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BIOFUELS – AN ENERGY, ENVIRONMENTAL OR AGRICULTURAL POLICY?

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INTRODUCTION

Biofuels are produced from renewable resources (plants, organic waste, etc.) and can be used as an alternative to fossil fuels (oil, gas). Ethanol and biodiesel are the two main biofuels widely used today, but there are others, such as biobutanol, at the research and development phase.

Global production of biofuels is booming, as higher oil prices and technological breakthroughs have made it a more profitable business. Other key factors are the political will in most industrialized countries to find a reliable source of energy, and the implementation of new incentive programs; these have stimulated the industry's growth and helped develop a level of infrastructure that can take advantage of favourable economic conditions.

GENERAL INFORMATION ABOUT BIOFUELS

A. Ethanol and Biobutanol

1. Ethanol

Ethanol is an alcohol produced through fermentation of sugar sources, such as plants. It can be used as is, or blended with regular gasoline. Fuel blends containing 5-10% ethanol require no changes to the engine and are the most widely available at present. Other blends are also available, such as E-85 (85% ethanol, 15% gasoline). In Brazil, more than 15% of cars can run on pure ethanol.

Brazil and the United States produce about 70% of the world's ethanol, which amounted to 44.7 billion litres in 2005. In the 1970s, Brazil initiated a massive ethanol production program as a response to oil price increases and to enhance its energy

self-sufficiency. Due to its abundance of sugarcane, Brazil is a world leader in ethanol production. The Brazilian federal government imposes a mandatory ethanol content of 20-25% in gasoline, depending on market forces.

In the United States, where ethanol production nearly doubled between 2002 and 2005, ethanol is derived almost exclusively from corn. The 2005 *Energy Policy Act* provides subsidies to ethanol producers and requires oil companies to blend at least 4 billion gallons (15.1 billion litres) of ethanol with gasoline annually. This baseline will increase to 7.5 billion gallons (28.4 billion litres) by 2012. Ethanol is produced primarily in the U.S. Corn Belt,(1) but production is now spreading to other parts of the country.

Canada produces about 600 million litres of ethanol annually; this amount will increase to 840 million litres in 2007. Given the current incentives, the Canadian government projects that ethanol production will increase to about 2.74 billion litres by the end of 2010. In Canada, ethanol is made from wheat in the western provinces, and from corn in Ontario and Quebec.

Because it tends to absorb water molecules, ethanol is difficult to transport, especially by pipeline. In addition, it is relatively corrosive and evaporates easily. For these reasons, some companies, such as British Petroleum (BP) and DuPont, are looking into converting their ethanol plants to biobutanol production.

2. Biobutanol

Butanol is an alcohol that can be produced by fermentation of the same types of sugar sources that are used for ethanol. As it can also be produced from fossil fuels, it is called “biobutanol” when it is derived from biomass. Butanol has various advantages over ethanol: it delivers more energy, evaporates more slowly, and can be transported by pipeline. According to DuPont, existing ethanol plants can be economically converted to produce biobutanol. In June 2006, BP announced that it would make biobutanol commercially available in the United Kingdom in 2007.

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(1) The “Corn Belt” consists of midwest states, notably Iowa, Indiana, Illinois and Ohio, as well as parts of South Dakota, Nebraska, Kansas, Minnesota, Wisconsin, Michigan, Missouri and Kentucky.

B. Biodiesel

Biodiesel is a biofuel produced from fats processed to obtain chemical compounds that are used as is, or blended with diesel fuel. The fats can come from a variety of sources, such as used cooking oils, plant extracts and animal fats.

The European Union (EU) leads global biodiesel production, with 3.6 billion litres in 2005, representing 1.5% of the diesel market in Europe. In the EU, about 80% of biodiesel is produced from rapeseed oil. In 1992, reforms to the Common Agricultural Policy allowed non-food crops to be grown on set-aside land. This land quickly became one of the main sources of crop acreage earmarked for biofuel production in the EU.

In the United States, biodiesel production totalled 288 million litres in 2005, three times higher than in 2004. The increase resulted in large part from a tax credit for blenders that provides a subsidy of US$1 per gallon to support the production of biodiesel from vegetable oil and $0.50 per gallon for tallow-based biodiesel. However, the 2005 production figures represent less than 0.2% of U.S. consumption of diesel fuel.

Until recently, commercial production of biodiesel in Canada was virtually non-existent. In 2005, Topia Energy Production opened Canada's first large-scale biodiesel production facility in Sudbury, Ontario. Other companies have demonstration plants or small commercial units using a variety of feedstocks (raw materials). At present, Canadian companies are using low-cost feedstocks, particularly fish oil, animal fats and recycled cooking oil. If biodiesel production were to increase significantly, canola would likely become the feedstock of choice, because of its wide availability in Canada. Biodiesel is mainly exported to the United States, but it is also used by vehicle fleets such as those of Montréal's public transit corporation, Ontario Hydro, Guelph Transit and the City of Toronto.

WHY ENCOURAGE BIOFUEL PRODUCTION?

A. Federal Measures to Promote the Biofuel Industry

Like most industrialized countries, Canada has launched programs to encourage biofuel production. In the mid-1990s, the federal government waived its excise taxes of $0.10 per litre for ethanol blended with gasoline, and $0.04 per litre for biodiesel.[2] It has also

(2) The provinces also offer similar tax incentives.

established a program to protect producers from any negative impact in the event of changes to this policy. In 2003, the Canadian government launched the Ethanol Expansion Program, which supported investments in building and enlarging ethanol plants.

On 20 December 2006, the government released a strategy with the goal, announced earlier in the year, of increasing biofuel consumption to 5% of total fuel consumption in Canada by 2010. The strategy comprises the following elements:

- The drafting of regulations that will require a renewable content of 5% in gasoline by 2010 and a 2% renewable content in diesel fuel and heating oil by 2012.

- The establishment of the Capital Formation Assistance Program for Renewable Fuels Production, a $200-million, four-year program designed to encourage agricultural producers' participation in the renewable fuels industry. It will build on the $10 million budgeted for 2006-2007 for the Biofuels Opportunities for Producers Initiative, which is aimed at assisting agricultural producers with preparing business plans and conducting feasibility studies into developing and increasing production capacity for renewable fuels.

- The establishment of the Agricultural Bioproducts Innovation Program, a $145-million, five-year program designed to promote research, development, technology transfer and the commercialization of agricultural bioproducts, including biofuels, in Canada.

B. An Energy Policy?

One of the main arguments put forward to encourage biofuel production is that biofuels will be a reliable source of energy and will decrease dependence on fossil fuels. However, a preliminary assessment of the extent to which the potential ethanol or biodiesel supply meets those fuel needs is disappointing. Global production is still too small and the need for raw materials is still too high for biofuels to have a significant impact on the fuel market and be able to compete with fossil fuels.

The energy yield from ethanol or biodiesel depends on the feedstock used. For instance, one hectare (ha) of sugarcane grown in Brazil produces almost twice as much ethanol as the same area of corn grown in Canada. It would take slightly less than 2 ha of wheat or 0.6 ha of corn grown in Canada to run a car entirely on biofuel for one year,[3] while 0.3 ha of sugarcane grown in Brazil would provide enough biofuel for the same level of consumption.

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(3) For a vehicle weighing under 4.5 tonnes that consumes an average of 11 litres per 100 km and travels 16,000 km annually (an average vehicle, according to the Statistics Canada Canadian Vehicle Survey).

By using 16% of its total corn production in 2006, the United States replaced 3% of its annual fuel consumption with biofuels. According to Agriculture and Agri-Food Canada (AAFC), if 100% of the total U.S. corn production were used, that figure would rise to 20%.

According to an article in the *New Scientist*,[4] Canada would have to use 36% of its farmland to produce enough biofuels to replace 10% of the fuel currently used for transportation. Brazil, by contrast, would need to use only 3% of its agricultural land to attain the same result.

In order for Canada to reach its biofuel target of 5% of fuel consumption by the year 2010 (about 2.74 billion litres of ethanol and 0.36 billion litres of biodiesel), the AAFC estimates that 4.6 million tonnes of corn, 2.3 million tonnes of wheat and 0.56 million tonnes of canola will be required. If all these feedstocks were grown domestically, they would represent 48-52% of the total corn seeded area, 11-12% of the wheat seeded area and about 8% of the total canola seeded area in Canada.[5]

It is very likely that the proportion of farmland required will decrease with improved yields and the cultivation of marginal soils, if the demand for biofuels raises the price of feedstocks. However, the need for feedstocks will remain high if the demand for biofuels increases. Therefore, there is concern about the rationale for allocating farmland to energy production rather than food production. Some observers believe that there is already competition between the two markets: according to the United Nations Food and Agriculture Organization (FAO), the rising demand for ethanol derived from corn is the main reason for the decline in world grain stocks during the first half of 2006.

The idea of finding feedstocks that are less demanding to produce is becoming more popular. Scientists are looking for better ways of producing ethanol from non-food crops and from biomass containing cellulose.[6] The development of an efficient cellulose-to-ethanol technology may promote the use of raw materials such as agricultural residues, straw and wood chips. Iogen, an Ottawa-based company, has built a demonstration plant and has been producing cellulosic ethanol for several years now.

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(4) "How Biofuels Measure Up," *New Scientist*, 23 September 2006.

(5) Estimate obtained by using the Canadian average over the past 5 and 10 years of wheat and corn seeded areas and yields (AAFC historical data).

(6) Cellulose is the main structural component of green plants.

Biobutanol is another possibility, as it is produced from the same feedstocks as ethanol, but has the advantage of delivering more energy. The technologies exist, but they must be made more economically attractive if they are to displace biofuel production from conventional agricultural products. Once these technologies have been implemented, biofuels will be more likely to enable a significant reduction in our dependence on fossil fuels.

C. A Greenhouse Gas Emission Reduction Policy?

Although biofuels, and ethanol in particular, have been used for more than a century, the environmental benefits of their use have only recently attracted attention. For instance, ethanol is used as an additive to replace other gasoline additives, including methyl tertiary butyl ether (MTBE), which is considered more damaging to health and the environment. Recently, it has been suggested that increased use of ethanol-blend fuel and biodiesel would reduce greenhouse gas (GHG) emissions from the transportation sector.

All analyses of GHG emissions on a life-cycle basis[7] appear to show that biofuels produce fewer emissions than fossil fuels. For instance, Natural Resources Canada estimates that in Canada:

- depending on the raw material (oil, fat, etc.) used to make it, pure biodiesel produces 64-92% fewer GHG emissions compared with petroleum diesel;
- a 20% blend of biodiesel with petroleum diesel produces 12-18% fewer GHG emissions than petroleum diesel;
- a 2% blend of biodiesel with petroleum diesel produces 1-2% fewer GHG emissions than petroleum diesel;
- E-10 blend (10% ethanol and 90% gasoline) from corn produces 3-4% fewer GHG emissions than gasoline;
- E-10 blend made from cellulosic materials produces 6-8% fewer GHG emissions than gasoline;
- E-85 (85% ethanol, 15% gasoline) from cellulose produces 75% fewer GHG emissions than gasoline.

(7) That is, the analysis of GHG emissions from production of the organic materials to the use of the final product as a fuel.

It should be noted, however, that GHG emissions over the full ethanol life-cycle can vary dramatically depending on the energy sources used to produce the ethanol. For example, in Canada, the manufacturing plants that produce ethanol from corn and wheat are fuelled by natural gas and produce fewer GHG emissions than many American ethanol plants that burn coal or other fossil fuels. There can thus be significant variations in the overall environmental benefit of using ethanol compared with gasoline.

At present, replacing 5% of conventional fuels with biofuels would have a relatively minor impact on reducing GHG emissions across Canada. In fact, if 10% of the fuel used were corn-based ethanol (in other words, if the E-10 blend were used in all vehicles), Canada's GHG emissions would drop by approximately 1%.(8) Therefore, in order to have a real impact on a country's total GHG emissions, certain types of biofuels must be targeted, such as biodiesel and cellulose-based ethanol.

D. An Agricultural Policy?

The federal government's announcement of a strategy to encourage biofuel production generated a great deal of interest in the agricultural sector. Increased demand for and production of biofuels, specifically ethanol, in North America will inevitably affect the agricultural market. However, there are very few studies of the expected impact, and almost all of them deal exclusively with the U.S. marketplace.

Ethanol is the dominant biofuel in the United States, as in Canada. It is estimated that about 16% of the U.S. corn crop is used for ethanol production, the third-largest use of American corn, behind animal feed and export purposes.

In light of the significant increase in demand for ethanol, there is expected to be a sharp increase in demand for corn, as shown in Figure 1. A number of observers are wondering what effect the increase in demand will have on the food market, and especially food prices. In Canada, the livestock industry has expressed concern that the expansion of the biofuels market will affect the price and availability of grains used for animal feed.

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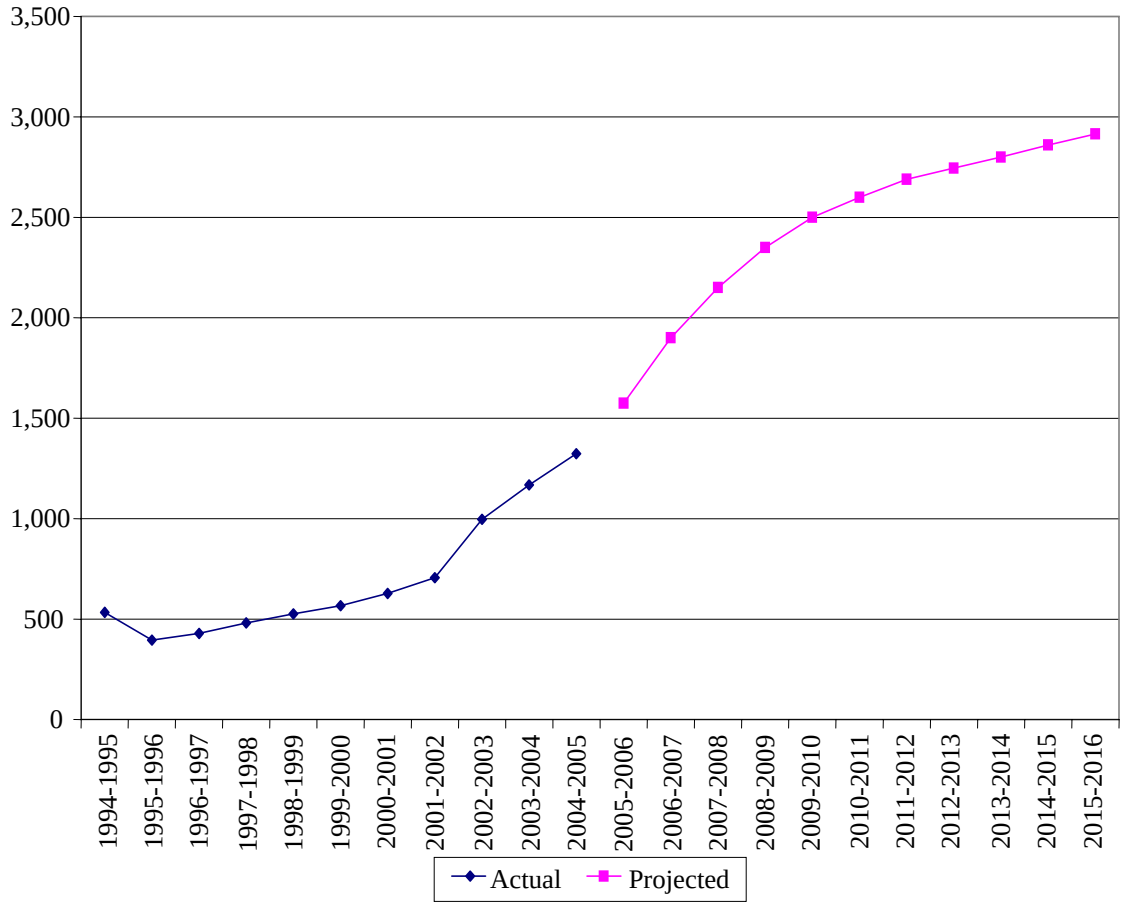
(8) Road transportation accounts for 27% of GHG emissions in Canada (i.e., fuel production and use). If all the fuel sold in Canada were E-10, this figure would be 3-4% lower.

Figure 1: Demand for Corn for Ethanol Production in the United States (in millions of bushels)



Source: United States Department of Agriculture; University of Missouri, Food and Agricultural Policy Research Institute.

According to the United States Department of Agriculture, ethanol production adds $0.25 to $0.50 to the price of a bushel of corn – or $5.5 billion to the total production in the United States. As noted above, the FAO has said that the production of ethanol from corn is the principal reason for the decline in world grain stocks and the higher prices seen in the first half of 2006.

Over the longer term, however, observers generally expect that the forecast major increase in demand for corn-based ethanol production will cause only a small increase in the price of corn, primarily because they also expect continued improvements in yields,[(9)] a reduction in exports and, in the case of stock farmers, an increased use of other livestock feeds,

(9) In addition, farmers will likely place more emphasis on producing corn at the expense of other crops, such as cotton and soya, which will also curb increases in the price of corn.

including protein meal and dried distillers grains, to replace corn.(10) Increased use of these two replacement products in animal feed will likely affect the animal feed market by curbing the increase in the price of corn.(11)

At the local level, there may be some upward pressure on the price of corn if an ethanol production plant uses a high proportion of the local crop.(12) According to one study, farmers growing corn near an ethanol plant receive an average of 2-5% more for their corn. Recently, researchers at Purdue University, in Indiana, arrived at the same conclusion.(13) According to an analysis prepared for Natural Resources Canada, a similar phenomenon is to be expected in Canada.(14) It may be assumed that this premium is about the same as what it would cost an ethanol producer to bring corn from further away.

However, it is still too early to determine the specific effect of the biofuel boom on the various agricultural food and feed markets, and to know whether farmers will benefit over the long term. While the Canadian grains and oilseeds industry has stated on a number of occasions that increased biofuel production will have a positive impact on prices, it has not indicated whether this impact could reverse the long-standing downward trend in grain prices and have a significant effect on farm income.

It is not surprising, then, that a portion of the biofuel production assistance targets farmers, and encourages them to invest in biofuel processing plants ($200 million over four years for the Capital Formation Assistance Program for renewable fuel production). This measure is consistent with policies encouraging farmers to invest in value-added products and processes to offset lower farm incomes.

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(10) According to the AAFC, the target ethanol production of 2.74 billion litres in 2010 will yield about 2.1 million tonnes of dried distillers grains, which can be used as animal feed.

(11) On the implications of increased biofuel production with regard to agriculture, see University of Missouri, Food and Agricultural Policy Research Institute, *Implications of Increased Ethanol Production for U.S. Agriculture*, FAPRI-UMC Report 10-05, 22 August 2005.

(12) John Urbanchuk and Jeff Kapell, “Ethanol and the local community,” produced for the Renewable Fuels Association, Washington, D.C., 20 June 2002.

(13) Purdue University, “Economists: Ethanol’s impact on agriculture a mixed blessing,” Press release, 19 October 2005, http://news.uns.purdue.edu/html3month/2005/051019.Hurt.ethanol.html.

(14) S&T2 Consultants and Edna Lam Consulting, “Economic, Financial, Social Analysis and Public Policies for Biofuels – Phase 2,” produced for Natural Resources Canada, 30 April 2005.

An assistance program with a similar objective has been implemented in the United States, with some success. According to the Renewable Fuels Association, early in 2006, 46 of the 96 ethanol plants in the United States were farmer-owned; they accounted for 39% of the country's total production capacity. There has been, however, a slowdown in farmers' participation, as only 4 of the 31 new facilities planned in 2006 (or 11% of the construction capacity) were farmers' initiatives.

The United States is currently seeing a consolidation of the industry and a buyback of the smaller plants that began ethanol production by larger companies. Economies of scale have become essential to keeping the refineries profitable. Some observers say that a plant must have a minimum production capacity of 130 million litres per year in order to achieve major economies of scale.(15) In Canada, only Husky Energy in Lloydminster, Saskatchewan, Suncor Energy in Sarnia, Ontario, and Les Alcools de Commerce in Chatham, Ontario, and Varennes, Quebec, meet or exceed this capacity. The economic imperatives of building high-throughput ethanol plants may well be obstacles to investment opportunities for farmers.

CONCLUSION

The expansion of biofuel production will depend largely on government policies with ambitious goals, such as decreasing dependence on fossil fuels and reducing greenhouse gas emissions. According to the current data, biofuels alone will not enable these goals to be met. Their advantages, however, are expected to increase if technologies that allow for the use of feedstocks that are less demanding to produce become more attractive economically.

The effect of future biofuel market expansions on agriculture should also be monitored. Despite strong hopes for higher grain prices, there is still much uncertainty about the effect of an increased demand for grains for biofuel production. Food and feed markets could well be affected, and production adjustments may offset the higher prices to the farmer.

(15) Kurt Klein, Standing Senate Committee on Agriculture and Forestry, *Evidence*, 30 November 2006.