xvii] reached approximately US$3 billion in 2006 (Godoy, J., 2007) and began weighing on the country's budget. To remedy this situation, Germany introduced new biofuels legislation in the shape of the Energy Taxation Law and the Biofuels Quota Law, which took effect in August 2006 and January 2007 respectively. Under the new legislation, biofuels face the same specific taxes as fossil fuels, with the exemptions replaced by discounts to be requested from the government after sale. As shown in **Table 7**, the discounts given to biofuels used in blends were abolished in 2007[xviii], while discounts for pure biofuels except E85 were progressively reduced, with their extinction predicted for 2015. E85 continues to benefit from total exemption, as do second-generation biodiesel and ethanol.

To compensate for the higher taxes, the Biofuels Quota Law imposed mandatory biofuels sales quotas on fuel suppliers. These quotas are related to the total sales of petroleum derivatives, with individual sub-quotas for sales of gasoline and diesel. **Table 8** shows the biofuels quotas and sub-quotas that must be met by 2015. The quotas and sub-quotas are based on the energy content of the fuels, rather than volume.

Quotas can be met by selling biofuels pure or in blends of petroleum derivatives, and compliance requirements for these obligations can be transferred from one supplier to another by means of a formal contract. However, lack of compliance renders the supplier liable to a fine based on the amount of energy he failed to supply to meet his quota, and on the marginal cost of producing one unit of energy from biodiesel or ethanol[xix].

Introduction of the new legislation had two adverse impacts on the German biofuels industry (Mabee, W.E. et al., 2009). The first was a drop in national production. After reaching a peak of 3.56 billion liters in 2007, biodiesel production fell by 12% in 2008, to 3.18 billion. In March of 2008, biodiesel production plants had 85% of unused capacity, and half the companies in the sector either suspended operations or went bankrupt; with 14% of filling stations stopping selling the fuel. The situation improved only slightly in the summers of 2008 and 2009 as fuel prices increased, but still remained well below the production peak of 2007.

The second impact was an increase in biofuels imports. Up to 2005, domestic production was close to domestic consumption. This balance changed starting 2006, with imports increasing to supply 66% of the biofuel required to meet the quota legislation.

The situation led the government to send the German parliament the Amendment for Promotion of Biofuels in October of 2008. Parliament approved this amendment the following April, and it was awaiting publishing in the Federal Gazette to take effect. In addition to altering existing legislation for biodiesel tax and quotas (see **Table 7** and **Table 8**), the amendment also required the government to ensure that sustain-

Table 7

Discounts of specific taxes for biofuels in Germany

In Euro cents per liter

Year	Ethanol		ETBE	Biodiesel		Vegetal oil		Biofuels (2nd generation)(3)	
	E85(1)	Blend	Blend	B100	Blend	Puro	Blend	BTL(4)	Ethanol cellulose
2004	65.05	65.05	65,05	47.04	47.04	47.04	47.04		
2005	65.05	65.05	65,05	47.04	47.04	47.04	47.04		
2006(2)	65.05	0.00	0	38.04	32.04	47.04	47.04		
2007	65.05	0.00	0	38.04	0.00	47.04	0.00	47.04	65.05
2008	65.05	0.00	0	33.64	0.00	38.89	0.00	47.04	65.05
2009	65.05	0.00	0	27.34/ 30.34(5)	0.00	30.49	0.00	47.04	65.05
2010	65.05	0.00	0	21.04/ 24.04(5)	0.00	22.09	0.00	47.04	65.05
2011	65.05	0.00	0	14.74/ 17.74(5)	0.00	14.74	0.00	47.04	65.05
2012	65.05	0.00	0	2.14/ 5.14(5)	0.00	2.14	0.00	47.04	65.05
2013	65.05	0.00	0	2.14	0.00	2.14	0.00	47.04	65.05
2014	65.05	0.00	0	2.14	0.00	2.14	0.00	47.04	65.05
2015	65.05	0.00	0	2.00	0.00	2	0	47.04	65.05

Notes: (1) E85 exempted until 2015. • (2) Tax altered starting August 1st 2006. • (3) Situation of second-generation biofuels will be examined annually. • (4) Biomass conversion to liquid. • (5) New values fixed by the Amendment for the Promotion of Biofuels in 2009.
Source: Prepared by the authors from Mabee, W. E., et al. (2009).

Table 8

Energy percentages of biofuel blend quotas in Germany

Year	Gasoline + Diesel	Gasoline	Diesel
2007	n.a.	1.2%	4.4%
2008	n.a.	2.0%	4.4%
2009	6.25% / 5.25% (*)	2.8%	4.4%
2010	6.75% / 6.25% (*)	3.6%	4.4%
2011	7.00% / 6.25% (*)	3.6%	4.4%
2012	7.25% / 6.25% (*)	3.6%	4.4%
2013	7.50% / 6.25% (*)	3.6%	4.4%
2014	7.75% / 6.25% (*)	3.6%	4.4%
Quotas required for climate protection*:			
2015 / 2016	3% reduction in GHG emissions using biofuels		
2017 / 2019	4.5% reduction in GHG emissions using biofuels		
2020	7% reduction in GHG emissions using biofuels		

Note: (*) New values fixed by the Amendment for Biofuel Promotion in 2009; n.a. – not applicable.
Source: Prepared by the authors from Mabee, W. et al. (2009).

able standards are observed in the production, distribution and use of biofuels. The amendment introduced significant changes in the principles governing biofuels promotion beginning in 2015, establishing that the use of biofuels would no longer be based on mandatory quotas but would serve to reduce GHG emissions caused by the use of fossil fuels in transportation. With this amendment in force, the use of biofuels is likely to grow more slowly than previously predicted.

▶ 3 Final considerations

The worldwide production and use of biofuels has grown rapidly in recent years, motivated by concern about climate change and by questions of energy security and safety that become relevant in the context of potential petroleum depletion. The United States and Brazil are the world's largest producers of ethanol, while biodiesel production is dominated by EU countries, in particular Germany. While GHG emission reduction is a more or less common objective of all these policies, other reasons for promoting the production and use of biofuels include energy security, reduced fossil fuel consumption, local environmental impacts, rural development and increasing potential exports.

In most countries, however, biofuels are not very competitive, economically speaking, compared to petroleum derivatives. Even with the recent rise in the price of oil and its derivatives, many biofuels are still not very competitive, given that the prices for agricultural commodities and the inputs used in their production have also risen sharply. Consequently, with the exception of a few countries, the production and use of biofuels, and indeed of most new alternative energy sources, depend on public policies.

The success of these policies is related to the existing price structure in each country. Policies are unlikely to succeed when promoted in countries where petroleum derivatives prices are subsidized or carry a tax burden that does not cover the costs of externalities in the production and use of fossil fuels. Similarly, in countries where fuel prices are established ad hoc, the lack of price predictability erodes the viability of required investments for agricultural production and the installation of infrastructure for the distribution, retail sale and use of biofuels, unless substantial fiscal incentives or mandatory measures are introduced.

While public policies aimed at biofuels promotion can have several formats, they are based on three instruments: (i) financial support in the form of tax exemption or reduction, or the concession of direct fiscal incentives for agents in the supply chain or for biofuel consumers; (ii) mandatory quotas that require a minimum participation of biofuels in the automotive fuel matrix; and (iii) commercial restrictions in the form of custom taxes on biofuel imports to protect domestic production.

Measures of financial support impact the public budget, either through income loss due to fiscal waivers or additional expense through fiscal incentives. These therefore represent a transfer from taxpayers to the producers or users of biofuels. The United States is an example of a country that subsidizes producers and blenders, whereas Sweden grants tax exemption to biofuels. The United Kingdom abandoned fiscal waivers, while Germany has been progressively reducing this practice.

Mandatory quotas can be accompanied by fines on fuel suppliers who fail to comply with requirements, or blend certificates that can be traded between suppliers that exceed their quotas and others that fail to reach them. These measures do not impact the public budget, but imply greater costs for users who transfer income to agents in the biofuels supply chain. The United States, the United Kingdom and Germany all apply mandatory quotas in their biofuels promotion policies. In the United Kingdom, the adoption of quotas is accompanied by certificate emissions, while in Germany the obligation can be transferred to other suppliers.

Restrictions imposed on biofuel importation protect domestic production against foreign producers who are more efficient or who enjoy comparative advantages that reduce production costs. These measures limit the prospects for development of more competitive suppliers in other countries and impose a transfer from consumers to domestic producers. The United States and EU countries impose custom duties on biofuels imports. However, the analyses presented in this study suggest that the future demand for ethanol in these countries is unlikely to be met without importation. This is even more the case when taking into account that the sustainability criteria established by the United States and the EU in their energy policies for fossil fuel substitution restrict the use of certain technological production paths existing in these countries.

The prospect for internationalizing the use of biofuels creates opportunities not only for exporting raw material, but also technology. For Brazil to maintain its leadership in the ethanol market, it is vital to open up importing markets, grant incentives for investment in research and development, seek technological innovation that secures competitive production, create new uses for the product, and encourage the market for byproducts.

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Explanatory Notes

[i] Some studies question the technical viability of using gasoline blended with more than 10% of ethanol without modifying vehicle systems. Among the contentious issues are the increase in emissions of nitrogen oxide and aldehydes, and the increase in consumption, along with the reduction in the durability of vehicle components such as catalytic converters. UNICA questioned these findings in a letter sent to the U.S. Environmental Protection Agency (UNICA, 2009a).

[ii] The lifecycle analysis of fuels calculates greenhouse gas emissions originating from the prospection, production, distribution, and final use of fuels. In the case of biofuels, it also includes emissions resulting from the direct or indirect alteration to land-use in other countries as a result of the production of renewable fuels.

[iii] OECD member countries include Australia, Canada, the United States, South Korea, Mexico, Japan, New Zealand, Turkey and 22 European countries.

[iv] The graphs are presented to illustrate the classification of countries according to the level of fiscal incentives and taxation. Depending on the reference period for the prices, the relative positions of the countries may change, including their position within the categories.

[v] For purposes of this paper, a fuel is considered to be subsidized when its consumer price is lower than a reference (benchmark) price that represents an estimate of an "economic price" calculated using commercial fundamentals.

[vi] The retail prices of fuels shown for the United States include industry costs and profits margins, value added tax, and a specific fuel tax of approximately US$0.10 per liter that goes towards the maintenance and building of roads. Because it does not include other forms of specific taxation, the US price is adopted as a reference for the minimum price of derivatives without fiscal incentives.

[vii] For purposes of this paper, we consider a fuel to be taxed when its consumer price is higher than its reference (benchmark) price which represents an estimated "economic price" calculated according to commercial fundamentals.

[viii] The EU-15 comprises the initial member countries of the EU, who joined before the accession of 10 new countries on May 1, 2004.

[ix] Florida, Hawaii, Iowa, Kansas, Louisiana, Minnesota, Missouri, Montana, Oregon and Washington.

[x] An Updated Annual Energy Outlook 2009 Reference Case Reflecting Provisions of the American Recovery and Reinvestment Act and Recent Changes in the Economic Outlook (EIA, 2009b).

[xi] The Blair House Agreement of 1992 allowed the EU to produce oil seeds for non-food purposes up to the equivalent to one million tonnes of soy.

[xii] The official name of the Directive on the Promotion of the Use of Biofuels and Other Renewable Fuels for Transport.

[xiii] The CAP is a system of a fiscal incentives and agricultural programs in the EU, which in 2006 consumed 48% of the EU's €49.8 billion budget. The CAP takes a three-pronged approach: i) the unification of markets for the free movement of agricultural products within the EU; (ii) financial solidarity with regards to all the costs of CAP, which are financed by a communal treasury supported by import tariffs and contributions from European countries; and iii) community preference, so that EU products enjoy preferential treatment over imports.

[xiv] Developed by Sekap (Svensk Etanolkemi AB), one of the largest producers, importers, and vendors of ethanol in Europe, ED95 is an ethanol blend with a 5% ignition additive that is used in buses and trucks with adapted diesel engines.

[xv] The congestion tariff in Stockholm is applied to vehicles entering and exiting the city.

[xvi] The Renewable Transport Fuel Obligation Order 2007 originally stipulated an increase in the obligation from 2.5% in 2008-09 to 3.75% in 2009-10, and to 5% in 2010-11. These percentages were changed by the Renewable Transport Fuel Obligation (Amendment) Order 2009, which came into operation on April 15, 2009.

[xvii] In March 2009, specific tariffs on fossil fuels in Germany were €0.4704/liter for low-sulfur diesel and €0.6545/liter for unleaded gasoline. In addition to these tributes, there was also 19% VAT on the final price of all fuels, fossil or not. The sum of the taxes on fossil fuels averages €1.03 per liter for diesel and €1.22 per liter for gasoline.

[xviii] The difference of €0.02 between the tax for vegetable oil and diesel serves to compensate for the lower caloric value of vegetable oil.

[xix] In December 2006, these values were €16/GJ for biodiesel and €38/J for ethanol.