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Subsidies: The Distorted Economics of Biofuels

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ABSTRACT

Governments have influenced the development of bioenergy, particularly liquid biofuels (ethanol, biodiesel and pure plant oil used as a fuel), for several decades. This paper discusses the economics of biofuels and provides an overview of current policy measures to support their production and consumption. It discusses also how the different policies supportive of biofuels interact with broader agricultural, energy, environmental and transport policies, and the relative effectiveness of biofuels in achieving objectives in these areas. The paper concludes with several recommendations on further research.

Keywords: *biofuels, ethanol, biodiesel, costs, subsidies.*

1. INTRODUCTION

As proponents of liquid biofuels frequently remind us, both ethanol and straight vegetable oil (SVO) were used as motor fuels at the dawn of the internal combustion engine, only to be supplanted within a few years by cheaper petroleum-derived gasoline and diesel. Biofuels have only started to emerge as serious rivals to those petroleum fuels within the last couple of decades, and particularly since 2003, when prices for a barrel of crude oil started rising above USD 30.

Currently, ethanol is being produced at a rate of around 60 billion litres a year worldwide, and the trajectory is sharply upward. Until recently, Brazil was the world's leading producer. In 2005, however, the United States and Brazil produced roughly equal amounts and in 2006 and 2007 the United States is expected to have moved into first position. China ranks a distant but important third place in world rankings, followed by India, France and Russia. The biodiesel industry emerged only in the 1990s, and the amounts produced, at around 5 billion litres a year in 2006, are still far below those of ethanol. But annual output is now growing at double-digit rates, with new countries joining the ranks of major producers every year.

These are not industries that have emerged simply in response to market forces, however. The production and demand for biofuels has been, and continues to be, shaped profoundly by government policies, both regulatory and directly financial.

Currently, the bulk of support to biofuels is linked to production, mainly through exemptions or rebates of fuel taxes that apply to gasoline and diesel, or (mainly in the United States), volumetric tax credits. Already the level of support enjoyed by the industry in OECD countries is of the order of US$ 10 billion a year in excise tax exemptions and income tax credits, for a pair of fuels that account for less than 3% of overall liquid transport fuel demand. Bringing that share to 30% — a level frequently suggested by proponents — without making radical changes to the current support system, and without substantially reducing demand, would imply annual subsidies of $100 billion a year or more, pushing them ever closer to the order of magnitude of support currently provided to the entire agricultural sector by OECD countries.

In order to assist policymakers in gaining a better understanding of the magnitude, direction and coherence of government policies supporting liquid biofuels, the Global Subsidies Initiative (GSI) — a new programme under the International Institute for Sustainable Development — embarked in 2006 on a series of studies on support policies in five OECD member countries, plus Brazil. The U.S. study was released in October 2006, and the remainder are expected to be released in 2007.

This paper highlights the main support elements documented in these studies, stressing the high number of policies that vary in proportion to output, or to sales. It then discusses some of the interlinkages between these policies and objectives in other policy domains that government support for biofuels affects.

2. OVERVIEW OF THE LIQUID BIOFUELS INDUSTRY

To understand the political economy of government support to biofuels, it is helpful to review the industry's ownership and cost structure. As background, this section begins with an overview of production by country.

2.1. Global overview

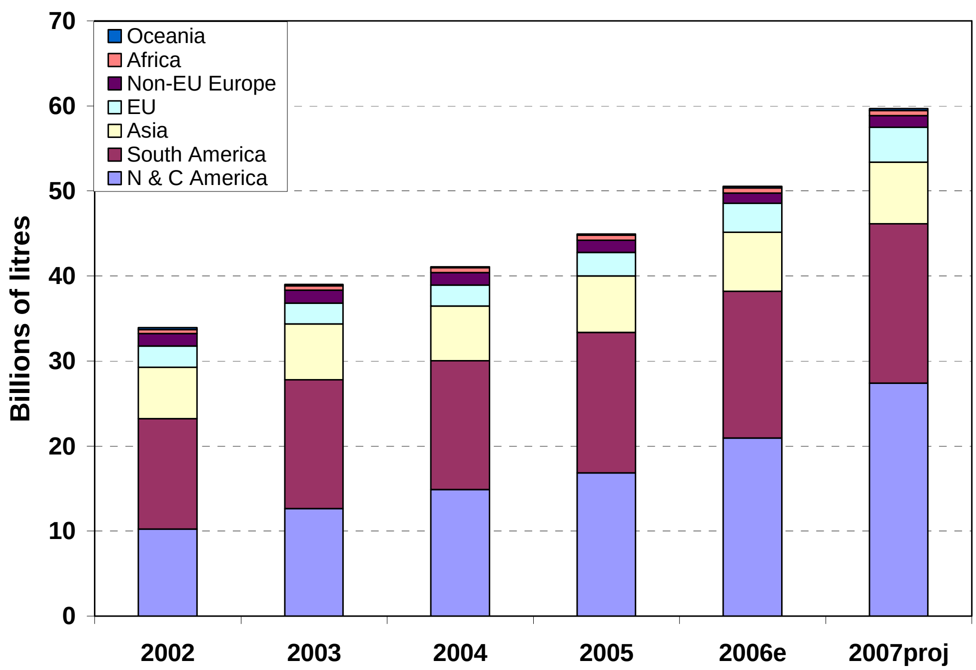
2.1.1 Bio-ethanol

Currently, ethanol is being produced at a rate of around 60 billion litres a year (Figure 1). Until recently, Brazil was the world's leading producer. In 2005, however, the United States and Brazil produced roughly equal amounts and in 2006 and 2007 the United States is expected to have moved into first position. China holds a distant but important third place in world rankings, followed by India, Germany, Spain and France.

Generally, countries lying within the tropics produce ethanol from sucrose, mainly from cane sugar or molasses. Much smaller quantities of ethanol are produced from sweet sorghum or cassava. Production in temperate-zone countries is largely based on starchy grains, particularly maize (corn) in the United States, and wheat, barley and sorghum elsewhere. The exception is the Europe, where some ethanol is produced from beet sugar.

Production of bio-ethanol for fuel commenced later in Switzerland than in other countries (in 2005), in large part because of the high prices of its sugar and starch yielding crops, but also because of a law that remained in effect until 1997, effectively banning the domestic production of ethanol from crops. In contrast with other countries, its production (just under 1 million litres in 2005) is based entirely on wood cellulose. Japan imports small amounts of EBTE (ethyl tertiary butyl ether), an octane enhancer and oxygenate derived from ethanol, from France, but produces very little fuel-grade ethanol of its own. However, its government has established a target to use 6 billion litres of biofuels, or roughly 10% of transport fuel consumption, by 2030, and is investigating options to supply a substantial portion of that from domestic sources (Siu, 2007).

Figure 1. Ethanol production by world region, 2002-2007

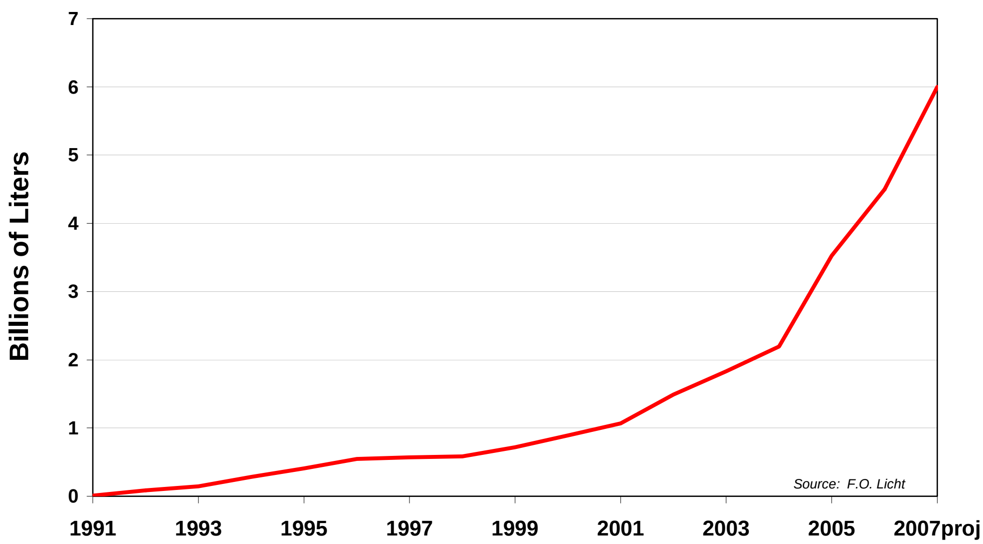


Source: Data from F.O. Licht.

2.1.2 Biodiesel

Biodiesel started to be produced on a commercial scale in the EU during the beginning of the 1990s, and in Switzerland a few years later, based mainly on virgin vegetable oils — generally rapeseed or sunflower-seed oil. Small (<5 million litre per year) plants turning waste cooking oils ("yellow grease") started to be built in other OECD countries by the end of the 1990s, but the industry outside Europe remained insignificant until around 2004. Since then, governments around the world have instituted various policies to encourage development of the industry, and new capacity in North America, south-east Asia and Brazil has begun to come on stream at a brisk rate (Figure 2).

Figure 2. Biodiesel production by world region, 1991-2007



Source: Data from F.O. Licht.

Although plants using recovered waste oil continue to be built, as well as some large-scale plants using tallow or even fish oil as feedstocks, most of the new capacity is designed to use virgin vegetable oils. In Argentina, Brazil and the United States, soybean oil has so far been the feedstock of choice. In Canada, the EU, Switzerland, Russia and Eastern Europe, oilseed rape (canola) remain dominant. Companies in Malaysia and Indonesia are building their plants based on palm oil and palm-kernal oil. Elsewhere, governments and entrepreneurs are experimenting with producing biodiesel from nitrogen-fixing and drought-tolerant plants such as like *Jatropha* or *Jajoba*, which produce non-edible oils.[1]

2.2. Ownership structure of production and capacity

Because of the fast pace of developments in the biofuel industry, and the relatively small percentage of final product that enters international trade, its market structure is still fragmented, and not as vertically integrated as the petroleum industry with which it is often compared. The following provides merely a snapshot of the structure.

2.2.1 Production of feedstock crops

The production of the crops used as feedstock in biofuel manufacturing is carried out by hundreds of thousands of farmers across the world. Although no figures are available on the size distribution of the farms involved in that production, there is no reason to suppose that it is any different than that for the crops themselves.

The size of farms producing sugarcane tends to be larger than farms producingsugar beets, starch-based crops, such as maize and wheat, and oilseeds. And all of these farms tend to be larger on average than farms growing horticultural crops. Sugar cane is generally grown as a monocrop, but maize (for ethanol) and soybeans (for biodiesel) are often grown in rotation on the same parcel of land, as are wheat, sugar beets and oilseeds.

The other providers of feedstock are companies that collect yellow grease and other waste oils and fats. These companies tend to be small and local.

2.2.2 Biofuel manufacturing

Several companies stand out from among the crowd as major players, most notably Archer Daniels Midland (ADM), Bunge, Cargill and Louis Dreyfus. ADM is not only the leading manufacturer of bio-ethanol in the United States, but it is also the second-largest manufacturer of biodiesel in the EU. It has also invested in plants in Brazil and Indonesia.

Few other companies have the same scale of international presence as the agri-business giants, though the number of companies operating in more than one country is increasing rapidly. Examples include Malaysia’s Golden Hope (in The Netherlands), Spain’s Abengoa (in the United States), and France’s Tereos (in Brazil).

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1. One company in particular, UK-based D1 Oils Plc., has formed joint ventures with governments in countries surrounding the Indian Ocean, and in the Philippines, to establish plantations of Jatropha curcus, and small-scale units for producing biodiesel.

Ethanol manufacturing

Because bio-ethanol has emerged by and large as a by-product or alternative product of processing sugar and starch crops, ownership of production plants has so far been dominated by companies that were already major players in the agri-food business.

In *Brazil*, the country that until recently was the largest bio-ethanol producer in the world, production is dominated by companies with integrated mills that can switch production streams within their plants between sugar and ethanol in response to market prices. Most of these producers have gone on to develop the technology and logistics of ethanol production and distribution.

The structure of the industry in the *United States* has gone through several stages of expansion and consolidation, at all times dominated by ADM and a handful of other companies, mostly agri-food giants. However, because of policies intended to encourage farmer-owned value-adding activities, the number of plants owned by agricultural co-operatives remains significant. Ethanol is produced in the *EU* from a variety of sources, including sugar beets, grains (wheat and maize), potatoes, and wine. The companies involved are typically part of the agricultural industry. *Canada* until recently had only a handful of ethanol producers, and total output was small. Although agri-food companies have become engaged in the business, some energy companies — most notably Husky Oil — have entered the business as well. Ethanol is produced in *Australia* from molasses and downgraded grains. The biggest producers are sugar refiners.

Biodiesel manufacturing

The structure of the biodiesel industry can be described as bi-polar, with a few large companies involved in producing biodiesel on an industrial scale, and at the other end a large number of very small, often locally or farmer-owned companies.

In the *EU*, the European Biodiesel Board (www.ebb-eu.org/members.php) lists more than 20 separate producing members (and another 20 “associate members”), representing multinational agri-food giants (e.g., ADM, Bunge [Novaol] and Cargill), chemical companies (Dow), and specialist biodiesel producers (e.g., D1 Oils). The *United States*’ National Biodiesel Board lists a similarly diverse membership, including numerous small companies producing biodiesel from yellow grease. Much of the newest, and largest capacity, however — plants with an annual capacity of 40 million gallons (150 million litres) or greater — is being built by agri-business companies such as ADM or Louis Dreyfus, or joint ventures involving agri-business companies (e.g., Bunge).

Brazil has only recently begun producing biodiesel on a commercial scale. The first, and currently the leading producer of biodiesel in the country (accounting for 58% of the biodiesel sold at auction through August 2006) is Brasil Ecodiesel, a company set up to co-ordinate production from mainly family-run farms growing castor oil plants, sunflower, or *Jatropha curcas*. Numerous other companies have built or are building biodiesel plants designed to process soybeans, including several Brazilian and multinational agri-food companies (including ADM), as well as Petrobras, Brazil's state-controlled oil company.

2.2.3 Distribution and retail sales

The wholesale distribution (including blending) and retail segments of the biofuels industry is carried out by small and medium-sized companies in some countries and by large, sometimes state-owned, oil companies in others.

Brazil decided early on to market its ethanol through the state oil company, Petrobas. At the retail level, however, ethanol is available at virtually all the filling stations in the eastern part of the country. In *Australia, Canada,* the *United States* and the *EU*, both ethanol and biodiesel are distributed through the existing networks of gasoline and diesel fuel distributors. At least one company in the United States, Earth Biofuels, was created expressly to distribute and sell biofuels, and is now trying to build up a network of filling stations dispensing blends of ethanol and biodiesel. In *Switzerland*, Alcosuisse, the commercial arm of the State Alcohol Board, manages the storage, blending and wholesale distribution of ethanol throughout the country, but fuel retailers sell the blended fuel to final customers.

2.2.4 End users

The majority of end users of biofuels are individual owners of private automobiles. In some countries, however, government agencies, including military forces, account for a significant share of purchases. In many countries, municipal governments have taken the lead in converting their fleets of vehicles to run on E85 or biodiesel-diesel blends. A number of cities around the world, from Auckland to Helsinki, now run at least some of their public buses on biodiesel blends.

Many state-owned enterprises have also decided to buy biofuels for their fleets. Switzerland's fuel-ethanol industry, for example, was kick-started by a decision by Swisscom, the state telecoms company, to cut back its fuel consumption, by reducing the size of its fleet and using E5 in some of its vehicles in the Bern region.[2]

Perhaps the biggest single consumer of biodiesel is the U.S. military, through its Defense Energy Support Center (DESC), which coordinates the U.S. federal government's fuel purchases. The DESC is the largest single purchaser of biodiesel in the United States and has been procuring B20 for its administrative vehicles since 2000.

[2]. Etha+ project's website: <www.etha-plus.ch/page-e.asp?page=1000&language=e>

2.3. Current and future production costs

The costs of producing biofuels varies significantly according to feedstock, process and location. Location determines access to particular feedstocks and energy supplies, the prices of which to a large degree are driven by market developments at the global scale — including, increasingly, the demand for crops to supply biofuel production itself. The basic processes currently used for producing ethanol and biodiesel do not vary so greatly, though the scale of actual plants does. Moreover, rapid developments in the design of ethanol plants in order to make more-efficient use of energy, or to improve the profitability of by-products, are having a profound effect on the economics of new plants. For these reasons, the brief discussion that follow should be regarded as only roughly indicative of the relative costs of biofuel production in different countries, and for the potential for changes in those costs.

2.3.1 Ethanol

Production costs for ethanol vary widely from one country to another, depending on the feedstock and process used, and the costs of energy and labour.

Currently there are three “conventional” processes in use for producing ethanol from biomass, all relatively mature: (i) distillation of alcohol from wine; (ii) fermentation and distillation of alcohol from sugars or mollases; and (iii) conversion, fermentation and distillation of alcohol from starch derived from crops. The first process is straight-forward. Because its production exists largely as a result of structural surpluses in the European wine market, it is expected to account for a diminishing share of the world’s supply in future years.

Most of the fuel ethanol produced in the tropics and subtropics is derived from sugar-cane, either the sugar itself or its molasses. The cost of the process depends primarily on the cost of the feedstock as well as the scale of the operation and the ability to switch between the ethanol and the sugar markets. Most modern ethanol-manufacturing plants based on sugar-cane have been able to avoid high costs for process heat by burning bagasse (cane residue). Many also co-generate electricity and sell surplus electric power to the grid.

Some fuel-ethanol is produced in northern climates, chiefly the EU, from sugarbeet. The process of fermenting and distilling the sucrose sugar is similar to that used for cane-derived sucrose, but the plants do not have access to bagasse — the leftover cane stalk after the sucrose is pressed out — hence they must purchase commercial fuels for their process heat. Labour costs are considerably higher than in developing countries, which also works to their disadvantage.

Two grains account for the bulk of ethanol produced from starch. Maize is the most significant of the starchy crops used for ethanol production (in eastern Canada, China, southern and central Europe, and the United States), followed by wheat (in western Canada and northern Europe). Smaller amounts of fuel ethanol are produced from cassava, potatoes and sorghum.

A great variety of plant configurations are being used to manufacture ethanol from starchy grains. One basic distinction is whether the plant uses a dry-milling or a wet-milling process. In *dry milling*, the entire maize kernel (or other starchy grain) is ground into a flour and processed without first separating out the various component parts of the grain. Water is then added to form a "mash", to which enzymes are added in order to convert the starch to dextrose. The mash is then processed at a high-temperature, cooled and fermented, yielding a "beer" containing ethanol, carbon dioxide (CO_2), water and solids ("stillage"). Further processing concentrates the ethanol and dehydrates the stillage, ending up with a by-product called dried distillers grains with solubles (DDGS), a high-protein livestock feed. The CO_2 released during fermentation is also captured, and typically sold for use in carbonating beverages and the manufacture of dry ice. In *wet milling*, maize is steeped in water and dilute sulphuric acid to facilitate the separation of the grain into its many component parts. Additional processing eventually yields corn germ (from which corn oil is extracted), fiber, gluten and starch. The gluten component is filtered and dried to produce a corn-gluten meal, which is sold as livestock feed, and the starch is fermented and distilled much as in the dry-milling process.[3]

Additional differences arise from the fuel used for process heat. Traditionally in the United States and eastern Canada, ethanol plants have relied primarily on natural gas, and electricity purchased from the grid. With the recent steep rises in the price of natural gas, some operators are turning to cheaper coal. A few plants are being built adjacent to power plants, so as to use their waste heat. And at least one is being built to run off of methane generated from manure produced by cattle in an associated feedlot.

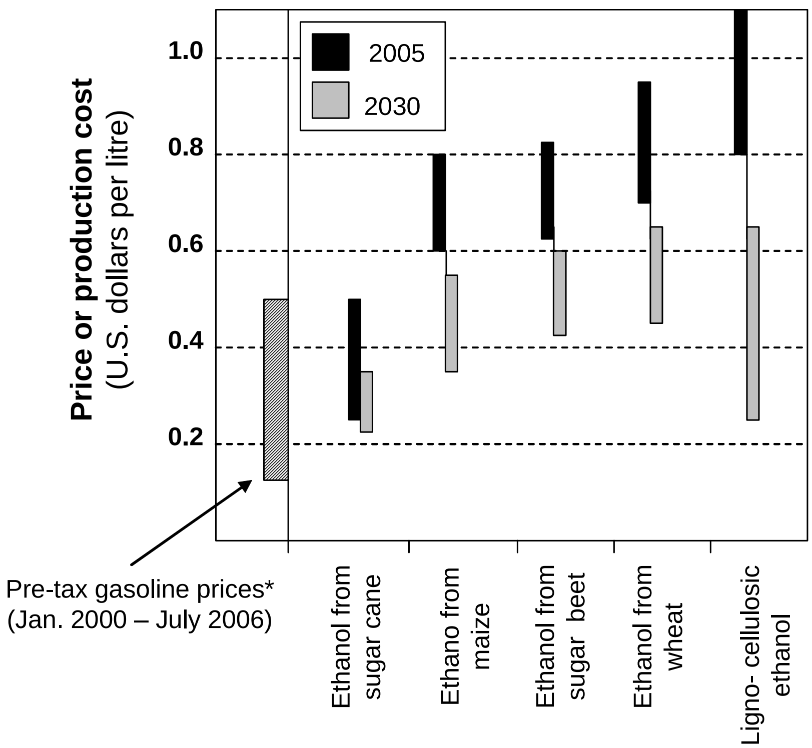
Figure 3 compares the current and projected future costs of producing ethanol from different feedstocks, as calculated by the IEA. Brazil's costs, at USD 0.20 per litre (USD 0.30 per litre of gasoline equivalent) for ethanol produced in new plants, are the lowest in the world. Even before the recent rise in maize prices in the United States, grain-based ethanol cost some 50% more to produce in the United States than in cane-based ethanol Brazil, and 100% more in the EU than in the United States. These costs do not include the costs of transporting, splash blending and distributing ethanol, however, which can easily add another USD 0.20 per litre at the pump.

According to the IEA (2006), "further incremental cost reductions can be expected, particularly through large-scale processing plants, but no breakthroughs in technology that would bring costs down dramatically are likely." They foresee such technological improvements helping to reduce costs by one-third between 2005 and 2030, in part driven by reductions in the costs of feedstocks. Whereas they project

[3].Condensed from Renewable Fuels Association, "How ethanol is made" (www.ethanolrfa.org/resource/made/).

feedstock costs declining by around one-quarter in the EU, and one-third in Brazil, they assume that net feedstock costs will shrink by more than half in the United States. In all cases, the IEA[4] assumed current rates of subsidies to crops and ethanol production remain in place.

Figure 3. **Current and projected future ethanol production costs, compared with recent (pre-tax) gasoline prices**



*Based on monthly average import prices for crude oil into the IEA region.
Note: Cost estimates exclude from consideration subsidies to crops or to the biofuel itself.
Source: Adapted from IEA (2006), Figure 14.7.

Expecting feed-stock costs in the EU to fall over the next 25 years is not an unreasonable assumption, given changes in policies (notably the elimination of export subsidies for sugar) and improvements in plant genetics alone could put downward pressure on costs. Yet with pressure on commodities to feed a growing

[4].In conjunction with the Energy Economics Group of the Vienna University of Technology.

world population, uncertain changes in yields caused by global climate change, as well as demand for biomass for fuels, relative prices for feedstocks could well rise significantly. Already, between 2005 and May 2007, prices for key ethanol feedstocks rose by between 6% and 68% in nominal terms (Table 1), with the largest proportional increase being observed for maize. Certainly spot prices can be expected to remain volatile. At its peak in February 2006, for example, the reference price for sugar was more than twice its lowest value only nine months earlier.

Table 1. **Reference international commodity prices for sugar, maize and wheat, 2005-2007**

Commodity	Average price for 2005 (USD/tonne)	Peak price since May 2005 (USD/tonne and week ending)	Average price, 1 January 2007 through 1 May 2007 (USD/tonne)	Percentage change, nominal terms, 2005 to mid-May 2007
Sugar[1]	$218	$406 (*03.02.06*)	$231	6%
Maize[2]	$109	$203 (*23.02.07*)	$183	68%
Wheat[3]	$150	$229 (*20.10.06*)	$191	27%

1. Based on weekly averages of International Sugar Organization (ISO) daily price, expressed in US cents per pound.
2. US No.2, Yellow, price at U.S. Gulf ports (Friday quotations), expressed in USD per short ton.
3. US No.2, Soft Red Winter Wheat , price at U.S. Gulf ports (Tuesday quotations).
Source: Data from Food and Agricultural Organization of the United Nations, “International Commodity Prices” website (www.fao.org/es/esc/prices), accessed on 22 May 2007.

It bears stressing that while the costs of producing sugar in Brazil, maize in the United States or wheat in Argentina or Canada will be lower than the international prices shown in Table 1, what matters to the economics of biofuels is the *opportunity cost* of diverting these feedstocks to ethanol production, as opposed to selling them to other buyers. Studies of the costs of producing biofuels must make assumptions about the price of the feedstock biomass as well as the price that the fuel will fetch in the market. As Kojima et al. (2007, forthcoming) point out, while the accounting cost of producing a biofuel may be less than the price of its nearest petroleum alternative, it still may not be economical to produce if the market price for the feedstock is high.

2.3.2 Biodiesel

Over 50 species of plants produce oils that can be extracted from their seeds, nuts or kernels. All, technically, can be used as fuel (or transformed into biodiesel). Most of these oils are prohibitively expensive to produce on a large scale for a comparatively low-value use such as fuel, however. Currently, the main oils used for fuel in one way or another are derived from one of a handful of seeds or nuts: soybeans, oil-palm fruit or kernels, coconut, rapeseed (canola), sunflower seed, and physic nut (*Jatropha curcas*).

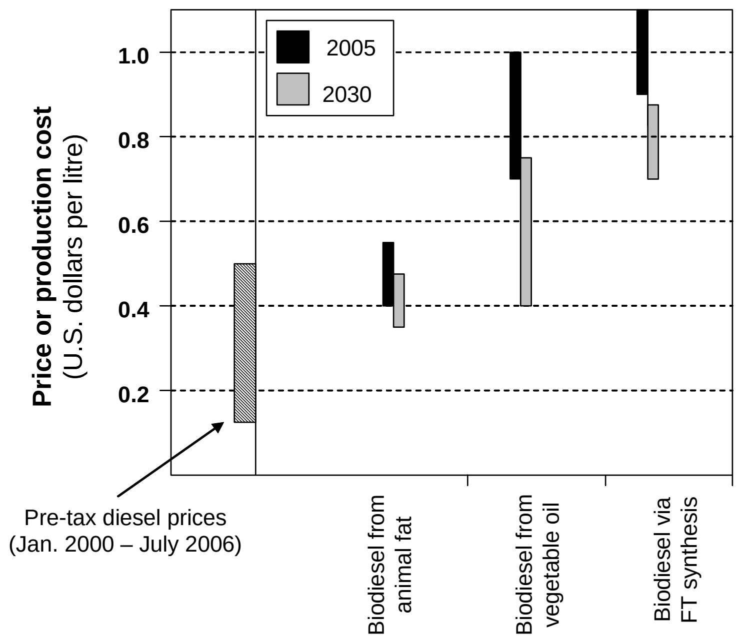
Oil yields (in kilogrammes or litres per hectare) vary widely among the leading sources. Typical yields are 400-600 litres per hectare for soybeans, 1200-1700 litres per hectare for oilseed rape, and 4000-7000 litres per hectare for oil palm. Yield is not the only determinant of supply, however. Soybeans and rape have a value to farmers as crops that can be grown in rotation with other crops; and soybeans, because they fix nitrogen in the soil, reduce the need for nitrogenous fertilizers — both for the crop itself and for the follow-on crop. *Jatropha* is also nitrogen-fixing, but is planted as a perennial, often as a vegetative border, support (as for vanilla vines in Madagascar) or wind break.

All oil-bearing plants yield a residue after pressing, and that residue (cake or meal) has a value as well. The most valuable meal is soybean meal, because of its high protein content. Indeed, traditionally, soybean meal has been the main market for which soybeans have been produced, and soybean oil has been regarded as a by-product. The rapid growth in biodiesel produced from soybean oil may turn that market on its head, however, reversing the relative profitability of the two product streams. The meal left over from pressing rapeseed is also valuable, but normally commands a lower price than soy meal. The meal from Jatropha, because it is toxic to animals, is mainly ploughed back into the soil an organic fertilizer.

In OECD countries, the first plants using the transesterfication process to produce biodiesel have typically used low-value oils, such as used cooking oil (also known as “yellow grease”), fish oil or tallow. Because of the limited nature of the supply of yellow grease, these plants rarely exceed annual capacities of 30 million litres, and most have capacities of 5 million litres per year or less.

As low-cost supplies of these fats are exhausted, additional capacity has then had to be based on virgin oils. Over the long run, it is the cost of procuring virgin vegetable oils that largely determines the cost of producing biodiesel. As discussed in the previous section, the costs of producing biodiesel from virgin plant oils are heavily influenced by yields, the value of the oils in other uses, and the value of co-products. Generally, therefore, biodiesel made from palm oil will cost less to produce than from soybean oil or rapeseed oil, defining respectively the two ends of the range of costs shown in Figure 4.

Figure 4. **Current and projected future biodiesel production costs, compared with recent (pre-tax) gasoline prices**



*Based on monthly average import prices for crude oil into the IEA region.
Source: Adapted from IEA (2006), Figure 14.7.

The IEA (2006, p. 408) is less bullish on further incremental cost reductions , noting that “[t]here remains some scope for reducing the unit cost of conventional biodiesel production by building bigger plants. But technological breakthroughs on the standard transesterfication process, leading to substantial cost reductions in the future, are unlikely.” They foresee production costs falling to by 37% between 2005 and 2030 in the United States (to around USD 0.33 per litre of diesel equivalent), and by 32% in the EU. Again, these projections assume net costs of feedstocks falling by around one-third in real terms over the projection period.

As with feedstocks for ethanol production, the prices of feedstocks for biodiesel production have been heading in the opposite direction since the IEA’s cost estimates were produced. Between 2005 and February 2007, international reference prices for rapeseed oil, soybean oil, and crude palm oil rose, respectively, by 19%, 29% and 43% in nominal terms (Table 2). The price rises have been more monotonic, exhibiting less volatility than the prices for sugars and grains over the same period. What is interesting is that the prices for lower-value oils have been rising at a faster rate than for the traditionally higher-value oils, suggesting that palm oil is being substituted for the other, more-expensive oils.

Table 2. **Reference international commodity prices for rapeseed oil, soybean oil and crude palm oil, 2005-2007**

Commodity	Average price for 2005 (USD/tonne)	Peak price since May 2005 (USD/tonne and month)	Average price, January-February 2007 (USD/tonne)	Percentage change, nominal terms, 2005 to avg. 2007 to date
Rapeseed oil[1]	$669	$856 (*12.06*)	$800	19%
Soybean oil[2]	$545	$714 (*02.07*)	$706	29%
Crude palm oil[3]	$422	$605 (*02.07*)	$602	43%

1. Monthly averages of ex-mill price (f.o.b.), Netherlands.
2. Monthly averages of ex-mill price (f.o.b.), Netherlands.
3. Monthly averages of import price (c.i.f.), north-west Europe.

Source: Data from Food and Agricultural Organization of the United Nations, "International Commodity Prices" website (www.fao.org/es/esc/prices), accessed on 22 May 2007.

The economics of biodiesel also depends on the price of crude glycerine, a by-product of transesterfication process that is used in a wide range of foods, cosmetics and other products. In the early years of the biodiesel industry, production of glycerine was small enough that it did not substantially affect market prices for the by-product. But as the amount of biodiesel and thus glycerine produced in the world has increased, the value of the glycerine has declined. In September 2006, *Biodiesel Magazine* (Nilles, 2006) reported that crude glycerine, having once fetched USD 0.20-0.25 per pound, was heading towards 5 cents per pound (USD 110 per tonne) and perhaps lower. In response, some of the major biodiesel producers are considering building the capacity to refine crude glycerine to pharmaceutical grades, and are investigating new uses for the chemical. But for the near and medium-term future, the glut of crude glycerine is expected to reduce the profitability of biodiesel production.

2.3.3 Emerging processes

An explicit assumption behind government plans for large-scale displacement of petroleum fuels by biofuels is that the expansion of biofuels derived from starch, sugars or plant oils alone will hit a limit within the next decade or so, and that any increase in supplies beyond that will have to come from so-called second-generation technologies and feedstocks. For ethanol, that means technologies that are able to extract fermentable sugar from ligno-cellulosic and hemi-cellulosic materials ("cellulosic" for short). Potential sources of cellulosic materials include the non-starchy parts of the maize plant, perennial grasses, wheat straw, pulp from fast-growing trees, and even waste paper. Some cellulosic feedstocks could be grown on land that is not suitable for food crop production. Ligno-cellulosic biomass can also be gasified and then converted to a form of diesel via Fischer-Tropsch (FT) synthesis.

Demonstration plants have already been built to produce ethanol from ligno-cellulosic materials, but production costs are high, generally around USD 1.00 per litre on a gasoline-equivalent basis (IEA, 2006). Hundreds of millions of dollars have already been spent by both government and private industry researching ways to bring down those costs. Most of these efforts are focussing on the front-end of the process, the breaking down (through enzymes or microbes) of lignin, cellulose or hemi-cellulose into a form that can then be fermented, and increasing the ethanol contented in the fermented broth, so as to reduce the energy needed in the distillation stage.

Because of the rapid pace of technological developments, and uncertainty over the long-run costs of feedstock, projections of the probable future costs of producing ethanol from lingo-cellulosic materials vary widely. The IEA, in its *World Energy Outlook 2006*, notes that they could fall eventually to USD 0.40 per litre of gasoline equivalent. This goal may be achievable sooner than previously forecast, at least in integrated sugar-and-ethanol plants. In May 2007, Dedini SA, Brazil's leading manufacturer of sugar and biofuel equipment, announced that it had developed a way to produce cellulosic ethanol on an industrial scale from bagasse (Biopact team, 2007) at a cost of below USD 0.27 per liter, or USD 0.41 per litre on a gasoline-equivalent basis.[5] Dedini began producing small quantities of cellulose bioethanol from bagasse at the São Luiz Mill in São Paulo state in 2002. Its main innovation involves pretreatment of the biomass with organic solvents, followed by hydrolysis with diluted acids.

As with cellulosic ethanol, a considerable amount of research is being devoted also to reduce the costs of producing diesel from biomass, using the Fischer-Tropsch process, breaking down biomass into gas with heat or chemicals. A completely different approach to producing biodiesel would extract lipids from specially bred species of algae, which would then be transformed using the standard transesterfication process. However, recent evaluations of the potential for algal biodiesel are pessimistic about prospects for commercializing that technology (Dimitrov, 2007).

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[5]. Statements by Dedini released so far do not provide details on these cost estimates, however. In particular, it is not known whether they a positive cost to the bagasse, which currently is burned to cogenerate steam an electricity in many sugar-and-ethanol plants.

In addition to favourable technological breakthroughs, bringing down costs of biofuel production may also require exploiting significant scale economies in the manufacturing plants. However, large manufacturing plants imply procuring biomass from over a wide area — a not insignificant logistical challenge. For production of biomass on marginal land this is a particularly significant cost, as with lower fertility or harsher climates yields are lower and the area over which biomass has to be sourced correspondingly larger. Moreover, most analyses of the procurement cost of the biomass feedstock undertaken to date focus on actual production costs, either without taking into account the rental value of the land or assuming a low value for it.

A notable exception is the study by the Center for Agricultural and Rural Development (CARD) at Iowa State University (Tokgoz et al., 2007). The CARD analysis observes that farmers will not be willing to plant crops dedicated cellulosic crops like switchgrass unless the crops offer a net return comparable to that of maize. Citing a study by Babcock et al. (2007), which calculated the price at which farmers would consider changing to switchgrass as USD 121 per tonne of switchgrass from land with a yield of 9 tonnes per hectacre, and USD 90 per tonne for land with a yield of 13.5 tonnes per hectare, the authors estimate that the maximum that ethanol plants can bid for these same tonnes is about USD 41 per tonne in years when ethanol is selling for USD 1.75 per gallon (USD 0.46 per litre). “Under these conditions”, they note “switchgrass simply cannot offer farmers a market incentive that offsets the advantages of growing corn”. Continuing:

> A key and possibly counterintuitive insight is that there is no ethanol price that makes it worthwhile to grow switchgrass because any ethanol price that allows ethanol plants to pay more for switchgrass also allows them to pay more for corn. So long as farms are responding to net returns in a rational manner and so long as ethanol plants are paying their breakeven price for raw material, farmers will plant corn as an energy crop. Switchgrass in the Corn Belt will make economic sense only if it receives an additional subsidy that is not provided for corn-based ethanol.

Not surprisingly, there are now several bills before the U.S. Congress proposing new, additional incentives to encourage farmers to produce feedstock crops other than corn.

2.4. Price relationships between biofuels, petroleum products and crops

Ethanol and biodiesel are both complements and substitutes for gasoline and petroleum diesel, so one would expect their prices to track the prices of these fuels fairly closely, after adjusting for product subsidies or tax differentials. Yet, owing to government policies, and because biofuels in most countries are imperfect substitutes for their corresponding petroleum-derived fuels, price behaviour is a bit more complex than this.

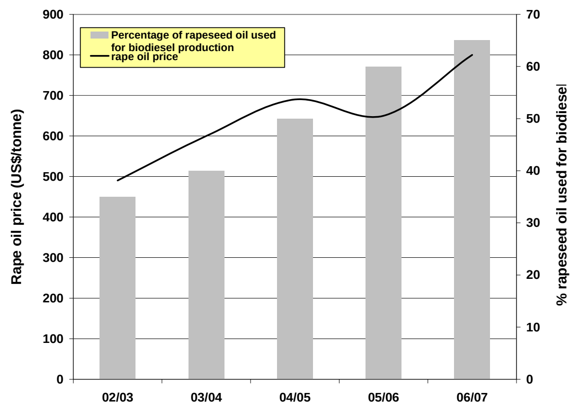
Ethanol contains less energy than gasoline but has a higher octane rating and is therefore used as an octane enhancer (necessary for modern engines using lead-free fuels). As a pure fuel, it has an octane rating of 113, compared with 87 for gasoline. In blends of up to around 5% with gasoline, therefore, ethanol should command a premium over gasoline. Tyler (2007) places this premium at around USD 0.25 per gallon (USD 0.066 per litre); Stoft (2007) argues it should be worth only a few percentage points, because ethanol also has some negative attributes — namely, it has an affinity for water, and raises the vapour pressure of ethanol-gasoline blends. The unusually high spread between the ethanol and the gasoline price in the United States in May through July 2006 has been attributed to the regulatory changes that prompted gasoline producers to turn to ethanol after abandoning MTBE (methyl tertiary-butyl ether) when the U.S. Environmental Protection Agency ruled MTBE could no longer be used as an octane enhancer (or oxygenate).

As the share of ethanol in a gasoline blend rises, the incremental value of the octane declines, and what matters more is the ethanol's energy content, which is about 65% that of gasoline. Running on blends containing 85% ethanol and 15% gasoline (E85), so-called flex-fuel vehicles (FFVs) designed to operate on that fuel typically travel 25% fewer kilometres than on an equal volume of pure gasoline. Hence, the market-clearing price for ethanol used in E85 should be not much more than 75% of the price of gasoline.

In the absence of blending mandates, the relationship between biodiesel prices and diesel prices should depend largely on the quality of the biodiesel and diesels being compared (particularly in terms of sulphur content), and their relative energy contents. These qualities depend on the type of engine in which the biodiesel is burned, the ratio of the blend, air-quality considerations, and so forth.

The demand for crops for producing biofuels has been an important factor — though not the only factor — in firming up prices for not only crops used directly in the production of ethanol and biodiesel (Figure 5), but also for substitutes for those crops, especially in the markets for feedgrains. While these price rises have been regarded as boons for producers of those crops, they have adversely affected livestock farmers, especially those that depend on purchased feed for the bulk of their livestock-feeding requirements.

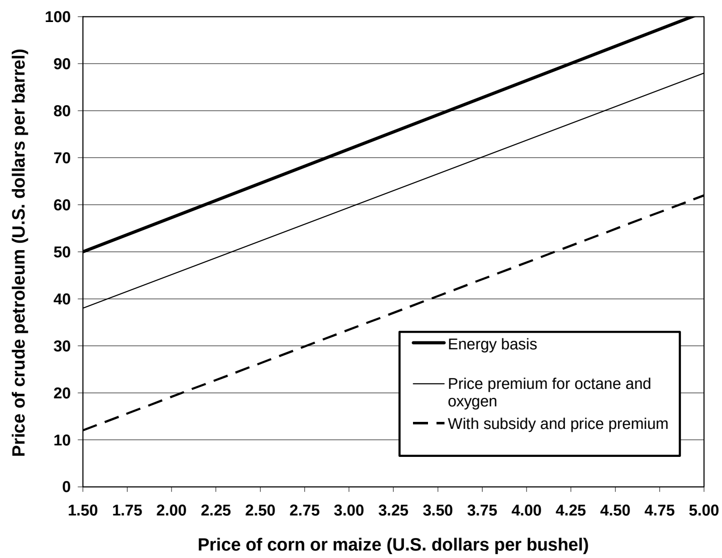
Figure 5. **Growth in EU biodiesel production and rape oil prices, 2002/03 through 2006/07**



Source: Jank *et al.* (2007).

Rising prices for grains and oilseeds also raises production costs for biofuel producers. At some point, as feedstock prices rise, biofuel producers get caught in a price squeeze. Where that occurs depends on the prices of competing petroleum-based fuels, and of course levels of subsidies. Figure 6 shows, using the example of the United States, that the price that ethanol manufacturers can pay for maize and still cover their costs is substantially increased by the existence of the USD 0.51 per gallon (USD 0.135 per litre) federal volumetric ethanol excise tax credit (VEETC). At a crude-oil price of USD 60 per barrel, the break-even price is USD 4.75 per bushel, or more than USD 1.75 per bushel higher than without the subsidy, even allowing a generous premium for the value of ethanol as an octane-enhancer.

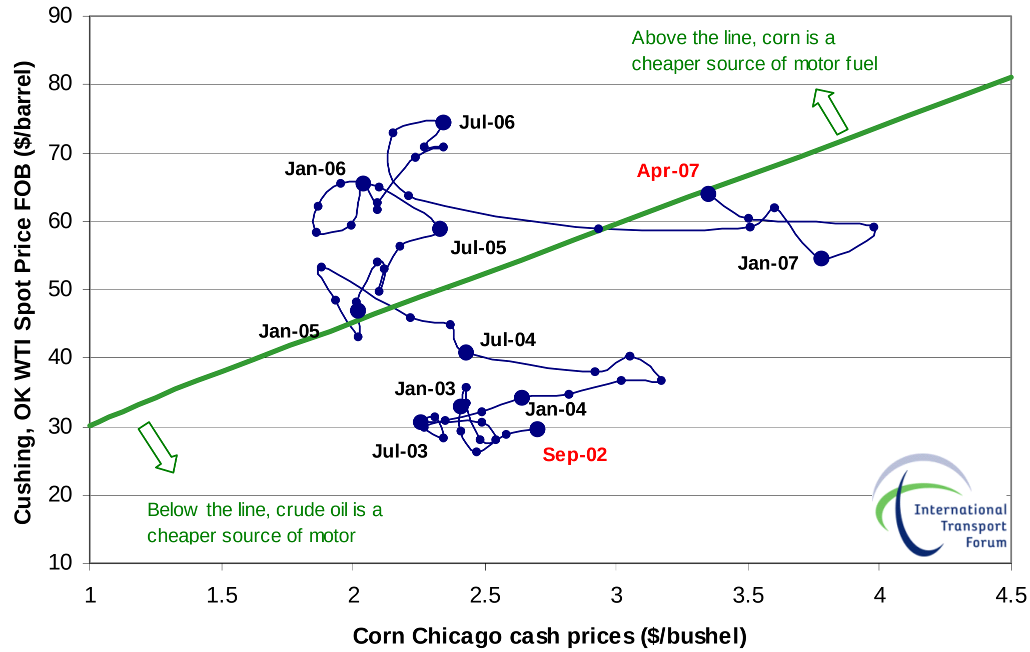
Figure 6. **Prices for maize and crude oil at which ethanol production breaks even in the United States**



Source: Hurt *et al.* (2006) and Tyner (2007).

Figure 7 plots the actual co-evolution of prices of maize and crude oil in the United States over the last five years. It shows that during 2005 and 2006, at the height of investment interest in the ethanol industry, corn prices were relatively low and petroleum prices relatively high. Before that period, petroleum prices were too low, and since the end of 2006 to date the maize price has been too high, for corn-based ethanol to compete with petroleum without subsidies.

Figure 7. **Prices of crude-oil and maize in the United States, September 2002-January 2007**



Source: Joint Transport Research Centre of the OECD and the International Transport Forum; data from the Energy Information administration (http://tonto.eia.doe.gov/dnav/pet/hist/rwtcM.htm) and USDA.

Blending mandates can also change the price relationship between the mandated and the non-mandated fuel. Whether they do depends on the cost of producing the mandated product relative to the market price of the non-mandated product. In the most simple situation, involving a 5% minimum blending mandate for biodiesel, if the price of petroleum diesel is below the marginal costs of producing biodiesel, the price of the biodiesel (adjusted for energy-content and quality differences) will keep rising until the mandated level is reached. If the price of petroleum diesel is higher than the short-run marginal cost of supplying biodiesel, the price of biodiesel should approach the price of the former as long as the share of biodiesel in the market is below whatever limits may be in place on the maximum percentage that can be sold commercially.

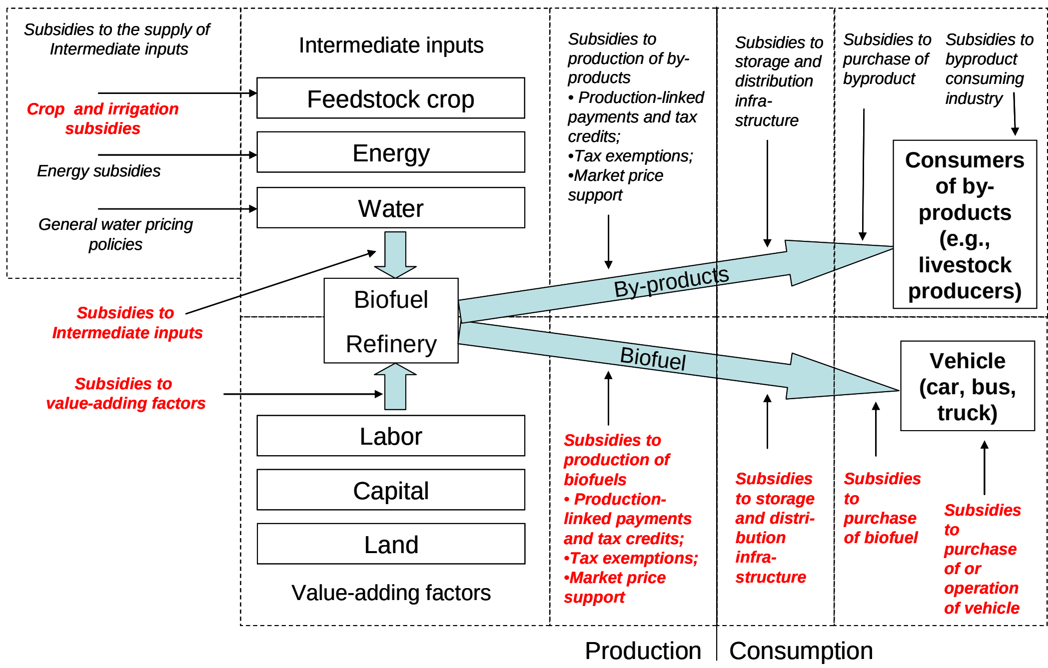
3. GOVERNMENT SUPPORT FOR LIQUID BIOFUELS

3.1. A framework for understanding industry support

Figure 8 illustrates the framework used in the GSI's country studies to discuss subsidies provided at different points in the supply chain for biofuels, from production of feedstock crops to final consumers. Defining a baseline requires deciding how many attributes to look at, and determining what programs are too broadly cast to consider in an analysis of one particular industrial sector. In our analyses, we focused on subsidies that affect production attributes that are significant to the cost structure of biofuels, including subsidies to producers of intermediate inputs to production, namely crop farmers. More remote subsidies, such as to particular modes of transport used to ship biofuels or their feedstocks, were beyond the boundaries of the analysis.

At the beginning of the supply chain are subsidies to what economists call "intermediate inputs"—goods and services that are consumed in the production process. The largest of these are subsidies to producers of feedstock crops used to make biofuels. For ethanol, the main feedstocks are sugarcane, maize (corn), sugar beet and wheat, and for biodiesel the main feedstocks are oilseed rape and soybeans. In some countries, the crop subsidies are small enough that they are only wealth transfers, and do not materially affect supply or prices. In others, border protection raises the domestic prices of the crops above international prices, thereby effectively taxing consumers of those crops, including biofuel producers. Some countries compensate for these "taxes" on the input feedstocks by providing countervailing subsidies to biofuel producers. However, to the extent that production of the feedstock crops creates a demand for subsidies, the proportional share of the total subsidies to those crops used in the production of biofuels can be considered one element of the gross costs to government of promoting biofuels. (The net cost would take into account any increased taxes paid by farmers as a result of increasing their taxable incomes.)

Figure 8. **Subsidies provided at different points in the biofuel supply chain.**



Source: Global Subsidies Initiative.

Subsidies to intermediate inputs are often complemented by subsidies to value-adding factors—capital goods; labor employed directly in the production process; and land. These may take the form of grants, or reduced-cost credit, for the building of ethanol refineries and biodiesel manufacturing plants. Some localities are providing land for biofuel plants for free or at below market prices as well. These types of subsidies lower both the fixed costs and the investor risks of new plants, improving the return on investment.

Further down the chain are subsidies directly linked to output. Output-linked support includes import tariffs on ethanol and biodiesel; exemptions from fuel-excise taxes; and grants or tax credits related to the volume produced, sold or blended. Although in a few cases, tax exemptions and subsidies have been used to actually depress biofuel (mainly ethanol) prices below the energy-equivalent cost of competing petroleum fuels, mainly they have enabled biofuels to be sold at retail prices that are roughly at parity with their (taxed) fossil-fuel counterparts.

Support to the downstream side of the biofuel market has generally been provided in one of five ways: credit to help reduce the cost of storing biofuels inbetween the production seasons; grants, tax credits and loans to build dedicated infrastructure for the wholesale distribution and retailing of biofuels; grants to demonstrate the feasibility of using biofuels in particular vehicle fleets (e.g., biodiesel in municipal buses); measures to reduce the cost of purchasing biofuel-capable fleets; and government procurement programs that give preference to the purchase of biofuels.

A diagram such as Figure 8 is helpful for visualizing the different points at which governments intervene in the market for biofuels. When discussing support policies, however, it is standard to structure the discussion in an order reflecting the degree of influence on market outcomes. Generally, policies that directly bear on the level of production are considered to have the greatest level of distortion on production decisions, followed by subsidies to intermediate inputs, and subsidies to value-adding factors. Government support for research and development (R&D), as long as it is not production support in disguise, is normally the least distorting.

Following this structure, this section of the paper provides a brief survey of the types of support measures identified in the course of the GSI's studies of support for ethanol and biodiesel in Australia, Brazil, Canada, the EU and its Member States, Switzerland, and the United States.

3.2. Current support for ethanol and biodiesel

3.2.1 Output-linked support

Domestic production of biofuels is directly supported by governments through two main instruments: border protection (mainly import tariffs) and volumetric production subsidies. Regulations mandating usage or blending percentages, and fuel-tax preferences, stimulate production directly as well. But whether that production occurs within a country's borders or elsewhere depends in part on the level of border protection.

Most countries producing bio-ethanol apply a most-favoured nation (MFN) tariff that adds at least 20%, or €0.10 per litre, to the cost of imported ethanol (Table 3). The World Customs Organization (WCO), of which all OECD countries and Brazil are members, specifies two tariff lines for ethyl alcohol (ethanol) under its Harmonized Commodity Description and Coding System (HS): HS 2207.10 (undenatured ethyl alcohol of an alcoholic strength of at least 80% by volume) and HS 2207.20 (denatured ethyl alcohol of an alcoholic strength of at least 80% by volume). Most fuel-grade ethanol is traded in undenatured form — i.e., containing only pure ethyl alcohol and a small percentage of water. The United States further distinguishes between ethanol intended for as a fuel from ethanol destined for beverages and other end uses, and charges an additional, "secondary" tariff on the former. The import duty on ethyl alcohol applied by Australia is set at the same level as the federal fuel excise tax on ethanol (and is among the highest in the OECD); however, domestically produced ethanol can qualify for a rebate of that tax.

Various exemptions from the MFN tariff and tariff-rate quotas apply. Biofuels are often charged at zero or reduced duty when imported from countries with which the importing country has signed a free-trade agreement, or which are covered by their General System of Preferences (GSP). The country coverage of these GSPs differ. Switzerland includes Brazil in its GSP, the EU does not. The United States maintains a low tariff-rate quota for ethanol imported from certain Caribbean countries under its Caribbean Basin Initiative.

Biodiesel, which is classified as a chemical under HS 3420.90, along with a wide number of other chemicals, is subject to much lower import tariffs than ethanol; these tariffs range from 0% in the Switzerland to 6% in the EU. Australia applies an excise duty of AUD 38.143 per litre on imported biodiesel, but as this duty is refunded, the effective duty is zero.

Table 3. **Applied tariffs on undenatured ethyl alcohol (HS 2207.10) in several representative countries, as of 1 January 2007**

Country	*Applied MFN tariff (local currency or ad valorem rate)*	*At pre-tariff unit value of € 0.50/litre*		*Exceptions (in addition to other WTO member economies with which country has a free-trade agreement) or notes*
		Ad valorem equivalent (%)	*Specific-rate equiv. (€/litre)*	
Australia	5% + AUD 38.143/litre	51%	€ 0.256	USA, New Zealand
Brazil	0%	0%	€ 0.000	Lowered from 20% in March 2006
Canada	CAD 0.0492/litre	6%	€ 0.032	FTA partners
European Union	€ 19.2/hectolitre	38%	€ 0.192	EFTA countries, developing countries in GSP
Switzerland	CHF 35 per 100 kg	34%	€ 0.172	EU, developing countries in GSP
United States	2.5% + $0.51/gallon	23%	€ 0.114	FTA partners; CBI partners

In addition to providing border protection, several countries and sub-national governments provide direct, production-related subsidies. The leading country in the use of these subsidies is the United States, which grants a USD 0.51 per gallon (€ 0.10 per litre) tax credit to blenders according to the amount of pure ethanol they bend with gasoline (petrol). The U.S. federal government also grants a similar tax credit to companies that blend biodiesel with petroleum diesel. The credit is USD 1.00 per gallon (€ 0.20 per litre) for biodiesel derived from virgin agricultural fats and oils, and USD 0.50 per gallon (€ 0.10 per litre) for biodiesel derived from waste oils. An additional "federal small producer tax credit" of USD 0.10 per gallon (€ 0.02 per litre) is granted on the first 15 million gallons (56 million litres) of ethanol or biodiesel produced by plants with an annual capacity of less than 60 million gallons (225 million litres). Several U.S. states provide their own volumetric subsidies to support in-state production of ethanol or biodiesel at rates equivalent to USD 0.20 per pure biofuel gallon (€ 0.04 per litre) or more. And in a few cases, these subsidies are contingent on the use of feedstock produced in the same state.

In March 2007 Canada announced that it would allocate CAD 1.5 billion over seven years towards an operating incentive to producers of renewable alternatives to gasoline, such as ethanol, and renewable alternatives to diesel, such as biodiesel, "under conditions where industry requires support to remain profitable" (Department of Finance Canada, 2007).[6] Payments rates from 2007 through 2009 will be up to CAD 0.10 (USD 0.09) per litre for renewable alternatives to gasoline and up to CAD 0.20 (USD 0.18) per litre for renewable alternatives to diesel, then decline thereafter. Uniquely, no government support will be provided when rates of return earned by producers exceed 20% on an annual basis. Support under the program to individual companies will also be capped. Concurrent with the implementation of the operating incentive programme, the Government has proposed that the *Excise Tax Act* be amended to eliminate the current exemptions for ethanol and biodiesel as from 1 April 2008.

Most other countries (and some U.S. states) support biofuel use (and therefore production, where border protection is effective) through tax preferences tied to fuel-excise taxes or sales taxes (Table 4). These most commonly take the form of reductions in, or exemptions from, per-litre excise taxes normally charged on transport fuels. Brazil was one of the first countries to grant reductions in taxes applied to biofuels. Its national exemption for ethanol, worth about € 0.11 per litre, is topped up by even higher exemptions in some states. Thus ethanol sold in the State of São Paulo, benefits from a R$ 0.50 (€ 0.181) lower fuel tax than that applied by the state on petrol. Brazil's tax exemptions for biodiesel depend on the location and type of producer from which the vegetative feedstock was procured. It is highest for biodiesel made from castor or palm oil harvested from subsistence farms in the north and northeast.

The European Union has no Community-wide excise tax on transport fuels. Rather, it has authorized its Member States to grant tax preferences to biofuels, within limits. Expressed on a pure biofuel-equivalent basis, these range from 0 to € 0.60 per litre, with many in the neighbourhood of € 0.30 per litre. The Netherlands had offered a temporary fuel-tax exemption for biofuels in 2006, but stopped offering it when it introduced a blending mandate. Germany has followed a similar policy, but still offers a fuel-tax exemption for biodiesel and SVO when intended for use in unblended forms.

6. Prior to this decision, the Canadian province of Quebec was already offering a sliding-scale tax credit for ethanol that is based on the market price for West Texas Intermediate crude oil.

Canada began exempting the ethanol portion of blended fuels from the federal excise tax on petrol (now CAD 0.10 per litre) in the 1990s. It now grants an exemption to biodiesel as well. Most of Canada's Provinces have since created their own exemptions for ethanol, and British Columbia, Manitoba, and Ontario exempt the biodiesel proportion of fuel blends from their fuel excise taxes.

Switzerland, besides exempting biodiesel, SVO and ethanol produced in approved "pilot and demonstration plants" from its fuel excise taxes, also exempts these fuels from the CHF 0.015 per litre of diesel levy collected by the Climate Cent Foundation to fund projects for CO_2 reduction.

Table 4. **Value of excise tax reductions or rebates for liquid biofuels as of 1 January 2007**[1]

Country	**Ethanol or ETBE**		**Biodiesel or pure plant oil**	
Province or state	**Local currency**	**Euros per litre**	**Local currency**	**Euros per litre**
Australia[2]	AUD 0.38143/litre	€ 0.2310	AUD 0.38143/litre	€ 0.2310
Brazil				
Federal	R$0.30/litre	€ 0.1085	R$0-0.218/litre	€0 - €0.08
Sao Paulo state	R$0.50/litre	€ 0.1809	—	—
Canada				
Federal[3]	CAD 0.010/l of E10	€ 0.066	CAD 0.002/l of B5	€ 0.264
Alberta	CAD 0.009/l of E10	€ 0.059	—	—
B. Columbia	CAD 0.014/l of E10	€ 0.093	CAD 0.007/l of B5	€ 0.093
Manitoba	CAD 0.025/l of E10	€ 0.165	—	—
Ontario	CAD 0.015/l of E10	€ 0.099	CAD 0.007/l of B5	€ 0.093
Quebec	—	—	CAD 0.152/l of B100	€ 0.100
Saskatchewan	CAD 0.015/l of E10	€ 0.099	—	—
EU				
Austria	€ 15 per 1000 litres	€ 0.0150	€ 28 per 1000 litres	€ 0.0280
Belgium	€ 592.19 per 1000 litres	€ 0.5922	€ 367.91 per 1000 litres	€ 0.3679
Czech Rep.	—	—	€ 292 per 1000 litres	€ 0.2920
Denmark	€ 30 per 1000 litres	€ 0.0300	€ 30 per 1000 litres	€ 0.0300

Country	Ethanol or ETBE		Biodiesel or pure plant oil	
Province or state	**Local currency**	**Euros per litre**	**Local currency**	**Euros per litre**
Estonia	No information	No info	No information	No info
France	€ 370 per 1000 litres	€ 0.3700	€ 330 per 1000 litres	€ 0.3700
Germany	—	€ 0.6545	€ 470.40 per 1000 litres (sales of 100% biofuel only)	€ 0.4704
Hungary	ETBE: € 414 per 1000 litres	€ 0.1000	€ 340 per 1000 litres	€ 0.3400
Ireland	€ 368 per 1000 litres	€ 0.3680	€ 368 per 1000 litres	€ 0.3680
Italy	~ € 260 per 1000 litres	€ 0.2600	€ 413 per 1000 litres	€ 0.4130
Lithuania	€ 250 per 1000 litres	€ 0.2500	€ 250 per 1000 litres	€ 0.2500
Luxembourg	≤ € 23 per 1000 litres	€ 0.0230	≤ € 10 per 1000 litres	€ 0.0010
Malta	No information	No info	No information	No info
Netherlands	—	—	Pure plant oil f/ pilot	€ 0.3500
Poland	€ 500/1000 litres of E10 or higher	Up to € 5.0000	€ 500/1000 litres of B10 or higher	Up to € 5.0000
Slovakia	Full exemption for ≤ 15% ETBE	€ 0.0150	Full exemption for ≤ 5% methyl esters	No info
Slovenia	Full exemption on E100	No info	Full exemption on B100	No info
Spain	€ 420 per 1000 litres	€ 0.4200	€ 290 per 1000 litres	€ 0.2900
Sweden	≤ € 150 per 1000 litres	≤ €0.1500	≤ € 180 per 1000 litres	≤ €0.1800
UK	€ 320 per 1000 litres	€ 0.3200	€ 320 per 1000 litres	€ 0.3200
Switzerland	CHF 0.7312 per litre	€ 0.4530	CHF 0.7587 per litre	€ 0.4700
USA				
Arkansas	USD 0.098/gal of E85	€ 0.024	—	—
California	USD 0.090/gal of E85	€ 0.022	—	—
Delaware	USD 0.010/gal of E85	€ 0.002	—	—
Florida	USD 0.200/gal of E85	€ 0.048	—	—

Country	Ethanol or ETBE		Biodiesel or pure plant oil	
Province or state	Local currency	Euros per litre	Local currency	Euros per litre
Hawaii	4% on E10 or E85	€	4% on >B2	€
Idaho	USD 0.025/gal of E85	€ 0.006	USD 0.025/gal of B2	€ 0.255
Illinois	USD 6.25% on >E70	€	6.25% on >B10	€
Indiana	USD 0.020/gal of E85	€ 0.005	USD 0.010/gal of B2	€ 0.102
Iowa	USD 0.020/gal of E10	€ 0.041	—	—
Maine	USD 0.020/gal of E10	€ 0.041	—	—
Minnesota	USD 0.058/gal of E85	€ 0.014	—	—
Missouri	USD 0.270/gal of E85	€ 0.065	—	—
Montana	USD 0.041/gal of E10	€ 0.084	—	—
New York	USD 0.420/gal of E85	€ 0.101	USD 0.420/gal of B100	€ 0.086
North Carolina	USD 0.202/gal of E85	€ 0.048	USD 0.202/gal of B2	€ 2.060
North Dakota	—	—	USD 0.066/gal of B2	€ 0.673
Oklahoma	USD 0.002/gal of E10	€ 0.004	—	—
Pennsylvania	USD 0.041/gal of E10	€ 0.084	—	—
South Dakota	USD 0.020/gal of E10	€ 0.041	—	—

1. Rates refer to ethanol, biodiesel or pure vegetable oil content of fuels, unless otherwise indicated.
2. Excise tax is rebated in full for ethanol produced within Australia, and for all biodiesel.
3. Proposed for elimination effective 1 April 2008.

Sources: • **Australia:** Centre for International Economics (2006); • **Brazil:** Igly Serafim (2006); • **Canada:** Litman (2007, forthcoming); • **EU:** Kutas and Lindberg (2007, forthcoming); • **Switzerland:** Steenblik and Simón (2007, forthcoming); • **USA:** Koplow (2006).

Complementing many of the aforementioned production-related support measures are various targets and mandated requirements for the amount or share of designated “renewable fuels” consumed as components of ethanol-petrol or biodiesel-diesel blends. Some of these targets and mandates (confusingly called a “standard”, which implies voluntary compliance, in the United States), do not discriminate by biofuel (Table 5a). Many others are specific to either ethanol or biodiesel (Table 5b). Some jurisdictions in the United States have linked implementation of the mandates with the development of in-state biofuel manufacturing capacity. Generally, where specific blending targets or requirements are set, they are higher for ethanol are than for biodiesel. Switzerland has so far avoided establishing even target future levels of biofuel use.

Table 5a. **Use and blending share targets (T) and mandates (M) for liquid biofuels that can be met by either ethanol or biodiesel**

Country	Type	Quantity or blending share	Comment
Australia	T	350 million litres by 2010	
EU	T	2% by 2005; 5.75% by 2010; 10% by 2020	2020 target still under discussion
Austria	T	2.5% by 2006	
France	T	7% by 2010; 10% by 2015	
Japan	T	6 billion litres by 2020	
USA (federal)	M	2.78% by volume of gasoline consumption in 2006 (4 billion gallons , or 15 GL); 7.5 billion gallons (28 GL) by 2012	Of which 0.25 billion gallons (0.95 GL) must be cellulosic ethanol in 2013. Credit rate varies by feedstock.
Iowa	T	10% by 2009; 25% by 2020	

Source: Global Subsidies Initiative based on various sources.

Table 5b. **Use and blending share targets and mandates specifically for ethanol or biodiesel**

Country	**Ethanol**			**Biodiesel**		
Province or state	**Type**	**Quantity or blending share**	**Year**	**Type**	**Quantity or blending share**	**Year**
Brazil (federal)	M	4.5%	1977	M	2%	2008
	M	20-25%	198?	M	5%	2013
Canada (federal)	M	5%	2010	M	2%	2012
Ontario	M	5%	2007	—	None	—
Ontario	T	10%	2010	—	None	—
EU						
Germany		3.6%	2010		4.4%	2007

USA						
Hawaii	M	85% of gasoline must contain ≥10% ethanol	2006	—	None	—
Louisiana	M	2% (1)	200?	M	2% (2)	200?
Minnesota	M	20%	2013	M	2%	2005
Missouri	M	10%	2008	—	None	—
Montana	M	10% (3)	200?	—	None	—
Oregon (Portland)	M	10%	2007	M	2% (10%)	2007 (2010)
Washington[4]	M	2%	2008	M	2%	2008

1. Requirement starts to apply within six months after monthly production of denatured ethanol, produced in the state, equals or exceeds an annual production volume of at least 50 million gallons. To qualify, the ethanol must be produced from domestically grown feedstock.

2. Requirement starts to apply within six months after monthly production of biodiesel produced in the state equals or exceeds an annual production volume of 10 million gallons. To qualify, the biodiesel must be produced from domestically grown feedstock.

3. Requirement starts to apply within one year after the Montana Department of Transportation has certified that the state has produced 40 million gallons of ethanol and has maintained that level of production on an annualized basis for at least 3 months.

4. Requirement could apply earlier if a positive determination is made by the Director of the State Department of Ecology that feedstock grown in Washington State can satisfy a 2% fuel blend requirement. The biodiesel requirement would increase to 5% once in-state feedstocks and oil-seed crushing capacity can meet a 3% requirement.

Data sources: • **Brazil:** F.O.Licht; • **Canada:** Litman (2007, forthcoming) • **EU:** Kutas and Lindberg (2007, forthcoming) • **USA:** U.S. Department of Energy, www.eere.energy.gov/afdc/progs/reg_matrx.cgi

3.2.2 Support to production factors and intermediate inputs

The main intermediate inputs used in the production of ethanol are the biomass feedstock, which in Brazil and Australia is mainly cane sugar or molasses; in Canada, wheat; in the EU grains, sugar beets and wine; in Switzerland wood-cellulose; and in the United States corn. Water, and fuels for providing process heat in the fermentation and distillation processes, are also important inputs to ethanol manufacturing, and methanol and sodium hydroxide to biodiesel manufacturing, but identifying subsidies to these inputs was beyond the scope of these studies.

One indicator of the degree to which the price paid for a product by consumers is raised by market-intervention policies is the consumer nominal protection coefficient (consumer NPC), which measures the ratio of the average price paid by consumers and the price at the border (both normalized to the price at the farm gate). Table 6 shows that in 2005, in most of the countries studied, the consumer NPC was close to unity for major biofuel feedstock crops — i.e., biofuel producers were not being penalized by policies that kept domestic prices for these crops higher than the same crops available from foreign suppliers.

There were some exceptions. Some potential ethanol feedstocks in several countries are made prohibitively expensive by policies, mainly border tariffs, that raise their internal prices. Thus, were domestic firms in Switzerland to start producing bio-ethanol from domestically grown crops, using a standard fermentation and distillation process, their costs of the feedstock would be much higher than faced by bio-ethanol producers in other countries. The consumer NPC for crops imply that wheat was 46% more, maize 91% more, other grains 76% more expensive within Switzerland than available on international markets. Prices for sugar were 250% more expensive (i.e., almost 3½ times the world price).[7] Not surprisingly, Switzerland produced just under 1 million litres of ethanol in 2005, based entirely on wood cellulose.[8]

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7. With the recent rise in world prices for grains and sugar, these price gaps may have narrowed.

8. Production of bio-ethanol for fuel commenced only very recently in Switzerland, in large part because of the high prices of its sugar and starch yielding crops, but also because of an anti-intoxication law that remained in effect until 1996, effectively banning the domestic production of ethyl alcohol from crops.

Table 6. **Nominal consumer nominal protection coefficients for crops used, or could be potentially used, as biofuel feedstocks, 2005**

	Sugar (source)	**Starchy grains**	**Oilseeds**
Australia	Sugar cane: 1.00	Common wheat: 1.00	NA[1]
Brazil	Sugar cane: 1.00	NA	Soybeans: 1.00
Canada	NA	Wheat: 1.00 Maize: 1.00	Rape seed (canola): 1.00
EU	Beet sugar: 2.40	Common wheat: 1.08 Maize: 1.29 Potatoes: 1.10	Rape seed: 1.00 Sunflower seed: 1.00
Switzerland	Beet sugar: 3.51	Wheat: 1.46 Maize: 1.91	Oilseeds: 3.87
United States	Cane & beet sugar: 2.09	Maize: 1.00 Sorghum: 1.00	Soybeans: 1.00

1. Biodiesel in Australia is made principally from tallow and waste cooking oil.
Sources: • **Brazil:** OECD (2005); • **All other countries:** OECD, Producer and Consumer Support Estimates, OECD Database 1986-2005, www.oecd.org/document/55/0,2340,en_2649_37401_36956855_1_1_1_37401,00.html

3.2.3 Support to production factors

One of the most difficult forms of support to track to any industry is support for factors used in production, particularly capital plant. By definition, general policies designed to spur capital investment generally are not considered specific subsidies and therefore not counted in sectoral subsidy accounting. Specific budgetary allocations for grants, government loans or government guaranteed loans for capital investment are often reported, but details of the actual allocations (and in the case of loans and loan guarantees, the financial details) are less often made publicly available. That certainly seems to be the case for public assistance to investments in biofuel plants, which have benefited from a host of subsidies, many provided by sub-national governments.

Brazil's sugar and sugar-to-ethanol industry benefited from some very large loans in the 1970s and 1980s, many of which were forgiven, or paid back at interest rates far below the prevailing market rates. It has been several years since the Brazilian government offered such assistance.

Numerous more recent examples can be found elsewhere, though in total the values provided are probably much less than the value of production-related incentives. In 2003, for example, Australia introduced an AUD 37.6 million Biofuels Capital Grants Program in an attempt to stimulate the development of new biofuel plants. Much more significantly, Section 1512 of the United States' Energy Policy Act of 2005 authorizes grants for building cellulosic ethanol plants, starting at USD 100 million in 2006 and rising to USD 400 million in 2008.

In several countries, grants and government loans have been used to increase farmer participation in biofuel plants. The U.S. state of Minnesota, for example, specifically targeted farmer-owned ethanol co-operatives in its Ethanol Production Facility Loan Program, which ended in 1999. Similarly, in Europe, Austria provides support for biofuel production facilities up to 55% of the total investment costs as long as at least 51% of the facility in question is owned by farmers. Canada's Province of Manitoba has provided CAD 1.2 million in subsidies to support small and medium-size biofuel plants.

Canada, for the most part, however, has avoided providing pure grants for biofuel production facilities, preferring to offer loans. The Federal Government of Canada, for example, recently announced that it would provide CAD 200 million in loans to renewable fuels projects, starting April 2007. This follows an earlier "Ethanol Expansion Programme" which provided deferred-repayment loans worth CAD 117.5 million to support the construction or expansion of 12 ethanol plants across Canada.

One phenomenon increasingly witnessed in federal systems is what the U.S. study calls "subsidy stacking" — the ability of investors to tap into multiple sources of public financing assistance. It is not uncommon for biofuel plants to benefit from municipal-government support, often in the form of free land or utility connections; state-level support, such as tax credits for investment, or economic development grants or loans; and support from federal agencies under various regional development, agricultural or energy programmes. In one specific plant examined in the U.S. state of Ohio, more than 60% of the plant's capital is expected to be provided by government-intermediated credit or grants (Koplow, 2006).

Subsidies to value-adding factors, particularly for capital investments in new plants, are much smaller on a subsidy-equivalent basis than output-related subsidies, and many are provided under general programs. But because these government-intermediated loans and loan guarantees often shift the risk of default to the government body providing the assistance, a large number of communities have thereby committed a significant amount of public money to the future of biofuels production. The amount of public capital used, the degree of risk being taken, and the implications in terms of future local government dependence on the continuation of national biofuels subsidies are all important issues that warrant examining in greater depth.

3.2.4 Support for research, development and innovation

Most biofuel-producing countries have established government-funded programmes to support research, development and innovation in respect of different stages in the supply chain. Because of the multitude of specializations involved, from agronomy to combustion, and the different government agencies with an interest in biofuels (agriculture, energy, transport, environment), identifying all the programmes directly supporting the industry is not an easy task.

What does seem clear from the pattern of current funding across countries is that an increasing proportion of R&D funds are being channelled in support of second-generation biofuels, particularly cellulosic ethanol. Notable examples include:

- Canada's CAD 145 million Agricultural Bioproducts Innovation Program, which, beginning in 2007, will provide support for cross-sector research networks conducting scientific research and development related to the advancement of a Canadian bio-based economy.

- The EU's Sixth Framework Programme for research, technological development and demonstration, which will provide at least €68 million to, among other aims, support research in the area of biomass to develop second-generation biofuels and integrated biomass use through biorefineries.

- The United States' Biofuels Initiative, launched in 2006, aims to accelerate research so as to make cellulosic ethanol cost-competitive by 2012. This multi-agency programme focuses on the use of non-food based biomass, such as agricultural waste, trees, forest residues, and perennial grasses in the production of transportation fuels, electricity, and other products. One its goals is to displace up to 30% the nation's transport fuel use by biofuels by 2030. Funding is around USD 150 million a year.

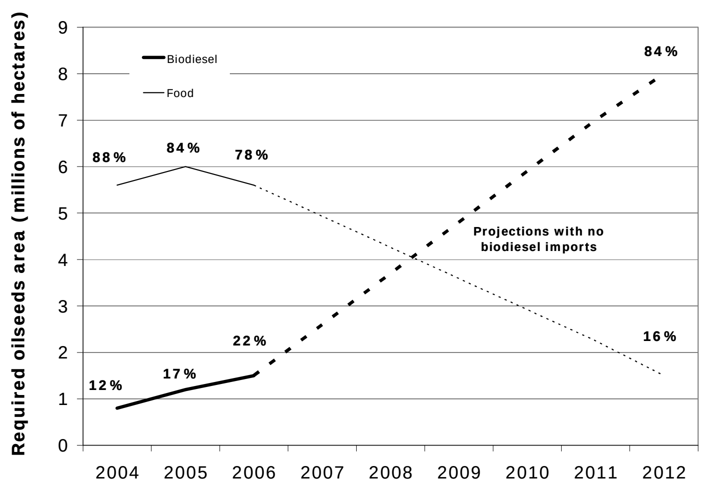
4. INTERNATIONAL MARKETS AND TRADE BARRIERS

Ethanol and vegetable oils have been travelling between countries for many decades. Ethanol was mainly imported for use in beverages or for industrial uses prior to the late 1970s. With the emergence of policies giving tax preferences to motor fuels blended with biofuels, particularly ethanol, however, a potential for an increase in traded volumes seemed likely. A major set-back occurred early on in the development of this trade, however, when the United States in 1980 imposed a so-called "secondary tariff" on imported fuel-ethanol.

With the return to high petroleum prices, and the creation of renewable-fuel targets in an increasing number of countries, trade in ethanol and vegetable oils is attracting attention once again. Because trade statistics do not distinguish fuel from other grades of ethanol, vegetable oils destined for use as feedstock from other uses, or biofiesel from other miscellaneous chemicals, it is not possible to determine precisely the volumes or the values being traded. However, a reasonable estimate is that in 2005 trade covered about 10% of the world's fuel ethanol consumption (Walter et al., 2007). The percentage of vegetable oils used for biofuel feedstock (or as SVO) and biodiesel that was sourced abroad is unknown, but unlikely exceeded 10% of the market in 2005.

Trade is likely to grow in the future, if for no other reason that limits to growth in production will be encountered in several of the main consuming countries of the OECD, particularly in Europe. Already, the area dedicated to growing oilseeds for energy use is taking up 22% of the land planted to oilseed crops in the EU. To meet its target volumes for 2012 would require dedicating 84% of its oilseed area — an unrealistic outcome (Figure 7). If, instead, the EU were to limit the oilseed area dedicated to biofuel feedstock to 50%, it would still need to import an additional 4.2 million tonnes of plant oils or biodiesel by 2012, compared with around 7.5 million tonnes (for both food and industrial uses) in 2006 (Jank *et al*., 2007).

Figure 7. **Share of current and projected oilseed area that would be needed in order to meet EU targets for biofuels**



Source: Jank et al. (2007).

Nonetheless, a number of barriers to trade in biofuels and biofuel feedstocks remain. These are traditionally classified under two headings: tariff barriers and non-tariff barriers.

4.1. Tariff barriers

As discussed in Section 3.1, tariffs apply both to feedstock materials for making biofuels, and the biofuels themselves. The tariffs countries apply to ethanol and feedstocks for ethanol (especially sugar) are generally higher than for biodiesel or feedstocks for biodiesel (which can also be sold as SVO). For ethanol, the MFN tariffs range from roughly 6% to 50% on an ad-valorem equivalent basis in the OECD, and up to 186% in the case of India. Bound and applied tariffs on biodiesel in OECD economies are relatively low, varying between 0 and 7%. Tariffs applied by developing countries are generally between 14% and 50% (Steenblik, 2006).

Besides offering protection for domestic producers of these biofuels and feedstocks, enabling some production to take place that would not otherwise, the differential application of tariffs due to bilateral and regional trade arrangements and general systems of preferences, can be trade-diverting.[9] For example, prior to 1 July 2005, Pakistan benefited from Special Arrangements for Combating Drug Production and Trafficking under the EU’s Generalized System of Preferences (GSP) anti-drug regime. Able to export its ethanol to the EU at zero tariff, it became the EU’s second-leading foreign supplier of ethanol (Bendz, 2005). Once brought under the General Regime, Pakistan was still able to benefit from a 15% reduction in the import duty on ethanol for six months. But as of 1 January 2006, ethanol was withdrawn from the scope of the General Regime, which meant that Pakistan lost all preferences on its ethanol. Following the change in July 2005, Pakistan reported that the resulting loss of trade had led to the closing of two of its seven operating distilleries, and that another five new distilleries would probably abandon plans to begin operations due to uncertainties in the market situation (Bendz, 2005).

A similar fate could one day befall ethanol exporters in Caribbean Basin nations, which currently benefit from a special concession dating from 1983 that grants them tariff-free access to the U.S. market on volumes up to 7% of U.S. domestic consumption. Rather than produce ethanol themselves, most dehydrate ethanol imported from Brazil, a value-adding step that meets the U.S. requirement that products qualifying under the tariff quota be “substantially transformed” if they do not originate from the countries themselves. In the past, Caribbean Basin nations have consistently been under-quota. But the prospect of exporting up to 9.3 billion litres of ethanol to the United States tariff-free (while still benefiting from the tax credit) — should President Bush's goal of using 35 billion gallons (132.5 billion litres) of alternative fuels by 2017 become mandated — is now attracting a flurry of new investments in dehydrating capacity (Etter and Millman, 2007). Almost all of this capacity would become redundant should the U.S. Congress not renew the secondary tariff on ethanol when it expires at the end of 2008, or if it were to revoke the tariff-rate quota.

9. Walter et al. (2006) notes that 45% of the ethanol imported by the EU in 2005 came in under the normal MFN regime, 29% under reduced duty regimes and 26% of the imports had no duties.

Another tariff-related issue concerns the classification of biofuels in the Harmonized System (HS). Because the tariff classifications do not correspond well with the how the biofuels are used, problems can arise with respect to consistency, certainty and non-discrimination in the application of tariffs (Howse *et al.,* 2006). Until the end of 2006, for example, Brazilian fuel ethanol entered Sweden not under the classification for denatured ethanol (HS 2297.20) but under the same HS sub-heading as used for biodiesel, HS 3824.90.99, which attracts a much lower rate of duty.[10]

4.2. Non-tariff barriers

In trade parlance, the term "non-tariff barriers" (NTBs) refers to a wide range of border and behind-the-border measures that may slow or inhibit trade. The UNCTAD Secretariat (UNCTAD, 2005) has produced a classification scheme for NTBs that defines the following categories:

- Government participation in trade and restrictive practices tolerated by governments
- Customs and administrative entry procedures
- Technical barriers to trade
- Sanitary and phytosanitary measures
- Specific limitations (such as quantitative restrictions)
- Charges on imports (other than tariffs, such as surcharges or port taxes)

Many non-tariff barriers, such as regulations relating to public health and safety, are recognized by the trade-policy community as essential. Other barriers, such as long delays in clearing customs because of over-bureaucratic customs and administrative-entry procedures, are regarded as generally worth streamlining. Here, only NTBs that are specific in their application to biofuels or their feedstocks are discussed. These are: government participation in trade and restrictive practices tolerated by governments, sanitary and phytosanitary measures, and technical barriers to trade.

4.2.1 Sanitary and phytosanitary standards

Biofuel feedstocks, final products and vehicles designed to run on biofuels often face sanitary and phytosanitary (SPS) measures or technical regulations applied at borders. SPS measures mainly affect feedstocks which, because of their biological origin, can carry pests or pathogens. One of the most common form of SPS measure

10. Sweden's reasoning was apparently that the degree of denaturing was higher than would be normal for denatured ethanol (Howse et al., 2006).

is a limit on pesticide residues. Even though pesticide residues are regulated mainly to ensure the safety of food and beverages, and are much less of a problem in biofuels feedstocks that will undergo thermal or chemical processing, customs agents nonetheless may have no other choice than to apply the same regulations to vegetative biofuel feedstocks as to crops destined for human or animal consumption, especially if they have no way of determining the product's end use. Meeting pesticide residue limits is usually not difficult, but on occasion has led to the rejection of imported shipments of crop products, especially from developing countries (OECD, 2005).

4.2.2 Technical norms relating to product characteristics

In WTO parlance, technical regulations generally refer to mandatory requirements not covered by the SPS Agreement. In the area of biofuels, these concern the chemical and physical characteristics of the final product, as well as to regulations pertaining to how the biofuels or their feedstocks were produced and processed.

Regulations pertaining to the technical characteristics of liquid transport fuels, including biofuels, exist in all countries. These have been established in large part to ensure the safety of the fuels and to protect consumers from being sold fuels that could cause costly damage to their vehicles' engines.

Two types of technical regulations affect trade in biofuels: maximum levels of ethanol or biodiesel allowed in commercially sold blends with petroleum fuels, and regulations pertaining to the technical characteristics of the biofuels themselves.

Regulations pertaining to fuel characteristics are less of an issue for ethanol than for biodiesel. Ethyl alcohol is a simple chemical, and when sold as a fuel may contain water, trace amounts of impurities (such as methanol, chlorine and copper), and a denaturant, such as gasoline. Not all countries have created specific quality standards for fuel ethanol — in their absence, the standards that apply to neutral spirits suitable for making beverages, or to industrial-grade alcohol, are typically used — and thus some degree of variability in import requirements exists. (A listing of the applicable standards can be found at www.distill.com/specs/index.html.) Despite this variability in the levels of allowed denaturants and concentrations of impurities varying from one country to another, the regulations are generally not difficult to meet.

By contrast, many chemical and physical characteristics of biodiesel — such as density, viscosity, cetane value, flash point, iodine value and sulphur content — depend on the feedstock and how it has been processed, and can vary considerably. The definition of biodiesel applied by the World Customs Organization makes explicit reference to the ASTM (American Society for Testing and Materials) "Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels", or D 6751. However, under rules set out in the WTO's Agreement on Technical Barriers to Trade, Members are allowed to adopt their own regulations as long as they can justify them. Accordingly, the European Commission has issued its own norm (EN 14214), which in addition limits the iodine value of the biofuels to a maximum of 120 grams per 100 grams.[11] As Jank et al. (2007) point out, since soybean oil has a relatively high level of iodine, this regulation effectively limits the use of soy oil in biodiesel production to 20-25%. Biodiesel made from rapeseed oil, the principal feedstock for biodiesel in Europe, has no trouble meeting the norm.

Biodiesel made from palm oil encounters problems meeting the standards of several countries. Because the temperature at which dissolved solids begin to form and separate from the oil (as measured by its "cloud point") is lower for palm oil than for most other nut or seed oils, biodiesel made from palm oil is less suitable for use in cold weather. This problem can be remedied through further processing, but it limits its use in climates like those of Northern Europe and Canada.

4.2.3 Sustainability standards and regulations

Increasingly more significant to biofuels trade are requirements imposed or considering being imposed on either feedstocks (such as palm oil) or final products that relate to non-product-related processes or production methods (PPMs). Discrimination in trade on the basis of PPMs is highly contentious, and has been the nub of several precedent-setting trade disputes at the WTO.

The different standards and regulations under consideration are discussed in more depth in a companion paper to this one, but may be summarized as falling into four broad categories:

1. *Private-sector standards,* which are promulgated by non-governmental bodies and are strictly speaking voluntary.

2. *Government voluntary standards,* which are often implemented in connection with positive labels, and are intended to reward (through the higher prices expected to be paid by concerned consumers) performance beyond the norm.

3. *Regulations linked to tax exemptions or subsidies,* which make eligibility to benefit from a government support measure or similar policy contingent on satisfying particular criteria.

4. *Regulations linked to achievement of a domestic policy goal,* which make attainment of a domestic policy goal — e.g., meeting a sector-specific greenhouse-gas emission reduction target — dependent on certification of regulations or some stage in an imported product's production or processing.

The following provides some examples of current and emerging standards and regulations.

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[11]. http://www.biofueltesting.com/specifications.html

Private-sector standards

Private-sector standards and certification schemes may be led by producers, consumers, even by parties without a direct financial interest in the business, or any combination thereof. Numerous indicative standards are being developed at the national level, such as the U.S.-based Institute for Agriculture and Trade Policy (IATP's) "Principles and Practices for Sustainable Biomass Production", which aims to improve the sustainability of biomass production in the upper Midwest (Kleinschmit, 2006a and 2006b). At the international level, stakeholders with interests in the oilseeds and sugarcane industries have formed, respectively, the Roundtable on Sustainable Palm Oil (www.rspo.org) and the Roundtable on Sustainable Soy[12], as well as the Better Sugarcane Initiative (www.bettersugarcane.org). These initiatives tend to be aimed at improving environmental and social standards of producers within the industry, often through creating voluntary codes of good practice.

At a more global, all-encompassing level, is the Roundtable on Sustainable Biofuels, formally launched in April 2007. The Roundtable, which is hosted by the Energy Center at the Ecole Polytechnique Fédérale de Lausanne, Switzerland, has assembled non-governmental organizations, companies, governments, inter-governmental organizations, experts, and other concerned parties "to draft principles and criteria to ensure that biofuels deliver on their promise of sustainability."[13] Four sets of criteria are being developed: greenhouse gas lifecycle efficiency; environmental impacts, such as impacts on biodiversity, soil and water resources; social impacts, ranging from labour rights to impacts on food security; and implementation (i.e., that the standards are easy to implement and measure). The Roundtable has set a target of early 2008 for its first draft standards. Its hope is that these standards will then "create a tool that consumers, policy-makers, companies, banks, and other actors can use to ensure that biofuels deliver on their promise of sustainability" (EPFL Energy Center, 2007).

Government voluntary standards

Government-endorsed sustainability standards that serve merely an indicative role are also emerging in many OECD countries, often initially as preludes to the adoption of standards or regulations linked to subsidies or environmental policies (van Dam et al., 2006). At present, however, none are operating except as pilot schemes.

Standards linked to tax exemptions or subsidies

There is at least one operating and two proposed examples of type III standards in the world today. Brazil's Social Fuel Seal, which was created at the end of 2004 (Decrees 5297 and 5298) as part of a package of measures under the country's

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12. www.panda.org/about_wwf/what_we_do/forests/news/events_/index.cfm?uNewsID=17676

13. http://cgse.epfl.ch/page65660-en.html

National Biodiesel Programme, strives to take into account regional social inequalities and the agro-ecological potential for biodiesel feedstock production of different regions. Certification enables biodiesel producers to benefit from reduced rates of taxation on biodiesel, compared with the rates normally applied to petroleum diesel. The rate of exemption is 100% for biodiesel certified with the Social Fuel Seal produced from castor oil or palm oil in the North and North-east regions, versus 67% for biodiesel produced from any source in other regions that do not qualify for the Social Fuel Seal. In the way that it operates, only Brazilian firms can qualify for the higher tax breaks.

In March 2007, the Swiss Government amended its Mineral Fuel Tax in a way that will in the future (probably starting in 2008) also tie tax benefits for biofuels to a system based on various environmental and social criteria (Box 1). Under the new rules, both domestic and imported biofuels that benefit from a reduced fuel excise tax require "proof of a positive total ecological assessment that ensures also that the conditions of production are socially acceptable". But, in addition, the government, "taking into account of the amount of domestically available renewable fuels, shall establish the quantity of renewable fuels that can be exempted from the tax at the time of the importation."

Box 4.1 The 23 March 2007 Amendments to Switzerland's Mineral Oil Tax Law pertaining to tax exemptions for biofuels

Article 12b — Tax exemption for fuels derived from renewable raw materials

1. Domestically produced fuels derived from renewable raw materials are exempted from the [mineral oil] tax in accordance with Paragraph 3.

2. The Federal Council, taking into account the amount of domestically available renewable fuels, shall establish the quantity of renewable fuels that can be exempted from the tax at the time of the importation. This tax exemption can be granted only if the requirements of Paragraph 3 are also met.

3. The Federal Council shall establish for fuels derived from renewable raw materials:

   a. The amount of the tax exemption, taking into account:

      1. in particular, the domestic supply of renewable raw materials;

      2. the contribution that these fuels will make to environmental protection and the objectives of [the country's] energy policy;

      3. the competitiveness of these fuels compared with fuels of fossil origin;

   b. the minimal requirements relating to the proof of a positive total ecological assessment that ensures also that the conditions of production are socially acceptable.

Even more recently, a group commissioned by the government of the Netherlands in 2006 submitted their proposals to the Dutch Minister of Housing, Spatial Planning and the Environment on how to create a market for sustainable bio-energy (Creative

Energie, 2007).[14] The report proposes that access to any subsidies for biofuels be contingent on satisfying nine major criteria and numerous sub-criteria (Annex 1). According to Rembrant (2007):

> Many of these criteria still need to be worked out in further detail regarding how to monitor their compliance by bioenergy companies. A preliminary system with less stringent criteria will come into effect in the course of 2008 when the new subsidy scheme for sustainable energy of the Dutch Government will start to function. After that several years of development and testing will take place, [so] as to put the full system of criteria with the relevant indicators and monitoring systems in place in 2011. By then, the European Commission probably will have proposed a similar system for the entire European Union.

Taken together, the proposed criteria are extremely stringent, and would be a challenge to satisfy, even by many producers in OECD countries. Moreover, they are in several cases highly prescriptive. For example, Criterion 2.2 stipulates that the biomass production "will not take place in areas with a high risk of significant carbon losses from the soil, such as certain types of grasslands, peat lands, mangroves and wet areas." Would that bar, for example, ethanol produced from tapping mangrove palms in Malaysia — a practice that would seem to actually *encourage* the reservation of the carbon in these soils?

Regulations linked to achievement of a domestic policy goal

The leading example of this type of regulation is the UK's Renewable Transport Fuel Obligation (RTFO). Beginning 1 April 2008, the RTFO will oblige fuel suppliers to ensure that a certain percentage of their aggregate sales is made up of biofuels — 5% by 2010. Obligated companies will be required to submit reports on both the net greenhouse gas saving and sustainability of the biofuels they supply. This information, in turn, will be used to develop sustainability standards, which may be imposed if the RTFO is extended.

Although the reporting requirement does not (yet) discriminate among sources, failure to report makes a fuel supplier ineligible for any certificates proving that they have met their biofuel obligations. It remains to be seen whether the reporting obligation will bias the fuel suppliers towards biofuel producers whose records are comprehensive, and in English, and whose claims can be easily verified by inspection. Moreover, as described in the UK Department of Transport's web page on "Frequently Asked Questions"[15], the Administrator of the RTFO expects that these

[14]. The likelihood that these proposals will be considered very seriously seems high, as the woman who chaired the study group, Prof. Dr. Jacqueline Cramer, recently became the Dutch Minister of Housing, Spatial Planning and Environment, and thus submitted the report to herself.

[15]. http://www.dft.gov.uk/pgr/roads/environment/rtfo/faq

reports, once published, will constitute a “league table” of suppliers and biofuel producers, thus encouraging better performance.

Longer term, the scheme could evolve into one that specifically links RTFO certificates with GHG savings determined though a standardized GHG certification system. Already, a feasibility study, commissioned by the UK government (Bauen *et al.*, 2005), has recommended such a scheme.

On 18 January 2007 the Governor of California established a Low Carbon Fuel Standard (LCFS) by executive order. The LCFS requires that the carbon intensity of transportation fuels sold in California be reduced by at least 10% by 2020. Two weeks later, the European Commission announced a new pollution standard for motor fuels that is almost identical to California’s. Both plans would rely on developing an agreed method for measuring the full fuel-cycle carbon output of alternative fuels and a system of certification of the life-cycle carbon emissions of fuels, including biofuels. However, the Commission plans also to allow only those biofuels whose cultivation complies with minimum sustainability standards to count towards the EU’s renewable fuel targets. Collaboration between the EU and California aims at ensuring that their standards and rules converge and provide a more seamless market for fuel producers and distributors.

4.2.4 Possible effects on trade

It is too early to say whether any of the sustainability certification schemes in existence or proposed will on balance enhance or hinder trade. Today it is recognized that private-sector standards can have a small or a big effect on trade, depending on the share of the market they cover, the way they are implemented, their complexity, and so forth. At the moment, none of the private, voluntary standards appear to be influencing trade flows or volumes. But these are still early days.

In respect of to “sustainability requirements” imposed by governments, often compliance with the standards themselves is the least of an exporter’s concerns. Rather, the proliferation of different standards may be problematic, or the process of accrediting local certifiers may be onerous, thus requiring inspection by experts from abroad, which can raise the costs of producing for foreign markets considerably (OECD, 2005). Fortunately, the fact that countries and non-governmental organizations seem to have acknowledged these types of potential problems early suggests that some of barriers created by national regulation of organic product standards (see OECD, 2005) may be avoided in the case of biofuels. Encouragingly, the EU, for one, has expressed its intention to apply its proposed system of certificates in a non-discriminatory way to domestically produced biofuels and imports (EC, 2005).

4.3. Future changes in trade policy

Until around 2003, to the extent anybody used the words “ethanol” and “trade policy” in the same sentence, it was most likely in the context of ensuring that tariffs protecting domestic producers remained in place. Nowadays “biofuels” and “trade round” are being linked at every turn, though those making the linkage have very different agendas, and thus are advocating different ideas.

One of the discussions into which liquid biofuels have been injected are the negotiations on liberalizing trade in environmental goods and services (paragraph 31(iii) of the Doha Development Agenda). These negotiations have been taking place mainly in the WTO’s Committee on Trade and Environment, meeting in special session (CTE-SS), which has been set the task of identifying which goods (i.e., tariff lines) should qualify as “environmental” when the issue of modalities for implementing the mandate is taken up in the Negotiating Group on Non-Agricultural Market Access (NAMA). The CTE-SS discussions have been stymied by disagreement between OECD member economies and a large number (though not all) developing countries over whether normal liberalization of trade in environmental goods, as opposed to liberalization on a project-by-project basis, is in everybody’s best interest. Nonetheless, that has not prevented some of the WTO members who have remained non-commital in this dispute from suggesting that if they *were* to support the liberalization of particular goods, their priority products would be ethanol and associated technologies.

Many WTO Members, including virtually all OECD countries, have pointed to the fact that ethanol is covered by the Agreement on Agriculture, which, they insist, disqualifies it for consideration as an environmental good. Biodiesel is not burdened by that classification problem, by contrast, and has been proposed by several OECD member countries (e.g., Canada and New Zealand) to be included among a WTO list of environmental goods. This is a rather uncontroversial suggestion, as applied *ad valorem* tariffs on biodiesel, which is classified as a chemical rather than an agricultural product, are already 6.5% or less in OECD countries.

Alas, the negotiations on environmental goods and services came to a standstill in July 2006, along with the rest of the Doha Round multilateral trade talks, primarily over one issue: agriculture.

Enter biofuels to the rescue! Production of biofuels, it is assumed, by absorbing surplus production will allow developing countries either to sell more commodities to the industrial North, or transform more of their commodities, such as sugar and sweet sorghum, into biofuels, both for their own use and for export.

The notion that biofuels hold the key to unlocking the Doha Round trade negotiations already has some powerful supporters. The United Nations Foundation, the foundation endowed with a USD 1 billion grant from U.S. media tycoon Ted Turner, has been in the vanguard. At the WTO’s September 2006 Public Forum, Mr. Turner hailed biofuels as ushering in a brave new world in which low commodity prices will be a thing of the past, and agricultural export subsidies would disappear. Details on exactly what kind of deal he would like to see are sketchy, but it appears that it would involve a shift in subsidies from crop production to biofuel production: As Mr. Turner recommends at one point in his speech, “Developed countries should agree to phase out tariffs and reduce their subsidies for food and fiber crops and replace them with support for biofuels.” (Turner, 2006)

Meanwhile, another group, calling itself Biopact (www.biopact.com), is working for “a green energy pact between Europe and Africa”. It’s “Biofuels Manifesto”, written by John Mathews, a professor of Strategic Management at Macquarie University, Sydney, calls for, among other policy changes, the elimination of barriers to trade in biofuels: “Here the WTO has an enormously important role to play”, writes Mathews, “in ensuring that the coming biofuels century is not wrecked at the outset by greedy and short-sighted protectionist measures enacted by the developed world to obstruct global trade in biofuels.”

While there may be increasing agreement that biofuels hold the key to re-opening the WTO trade negotiations, there are major differences of opinion on the desired outcome. One scenario envisages a WTO deal on agriculture that legitimizes current and future subsidies to domestic production of ethanol and biodiesel; the other envisages reducing or bringing down barriers to trade in biofuels, including trade-distorting subsidies.

Of course, subsidies and tariffs benefiting crops used as inputs to biofuels (sugarbeets, maize, wheat and oilseeds) are not the only ones that are contentious at the WTO. Agreement needs to be reached on how to treat continuing high levels of support for cotton, rice and livestock products (particularly dairy products). Indeed, as feed prices are driven up by diversion of crops to biofuel production, livestock producers are finding themselves in a squeeze. We should not be surprised if they start demanding offsetting subsidies as well.

Meanwhile, in the absence of a renewed Agreement on Agriculture, trade policies affecting biofuels continue to be made. Recently, for example, the U.S. Congress extended its USD 0.54 per gallon (USD 0.143 per litre) MFN tariff on ethanol imported for fuel uses. That tariff had been due to expire at the end of September 2007; it will now remain in place until at least 31 December 2008. “At least” is a judicious phrase: a bill was introduced in the U.S. Congress early in January 2007 to make the tariff permanent.

5. POLICY IMPLICATIONS

The policy implications of government interventions in the market for biofuels — particularly use or blending mandates and production-linked subsidies and tax breaks — are manifold. The world is only just beginning to witness some of the effects of policies in this area, and not all are intended. This section provides only a brief overview of the implications that continued subsidization of biofuels has for agricultural markets, energy, environmental and transport policies.

5.1. Impacts on agricultural markets

The motivations for supporting biofuels have been surprisingly constant across countries. In all cases, the desire to stimulate new demand for crops in order to raise prices has been paramount. Although spokespersons for the Brazilian ethanol industry stress the emphasis given to find domestic substitutes for imported petroleum when the country embarked on its Proalcol programme in the 1970s, the depressed international price of sugar at the time was also an important factor. Similarly, policymakers in the United States and the EU have emphasize the opportunity growing crops for energy holds for its farmers. Frustrated by decades of propping up their farming sectors, they point to the “savings” in price-linked commodity payments that will result as prices for sugar, starch and oil crops rise.

Until recently, policies in OECD countries to promote biofuels provided an additional outlet for crops, helping at the margin to absorb surpluses, without substantially affecting end-user prices. In the last 18 months or so, prices for all crops used as inputs to biofuel production have risen dramatically (Tables 1 and 2).

In the United States, for one, the rises in the prices of corn and soybeans translate into smaller levels of certain crop-related government subsidies for 2006 and probably for 2007 (Annex Table 1). However, any savings to be squeezed out of the main price-triggered commodity support programmes — counter-cyclical payments and marketing loan benefits (loan deficiency payments, marketing loan gains, and certificate exchange gains) — have for the most part been realized. Meanwhile, the volumetric excise tax credits for ethanol and biodiesel — the main federal support mechanisms for biofuels in the United States — can be expected to continue to grow along with increased production. Thus while farm payments in 2007 are forecast to be at the same level as for 2002 (USD 12.4 billion), the total of farm payments plus the excise tax credits is forecast to be USD 16.4 billion. This is USD 2.9 billion more than the total of farm payments plus the excise tax exemptions in 2002. By 2010, losses to the U.S. Treasury from domestic biofuel production (i.e., not counting tax credits paid on imported biofuels) could reach USD 6.8 billion a year. Note also that one effect of support for biofuels has been to raise the value of farm assets, particularly land. While this benefits existing land owners, it raises costs for those who lease land for farming, and also the cost of reserving land for conservation purposes.

Producers of the feedstock crops number among the winners of the biofuels boom, of course, at least in the short term. (Time will tell whether there will be a biofuel bust.) The effect on livestock producers has been more mixed, however. The cattle industry, or at least that part of it in the proximity of grain-ethanol plants, has experienced only moderate rises in the price of protein feeds — thanks to increased production of dried distillers' grains with solubles (DDGS). Producers of pigs and poultry, however, have had to contend with steep increases in the prices of energy grains, such as maize.

Rising prices are also affecting the bottom line of companies that purchase sugar, wheat, maize and oilseeds as inputs into foods and other consumer products. Much has been made of the so-called "tortilla crisis" in Mexico, which witnessed a 60% rise in the price of tortillas — a staple food of poor families — in December 2006 (Navarro, 2007)[16], but there have been other industries that have been adversely affected as well, including manufacturers of soap (who use tallow) and beer.

5.2. Energy policies

The idea that producing biofuels at home will reduce a country's dependence on foreign sources of energy, particularly oil from the Middle East, has also helped increase the political popularity of biofuels. This rational, present at the time that Brazil's and the USA's first biofuel-support programmes were crafted, waned during the 1980s and 1990s, but has recently returned to centre stage.

Security of supply is perhaps the pre-eminent goal of "energy policy", often expressed in terms of minimizing risk of interruptions in supplies (such as imports of petroleum or natural gas, or electric-power outages), but more accurately stated in economic terms. Basically, all else equal, governments want to keep prices of energy low, minimize volatility and reduce the environmental impact of energy.

Most OECD countries have active departments in their Energy Ministries to promote renewable energy. Since the shock of the 1973-74 oil crisis, renewable energy has been widely viewed as an intrinsically "good thing" — produced at home, often "high tech", and not dependent on finite stock resources. Biofuels gained the coveted "renewable energy" label as soon as they started to be produced again in the 1970s. No matter that many of the inputs used to produce them are decidedly non-renewable — soils, agrichemicals, fossil fuels — the label has stuck. This labelling has benefited the industry politically to the extent that it has deflected criticism. Who can be against renewable energy?

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[16]. Although Mexican officials suspect uncompetitive behaviour on the part of the country's main tortilla producer, many are also pointing to the increased demand for corn for ethanol production.

Public subsidies to biofuels are often proposed as a way to wean a country from its dependence on fossil fuels in general, and petroleum in particular. How efficiently biofuels subsidies help to reduce reliance on petroleum, or on fossil fuels in general, depends on the amount of petroleum (or fossil energy in general) invested in creating and delivering the biofuel to the final user.

The production of ethanol, except in countries producing it from cane, relies heavily on fossil fuels, particularly natural gas. Unfortunately, natural gas markets are developing many of the same supply insecurities as exist with imported oil. Coal can also be used to fuel ethanol refineries, as is becoming commonplace in the United States, but that then worsens the environmental profile of ethanol substantially.

The degree to which the use of biofuels displaces petroleum (and fossil) energy varies fairly widely across estimates by different researchers, even when system boundaries have been standardized. For the U.S. cost study, Koplow (2006) side-stepped this controversy by simply using the highest and lowest normalized values from Farrell *et al.* (2006). He found that both ethanol and biodiesel provide fairly good petroleum displacement, though at a high cost. To displace one GJ of liquid petroleum fuels with ethanol, for example, costs roughly USD 15.60 (€ 11) in subsidies. That is equivalent to about € 0.38 per litre of petrol displaced, and is in addition to what the consumer pays for the fuel at the pump.

Displacement factors for fossil fuels overall are considerably worse for biodiesel and starch-based ethanol than for cellulosic ethanol. This is due to a fossil-intensive fuel cycle, including feedstock production and high consumption of natural gas within the plants themselves. Nonetheless, even the cellulosic process (assuming similar subsidies per litre as for starch-based ethanol) would still require between USD 10 and USD 14 in subsidies per GJ of fossil energy displaced. It is not clear that this would be competitive with alternative strategies, especially those that took into consideration the potential for demand-side measures.

In the current rush to promote biofuels, the demand side of the equation has almost been forgotten. Even the most ardent proponents of biofuels concede that starch-based ethanol takes a considerable amount of energy to make, and that the net yield is modest. That is not surprising for any supply-side approach. By comparison, a litre of gasoline or diesel conserved because a person walks, rides a bicycle, carpools or tunes up his or her vehicle's engine more often is a full litre of gasoline or diesel saved, at a much lower cost to the economy.

Table 7. **Subsidies to ethanol and biodiesel per net GJ of liquid petroleum fuels and net fossil fuels displaced, and per metric ton of CO_2-equivalent avoided in the United States**

Element		**Ethanol**		**Biodiesel**		**Cellulosic ethanol (hypothetical case)**[1]	
	Units	**Low**	**High**	**Low**	**High**	**Low**	**High**
Subsidy per net million Btu (MMBtu) of liquid petroleum fuels displaced[2]							
Estimate for 2006	$/GJ	15.10	16.10	14.60	18.60	10.50	13.20
Annualized estimate, 2006-2012	$/GJ	15.30	17.00	10.80	14.70	11.10	14.60
Subsidy per net million Btu (MMBtu) of fossil fuels displaced							
Estimate for 2006	$/GJ	29.30	38.90	25.80	32.90	10.10	12.70
Annualized estimate, 2006-2012	$/GJ	29.80	40.70	19.00	26.00	10.70	14.10
Subsidy per metric ton of CO2-equivalent emission reduced							
Estimate for 2006	$/tonne	NA	520	NQ	NQ	118	147
Annualized estimate, 2006-2012	$/tonne	NA	545	NQ	NQ	124	164

NA = not applicable.
NQ = not quantified.
1. This scenario assumes that all of the existing subsidization of ethanol (with the exception of support to crop feedstocks), would benefit cellulosic ethanol, and that it had successfully built an infrastructure with the current profile of our starch-based production system. We then evaluate subsidy intensity metrics to assess whether the incremental benefits from cellulosic ethanol are sufficient to significantly change the resultant subsidy cost per unit of fossil fuel or greenhouse gas displacement.
2. Displacement factors represent the high and low values in the range, from Farrell et al. (2006) and U.S. EPA (2006a). These are lifecycle estimates that compare the level of fossil fuel or petroleum use in the baseline (gasoline or diesel) with use of the biofuel.
Source: Based on Koplow (2006).

Because most liquid biofuels will be consumed as blends with gasoline or petroleum diesel, biofuels will for some time to come be complements to petroleum-based transport fuels, not major competitors with them. This complementarity is illustrated in some of the unintended consequences of policies (regulatory or tax incentives) to encourage the production and purchase of automobiles capable of running on pure petrol (gasoline) or any ethanol-petrol blend up to E85 (a blend of 85% ethanol by volume and 15% petrol) or even pure ethanol. Brazil's first supported the sale and consumption of cars designed to run only on 100% hydrous ethanol. These were not flex-fuel vehicles (FFVs), as they could not use gasoline. The policy was a success, measured by share of the market, but ended in tragedy in the 1980s, when high sugar prices and low petrol prices resulted in shortages of hydrous ethanol, and long queues at filling stations. The market for alcohol-only vehicles dried up almost over night. More recently, automobile manufacturers have started selling true FFVs, and now the majority of new cars bought are flex-fuel. But the actual fuel they consume depends on the relative prices of ethanol and gasoline.

The United States took a regulatory approach to promoting FFVs. Rather than subsidize FFVs directly, the U.S. Congress allowed makers of FFVs (and several other approved categories of alternative-fuel vehicles) to obtain credits against corporate average fuel-economy (CAFE) standards. The problem with what came to be known colloquially as the "dual-fuel" loophole was it depends only on "capability" to use E85, not actual use. The motivating hypothesis was that, as the number of FFVs on the road increased, pumps for dispensing E85 would follow. It did not happen that way.

As a result, the vast majority of owners of FFVs ran their vehicles exclusively on gasoline, and many were not even aware that their vehicle could run on E85. Moreover, because the fuel-economy credit for FFVs in the United States is greatest in respect of the least-efficient models, automobile manufacturers have concentrated on the larger, more-expensive end of the market — sport utility vehicles (SUVs) and "light trucks". Even in 2005 (the latest year for which figures are available), only 25% of the FFV models sold in the United States were sedans or minivans; the rest were SUVs, light trucks, or "medium-duty" vehicles. The consequence of avoiding having to comply with tighter fuel-economy standards means that the United States in 2005 actually imported 80,000 more barrels of oil a day than it would have in the absence of the dual-fuel loophole (MacKenzie *et al.*, 2005).

5.3. Environmental policies

Another motivation for supporting liquid biofuels has come from their emission profiles when used as motor fuels. Especially when compared with low-grade gasoline and diesel, liquid biofuels generate lower levels of particulate matter and sulphur oxides. Ethanol also boosts the octane level of gasoline, and is generally considered less harmful to human health than other octane boosters, such as lead- or methyl-tertiary butyl ether (MTBE). Such factors have been important in gaining support for biofuels in the cities of the United States, and to some extent Brazil and Europe.

In Europe, biofuels are supported because, by substituting for fossil fuels, they can (depending on the production process) reduce global emissions of carbon dioxide (CO_2), an atmospheric gas that helps to retard the escape of infra-red radiation from the earth and thus keep it warm. Since the oxidation of the carbon bonds in the biofuel are counterbalanced by the uptake of CO_2 by the feedstock plant material, the photosynthetic and combustion portions of the biofuel life cycle are carbon-neutral.

By contrast, the intermediate stages of the cycle — planting, fertilizing, harvesting, transporting and transforming the feedstock crops into biofuels and their byproducts — can require substantial energy inputs. Moreover, if growing the feedstock crops involves exposing carbon resident in the soil to air, or burning down forests, additional CO_2 may be released into the atmosphere. Whether the CO_2 emitted in the various stages of biofuel production (and how one counts those emissions) exceeds the CO_2 absorbed by the crops was already a topic of fierce debate in the 1980s, and remains so today. That the emission balance can vary widely depending on the type of crop, agricultural system, and the technology for transforming it into a biofuel, is, at least, widely acknowledged.

Once the intermediate stage is taken into account, the cost of obtaining a unit of CO_2-equivalent reduction through subsidies to biofuels can prove to be much higher than alternatives. Koplow (2006) calculated that ethanol subsidies are well over $500 per metric ton of CO_2 equivalent removed for corn-based ethanol in the United States, even when assuming an efficient plant using low-carbon fuels for processing (Table 7). (If the heat source for processing is coal, the GHG gain is small or even negative.) Yet even under such best-case scenario assumptions for GHG reductions from maize-based ethanol, one could have achieved far more reductions for the same amount of money by simply purchasing the reductions in the marketplace — more than 30 metric tons on the European Climate Exchange, or nearly 140 metric tons on the Chicago Climate Exchange.

Environmental policy concerns more than just emissions of air pollutants and greenhouse gases. In respect of soils and water, the expansion of crops for biofuels can actually have negative effects. Already, rapid growth in demand for biofuel feedstocks, particularly maize and soybeans, is changing cropping patterns in the U.S. Midwest, leading to more frequent planting of corn in crop rotations, an increase in corn acreage at the expense of wheat, and the ploughing up of grasslands. Maize is also a crop that requires lots of water, and the current trend in the expansion of maize-based ethanol is westward, into areas that are more dependent on fossil water sources, like the Ogallala Aquifer, than is corn produced in the central Midwest. The ethanol plants themselves also require significant volumes of water, and reports in the press of local concerns over their effects on water supplies are appearing with increased regularity.

Proponents of cellulosic ethanol argue that a broader mix of indigenous feedstocks would address many of these problems. However, once cellulosic acreage is scaled to provide meaningful displacement of gasoline, many similar issues regarding crop diversification, land conversion, and the need for additional inputs like water and fertilizers could arise.

5.4. Transport and related tax policies

Even though many of the arguments used to support liquid biofuels are aimed at the very heart of industrialized countries' transport systems — vehicles propelled by internal combustion engines — transport Ministries have generally been the policy takers rather than the policy makers with respect to biofuels. Transport planners and economists, as a rule, are sceptical of biofuels, and are often heard to argue that they are an expensive way to achieve public-policy objectives. Generally, this policy community has simply had to endure policies to support liquid biofuels that have been imposed on them by Parliaments.

Perhaps the largest intersection with transport policies has been the numerous exemptions from fuel excise taxes. In many countries, the revenues from these taxes flow straight into the treasury, and are not truly an element of "transport policy". In Canada, Switzerland and the United States, however, revenues from fuel-excise taxes are hypothecated to separate Trust Funds, from which investments in transport infrastructure are financed.

The United States was one of the first OECD countries to exempt ethanol-petrol blends from a fuel-excise tax, in 1979. The exemption was worth $0.04 per gallon of "gasohol" (E10), or $0.40 per gallon of pure ethanol. This had the unintended economic consequence of reducing appropriations from the Highway Trust Fund even to states that sold no gasohol. Rask (2004) estimates that between 1981 and 1996, U.S. state governments lost between USD 3.2 billion and USD 7.6 billion in highway funds (compared with the counterfactual of no federal tax relief on gasohol), and that some of the biggest losers were states such as Florida, New York, and Pennsylvania, which during those years sold very little fuel containing ethanol.[17] The haemorrhaging of the Highway Trust Fund only came to an end with enactment of the 2004 JOBS Creation Act, which eliminated the federal tax exemption for E10 and replaced it with a $0.51 per gallon (€ 0.11 per litre) credit against corporate income tax, called the Volumetric Ethanol Excise Tax Credit (VEETC). Meanwhile, at least one-third of U.S. states continue to apply lower fuel taxes to E10, E85, or biodiesel blends.

Switzerland has taken a slightly different approach. Although legislation passed by its Parliament in October 2006 would in the future exempt all liquid biofuels from at least a portion of the normal fuel-excise taxes, not just liquid biofuels produced in

17. These numbers do not count revenue losses from exemption of excise taxes levied by the states themselves on motor fuels.

recognized “pilot and demonstration plants”, the new policy is intended to have a neutral effect on the total stream of revenues from fuel taxes. The government will maintain this revenue neutrality by raising taxes on petroleum-derived liquid transport fuels.

Many policies (beside the kinds described in the previous section on energy) have been used at a local level to favour flex-fuel vehicles, sometimes in creative ways. For example, in Sweden, company cars powered by ethanol have qualified for an 80% reduction of the (taxable) benefit attributed to users, compared with that which would have to be declared for a comparable “conventional” automobile. In addition, “clean cars” (for which FFVs qualify) enjoy free parking in several cities and are also exempted from the congestion charge recently introduced in Stockholm.

London, England’s congestion charge — which is intended to reduce traffic in inner London, and all the externalities (unproductive time, air and noise pollution) that go along with it — has come under criticism for not allowing an exemption or reduction in the charge for FFVs.

It is reasonable to ask, if congestion charges and similar policies are aimed at reducing traffic *per se*, why any vehicle that adds to the traffic should be exempt from a congestion charge. Even the reduced pollution argument for exempting FFVs is difficult to uphold, since it would be impractical to verify whether at any time an FFV is running on E85, pure gasoline, or some ethanol-gasoline blend in-between.

Across the Atlantic, municipalities in the United States have implemented all manner of exemptions from regulations and charges to favour FFVs. Some have allowed them to use special lanes set aside for HOVs (high-occupancy vehicles) — lanes on motorways normally reserved for vehicles carrying two or more people — even when the FFVs are being driven solo. Others have exempted FFVs from having to pay for parking. And several states have offered differential regulations, such as exempting FFVs from emission testing.

In the meantime, rapid changes in the pattern of freight transport are taking place in several countries as a result of increased movement of biofuels and their feedstocks. In Brazil, increasing export demand for its ethanol is encouraging major investments in dedicated long-distance ethanol pipelines and terminals.

In the United States, the largest government-backed guaranteed loan ever — USD 2.3 billion to enable the Dakota, Minnesota and Eastern (DM&E) railroad to expand and upgrade its service in from north-eastern Wyoming to Wisconsin — has been justified in part on the grounds that it will help in the transport of fuel ethanol from the Upper Midwest to cities such as Chicago. At a more local level, numerous states and municipalities are helping to finance the upgrading or construction of new rail spurs to biofuel, particularly ethanol, plants. Of course, the more money is invested in transport infrastructure to bring ethanol from the American heartland to the coastal megalopolises — where the majority of transport fuel is consumed — the harder it will be, politically, to eliminate the tariff that keeps cheaper, imported, ethanol from being delivered directly to these areas by ship.

6. CONCLUSIONS AND RECOMMENDATIONS

The settings of current production-linked support—the per-litre rates of subsidization—are highly arbitrary, and warrant re-examination. Overlapping programs may also carry a high cost for little benefit in terms of energy infrastructure. In a number of countries, production of biofuels is subsidized even though their consumption (through blending mandates or targets) is pre-determined. The maintenance of high tariffs on imported ethanol by Australia, the EU and the United States, in particular, sits at odds with the professed policy of their governments to encourage the substitution of gasoline by ethanol.

One indicator of the long-run cost-effectiveness of a public policy that is aims at reducing the use of a particular good, or the externalities associated with using that good, is how prescriptive it is about the alternatives. When the profile of the ideal desired alternative — e.g., a source of automotive power that is cheap, clean and flexible — requires unpredictable technological change, prudent policy is to keep as many options open.

Current biofuel support policies in OECD countries score low in terms of technological neutrality. Most are not linked to a specific process for producing ethanol or biodiesel, but they are specific to biofuels, or even to a particular biofuel, particularly on the consumption side. Mandates for biofuel use in transport fuels, while not yet at a level that risk crowding out other transport alternatives (e.g., hybrid cars that can run on biofuels) , nonetheless send a strong signal by governments that they are committed to personal transport based on vehicles powered by internal-combustion engines.

The high proportion of production-related support also encourages investments in refineries that could require the maintenance of support policies over many years, if not decades, to remain viable. Many of these subsidies are defended as necessary to support the development of a market for biofuels, to prepare the ground for next-generation liquid biofuels in particular.

This logic has not been subjected to close scrutiny. In OECD countries, the potential markets for ethanol and biodiesel are quite large even without modifying the existing vehicle fleet at all. Petrol-powered vehicles can handle 10% ethanol on a volumetric basis, with no modifications. This level has been surpassed in Brazil but is not expected to be reached until sometime next decade in most other countries, except in regions such as the Midwestern United States where ethanol is most heavily supported.

If cellulosic ethanol were to become viable, there would be a phase-in period during which infrastructure would adjust without government subsidy at least up to the 10 per cent of domestic consumption threshold. If it were highly competitive, vehicle manufacturers would implement flexible fuel technology on their own.

Biofuels are but one of many technologies and policy shifts that can address issues such as GHG emissions, supply security, and petroleum displacement. Even cellulosic ethanol, despite being more efficient at meeting these goals than is starch-based ethanol, could still fail the market in competition with a wider range of fuels and demand-side approaches. Precluding this competition by instituting wide-ranging subsidies through the political process is not in the long-term interest of the public.

More research into the effects of continuing to subsidize and protect domestic production of liquid biofuels is sorely needed. But good research requires data, and that in turn necessitates that governments be much more transparent than they have been so far with information on subsidies to biofuels (and, indeed, to all forms of energy). More is needed than just descriptions of the programs. What is needed is amounts of expenditure associated with these programs, and suitable metrics that would allow evaluation of the cost-effectiveness of current and proposed policies.

Annex 1 —
Criteria for "Sustainable Biomass" proposed by The Netherlands' Project Group for Sustainable Biomass[18]

1. The balance of greenhouse gas emissions in the production chain and application of biomass needs to be positive

Criterion 1.1: The reduction in emission of greenhouse gasses should be at least 50% to 70% for electricity production and at least 30% for biofuels, calculated by means of a mathematical framework (see Creative Energie, 2006). Furthermore, the Group sees it more than fitting to strive for a greenhouse gas emission reduction of 80% to 90% within ten years with respect to current fossil references.

2. Biomass production should not come at the cost of important carbon reservoirs in the vegetation and the soil.

Criterion 2.1: The plantation of new biomass production units will not take place in areas in which the loss of above-ground carbon storage cannot be regained within a period of 10 years of the start of biomass production.

Criterion 2.2: The plantation of new biomass production units will not take place in areas with a high risk of significant carbon losses from the soil, such as certain types of grasslands, peat lands, mangroves and wet areas.

3. Biomass production for energy may not endanger the supply of food and local biomass applications (energy supply, medicines, building materials)

Criterion 3.1: A report can be issued when requested by the government regarding changes of land use in the region, including future developments.

Criterion 3.2: A report can be issued when requested by the government regarding information on changes in the prices of land and food in the region, including future developments.

4. Biomass production will not harm protected or vulnerable biodiversity and wherever possible will enhance biodiversity

Criterion 4.1: The relevant national and local rules will be upheld regarding land ownership and usage rights, forest and plantation management and exploitation, protected areas, hunting, spatial planning, management of the wild, national rules that originate from ratification of international conventions CBD (Convention on biological Diversity) and CITES (Convention on International Trade in Endangered Species).

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18. Translation from the original Dutch (Creative Energie, 2007), as posted in English on The Oil Drum: Europe blog (http://europe.theoildrum.com/node/2521) by Rembrandt on 8 May 2007, "How a market for sustainable bio-energy is being developed."

Criterion 4.2: Biomass production will not take place in recently developed areas that have by the government been marked as “gazetted protected areas”, or in a zone extending 5 kilometers around these areas.

Criterion 4.3: Biomass production will not take place in recently developed areas that by all involved parties have been classified as “High Conservation Value” (HCV) areas, or in a zone extending 5 kilometers around these areas.

Criterion 4.4: When development of new biomass production areas is initiated, 10% of the area should be set aside to remain in the historical state to prevent the shaping of large monocultures. In addition, an indication should be given regarding in what land use zones the biomass production unit resides, how fragmentation is being prevented, whether the concept of ecological corridors is being applied and if there is any concern regarding the recovery of already degraded areas.

Criterion 4.5: Good practices will be applied on and around the biomass production area to enhance and strengthen biodiversity, to take ecological corridors into account and to prevent fragmentation of biodiversity as much as possible.

5. When producing and processing of biomass the quality of the soil will be maintained or enhanced

Criterion 5.1: The relevant national and local rules and laws will be upheld regarding waste management, usage of agrochemicals (fertiliser and pesticides), mineral management, prevention of soil erosion, environmental effects report and company audits. At the utmost minimum the Stockholm convention (12 most harmful pesticides) must be upheld, even when the relevant national laws are missing.

Criterion 5.2: The formulation and application of a strategy aimed at sustainable soil use to prevent and combat erosion, to retain the balance of nutrients, to retain organic matter in the soil and to prevent soil salination.

Criterion 5.3: The use of agrarian rest products will not come at the cost of other essential function to maintain the soil quality (such as organic matter and mulch).

6. When producing and processing biomass, soil and surface water will not be exhausted and the water quality will be maintained or enhanced

Criterion 6.1: The relevant national and local rules and laws will be upheld regarding the usage of water for irrigation, the usage of soil water, the usage of water for agrarian purposes in flow areas, water purification, environmental effect reports and company audits.

Criterion 6.2: A strategy focusing on sustainable water management regarding efficient water usage and responsible use of agrochemicals will be formulated and applied.

Criterion 6.3: Water irrigation for the processing of biomass will not originate from non-sustainable sources.

7. When producing and processing biomass the air quality will be maintained or enhanced

Criterion 7.1: The relevant national and local rules and laws will be upheld regarding air emissions, waste management, environmental effect reports and company audits.

Criterion 7.2: A strategy focused on minimising air emissions regarding production and processing and waste management will be formulated and applied.

Criterion 7.3: Burning of land is a practice that will not be used when developing or managing biomass production units unless in specific situations, such as described in ASEAN guidelines or other regional good practices.

8. Production of biomass will add to the local welfare

Criterion 8.1: A report will be written which describes the direct added value to the local economy, the policy, practice and budget regarding local suppliers of biomass, the procedure for the appointment of local personnel and the share of local senior management. This will be based on the Economic Performance Indicators 1,6 & 7 of the GRI (Global Reporting Initiative).

9. The production of biomass will add value to the welfare of the employees and local population

Criterion 9.1: The tripartite declaration of principles concerning multinational enterprises and social policy, as established by the international labour organisation, will be upheld

Criterion 9.2: The Universal declaration of human rights from the United Nations will be upheld

Criterion 9.3: No land will be used without the consent of sufficiently informed original users. Land use will be described in detail and officially registered. Official ownership, usage and rights of the domestic population will be acknowledged and respected.

Criterion 9.4: A report will be written describing the programmes and practices initiated to determine and manage the effects of business activities on the local population. This will be based on the Social Performance Indicator SO1 of the GRI (Global Reporting Initiative).

Criterion 9.5: A report will be written describing the amount of training and risk analysis to prevent corruption and the actions that will be taken to respond to cases of corruption, This will be based on the Social Performance Indicator SO_2, SO_3 and SO_4 of the GRI (Global Reporting Initiative).

Annex Table 1. **Overview of the U.S. farm economy**
(Billions of U.S. dollars, unless otherwise indicated)

Item	2002	2003	2004	2005	2006F[a]	2007F[a]
1. Cash receipts	195.0	215.5	237.9	238.9	242.7	258.7
Crops[b]	101.0	109.9	114.3	114	121.6	133.5
Livestock	94.0	105.6	123.6	125	121.2	125.2
2. Government payments	**12.4**	**16.5**	**13.0**	**24.3**	**16.3**	**12.4**
Fixed direct payments[c]	3.9	6.4	5.2	5.2	5.2	5.3
Counter-cyclical payments	0.2	2.3	1.1	4.1	4.1	1.6
Marketing loan benefits[d]	2.8	1.3	3.5	7.0	2.0	0.8
Conservation	2.0	2.2	2.3	2.8	2.9	2.9
Ad hoc and emergency	1.7	3.1	0.6	3.2	0.4	0.7
All other[e]	1.9	1.2	0.2	2.1	1.7	1.1
3. Farm-related income[f]	14.8	15.7	16.9	17.6	18.0	18.7
4. Gross cash income (1+2+3)	222.2	247.8	267.8	280.9	277.1	289.8
5. Cash expenses	171.6	177.8	186.3	199.7	210.4	222.6
6. NET CASH INCOME (4-5)	50.7	70	81.5	81.2	66.7	67.2
7. Total gross revenues[g]	233.6	260.9	296.2	299.8	298.4	318
8. Total production expenses[h]	193.4	200.4	210.8	226	237.8	251.3
9. NET FARM INCOME (7-8)	40.2	60.4	85.4	73.8	60.6	66.6
Farm Assets	1 304.0	1 378.8	1 584.8	1 805.3	1 919.4	1 994.3
Farm Debt	193.3	196.1	204.7	215.6	226.2	235.5
Farm Equity	1 110.7	1 182.7	1 380.1	1 589.6	1 693.2	1 758.8
Debt-to-asset ratio (expressed as %)	14.8%	14.2%	12.9%	11.9%	11.8%	11.8%
10. Ethanol production (10^9 gallons)	2.1	2.8	3.4	3.9	4.9	7.1
11. Federal tax loss from $0.51/gal. ethanol excise tax exemption or credit (billions of U.S. dollars)	1.1	1.4	1.7	2.0	2.5	3.6
12. Biodiesel production (10^9 gallons)	neg	neg	neg	0.08	0.25	0.45
13. Federal tax loss from $1/ gal.biodiesel excise tax credit (billions of U.S. dollars)	na	na	na	0.1	0.2	0.4
14. Total of Government Payments + biofuel tax credits (billions of U.S. dollars)	**13.5**	**17.9**	**14.7**	**26.4**	**19.0**	**16.4**

na = not available; neg = negligible.
a. F = forecast.
b. Includes Commodity Credit Corporation (CCC) loans.
c. Direct payments include production flexibility payments of the 1996 Farm Act through 2001, and fixed direct payments under the 2002 Farm Act since 2002.
d. Includes loan deficiency payments, marketing loan gains and commodity certificate exchange gains.
e. Peanut quota buyout, milk income loss payments, and other miscellaneous program payments.
f. Income from custom work, machine hire, recreational activities, forest product sales, and other farm sources.
g. Gross cash income plus inventory adjustments, the value of home consumption, and the imputed rental value of operator dwellings.
h. Cash expenses plus depreciation and perquisites to hired labor.

Source: **Items 1-9 in table:** Randy Schnepf (2007), "The U.S. Farm Economy", Updated of 21 February 2007, Congressional Research Service, Washington, D.C. Original data from USDA, Economic Research Service,

briefing rooms: *Farm Income and Costs: Farm Sector Income*, and *Costs: Farm Sector Income*, available at <www.ers.usda.gov/Briefing/FarmIncome>; U.S. farm income data updated as of 14 February 2007; • **Ethanol production:** Renewable Fuels Association <http://www.ethanolrfa.org/industry/statistics/#A > and Food and Agricultural Policy Research Institute (FAPRI); • **Biodiesel production:** National Biodiesel Board and FAPRI <www.fapri.org/outlook2007/tables/7USTables.xls>

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