BIOFUELS – AT WHAT COST?

Government support for ethanol and biodiesel in Canada

One of a series of reports addressing subsidies for biofuels in selected OECD countries

April 2009

Prepared by:

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Prepared for:

Global Subsidies Initiative (GSI)

International Institute for Sustainable Development (IISD)

GSI Global Subsidies Initiative

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Currency conversion note

Exchange rates used in this report were the average annual rates published by the Bank of Canada, where US$ 1.00 equalled:

2005: C$ 1.2116

2006: C$ 1.1341

2007: C$ 1.0748

2008: C$ 1.0661

Abbreviations and acronyms

Canadian Provinces

AB	Alberta
BC	British Columbia
MB	Manitoba
NB	New Brunswick
NL	Newfoundland and Labrador
NT	Northwest Territories
NS	Nova Scotia
NU	Nunavut
ON	Ontario
PE	Prince Edward Island
QC	Quebec
SK	Saskatchewan
YT	Yukon

Abbreviations

C$	Canadian dollars at the year specified
US$	United States dollars at the year specified
AAFC	Agriculture and Agri-Food Canada
ABIP	Agricultural Bioproducts Innovation Program
AFA	Alternative Fuels Act
ASCM	Agreement on Subsidies and Countervailing Measures
AoA	Agreement on Agriculture
B5	fuel mixture containing five per cent biodiesel and 95 per cent diesel
B100	100 per cent biodiesel
BIDP	Bioenergy Infrastructure Development Grant Program
BQR	Biofuels Quality Registry
BOPI	Biofuel Opportunities for Producers Incentive
CBIN	Canadian Biomass Innovation Network

CBSA	Canadian Border Services Agency
CCA	capital cost allowance
CCAA	Canadian Clean Air Act
CCAF	Climate Change Action Fund
CCPC	Climate Change Plan for Canada
CED	Canada Economic Development
CEPA	Canadian Environmental Protection Act
CFAP	Capital Formation Assistance Program (for Renewable Fuels Production)
CITT	Canadian International Trade Tribunal
CRFA	Canadian Renewable Fuels Association
CSEA	Co-op Services for Energy Alternatives
E10	Fuel mixture containing 10 per cent ethanol and 90 per cent gasoline, also referred to *gasohol*
E85	fuel mixture containing 85 per cent ethanol and 15 per cent gasoline
ecoETI	ecoENERGY Technology Initiative
ecoABC	ecoAGRICULTURE Biofuel Capital program
EEP	Ethanol Expansion Program
FCC	Farm Credit Canada
FCM	Federation of Canadian Municipalities
FFI	Future Fuel Initiative
FTA	Free Trade Agreement
FY	fiscal year
GHG	greenhouse gas
GMF	Green Municipal Fund
GST	Goods and Services Tax
HS	Harmonized Commodity Description and Coding System
HST	Harmonized Sales Tax
IRAP	Industrial Research Assistance Program
MFN	Most Favoured Nation
MPS	market price support
NBEP	National Biomass Ethanol Program
NAFTA	North American Free Trade Agreement
NISA	Net Income Stabilization Account
NRC	Natural Research Council Canada

NRCan	Natural Resources Canada
OECD	Organisation for Economic Co-operation and Development
OEE	Office of Energy Efficiency
OEGF	Ontario Ethanol Growth Fund
OERD	Office of Energy Research and Development (Natural Resources Canada)
OMAFRA	Ontario Ministry of Agriculture, Food and Rural Affairs
PST	Provincial Sales Tax
PERD	Program of Energy Research and Development
R&D	research and development
RD&D	research, development and demonstration
RFS	renewable fuels standard
SaskBIO	Saskatchewan Biofuels Investment Opportunity Program
SDTC	Sustainable Development Technology Canada
SIMA	Special Import Measures Act
SR&ED	Scientific Research and Experimental Development (tax incentive program)
SVO	straight vegetable oil
TEAM	Technology Early Action Measures
T&I R&D	Technology and Innovation Research and Development Initiative
U.S.	United States
USDA	United States Department of Agriculture
WCO	World Customs Organization
WDP	Western Diversification Program
WEPA	WEPA (Western Economic Partnership Agreement)
WTO	World Trade Organization

Executive summary

Canadian governments, like many others around the world, have recently embraced biofuels[1] as a seemingly win-win opportunity to address some of their greatest policy challenges: climate change, rural development and diversification of energy supply. Subsidizing the establishment of a domestic biofuels industry has appealed to successive governments. At the federal level, financial support has spanned three administrations, with both Conservative and Liberal governments instituting substantial subsidy programs. Support is also offered by provinces and municipalities.

But the ability of biofuels to lower greenhouse emissions, support farmers and conserve fossil fuels has seldom been critically assessed or quantitatively analyzed by governments, and Canada is no exception. New studies appear almost daily from around the world providing different—often conflicting—information on the outcomes of biofuel support policies. Some find net benefits while others find net negative impacts, reflecting the assumptions and specific conditions of each particular study. Moreover, biofuels subsidies have been found to have unintended negative effects that can undermine the environmental, social, fiscal and even political goals that they are intended to support.

This study aims to reduce this complex debate to two simple questions: how much money are Canadian federal and provincial governments spending to support liquid biofuels—fuel-grade ethanol and biodiesel—and does it represent good value-for-money to Canadian taxpayers? It is one of a series of reports undertaken by the Global Subsidies Initiative (GSI) of the International Institute for Sustainable Development (IISD) examining government support for biofuels in selected countries.

Total transfers to biofuels approach C$ 1 billion for the 2006–08 period

Canadian biofuel production capacity has grown sharply since 2005, stimulated by generous subsidies. Between 2006 and 2008, total support to biofuels was between C$ 860 and C$ 1 020 million, averaging roughly C$ 300 million per year (see table).

Estimated ethanol and biodiesel subsidies

		Ethanol	Biodiesel	Total
Total support, 2006–08 period	C$, millions	710–815	150–205	860–1 020
Average support/year, 2006–08 period	C$, millions	235–270	50–70	290–340
Assistance per litre, average 2008	C$/litre	0.20–0.24	0.60–0.83	
Estimated market value	C$/litre	0.75–1.15	1.10–1.20	
Assistance as a % of market value	%	18%–27%	56%–69%	
Assistance per gross GJ of biofuel produced	C$/litre	9.40–11.30	18.70–25.45	
Assistance per litre of petroleum or diesel equivalent	C$/litre equiv.	0.30–0.36	0.67–0.92	

Notes: Calendar year 2008 except as noted; ranges in values reflect different calculations for accelerated capital depreciation and subsidy-equivalent values for interest-free loans for infrastructure and research and development.

[1] Biofuels refer to liquid renewable fuels such as ethanol (an alcohol fermented from plant materials) and biodiesel (a fuel made from vegetable oils or animal fats) that can substitute for petroleum-based fuels.

Subsidies are provided by federal and provincial jurisdictions[2] to almost all stages of the biofuel supply chain, delivered through a range of mechanisms (see table below). Excise tax reductions were historically the largest source of support, which in many jurisdictions have been replaced recently by direct subsidies to producers. Interest-free loans and grants for biofuel infrastructure and research and development also provide a significant component of total support. Mandates for the use of renewable fuels at the national and provincial levels ensure that biofuels will be sold even when they are more expensive than gasoline or diesel, their principal competitors.

Types of government support provided for biofuels in Canada

Stage of production	Subsidy types
Research, development and demonstration	Grants and low-interest loans
Business planning	Grants for feasibility studies and market development
Plant construction	Grants and low-interest loans, accelerated depreciation
Production	Fuel tax exemptions, producer payments
Price support	Mandated biofuel blending requirements and tariffs
Distribution	Grants for storage and distribution infrastructure
Consumption	Tax-breaks for the purchase of biofuel-consuming vehicles, government procurement and dissemination of information to consumers

Between 2009 and 2012, subsidies are expected to level-off as most unlimited excise tax reductions have been converted to production subsidies with limits and phase-outs. However, there are potentially significant requirements for future support that were not quantified in this report. Mandates provide a guaranteed source of demand for biofuels, regardless of the cost of production. In the face of declining oil prices, the mandates could provide substantial market price support to the biofuels sector in the future.

As consumption of biofuels rise under the mandates, new infrastructure will be needed. Ethanol is both hydroscopic and a solvent, requiring specialized transport, storage and distribution infrastructure. In other countries, such as the United States, the cost of installing this infrastructure has been heavily subsidized by governments. Such costs are likely to be high for provinces—particularly the Maritime Provinces—that do not produce biofuels locally. The petroleum sector and provincial governments are therefore likely to call for future resources in support of infrastructure requirements.

The GSI estimates do not include an analysis of secondary impacts of biofuel subsidies on the economy, such as the effects on other sectors or welfare implications. Other studies have indicated that such impacts could be significant. Further study is warranted.

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[2] Although municipal subsidies could not be characterized systematically in this study due to budget constraints, they do appear relevant to the policy debate. Fox and Shwedel (2007) note that "In addition to federal and provincial government support, municipal governments have promised property tax reductions as well as attractive terms for real estate acquisition in efforts to attract ethanol plants to Canada. The process has resembled, at the level of smaller rural municipalities, the rivalry of larger urban centres for professional sports franchises."

Costs per unit of fossil energy or GHG avoided are much higher than alternatives

Despite a levelling-off of total transfers, subsidies to Canadian biofuels remain an expensive way to conserve fossil fuels or reduce GHG emissions. Ethanol from corn (maize), the most common biofuel product in Canada, requires subsidies of between C$ 0.50 and C$ 0.70 per litre to replace an equivalent litre of fossil energy—enough to purchase the displaced fuels with the subsidy alone. This large range indicates the widely different estimates of the amount of fossil energy required to produce biofuels from specific feedstocks. Wheat-based displacement is slightly more costly at C$ 0.55 to C$ 0.75 per litre equivalent. To replace a litre of petroleum diesel with a litre of biodiesel was found to cost C$ 0.40–C$ 0.80 in subsidies. Even under a hypothetical scenario, where cellulosic ethanol replaces conventional ethanol production (and receives the same unit subsidies), the estimated cost would be C$ 0.24–C$ 0.33 per litre of fossil fuel displaced.

Tradeoffs with respect to greenhouse-gas reductions appear even less attractive. The best-case scenario—our lowest subsidy estimate divided by the best-case reductions in carbon emissions for biofuels (cellulosic ethanol)—is approximately three times the market price of those offsets on the European Climate Exchange. Other fuels and other scenarios are much worse, with subsidies per tonne of CO_2-equivalent avoided from corn ethanol 6–100 times the market value of the offsets. The values for wheat were similar. Comparable numbers for biodiesel are 6 to 137 times less efficient (see table below).

These values may seem abstract. Far from it: they measure the opportunity cost of current policy approaches. Subsidizing corn- or wheat- ethanol or canola biodiesel with public money in Canada removes only one tonne of CO_2-equivalent, rather than up to 100 tonnes through purchasing emission-reductions on the market. These choices have a significant impact on the trajectory and the cost of GHG control over time.

Assistance per tonne CO_2-equivalent avoided through the use of ethanol and biodiesel, 2008

Indicator	Unit	Ethanol		Biodiesel	
		Corn	Cellulosic	Recycled oil	Canola
Support per tonne of CO_2-equivalent avoided	C$/tonne of CO_2 equiv.	200–430	90–160	205–330	265–580
for a CO_2-equivalent offset, Chicago and European Climate Exchanges	C$/tonne of CO_2 equiv.	4.25–33.85			
Offset multiple foregone by subsidies		6x–100x	3x–38x	6x–77x	8x–137x

Canada has done a better job than other countries targeting and limiting its biofuel subsidies.

The proliferation of Canadian pro-biofuel policies has introduced distortions in the Canadian economy that were previously absent. Some of these distortions will have long-term economic consequences in Canada, due to the consequential costs of new infrastructure, especially to supply biofuels to non-producing provinces, and flow-on effects to other industries.

Several policy constraints adopted within Canada have been effective in mitigating the direct financial costs of current programs. A broad shift from excise tax reductions to production tax credits in recent years has greatly reduced the share of public money

supporting biofuels manufactured outside of Canada. This shift has occurred at both the provincial and national levels. Several major programs have elements that attempt to fine-tune the subsidies to avoid double-dipping and transferring large rents when economic conditions are favourable (when feedstock costs are low or oil prices are high). Similarly, production credits and other subsidies to manufacturers have tended to have caps on total outlays or years of eligibility, and phase support down over time. These features result in subsidies that are better targeted than schemes in many other countries and have the potential to wean the industry off on-going support.

On the other hand, the downside of targeting is that many programs are specifically designed to inhibit the production and consumption of the most cost-effective biofuels. Trade restrictions favour domestically produced biofuels—either at the national or provincial level—over cheaper imported biofuels. Many programs provide larger incentives for smaller facilities or agricultural producers. Such policies prevent the industry from making use of economies of scale to improve efficiency. As such, they encourage on-going subsidy dependence.

Transparency is poor

The other downside of targeting is that the amount of data on the volume of subsidized production and sales, and on payments, is surprisingly sparse, especially given the scale of the subsidies. Concerns that disclosure of information regarding specific recipients could negatively affect these firms, by affecting the behaviour of rivals, are presented as a justification for a lack of public information. But that is no excuse for failing to disclose this information. There are ways to release appropriate levels of information without compromising confidential business information. Legal precedent in other economies has established the public's right to know to whom their money is being given and how it is being spent.

Environmental impacts of biofuels are not well understood, anticipated, routinely evaluated or integrated into policy structure

The environmental downsides of biofuels, including water depletion, land conversion and habitat loss, and nitrogen runoff are increasingly recognized around the world. Yet the Canadian federal government's rationale for supporting biofuels is predicated on there being net environmental benefits from this approach. Comprehensive life-cycle assessments (LCAs) of the environmental impacts of biofuel production and consumption show a wide disparity in results, from net reduction in greenhouse gas emissions to net increases, as well as risks of unintended negative environmental impacts. However, the broader suite of environmental impacts that might arise from accelerated biofuels production is not currently taken into account in Canadian policies.

Canada's federal biofuels mandate requires review of the environmental impacts of biofuels production every two years. However, the assessment may not be sufficiently rigorous to ensure environmental objectives and obligations are being met. In 2008, Canada's federal Environmental Commissioner said that the federal government has repeatedly based claims of environmental effectiveness on flawed or lax analysis, and that

there is little evidence that multi-billion dollar environmental funding is achieving stated objectives.[3]

The federal government's first major biofuel support package, the Ethanol Expansion Program, initially included provisions to adjust subsidy payments based on the extent to which the plant would help reduce GHG emissions. These provisions were removed as a result of industry lobbying and GHG impacts were reported but did not affect awards. Similar provisions have not been included in subsequent federal programs. Only British Colombia includes environmental criteria as a condition of support. Quebec has turned away from support for ethanol production from corn and instead is focussing on cellulose ethanol production from its forest and household waste.

Policy neutrality across options is needed

In the push to subsidize biofuels at ever greater levels, policy makers appear to have forgotten that there are other ways to reduce GHG emissions or the amount of imported oil per vehicle-mile travelled. Alternative fuels beyond ethanol and biodiesel, alternative drive trains such as plug-in hybrids, better fleet maintenance, and even more efficient gasoline and diesel engines offer great promise. Yet Canadian biofuel policies continue to earmark benefits and mandates for specific technologies over a specific time frame. This replaces market choices with political ones, and makes it more difficult for other oil substitutes to enter the marketplace. Policy tools such as R&D tax credits and carbon taxes would promote the desired policy goals without "picking winners."

[3] See Office of the Auditor General, 2008

1 Introduction and outline of the report

1.1 Liquid biofuels in Canada

This report on Canada forms part of a multi-country effort by the Global Subsidies Initiative (GSI) of the International Institute for Sustainable Development (IISD) to characterize and quantify government support for liquid biofuel production, distribution and consumption. An overview of ethanol and biodiesel, the main fuels evaluated in this report, can be found in Box 1.1. The analysis also examines subsidies to producers of key factor inputs, although it does not characterize support for other energy uses of biomass, such as in boilers.

The GSI believes information on biofuel subsidy levels is vital to understanding the cost effectiveness of different policy options. The growing share of crops being diverted to energy production also means that the amount and form of support provided to biofuels is relevant to agricultural issues such as trade and food security.

Compared with major biofuel producing nations such as Brazil, France, Germany and the United States, Canada experienced a slow start with biofuels production, despite having a well-developed agricultural sector capable of producing large amounts of biofuel feedstocks (F.O. Licht, 2006a). Canada began providing relatively small amounts of subsidies for research into ethanol technologies in the mid-1980s, followed in the 1990s by excise tax exemptions and investment incentives to encourage ethanol production. The first major scheme, launched in 2003, was the federal Ethanol Expansion Program (EEP), which provided loans for the construction of new ethanol plants.

Canada's support for biodiesel lagged its subsidization for ethanol and remains relatively minor in comparison today. In 2003, the federal government exempted the biodiesel portion of diesel-methyl ester mixtures from the federal excise tax on diesel fuels. The government's Biodiesel Initiative provided early support for the use of biodiesel in municipal bus fleets. However, Canada's first commercial-scale biodiesel went into service only in 2006.

In recent years, both the provincial and federal governments in Canada have introduced a growing list of new subsidies to biofuels, with rising financial support. The Canadian federal government's strategy for supporting renewable fuels has four components: increasing the retail availability of renewable fuels through regulation; supporting the expansion of Canadian production of renewable fuels; assisting farmers to seize new opportunities in the sector; and accelerating the commercialization of new technologies. Several provincial governments have introduced similar support packages. Subsidies are delivered through a range of mechanisms including direct payments, tax exemptions, interest-free loans, grants and—increasingly—consumption mandates.

Subsidies have cropped up in some smaller municipalities as well. Fox and Shwedel (2007: 24) note that the process of attracting ethanol plants via property tax reductions and attractive terms for real estate has "resembled, at the level of smaller rural municipalities, the rivalry of larger urban centers for professional sports franchises."

The stated objectives of these policies include reducing greenhouse-gas (GHG) emissions,[4] encouraging rural development, supporting Canadian farmers, and promoting technological advances (e.g., Office of the Prime Minister, 2007). Unlike in many other biofuel-supporting nations, energy security has not been a major motivating force in Canada, given the country's large reserves of petroleum oil and natural gas. Canada has the world's second largest proven oil reserves (estimated at 178 000 million barrels) and is one of the top 10 oil-exporting countries in the world (Milbrandt and Overend, 2008).

The purported benefits of biofuels have appealed to successive Canadian Governments, with federal support spanning three administrations and both the Conservative and Liberal parties. Biofuel policies have bi-partisan appeal, as a domestic biofuel industry appears to promise rural economic growth while delivering the environmental benefits sought by many voters (McCarthy, 30 May 2008). The growing imperative to take action on climate change provided further political momentum to biofuel support. All major political parties at the federal and provincial level promised biofuel mandates in both the 2004 and the 2006 election campaigns.

Lobbying by biofuel producers and industry associations has been cited as a major driver behind government support (McCarthy, 30 May 2008). The Canadian Renewable Fuels Association (CRFA) has maintained pressure on successive governments to provide financial support to the industry, which has been described as having been "like pushing on an open door" (John Chenier, *The Lobby Monitor,* cited in McCarthy, 30 May 2008). Links between the CRFA and the Conservative party have been reported to have assisted in the success of the pro-biofuel lobby during the Harper administration (McCarthy, 30 May 2008). Several senior advisers to the Harper Government were previously in leadership positions in the CRFA, and the current CRFA leadership includes former Conservative political staffers. In late 2008, the CRFA ran television advertisements to thank the Prime Minister for keeping a campaign pledge to mandate ethanol use and to emphasize the benefits of the policy to rural communities (McCarthy, 10 September 2008).

The aim of this report is to present the history of government support for biofuels in Canada, catalogue the subsidies now in place, and comprehensively quantify the size of these subsidies wherever possible. These data are then used to assess the impact of subsidies against various criteria. These include inter-fuel competition, how efficiently support for biofuels reduces greenhouse-gas (GHG) emissions, and whether Canadian policies are well structured to minimize environmental damage in biofuel production chains.

The estimates of subsidies and their opportunity costs provided in this report are the result of a compilation of direct government support to the industry. They do not take into account flow-on effects in the economy (such as cross-sectoral or welfare impacts), likely consequential future, but not yet committed, government expenditures (such as for

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[4] The transportation sector in Canada currently accounts for approximately 27 per cent of greenhouse gases emitted in Canada each year (AAFC, 2006). Regulations under development by Environment Canada will require five per cent renewable content based on the gasoline pool by 2010 and two per cent renewable content in diesel and heating oil by 2012 (upon successful demonstration of renewable diesel fuel use under the range of Canadian conditions). These regulations are intended to require enough renewable fuel to reduce GHG emissions by about four megatonnes per year, the GHG equivalent of taking almost one million vehicles from the road.

biofuel infrastructure) or the costs of unintended social or environmental implications. Such analysis, clearly important, was beyond the scope of this study.

The impact of government biofuel policies on the emerging market structure appears significant. A recent U.S. Department of Agriculture (USDA) report, for example, noted that "[w]ithout the production incentives and additional support being provided by both the federal and provincial governments, it is unlikely that a Canadian renewable fuel standard would have been met by Canadian bio-fuels production instead of U.S. produced ethanol" (U.S. Department of Agriculture, 2007: 4).

The process used to evaluate subsidies to biofuels is explained in Section 1.2. The structure of the rest of the report is presented in Section 1.3.

Box 1.1 Biodiesel and ethanol production processes

Liquid transport biofuels are most commonly produced as either biodiesel or ethanol.

Biodiesel is typically produced from vegetable oil or animal fat. In a process known as *transesterification*, the fat or oil is reacted with an alcohol (usually methanol synthesized from natural gas) in the presence of a catalyst to yield mono-alkyl esters (biodiesel) and glycerine. Other by-products can include fatty acids, fertilizer and oilseed meal. Many of these by-products have a value, particularly the glycerine and oilseed meal (e.g., soybean meal is used for both human and animal food). The energy content of biodiesel varies between 88 per cent and 99 per cent of the energy content of diesel, depending on the feedstock and esterification process used.

Biodiesel substitutes for fossil diesel. It can be used pure or in a blend (commonly B5 or B20, which contain five per cent or 20 per cent, respectively, biodiesel mixed with fossil diesel).

Over 50 plant species produce extractable oils. All have potential for use as fuel, but most are prohibitively expensive. The main oils used for fuel are derived from rapeseed (canola), soybeans, oil-palm fruit or kernels, coconut, sunflower seed, and physic nut (*Jatropha curcas*). Another possible source of lipids (fats) is oil-rich microalgal feedstocks. Production of biodiesel from algae is currently at the research and demonstration phase.

Several alternative technologies are vying to replace transesterification. The costs of these technologies are highly sensitive to oil and fat prices. One new process uses existing equipment normally found in oil refineries to create a diesel substitute (called “renewable diesel”) using animal fats or vegetable oils. Longer term, diesel substitutes may be synthesized from almost any type of low-moisture biomass using the Fischer-Tropsch (F-T) process. Although the F-T process is well-developed and has been used to make liquid fuels from fossil-fuel feedstocks such as coal, production from biomass is still at the research and demonstration stage.

One technology that shows promise is the use of thermo-chemical processes to produce petroleum substitutes from syngas (a mix of carbon monoxide and hydrogen). Syngas generated from waste-to-energy gasification facilities can be converted to dimethyl ether (DME), a diesel substitute. Diesel engines need virtually no modification to run on DME.

Ethanol is a clear alcohol that can be used as a fuel in spark-ignition engines, either neat or blended with gasoline. The energy content of fuel ethanol is around two-thirds that of gasoline (regardless of the feedstock used), but it has a significantly higher octane rating.

Fuel ethanol can be either hydrous (also called “hydrated”) or anhydrous. Hydrous ethanol has a purity of about 95 per cent and has been used in Brazil since the late 1970s as a fuel in motor vehicles with modified engines. Further processing to remove residual water produces a high-purity anhydrous ethanol that is typically blended with petrol for use in unmodified engines.

More than 95 per cent of the world’s ethanol is produced by fermented plant-derived matter, mainly sugars and starches. The rest is produced synthetically, from petroleum or coal. Less than 25 per cent of total ethanol produced in the world is used for beverage or industrial purposes (Berg, 2003).

Production from sugar and starch is referred to as a *first-generation* technology. *Second-generation* technologies are under development to commercialize production of ethanol from **cellulosic** material, such as crop waste, wood and grasses. In second-generation ethanol manufacturing plants, the cellulose and hemi-cellulose constituents of the biomass are typically converted into simple sugars either biologically, using enzymes, or chemically, using acids and high temperatures, prior to fermentation.

Sources: Love and Cuevas-Cubria, 2007, Steenblik, 2007.

1.2 Framework of the analysis

Biofuel markets are complicated, with many stages of production and key inputs coming into the sector from related industries. Figure 1.1 provides an illustration of the organizing principle behind the report. The figure presents the framework used 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. This analysis has focused on subsidies that affect production attributes that are significant to biofuels' cost structure. While subsidies to producers of intermediate inputs (e.g., crop farmers) have been evaluated, more remote subsidies such as subsidies that reduce the costs of transporting biofuels or their feedstocks, were beyond the scope of this analysis.

Support to production and consumption is provided at many points in the supply chain. For the purpose of this report, the dividing line between production and consumption is taken as the point at which the biofuel leaves the manufacturing plant.

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, particularly corn and wheat (for ethanol), as well as canola (for biodiesel).

In Canada, these subsidies are largely decoupled from production and neither substantially raise nor depress the prices of domestically produced crops below those of imported crops.[5] 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 opportunity costs to government of promoting biofuels.[6]

Subsidies to intermediate inputs may be complemented by subsidies to value-adding factors: capital goods; labour employed directly in the production process; and land. In the case of biofuels, most of the subsidies that have supported value-adding factors in Canada have been linked to productive capital. These have in the past taken the form of grants, reduced-cost credit, and loan guarantees for the construction or expansion of biofuel manufacturing plants. These types of subsidies lower both the fixed costs and the investor risks of new plants, improving the return on investment. There are also a number of valuable income tax credits for accelerated depreciation and research and development that are available to the sector.

Further down the chain are subsidies directly linked to the biofuel volume produced or blended. In an effort to avoid subsidy leakage to foreign producers, direct volumetric

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[5] A decoupled subsidy is one not linked to production and provided to the farmer regardless of the crop grown or acreage planted. These types of programs are considered less distortionary than coupled subsidies because they do not influence the amount or the type of crop grown. However, even decoupled subsidies may keep recipient farmers in business longer than they would have otherwise. See de Gorter *et al.* (2004).

[6] The net cost would take into account any increased taxes paid by farmers as a result of increasing their taxable incomes.

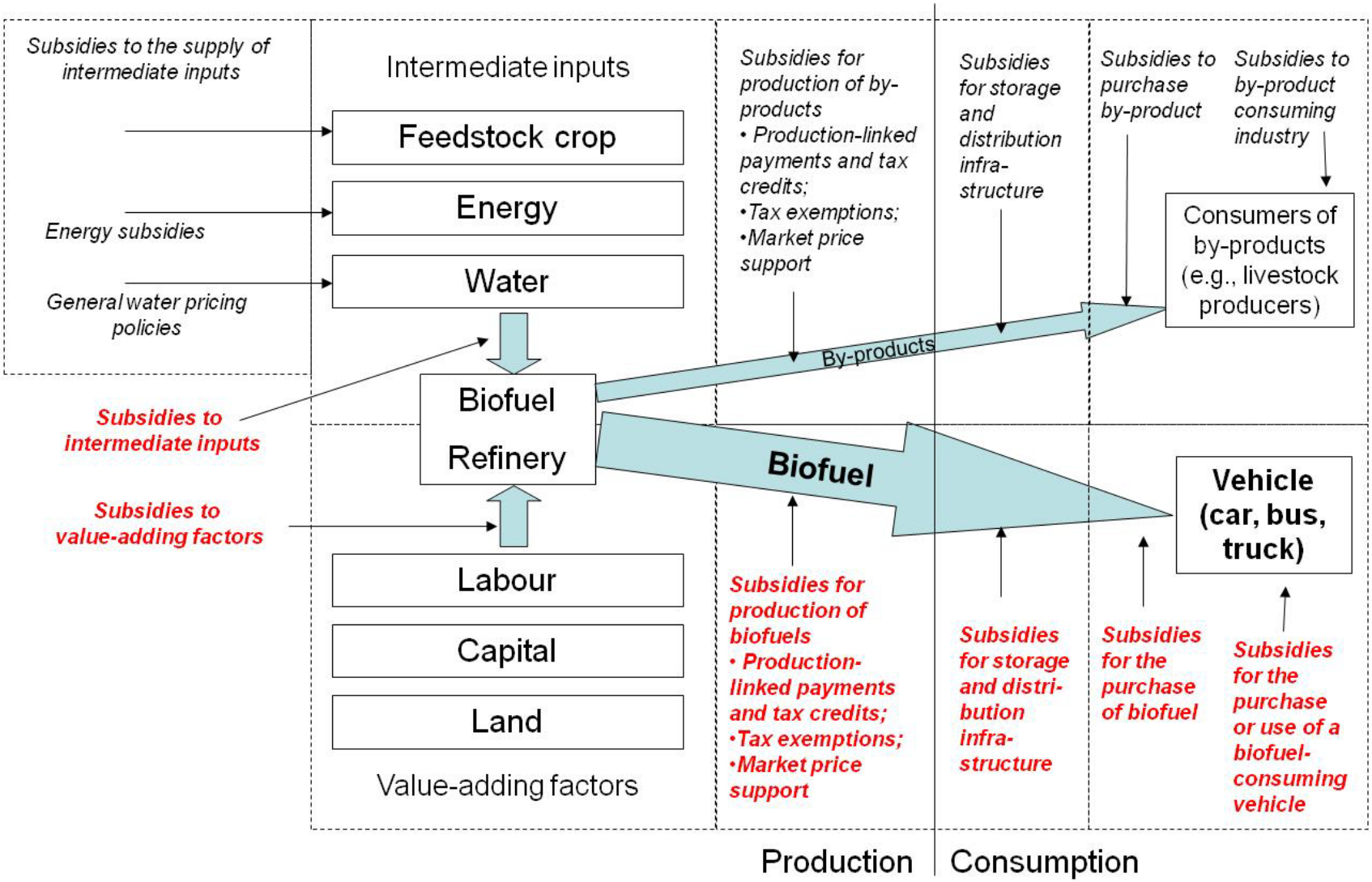
payments have largely replaced the full or partial fuel tax exemptions used in prior years. Government policies that discriminate between imports and domestic supplies are also relevant here.

Currently the federal government provides incentives and mandates to increase the purchase of biofuels, the purchase of biofuel-enabled vehicles, and the distribution of biofuels. Although Canada supports consumption of biofuels in various ways, the total amount of support is relatively low compared with its support for production, distribution, and research and development. For the moment, support for biofuels in Canada appears to be concentrated upstream.

1.3 Outline of the report

The remainder of the report provides increasing detail on Canadian subsidies to biofuels. Section 2 provides a brief overview of the biofuels industry in Canada. Section 3 contains a detailed presentation of industry supports for Canadian ethanol, with a similar discussion for biodiesel in Section 4. Section 5 contains estimates of the aggregate level of support for each biofuel, and key metrics such as subsidy intensity and per-unit of fossil fuel displaced. Section 6 summarizes the key findings and recommendations of the report.

Figure 1.1 Subsidies provided at different points in the biofuel supply chain

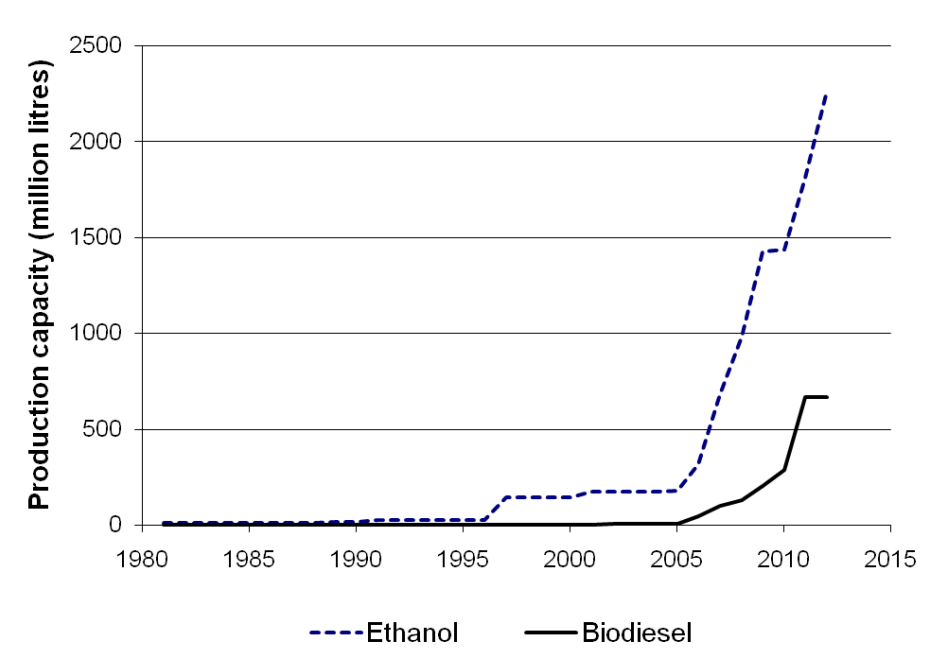


2 Overview of the liquid biofuels industry in Canada

The Canadian biofuel industry has grown rapidly since 2005, with annual production capacity by the end of 2008 reaching over 1 000 million litres for ethanol and 200 million litres for biodiesel (Figure 2.1). Biofuels make up only a small proportion of Canada's transport fuel needs. Total annual ethanol production is equivalent to about two per cent of Canada's total gasoline consumption and current biodiesel production capacity could replace less than one per cent of diesel fuel consumption (once the lower energy content of each fuel relative to their petroleum counterpart has been taken into account).[7]

If all biofuel plants currently under construction were to come into production, by 2012 Canada would have the capacity to produce annually around 2 300 million litres of ethanol and 670 million litres of biodiesel. This would be equivalent to around five per cent of total gasoline consumption and three per cent of diesel consumption. Several more facilities are in the business-planning phase but were on hold in early 2009 due to low oil prices making biofuel production less profitable.

Figure 2.1 Biofuel production capacity in Canada 1980–2012



Source: **Graph**: GSI; **Production capacity data**: Canadian Renewable Fuels Association (www.greenfuels.org), company websites and personal communication with company officials.

[7] In 2007, gasoline consumption was 42 400 million litres and diesel, 27 700 million litres (Statistics Canada: www.statcan.gc.ca/pub/45-004-x/2008010/t109-eng.htm). Calculations assume that gasoline and diesel consumption will continue to rise by one per cent per year (Auld, 2008). Ethanol has a 33 per cent lower energy density than gasoline. Biodiesel has 8.65 per cent less energy than diesel (National Biodiesel Board: www.biodiesel.org/pdf_files/fuelfactsheets/BTU_Content_Final_Oct2005.pdf).

2.1 Market context

The large majority of Canada's ethanol and biodiesel production is sold domestically in blends with petroleum gasoline or diesel. Both ethanol and biodiesel can be used in unmodified combustion engines but ethanol must be blended with petroleum gasoline to prevent engine damage. The threshold blend at which damage will occur is debated, but car manufactures generally recommend no greater than 10 per cent ethanol. Higher concentrations can be used in modified vehicles, but these are rare in Canada. As of February 2009, only four retail pumps in Canada were dispensing "E85" (a blend of 85 per cent ethanol with 15 per cent gasoline; Canadian Renewable Fuels, n.d.). The large majority of ethanol is sold as a five or 10 per cent blend with petroleum gasoline. Biodiesel can be used "straight" in unmodified engines (B100) but is generally also sold blended with petroleum diesel (B2, B5 or B10).

Like biofuels, petroleum fuels are subjected to taxation and subsidization, affecting the final price to consumers.[8] The price of blended fuel is thus a function of the price of the petroleum fuel plus taxes or minus subsidies, and the price of the biofuel plus any taxes or minus subsidies, i.e.

$$(P_{petrol.} + T_{petrol.} - S_{petrol.}) + (P_{biofuel} + T_{biofuel} - S_{biofuel})$$

(where P refers to the before-tax market price of fuel, T refers to taxes and S refers to subsidies) (D. Auld, personal communication).

As biofuels are generally more expensive to procure than petroleum fuels, governments tend to support biofuels to a level where they become competitive with petroleum fuels. Subsidies to biofuels rarely reduce the price of fuels to consumers. In the case of biofuel mandates, except at the times when the prices of petroleum fuels exceed the cost of producing biofuels, the higher price of biofuels will push up the price of blended fuel for consumers, which may or may not be offset by government subsidies.

While most Canadian biofuel production is produced and consumed domestically, there is some international trade. Canada's fuel market is integrated with the United States, with energy products tending to move north-south across the border, as east-west transfers within Canada can be prohibitively expensive due to long distances and high overland transport costs. The North American Free Trade Agreement (NAFTA) allows tariff-free trade in biofuels. However, the extent of integration between the U.S. and Canadian motor-fuel markets is constrained by differences in fuel specifications between the United States and Canada, which reduce the levels of cross-border trade. Within the United States, fuel specifications are largely determined at the federal level (with California as the notable exception), whereas in Canada some specifications are determined by federal regulations, others by the individual provinces.

The exact extent to which ethanol and biodiesel move across the border is unclear, as neither government keeps detailed trade records for these commodities. Industry data

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[8] Taylor *et al.* (2005) estimated total subsidies to the Canadian oil and gas sector of around C$ 1.4 billion in 2002, comprising direct expenditure (such as grants), funding for program resource management and tax exemptions (the largest component). Most of these subsidies supported oil production. Consumer subsidies for petroleum fuels (that result in lower than world market prices for consumers) are common in developing countries, but not in Canada or other OECD countries (Morgan, 2008).

indicate that Canada is a net importer of ethanol—mostly from the United States—and may export some biodiesel (see subsequent sections for more discussion).

Imports of biofuels from non-NAFTA countries are more likely to be constrained by high transport costs than by tariffs, due to shipping as well as overland transport from the port to the main population centres in Canada.

In evaluating subsidy levels, cross-border trade is relevant in estimating tax-exemptions and blender credits, which are potentially applicable to both domestic and imported products. In 2008, most Canadian governments shifted from excise tax exemptions to producer credits, which are available only to domestically produced product. Thus cross border flows do not significantly affect subsidy estimates from 2008 onwards.

Before these policy changes came into effect, it is possible that some Canadian biofuel may have been exported to the United States, blended to collect the U.S. tax credit for blending biofuels with petroleum fuels, then imported back to Canada where its consumption benefited from excise tax exemptions (until March 2008). The scheme was originally intended to benefit U.S. biofuel producers, but owing to a loophole in the law, biofuel could be imported and blended with 0.1 per cent fossil fuel then re-exported, with the blender claiming the full tax credit. There are no data available on whether this occurred, or to what extent. This loophole was closed by U.S. Congress in September 2008 to require that blenders' credits can be claimed only if the resulting blend is destined for consumption in the United States.

2.2 Ethanol

The development of the liquid biofuel industry in Canada began in the early 1980s, following the 1979–80 oil-price spike (EC, 2003). Canada's first commercial-scale ethanol refinery was built in Minnedosa, Manitoba, by Husky Energy Inc., in 1981. Using wheat as a feedstock the plant began producing at a rate of 10 million litres a year. This ethanol was mainly sold as a blending component of gasoline, in ratios of up to 10 per cent (E10). By 1987, five per cent ethanol-gasoline blends (E5) became available in the four Western Canadian provinces, with about 250 service stations selling this fuel.

Declining world oil prices and rising wheat prices in the mid-1980s discouraged further expansion of wheat-based ethanol until the 1990s. The 12 million litres per year Poundmaker Agventures Ltd. plant in Lanigan, Saskatchewan, came on stream in 1990, also using wheat as a feedstock. In 1998, the 26 million litres-per-year Permolex plant in Red Deer, Alberta, began production, using wheat as feedstock and exporting most of its production as beverage-grade ethanol to the United States.

Commercial Alcohols (now GreenField Ethanol) was the first distillery in Canada to manufacture fuel-grade ethanol on a commercial scale using corn starch as its feedstock.[9] The plant, at the Bruce Energy Centre near Tiverton, Ontario, came on stream in 1997, producing ethanol at a rate of 23 million litres per year. The same company subsequently built a 150 million litres per year plant in Chatham, Ontario, which started production in 1998, and has continued its expansion with several more facilities constructed or planned.

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[9] Ethanol blends had already been introduced into Ontario in 1992 and into Quebec in 1995.

Planned capacity expansion as of late 2008 indicated a dramatic growth in productive capacity through 2012. A combination of more newer plants (some of which are already under construction) and larger unit sizes than what has been built in the past, were the driving factors (Table 2.1). Despite larger plant sizes than in the past, Canadian facilities continue to be smaller scale than those built by their U.S. counterparts. The recent declines in the price of gasoline have led to several planned facilities being put on hold.

Another potential risk factor for the industry is its environmental profile. The U.S. Department of Agriculture (2008) notes that even the *Notice of Intent* regarding the Canadian national renewable fuel mandate acknowledged that the energy and environmental benefits of grain ethanol were questionable, and that the real gains would come through cellulosic-ethanol production. This is similar to the position being taken by biofuel proponents in the United States as well.

Since the mid-1980s, the Iogen Corporation (located in Ottawa) has been developing cellulosic ethanol production technologies on a research and demonstration scale. Until recently, it was the only facility producing ethanol using cellulosic technology. In January 2009, a new commercial-scale synthesis-gas-to-ethanol and methanol facility commenced operations in Westbury, Quebec (see Box 1.1 for a description of the technology; Austin, 2009). One additional facility that will use cellulosic technology is planned for Edmonton, Alberta, which will convert municipal waste to ethanol (GreenField Ethanol).

Table 2.1 Canadian ethanol production capacity

Company	Town	Province	Year commencing	Capacity (million litres)	Feedstock(s)
In production					
Husky Energy Inc.	Minnedosa	MB	1981	10	wheat starch
GreenField Ethanol	Tiverton	ON	1989	3.5[1]	corn
Poundmaker	Lanigan	SK	1991	12	wheat
GreenField Ethanol	Chatham	ON	1997	120[1]	corn
Permolex	Red Deer	AB	1998	40	wheat
Iogen	Ottawa	ON	2004	3	wheat straw
Suncor Energy	St. Clair 1	ON	2006	200	corn
Husky Energy	Lloydminster	SK	2006	130	wheat, corn
NorAmera Bioenergy	Weyburn	SK	2006	25	wheat, corn
Husky Energy (expansion)	Minnedosa	MB	2007	120	wheat, corn
Collingwood Ethanol	Collingwood	ON	2007	50	corn
GreenField Ethanol	Varennes	QC	2007	120	corn
Terra Grain Fuels	Belle Plaine	SK	2008	150	wheat
GreenField Ethanol	Johnstown	ON	2008	200	corn
Integrated Grain Processors Cooperative	Aylmer	ON	2008	150	corn
Enerkem	Westbury	QC	2009	5	wood waste
Total production capacity in April 2009				**1338**	
Under construction					
North West Bio-Energy & Terminal	Unity	SK	2009	25	wheat
Kawartha Ethanol	Havelock	ON	2009	80	corn
GreenField Ethanol	Edmonton	AB	2012	36	municipal waste
Northern Ethanol	Niagara Falls	ON	2011	409	corn
Northern Ethanol	Sarnia	ON	2011	378	corn
Expected total production capacity in 2012				**2266**	
On hold					
GreenField Ethanol	Hensall	ON	2010	145	corn
Suncor Energy	St. Clair 2	ON	2011	200	corn
Status unknown					
Okanagan Biofuels	Kelowna	BC	2007	114	wheat

1 GreenField Ethanol also produces ethyl alcohol for industrial purposes. The figures cited here refer only to fuel production.

Source: Company websites and personal communication with company officials in January and February 2009.

2.2.1 Cost structure

The main ethanol production input is feedstock biomass that is fermented to yield ethyl alcohol, carbon dioxide and protein residues (dried or wet distillers' grains). In 2006 the cost of producing ethanol from grains in Canada has been reported to have been between C$ 0.36 and C$ 0.46 per litre for ethanol (Milbrandt and Overend, 2008).

In Canada, the prices of wheat and corn have been estimated to account for approximately 50 per cent of the cost of producing ethanol made from these feedstocks, a share that varies depending on production and market conditions (Ho, 2006). The prices of these commodities, and of competing protein feeds (especially soy meal), also affect the value of the by-product distillers' grain in the market, as does the market for the livestock that consume the distillers' grain. Therefore, policies that affect the costs and prices of these commodities have a direct bearing on the profitability of ethanol distilleries.

2.2.2 International trade

Canada has low barriers to ethanol trade compared with other OECD biofuel-producing countries, such as Australia, the United States and countries in the European Union. The effective tariff rates are low for both ethanol and biodiesel (see Section 3.1.1.1). Until April 2008, imported ethanol was eligible for the same excise tax exemptions as domestically produced fuels, resulting in substantial imports from the United States and Brazil (Table 2.2 and Table 2.3). There is a large jump in imports of denatured ethanol to Canada in 2007 and 2008. Despite repeated inquiries, we have not been able to find an explanation for the jump.

Table 2.2 Canadian imports and exports of denatured ethanol (volume of pure alcohol '000 litres)

	2004	2005	2006	2007	2008
Exports	18 339	18 938	37 457	19 057	17 086
Imports	115 170	100 998	53 235	510 900	566 529
Net imports	**96 831**	**82 060**	**15 778**	**491 843**	**549 443**

Notes: While both denatured and undenatured ethanol can be used as fuel, denatured is more generally traded as fuel (personal communication between T. Laan and R. Speer, Canadian Renewable Fuels Association on 6 February 2009, and between Tara Laan and D. Dessureult, U.S. Foreign Agricultural Service, Ottawa, on 13 February 2009).

Imports relate to Harmonized System Classification code 2207.20.12.00: Ethyl alcohol, denatured, within the meaning of the Excise Act 2001. Fuel ethanol would be included in this category but not all of this classification will be fuel. Non-fuel imports appear to have been approximately 20 million litres per year, based on pre-2000 import levels (Le Roy *et al.*, 2008). Export data were available only at the level of HSC code 2207.20 (denatured ethanol).

Source: World Trade Atlas.

Table 2.3 Source of imports of denatured ethanol ('000 litres)

	2006	2007	2008
The World	53 235	510 900	566 529
United States	39 905	420 526	479 239
Brazil	13 330	90 374	87 290

Source: Statistics Canada, based on HSC code 2207201200: Ethyl alcohol, denatured, within the meaning of the Excise Act 2001 Industrial alcohol not for use as a beverage. Fuel-grade ethanol would be classified in this category but not everything in this category is fuel ethanol.

2.3 Biodiesel

The biodiesel industry in Canada emerged later than ethanol and it remains smaller. The first biodiesel production facilities were a handful of plants intended primarily to recycle waste and low-value oils. BIOX operated a now-retired demonstration plant in Oakville, Ontario that produced biodiesel from waste oils. In 2001, the Rothsay plant in Montreal, Quebec, began using waste cooking oil (yellow grease) to produce about four million litres annually. Ocean Nutrition, a Nova Scotian producer of nutritional supplements, used fish oil in its one million litres per year production plant, which was expanded to six million litres per year in 2004.[10]

A large, full-scale commercial biodiesel plant did not appear in Canada until 2005, when Rothsay expanded its production capacity. In 2007, the BIOX Corporation completed construction of a 60 million litres per year plant in Hamilton, Ontario.[11] The conversion process used at the multi-feedstock plant was developed at the University of Toronto.

Many new facilities are under construction or planned. These facilities tend to be larger than past plants, and rely on virgin oils as feedstock, such as canola, rather than "waste" lipids, such as tallow or used cooking oils (Table 2.4).

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[10] Ocean Nutrition's oil is marketed by Wilson Fuels, an independent petroleum marketer, as a five per cent to 20 per cent blend with heating oil.

[11] BIOX is looking to expand commercially (whether it will build another plant in Canada is unknown at this time), and recently announced that the company received private investments of C$ 22 million from existing shareholders and C$ 48 million from Birch Hill Equity Partners, Inc.

Table 2.4 Canadian biodiesel production capacity

Company	Location	Province	Finished	Capacity (ML/year)	Feedstock(s)
Biox Corporation	Oakville	ON	2001	1	mixed
Milligan BioTech	Saskatoon	SK	2002	1	canola
Rothsay	Ville Ste. Catherine	QC	2005	30	animal fat, recycled oil
Ocean Nutrition Canada	Mulgrave	NS	2006	9	fish oil
Biox Corporation (expansion)	Hamilton	ON	2007	66	mixed
Western Biodiesel	Aldersyde	AB	2008	19	recycled fryer oil, animal fats, canola oil
Milligan BioTech	Foam Lake	SK	2008	10	canola
Biodiesel Quebec	St Alexis des Mont	QC	2008	10	recycled fryer oil
Greenway Biodiesel	Winnipeg	MB	2009	20	canola oil
Total production capacity in April 2009				**166**	
Under construction					
Kyoto Fuels	Lethbridge	AB	2009	66	mixed
Bifrost Biodiesel	Arborg	MB	2009	3	canola
Eastman Bio-Fuels	Beausejour	MB	2009	11	canola oil and recycled fats
Methes Energies	Mississauga	ON	2009	25	mixed
Canadian Bioenergy	Edmonton	AB	2010	225	vegetable oils
BioStreet Canada	Vegreville	AB	2010	175	canola
Estimated total production capacity in 2012				**670**	
On hold					
BioNex Energy	Olds	AB		20	canola
Canadian Bioenergy	Fort Saskatchewan	AB		227	canola
Cansource Biofuels	Mayerthorpe	AB		10	canola
Status unknown					
Green Machine Biofuels	Kelowna	BC		1	multi-feedstock
General Bio Energy (formerly Canadian Green Fuels)	Regina	SK		200	vegetable oils

Sources: Canadian Renewable Fuels Association (www.greenfuels.org), company websites and personal communication with company officials in early 2009.

2.3.1 Cost structure of production

As with ethanol, a significant proportion of the costs of producing biodiesel are accounted for by the price of its feedstock. In Canada, biodiesel is produced from several sources, including tallow (animal fat), virgin vegetable oils (mainly canola), recycled cooking oils (yellow grease) and fish oil. Costs of production in Canada in 2006 have been reported as C$ 0.48 per litre for biodiesel from yellow grease, C$ 0.61 per litre from tallow and C$ 0.81 per litre from canola oil (Milbrandt and Overend, 2008).

2.3.2 International trade

Canada does not publish data on trade in biodiesel.[12] Minnesota's two per cent biodiesel blending mandate, combined with the United States' US$ 1.00 per gallon tax credit, may be drawing some Canadian biodiesel across the border into the United States. However, it is difficult to know its volume, because information at that level of detail is considered commercially confidential. One Canadian biodiesel producer told the GSI that his production facility was exporting approximately 25 per cent of its production to the United States, with the remainder sold within the province.

2.4 Ownership

The majority of ethanol and biodiesel plants are run by companies which claim biofuel production as their only business, though a few of the larger plants are owned by petroleum companies or energy groups. Rarely do companies own or operate both biodiesel and ethanol plants. Given that biofuel production is a nexus between the energy and agricultural sectors, it is not surprising to see agricultural businesses such as Archer Daniels Midland continuing to invest in the sector.

Several programs favour local ownership. Two federal programs require agricultural producer investment for eligibility or provide higher rates of support with increasing agricultural producer investment. In addition, Saskatchewan requires local ownership as a condition of eligibility for one of its grant programs. Both Saskatchewan and Manitoba require biofuels to be produced and consumed in the province to be eligible for a tax exemption.

Canadian plants are for the most part owned by Canadian investors. Northern Ethanol, for example, is owned by a consortium of 50 investors of which most are Canadian. Similarly, GreenField Ethanol, Canada's leading manufacturer of ethanol, is under majority ownership of a single Canadian, its Chairman and President Ken Fields. Like many ethanol producers in Canada, Northern Ethanol and GreenField focus their businesses solely on ethanol and its co-products.

Other owners, such as Husky Energy Inc. and Suncor Energy Products Inc., are Canada-based energy companies. They deal primarily in petroleum products but have recently expanded their business portfolio to include renewable fuels. Husky markets its ethanol-gasoline blend, "Mother Nature's Fuel", at its Husky and Mohawk retail outlets, and

[12] Data on biodiesel trade are not published separately, but as part of a broad commodity grouping code (3824.90.90.81), which covers many different chemicals ("Fatty acids, dimerized, trimerized, esterfied or epoxidized").

Suncor supplies its own ethanol-gasoline blend to Sunoco stations throughout Canada (Suncor owns the Sunoco retail stations in Ontario.)

A few ethanol producers are co-operatives. For example, Co-op Services for Energy Alternatives (CSEA) is a farmers' co-operative seeking outside private investment to assist in the construction of its sweet potato, sorghum, and millet conversion facility.[13] Like several other co-ops and private enterprises, CSEA has been successful in teaming up with local governments in ownership-sharing plans.

Some rural municipalities either directly invest in ethanol plants or reduce up-front costs to producers, the goal being to bring long-term business to local farmers and communities. In CSEA's case, for example, the plant will be partly owned by the city of Tillsonburg, Ontario. The city also expects to benefit from power produced at the co-generation plant, attached to the larger ethanol facility. The GSI has not been able to estimate the value or distribution of municipal-level support to the sector, however.

A few international investors are involved in ethanol production in Canada, but generally as minority stakeholders. A 2006 report noted that, at the time, multinational companies "have not expressed interest in Canadian produced ethanol, seeing it primarily as a market for US-produced ethanol" (Dickson, 2006). One exception is Archer Daniels Midland, which has invested an undisclosed amount in Husky's plant in Lloydminster, Saskatchewan.

[13] The plant is expected to produce 150 million litres of ethanol annually. It was not included in our plant list as it appears to be only in the preliminary stages of planning. www.cseacoop.ca/index.php?option=com_frontpage&Itemid=1

3 Government support for ethanol

Federal, provincial and municipal governments support the Canadian ethanol industry with a variety of overlapping programs that subsidize production, capital investment, distribution infrastructure and consumption. Despite having a well-developed agricultural sector with large potential feedstocks, Canada has only recently implemented major pro-biofuel policies (F.O. Licht, 2006a). Initially, support was provided for research and the development of markets, through incentives for private purchases of alternative fuelled vehicles and mandates for government procurement.

Canadian government support to ethanol began with relatively small levels of subsidies in the early 1990s. These came in the form of excise tax exemptions and investment incentives for ethanol plants. Investors were concerned about making large-scale, multi-year investments in ethanol infrastructure if the government could quickly change its excise tax exemptions while the plant was in-process. To mitigate this fear, the federal government launched the National Biomass Ethanol Program (NBEP), a C$ 140 million loan guarantee program that would become available if the excise tax exemptions were revoked. By the mid-1990s, several provincial governments, including Alberta, British Columbia, Manitoba and Ontario, had also exempted the ethanol portion of ethanol blends from provincial excise taxes.[14]

A major expansion of support for ethanol was heralded in 2003 by the federal government's implementation of its Ethanol Expansion Program (EEP), under which it pledged C$ 100 million in repayable contributions to support increases in ethanol capacity. The program aimed to support the construction of more than one billion annual litres of capacity and provided a significant boost to the Canadian ethanol industry. The EEP was the first of several such programs at the federal and provincial level that has provided assistance to new plants through contingent loans—i.e., loans for which repayment depends on market conditions.

Possibly the most significant development, however, was the announcement of new mandates for renewable fuel mixtures. The relevant federal legislation, enacted in 2008, allows the government to establish regulations to require a minimum renewable fuel content for petroleum fuels (also called a "renewable fuels standard"). The regulations are expected to require a five per cent renewable content in gasoline by 2010. This would require at least three billion litres of ethanol production per year. Several provincial governments have also put in place mandates. Many are aligned with the federal policy, but some come into effect sooner or require higher a higher proportion of ethanol. The federal and provincial policies have not been coordinated as a national biofuels strategy, but are in reality a federal strategy with six separate provincial strategies.

Mandates combined with border protection (tariffs) can constitute a major form of market price support to the domestic industry. They guarantee a floor level of consumption, while reducing competition from potentially cheaper imports. However,

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[14] In Quebec, a similar measure was announced at the end of December 1996 to encourage the building of a local ethanol plant. However, construction of the plant was delayed and this measure, which was to become effective on 1 January 1999, was never used. The province's first producing plant began operating in 2007. See <www.budget.finances.gouv.qc.ca/budget/2005-2006/en/pdf/AdditionalInfoMeasures.pdf>, p. 92.

market price support is likely to negligible at present, as Canada's import tariff is zero on fuel ethanol imported from the United States and other countries with which Canada has a free-trade agreement, and C$ 0.0492 per litre for ethyl alcohol imported from other countries, including Brazil.

Canadian governments have put in place other policies to ensure that most of the mandated ethanol consumption is sourced from domestic suppliers. A C$ 1.5 billion federal program, ecoEnergy for Biofuels, includes a package of measures to support Canadian biofuel producers. Under the scheme, direct producer payments will replace the federal excise tax exemptions for ethanol and biodiesel. Around C$ 1 billion of the funds have been allocated for ethanol, to support production of around two billion litres per year. Unlike tax exemptions, operating grants are not available to imports. Most other jurisdictions have also replaced their excise tax exemptions with per-litre producer payments or operating grants.

Other programs aim to boost the construction of new ethanol facilities, providing grants and preferential loans for capital, business-planning, market development and research. The largest of these is a federal contingent loan program for capital investments, announced in July 2007 by Prime Minister Stephen Harper. The two programs, the C$ 200 million ecoAGRICULTURE Biofuel Capital (ecoABC) Initiative and the C$ 20 million Biofuel Opportunities for Producers Incentive (BOPI), encourage participation by farmers in biofuel production by providing greater incentives to producer-owners.

Significant support is also available from provincial governments. The largest of these is the Ontario Ethanol Growth Fund (OEGF), which provides C$ 520 million for operating and construction grants.

Canada has also provided significant support for "second-generation" ethanol technologies, largely in the form of partnerships between government and private research institutions. From the mid-1980s until 2007, the federal government funded approximately half of the research on second-generation biofuels. This support also saw a significant increase in 2007, with the federal government committing C$ 500 million for research into next-generation biofuels.

3.1 Volume-linked support

3.1.1 Market price support

Market price support is a measure of how much extra income Canadian ethanol producers receive as a result of market interventions that artificially raise domestic returns.[15] The most common policies that cause these price increases are purchase mandates and border protection. Purchase mandates are often called "Renewable Fuel Standards" (RFS) and operate by requiring consumers to purchase biofuels even if they are more expensive than standard petroleum fuels. The most common form of border protection is a tariff.

[15] Market price support (MPS) is an indicator of the annual monetary value of gross transfers from consumers and taxpayers to producers arising from policy measures creating a gap between domestic producer prices and reference prices of a specific commodity measured at the farm- or factory-gate level (OECD, n.d.).

The effects of the tariffs on imported ethanol are twofold. The smaller effect is that the tariff acts as a tax on any imports that do enter the country. The second and much more important effect of a tariff is to protect domestic markets from competition from lower-priced imports, thus allowing domestic prices to rise higher than they would otherwise. A complicating factor is that ethanol can be both a complement to gasoline when it is used as an additive, and a substitute for it when used as an extender. This makes estimating the appropriate market characteristics more difficult.

When only a tariff is in place, competition from foreign suppliers of ethanol will be reduced, but domestic manufacturers must still compete with non-ethanol alternatives, notably gasoline. However, a renewable fuels mandate forces the use of ethanol. With a mandate but no tariff, the amount of ethanol sold domestically would be possibly higher than otherwise, but its price would be constrained by foreign competition. A mandate plus a tariff both raises the threshold price at which foreign-sourced ethanol becomes competitive, and protects domestic suppliers from being undercut by the price of gasoline. The higher the tariffs and the higher the mandated fuel consumption, the higher the MPS is likely to be.

Although government policies create the market price support, the actual financial flows usually involve a transfer from consumers to producers. Producers gain in two ways. The most direct is through higher pump prices for their product than what would have prevailed without the tariffs and mandates. The second source of support comes through the tradable credits (Renewable Fuel Credits) that countries often create to provide flexibility for the fuel sector to meet the RFS mandates. Renewable Fuel Credits are earned by producing a particular favoured fuel, and can have a market value to producers even when pump prices of their product do not rise.

The regulations to implement Canada's biofuel mandates were still under development as of February 2009. These regulations could establish Renewable Fuel Credits to improve the flexibility of implementing the biofuel blending mandates.

The relationship between renewable fuel mandates and renewable fuel credits can be confusing, but they are really operating in tandem to achieve a targeted level of consumption. When a mandate is introduced, all fuel blenders or retailers must prove they have blended in enough biofuel to be in compliance with the law. While every single one, in theory, could blend in exactly the five per cent ethanol Canada will require, this would be inefficient and inconvenient. Some blenders might be able to easily handle 10 per cent ethanol blends, while for others it would require expensive retrofits. Some parts of the country may have convenient access to ethanol blending stock, while other parts would incur expensive transport.

Since the government is using the mandate to boost *aggregate* reliance on biofuels, it does not care how the mandate is met, so long as nationally enough alternative fuel is used. Thus, a tradable credit system is often created so that biofuels can be blended where it is most efficient to do so. Some firms can blend more than is needed, sell the extra credits to regulated parties for whom compliance is more expensive, and bring down overall compliance costs. Because Renewable Fuel Credits are earned by producing a particular favoured fuel, the sale of Renewable Fuel Credits to other parties can generate revenues to producers even if the pump prices of their product do not rise.

The tax credit and finance subsidies aim to bring visible prices down, but the mandates work the opposite way—pushing the demand curve up so that a higher quantity is used at any given price. In Canada, the five-per-cent ethanol mandate from 2010 is unlikely to drive up ethanol prices significantly, given that Canada has a free trade arrangement with its major source of imported ethanol—the United States. Also, the existence of producer

payments for Canadian ethanol is more likely to be the primary driver of domestic production, rather than the mandates.

Nonetheless, there could be local effects on fuel prices in provinces that do not produce biofuel feedstocks in sufficient quantities to support a local biofuels industry and must rely either on expensive overland transport from production centres in North America or imports from South America (subject to tariffs and sea-freight costs). These difficulties would be exacerbated if mandates in other Canadian provinces and the United States were to require those jurisdictions to consume all the biofuels they produced, leaving little available for export to non-producing states.

3.1.1.1 Tariffs

As of mid-November 2008, Canada's tariffs for absolute ethyl alcohol (i.e., the alcohol content), whether denatured or not, were C$ 0.0492 per litre from countries with most-favoured nation (MFN) status and duty-free from countries with which Canada has a free trade agreement (FTA), such as Chile, Costa Rica, Israel, Mexico and the United States.[16]

No special tariff is provided for ethanol imported from developing and transition countries eligible for Canada's General Preferential Tariff. Thus, the main effect of the tariff has been to raise the price of ethanol imported from any country not party to an FTA with Canada. In particular, ethanol from Brazil is levied an import duty of C$ 0.0492 per litre (US$ 0.17 per gallon), though that amount is substantially lower than the US$ 0.54 a gallon (C$ 0.15 per litre) duty levied on Brazilian ethanol by the United States and the even higher import tariffs applied by Australia and the European Union.

The actual impact of the tariff on current ethanol flows is not likely to be large. The United States is by far the largest source of imports (see previous section). Data compiled by USDA indicate that 80 per cent of ethanol imports came from the United States in 2007 and all exports were destined for the United States in that year (U.S. Department of Agriculture, 2007) (see Section 2.1.1 for further discussion of trade flows).

The shift from excise tax exemptions (available to imports) to production subsidies, which commenced in April 2008, is likely to significantly reduce imports. Similarly, the introduction of purchase mandates in Canada will likely reduce imports. However, the USDA reports that the Canadian government does expect their mandate to be met first with grain- and sugar-cane based ethanol, the latter of which would be imported from Brazil (U.S. Department of Agriculture, 2007).

Canada has some provincial non-tariff barriers that also warrant attention. For example, Husky Energy has agreed that 80 per cent of the feedstock needed for its wheat-based facility in Minnedosa, Manitoba will be supplied by Manitoba producers (U.S. Department of Agriculture 2008: 29). The agreement with the Manitoba government lasts eight years, but could drive up the cost of meeting the province's 8.5 per cent ethanol blending mandate (see below) by reducing the ability for other ethanol to enter Manitoba. The U.S. Department of Agriculture (2008: 32) notes that

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[16] Source: Canada Border Services Agency , www.cbsa-asfc.gc.ca/general/publications/tariff2007/01-99/ch22ne.pdf

Provincial incentives that create trade barriers by having only ethanol produced from feedstock produced in-province may face increased scrutiny as they violate the national treatment embodied in the WTO and NAFTA as they are barriers to trade.

3.1.1.2 Renewable fuels standards

Renewable fuel standards are politically-set consumption mandates that stipulate the minimum quantity of specific fuels that must be purchased in particular markets. As in the United States, Canada has a growing number of mandates, and they have been applied at the provincial as well as the national level.

Functioning markets normally trade off between similar products based on availability and price. Purchase mandates force markets to use a specified product even if it is more expensive. In some cases, the mandates may force prices far above the prices that would have prevailed in the absence of the requirement. By creating a premium price for specified fuels, the RFS allows less competitive blends to survive in the marketplace.

The magnitude of pricing distortions from an RFS will be larger if the mandated quantity is a bigger share of the local market for the fuel; if new capacity must be built to supply the mandated quantity; if imported fuels are restricted through tariff or non-tariff barriers; and if the market price of conventional fuels is much lower than the cost of producing the renewable fuel (Koplow, 2007). These conditions will more likely make the mandate "binding," in as much as it is forcing more biofuels into the market than would occur based on market conditions (or other subsidies such as tax credits) alone, thus driving up prices.

However, purchase mandates provide important transfers to an industry even when they are not binding, by protecting producers from downside market risks. The RFS reassures investors that the production facility will be far more likely to find a buyer for its output even in down markets, resulting in a lower cost of capital, and ultimately in expanded rates of new plant construction (Koplow, 2007).

Canada's first national-level renewable-fuels mandate was announced in December 2006.[17] An amendment to the *Canadian Environmental Protection Act* (CEPA) *of* 1999, that will allow the government to bring in a renewable fuels mandate, received royal ascent in June 2008 (Banks, 2008). As of April 2009, the amendments had yet to come into force. Regulations under the Act—under development—are expected to require five per cent renewable fuel in gasoline by 2010 (in line with a 2006 notice of intent issued by the federal government). An estimated three billion litres of ethanol per year will be needed to meet the gasoline requirement.

Several amendments were made to the relevant legislation while it was being considered by parliament. These included a clause that a review of the environmental and economic merits of biofuel production in Canada should be undertaken by a House or Senate committee every two years after the legislation comes into force (U.S. Department of Agriculture, 2008).

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[17] In 2002, the Canadian climate change emission reduction plan included a target that, by 2010, at least 35 per cent of Canadian consumption of fuel must be a 10 per cent blend of ethanol, or 3.5 per cent of total vehicle fuel volume (Government of Canada, 2002). However, this was merely a target rather than a mandated consumption requirement.

Four provinces had already announced their own RFS before the federal government: Manitoba, Ontario, Quebec and Saskatchewan. Alberta and British Columbia added their mandates more recently (Table 3.1).

Table 3.1 Renewable fuel mandates in Canada for ethanol

Jurisdiction	Consumption requirement	Implied consumption per year in 2012 (million litres)
Federal	5% from 2010	2 145
Alberta	5% from 2010	290
British Columbia	5% from 2010	250
Manitoba	5% from January 2008; 8.5% from April 2008	135
Ontario	5% from January 2007	830
Quebec	5% from 2012 (cellulosic ethanol)	445
Saskatchewan	1% in November 2005; 7.5% in October 2006	125

Sources: **Renewable fuel mandates:** Government press announcements; Alberta Energy (2008); Auld, 2008; Canada Gazette (2006); U.S. Department of Agriculture (2007); Walburger *et al.* (2006). **Motor fuel demand:** Statistics Canada (www.statcan.gc.ca); based on total sales of all road grades of gasoline for all uses; assumed to increase by one per cent per year (Auld, 2008).

Manitoba first enacted a RFS in 2003, which required 85 per cent of the gasoline sold in the state to contain 10 per cent ethanol by 2005. However, it was never enforced it due to a lack of local production capacity (Manitoba Press Release, 2003; U.S. Department of Agriculture, 2007). This changed in November 2007 with the passage of the *Biofuels Amendment Act*, which required a five per cent ethanol content in gasoline from January through March 2008, and an 8.5 per cent ethanol blend from 1 April 2008 (Manitoba Science, Technology, Energy and Mines, 2008). The mandate may be met by ethanol sourced from anywhere, although only ethanol produced and consumed in the province is eligible for subsidies.

Effective November 2005, Saskatchewan required that all gasoline sold in the province must be a blend containing one per cent ethanol. The blend ratio was increased to 7.5 per cent ethanol, effective October 2006 (Canadian Gazette, 2006). [18] The Saskatchewan ethanol mandate stipulated that 30 per cent of the ethanol used in the province should come from producers with production capacities less than 25 million litres per year (6.6 million gallons per year) (Bryan and Moore, 2004).

In 2005, Ontario required that gasoline sold in the province contain five per cent ethanol, starting from 1 January 2007. The provincial government considered increasing

[18] This is predicted to have cost C$ 4.87 million in rebates during the 2005–06 budget year. Provincial law specifies that fuel distributors must purchase 30 per centof ethanol from plants with an annual capacity of less than 25 million litres.

the mandatory ethanol content to 10 per cent, but officially dropped the proposal in September 2008.[19] In Quebec, the 2006–2015 Energy Strategy sets a target of five per cent cellulosic ethanol by 2012. Meeting this target will require the production of at least 300 million litres of ethanol per year come from "second-generation" ethanol plants using forest biomass from their forestry industry, agricultural or municipal waste (U.S. Department of Agriculture, 2007).

The *BC Energy Plan*, announced in February 2007, included a five per cent average renewable fuel standard to be implemented by 2010.[20] The policy initiative was given Royal Assent on 1 May 2008.[21]

3.1.2 Federal and provincial excise tax concessions

Gasoline is taxed by Canadian federal, provincial and territorial governments (DFC, 2005). The sales tax system in Canada is a mélange of federal, provincial, and territorial sales taxes in which federal and sub-federal taxes are either combined or separated, depending on the region. At the federal level, there is also a Goods and Services Tax (GST), a point-of-sale tax which levies a five per cent charge (seven per cent prior to 1 July 2006) on all goods and services except for certain essentials such as groceries and residential rent. Companies and self-employed people can claim full refunds (called *input tax credits*) of GST paid on any business-related expense, including gasoline and other kinds of fuel. This ensures that the burden of paying the GST is usually shouldered by the final consumer.

Since its debut in 1991, the GST has been a controversial tax because in most areas Canadians already paid a regional sales tax, generally referred to as the Provincial Sales Tax (PST).[22] In instances where a province chooses to combine the federal and provincial sales taxes, a Harmonized Sales Tax (HST) is formed.[23]

Currently, at the federal level, pure gasoline is subject to:

- An excise tax on gasoline of C$ 0.10 a litre.
- A GST equal to five per cent of the final price paid for the fuel, including federal and provincial excise taxes. The GST is levied at the producer or wholesaler level, and is embedded in the retail price. It does not apply to provincial sales taxes levied at the pump as a percentage of the final price.

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19 Ontario Energy Minister George Smitherman speaking to media on 26 September 2008. Retrieved on October, 17, 2008 from www.canadiancattlemen.ca/issues/ISArticle.asp?id=90708&issue=10102008&story_id=&PC=FBC

20 Accessed on the 10 June 2008 from the Provincial Government of British Colombia's website: www.energyplan.gov.bc.ca/default.htm

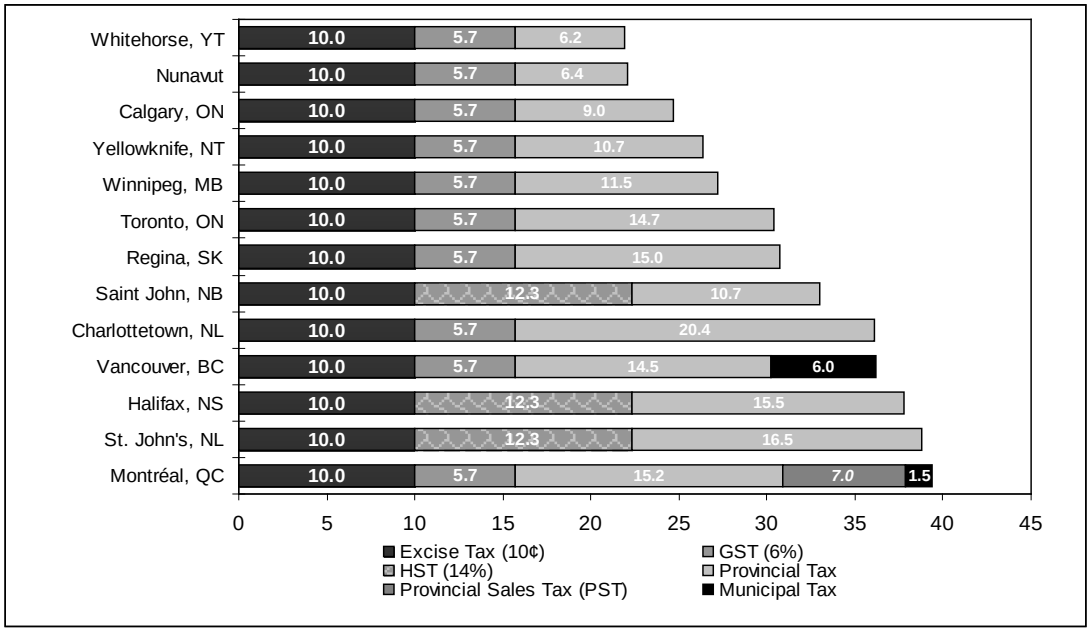
21 Email correspondence on 12 June 2008 with Mr Mel Harris, Administrative Assistant, Public Education & Outreach Legislative Assembly of British Columbia.

22 The PST is referred to in different ways, depending on the province. In Ontario and Manitoba it is known as the Retail Sales Tax (RST), while in Quebec it is known as the Social Services Tax (SST).

23 Nova Scotia, New Brunswick, and Newfoundland and Labrador have a HST. In Alberta, Yukon, Nunavut, and the Northwest Territories, there are no are no provincial sales taxes.

Provincial gasoline tax rates average about C$ 0.145 per litre overall, ranging from C$ 0.062 per litre in Yukon to around C$ 0.204 per litre in Prince Edward Island. Quebec imposes an additional sales tax of 7.5 per cent. Three municipalities also collect a tax on gasoline: Montreal (C$ 0.015 per litre), Vancouver (C$ 0.06 per litre) and Victoria (C$ 0.025 per litre).

Figure 3.1 Taxes on gasoline when the pump price is one dollar a litre, 2007 (cents per litre)



Source: Fuel Focus, Natural Resources Canada, 2007

From 1992 to 1 April 2008, the ethanol portion of blended gasoline was exempted from the federal excise tax on gasoline. The tax was C$ 0.081 per litre from 1992 to February 1995, when it rose to C$ 0.10 per litre. Several provinces also exempted ethanol from tax (Table 3.2).

Table 3.2 Excise tax exemptions for ethanol in Canada

Jurisdiction	Excise tax exemption (C$ per litre)	Date effective
Federal	0.085 per litre until 1995, then 0.10	1992 to 1 April 2008
Alberta	0.09 per litre	mid-1990s to 2007
BC	0.145 per litre	mid-1990s
Manitoba	0.25 per litre	1980s to 2007
Ontario	0.147 per litre	mid-1990s to end 2006
Saskatchewan	0.10 per litre	2002 to 2007

Sources: Alberta Finance, 2005; Auld, 2008; Manitoba's *Biofuels and Gasoline Tax Amendment Act* of 2003.

The tax exemptions apply to the ethanol component of blended fuel, such as E85 (in British Columbia; NRC, 2004b) or E10 (Manitoba; *Manitoba Biofuels and Gasoline Tax*

Amendment Act). Saskatchewan and Manitoba offer the exemption only on ethanol produced and consumed in the province (NRC, 2004b). Quebec indicated that it would exempt ethanol from excise tax once a facility was built in the province.

The gasoline excise tax in British Columbia is C$ 0.145 per litre for most of the province (some municipalities add an additional tax). Fuel blends of 85 per cent or more ethanol fuel are fully exempt from these taxes and the ethanol portion is exempt where the ethanol content is not less than five per cent or more than 25 per cent ethanol of the volume of the blend.[24]

Since GST is also applied to the fuel price over these excise taxes, the value of the total tax reduction is even greater. While there are no GST exemptions in Canada, the lower price of the fuel (due to excise tax exemptions) also reduces the total GST paid. The value of the total tax reduction is therefore greater than the excise tax exemption alone. However, due to resource constraints, the lower GST levels have not been included in the analysis.

3.1.3 Carbon tax exemptions

British Colombia introduced a carbon tax in 2008, which went into force on 1 July 2008 (BC Ministry of Finance, 2008). The tax will apply to the consumption within the province of most fossil fuels, including gasoline, diesel, natural gas, coal, propane, and home heating fuel. The starting tax rate will be C$ 10 per tonne of associated emissions of CO_2 equivalent, increasing by C$ 5 each year to C$ 30 per tonne by 2012.

Biofuels are exempted from the tax, regardless of their life-cycle emissions profile or origin. As discussed further in Section 5.2.2, most biofuels are not carbon neutral, as they require carbon-intensive inputs in their production. The fossil-fuel inputs required for producing the biofuel, such as for sowing, harvesting and transporting the feedstock or powering the biofuel refinery would be subject to the carbon tax if produced within the province. This would not be the case for any non-taxed inputs used in the production of biofuels that are imported from elsewhere. Nor does the scheme take into account non-fossil fuel inputs that significantly increase the carbon footprint of biofuels, such as N_2O released following the application of chemical fertilizers or release of soil carbon. To the extent that biofuels are not taxed for these emissions, biofuels receive a tax-exemption subsidy relative to fossil fuels.

In February 2009, the BC Climate Change Secretariat informed the authors of this report that the specifics of the "low carbon fuel standard"[25] were under development by the Ministry of Energy, Mines and Petroleum Resources. Details were therefore not unavailable as to how BC policy-makers intend to take account of the carbon embedded in biofuels imported from other provinces and other countries or to adjust for the GHG emissions emitted in the production stage (even in BC) that will not be taxed. The rationale for granting the C$ 0.145 per litre tax exemption on ethanol, and a C$ 0.15 per litre tax exemption on biodiesel is also unclear.

Quebec has had a carbon tax in place since 1 July 2007, though it is just C$ 0.008 per litre on gasoline and C$ 0.0094 per litre on diesel distributed in Quebec. Roberts (2008)

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[24] www.smartchoicesbc.ca/EN/tax_incentives

[25] See www.climateactionsecretariat.gov.bc.ca/clas/mediaroom/fact/standard.html

reported that the tax was expected to generate revenues of around C$ 69 million a year from gasoline sales, C$ 36 million from diesel fuel and C$ 43 million from heating oil. Revenues will go into a "green fund" to help the province meet its GHG emission reduction goals. It appears that biofuels are exempt from the tax.

The financial benefits of exemptions from carbon taxes were not calculated in this study, due to the lack of available information on the details of implementation of the schemes. However, such support could be important in the future if biofuels are given a blanket exemption without consideration of their carbon footprint.

3.1.4 Federal and provincial income tax concessions

3.1.3.1 Manufacturing and Processing Tax Mechanism

Historically, manufacturing and processing industries in Canada received a favourable treatment with federal taxation of income levied at seven percentage points below the statutory rate. Called the Manufacturing and Processing Tax Credit, McIlveen *et al.* (1996) of Natural Resources Canada noted that the subsidy was "relevant to alternative transportation fuels, such as ethanol" and that "many provincial corporate income tax systems contain a similar feature." Although the tax credit remains in the statutes, federal policy has aimed to tax all types of income similarly. As a result, effective tax benefits of the credit were eliminated over the 2001–04 period as the general corporate tax rate came down (McIlveen, 22 January 2009). A number of provinces continue to offer reduced taxation of Manufacturing and Processing Income, however. This includes Saskatchewan and Ontario (two percentage point reduction), as well as a nine percentage point reduction for Newfoundland (KMPG, 31 December 2008).

3.1.4.1 Scientific Research and Experimental Development (SR&ED) Tax Incentive Program

The Canadian federal government provides tax incentives under a scientific research and experimental development (SR&ED) tax incentive program. The program provide over C$ 4 billion in tax assistance in 2008–09 to promote business investment in R&D (Ministry of Finance, 2008). It is the single largest federal program supporting business R&D in Canada.

The basic credit is 20 per cent of eligible SR&ED for most corporations. The credit can be used in the year to reduce corporate income tax otherwise payable, or it can be carried forward or back to reduce the tax liabilities of other years. Some corporations which are smaller and meet other criteria can earn the credit at a 35 per cent rate. These smaller corporations may also have some or all of the credit refunded to them if they are not currently liable for tax. In addition to the federal SR&ED tax credit, almost all of the provinces in Canada provide an additional provincial tax credit for R&D as well (Ministry of Finance, 2008).

Budget 2008 announced measures to enhance the availability and accessibility of the financial support for research and development by small and medium-sized businesses. The upper limits were raised for the more generous tax deductions, allowing more companies to access larger tax breaks. Budget 2008 also announced that SR&ED investment tax credits would be available for some salary or wage expenses incurred for SR&ED carried on outside Canada.

This tax incentive is generally available to all industries in Canada. The biofuels industry, as a sector that is new and probably carrying out significant amounts of R&D relative to its total size, may also utilize this credit. Corporate income tax information is confidential

so there is no information on which companies are claiming this credit. Annual reports of public companies might provide some insight on the use of this tax "expenditure."

Finance Canada provides estimates for the total cost of the SR&ED program (Table 3.3).

Table 3.3 Tax expenditure: estimates and projections for the Scientific Research and Experimental Development (SR&ED) Tax Incentive Program

($ millions)

Corporate Income Tax Expenditures	2003	2004	2005	2006	2007	2008	2009	2010
Earned and claimed in current year	1 745	1 965	2 075	2 305	2 565	2 715	2 870	3 035
Claimed in current year but earned in prior years	545	1 095	860	960	1 065	1 150	1 240	1 335
Earned in current year but carried back to prior years	110	120	100	110	110	110	110	115
Total tax expenditure	2 400	3 180	3 035	3 375	3 740	3 975	4 220	4 485

Source: Ministry of Finance (2008)

3.1.5 Support based on current output

The federal excise tax exemption and those in Alberta, Manitoba, Ontario and Saskatchewan have been replaced with producer payments and operating grants, which cannot be accessed by imported product. Quebec never introduced an excise tax exemption, but instead implemented a producer credit scheme.

The ecoENERGY for Biofuels Initiative, announced by the federal government on 5 June 2007, contained for the first time a volumetric producer payment for production from eligible facilities constructed before 31 March 2011. The program has been structured to limit the amount and duration of subsidies to any single plant, with a goal of spreading the money to build a broader biofuels base.

The initial payments began in April 2008, subsequent to work with industry to refine concerns about how payments were set. They are scheduled to continue through 31 March 2017. Outlays are limited in multiple ways. Nationally, payments are limited to two billion litres of ethanol in total, and a separate 500 million litre cap on renewable diesel. However, the government has indicated that the eligible volume could be increased over time if sufficient funds were to become available. The total maximum payment in one year, for FY 2008–09, is capped at C$ 146 million. This cap rises to C$ 200 million, then declines over time with the limit set at C$ 80 million for FY 2016–17.

Limitations also exist at the plant level, with eligible facilities receiving payments for seven years. Of the total cap, no more than 30 per cent may go to any one facility (600 million litres for ethanol, and 150 million litres for biodiesel) (U.S. Department of Agriculture, 2008: 5). The per litre payments are scheduled to decline over time, ranging from as high as C$ 0.10 per litre during the first three years of the program, dropping to

C$ 0.08 per litre provided in FY 2011–12 and then dropping by one cent per year, reaching C$ 0.04 per litre in FY 2015–16. These are maximum payment levels, and their declining trend appears focused on gradually weaning producers away from public support. In addition, the actual payments are linked to industry profitability in an effort to reduce incentives when market conditions are favourable for the industry, and boost them when market conditions are unfavourable (U.S. Department of Agriculture, 2008: 6). No incentive is currently scheduled to be provided after 31 March 2017.

Based on existing and announced capacity, it would appear that the annual threshold of two billion litres per year will be reached by FY 2009–10, implying total payments for ethanol over the nine years of the program of as much as C$ 1.23 billion. However, given that the government has set an upper limit of C$ 1.5 billion for combined payments to ethanol and biodiesel, a more likely nine-year total for ethanol, pro-rated among the two fuels, would be C$ 1.0 billion.

Direct support based on current output is provided by five provinces in Canada: Alberta, Manitoba, Quebec, Ontario and Saskatchewan (Table 3.4).

Table 3.4 Per-litre producer subsidies for ethanol

Jurisdiction	Level of producer subsidy	Program name	Duration
Federal	Maximum of C$ 0.10 per litre declining to 0 by 2017	ecoENERGY for biofuels	2008 to 2017
Alberta	Between C$ 0.09 and C$ 0.14 per litre depending on producer size	BioEnergy Program	2006 to 2011
Manitoba	C$ 0.20 for the first two years, C$ 0.15 for the next three years and C$ 0.10 for the final three years	The Biofuels Act (as amended in November 2007)	2008 to 2015
Ontario	up to C$ 0.11 per litre based on the combination of the market price for petroleum oil, corn and ethanol	Ontario Ethanol Growth Fund (OEGF)	2007 to 2016
Quebec	Up to C$ 0.185 per litre when the price of crude oil is under US$ 65 per barrel, otherwise zero		2006 onwards
Saskatchewan	C$ 0.15 per litre		2007 onwards

Source: Auld, 2008; federal and provincial government websites.

In 2005, the Province of Quebec established a refundable income tax credit for ethanol produced in the province, up to a maximum of 126 million litres a year (Quebec, 2005). The tax credit is based on the international price of crude oil, ranging from C$ 0.185 per litre if the price of West Texas Intermediate falls to US$ 31 a barrel or less, and declines and reaches zero when the price reaches US$ 65 per barrel or more.[26] A maximum of C$ 182.4 million is available to an eligible corporation for a maximum of 10 years. In the

[26] The maximum rate of the tax credit in any given month will be C$ 0.185 per litre. For a given month, the average monthly price of crude oil will consist of the arithmetic average of the daily closing values on the New York Mercantile Exchange (NYMEX) of the price per barrel of West Texas Intermediate in Oklahoma (WTI-Cushing), expressed in US$. From: *2005–2006 Budget Additional Information on the Budgetary Measures* www.budget.finances.gouv.qc.ca/budget/2005-2006/en/pdf/AdditionalInfoMeasures.pdf.

Province's budget statement for FY 2005–06, the financial impact for the government of the refundable tax credit was estimated at C$ 12 million per year in FY 2006–07.

In June 2005, Ontario announced the establishment of a C$ 520 million, 12-year *Ontario Ethanol Growth Fund* (OEGF). The majority of the funding commitment will deliver operating grants to ethanol producers over a period of up to 10 years (from 2007 until 2017). Payments will be based on a formula reflecting fluctuating market prices of corn, ethanol and crude oil.[27] No operating grant will exceed C$ 0.11 per litre of ethanol produced in a particular year, and annual grants will be capped at a total of C$ 60.5 million per year (U.S. Department of Agriculture, 2007). To offset this ethanol production subsidy, as of 1 January 2007 the Province made ethanol subject to the same retail fuel taxes as gasoline.

Alberta's Bio-fuel and Bio-gas Producer Credit Program, announced in 2006, pays 14 cents per litre for production of biofuels (ethanol, biodiesel and biogas) from plants with an annual capacity of less than 150 million litres, and C$ 0.09 per litre for production from plants with an annual capacity of 150 million litres or greater. For small plants, annual payments cannot exceed C$ 15 million per year. For large plants, a lifetime ceiling of C$ 75 million applies, as well as an annual payment ceiling of C$ 20 million. The payments apply only to actual production and sales occurring between 1 April 2007 and 31 March 2011.

3.2 Policies affecting the cost of intermediate inputs

3.2.1 Policies affecting the costs of feedstocks

Canada is a major producer of its main ethanol feedstocks, corn and wheat. In 2006, corn supplied 77 per cent of the feedstock used in the Canadian ethanol production, though this share was expected to drop to 66 per cent by 2008. Most of the remainder is wheat (U.S. Department of Agriculture, 2007: 24, 25).

Canada's federal government historically has subsidized farmers with cash payments and transportation subsidies (AAFC, 2005a). However, there are no direct payments for growing biofuel feedstock crops. Most of the financial support provided to crop growers takes the form of direct payments not related to production, and so the overall effect on feedstock prices of these payments is likely to be small.

Canadian federal farm subsidies and tariffs have declined since the 1990s, following negotiations to include agriculture in the General Agreement on Tariffs and Trade. The Uruguay Round's Agreement on Agriculture (AoA), which was implemented over six years, starting in 1995, committed Canada and other member nations to move towards reform of distortions in agricultural trade. These included commitments to reduce tariffs and to allow increased import access to protected domestic markets. Commitments were also made to reduce agricultural export subsidies and to reduce domestic support that distorts agricultural production and trade.

27 The OEGF operating grant payment depends on whether or not the price of fuel ethanol is trading within its normal historical relationship to the price of crude oil. See Appendix A of the OEGF Round Two Call for Proposals (July 2007), at www.omafra.gov.on.ca/english/policy/oegf/invitation.pdf

In 1995, the "Crow Rate"[28] subsidization of grain shipment to export points was ended. This policy, dating back to 1897, had reduced the costs of exporting grain produced in Alberta, Manitoba and Saskatchewan. Under the Western Grain Transition Payment Program, prairie farmers were offered a one-time financial payment to help them make the necessary adjustments in their operations. Since then, the cost to farmers for shipping western grain by rail has increased. The immediate effect of this change was a reduction in the price of wheat and other grains in the Prairie Provinces, and an increase in the price of these grains elsewhere in Canada. Lower prices for feed encouraged increased livestock production and feeding in the Prairies and formed the basis for a large expansion of the hog industry in 1998. The resultant lower prices of grains in certain provinces may have encouraged the establishment of local ethanol production.

From the end of 2005 until April 2006, the Canadian government applied a C$ 1.65 per bushel duty to corn also imported from the United States. During this time, several Canadian corn-to-ethanol projects were put on hold pending resolution of the issue. Finally, in April 2006, the Canadian International Trade Tribunal ruled that U.S. corn imports were not causing harm to the Canadian corn market, and the tariff was removed (Irwin, 2006).

3.3 Subsidies to factors of production

Subsidies to factors of production include grants and preferential loans (i.e., interest-free, low interest, deferred payment or loan-guarantees) for capital investments, business-case development or land purchases.

3.3.1 Federal programs for capital

3.3.1.1 The National Biomass Ethanol Program (NBEP)

The National Biomass Ethanol Program (NBEP) was launched in 1994, shortly after the federal government exempted ethanol from the gasoline excise tax. The NBEP provided for C$ 140 million in contingent loan guarantees to encourage financing for new plants that produce ethanol from biomass.[29] The aim of the program was to overcome lender resistance to investing in ethanol plants because of uncertainty about excise tax policy. The loan guarantee program would come into effect only if all or part of the excise gasoline tax were imposed on ethanol before December 2010.

Initial funding for the program was C$ 70 million. In 2001 the program was renewed and extended, with the total credit limit increased to C$ 140 million.[30] Farm Credit Canada

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[28] The Crow's Nest Pass Agreement, dated 6 September 1897 refers to an early agreement between the Canadian Government and the Canadian Pacific Railways in keeping grain-shipping costs below a fixed level. Accessed on the Canadian Encyclopaedia website on the 2 June 2008. The information can be accessed on the following link www.thecanadianencyclopedia.com/index.cfm?PgNm=TCE&Params=A1SEC819041

[29] See Natural Resources Canada site, Ethanol The Road to a Greener Future, http://oee.nrcan.gc.ca/publications/infosource/pub/vehiclefuels/ethanol/M92_257_2003.cfm

[30] See Treasury Board of Canada Secretariat Site, 2004–05 Budget Estimates Part I & II, www.tbs-sct.gc.ca/est-pre/20042005/page.asp?page=002_e_40.htm Retrieved 20 October 2008.

(FFC), the lending agency, accepted applications under the program until March 2006. The maximum line of credit per applicant is established by multiplying the eligible new or expanded plant capacity in litres of annual output by C$ 0.208 per litre. Contingent loans were to be repaid at commercial rates (Walburger *et al.,* 2006).

This loan guarantee was made available to a limited number of applicants from 1999 to 2005. However, because the excise tax exemption, though withdrawn in April 2008, was replaced by a producer credit of a similar value, no producers have drawn on the line of credit.

3.3.1.2 The 2003 Ethanol Expansion Program (EEP)

In October 2000 the federal government released its *Action Plan 2000 on Climate Change*, intended to enable the country to achieve its greenhouse-gas emission reduction obligations pursuant to the Kyoto Protocol. The Plan included a *Future Fuel Initiative* (FFI) to develop alternative fuels, including renewables. It envisaged a quadrupling of Canada's ethanol annual production capacity by 750 million litres, to enable 25 per cent of Canada's total gasoline supply to contain up to 10 per cent ethanol, an overall average of 2.5 per cent (TC, 2002). Specific measures to support this target did not appear until 2003.

The Ethanol Expansion Program (EEP), announced on 12 August 2003, marked a major shift in national policy. It was the first federal program directly supporting the construction of ethanol refineries, providing a total of C$ 107 million in deferred, conditional loans over three years to support the construction of a total of 11 plants across Canada (Table 3.5).

Table 3.5 Ethanol Expansion Program funding

Company name	Production capacity	EEP funding (C$ million)
NorAmera BioEnergy Corp., Weyburn, SK	25	3.5
Suncor Energy Products Inc., Sarnia, ON	208	22.0
Husky Oil Operations Ltd., Lloydminster, SK	130	7.8
GreenField Ethanol, Inc., Varennes, QC	200	18.0
Power Stream Energy Services, Collingwood, ON	52	7.3
Husky Oil Marketing Company, Minnedosa, MB	130	10.4
Okanagan Biofuels Inc., Kelowna, BC	114	10.0
Permolex Ltd., Red Deer, AB	12	1.1
GreenField Ethanol Inc., Johnstown, ON	120	15.0
Integrated Grain Processors Co-Operative, Aylmer, ON	150	11.9
Seaway Grain Processors, Inc., Cornwall, ON[1]	0	—
Total	986	107.0

1. Plant cancelled.

Source: Natural Resources Canada, 2007.

Conditional loans were allocated through a competitive bidding process, based on the subsidy per litre of ethanol produced and the extent to which the plant would help reduce greenhouse gas (GHG) emissions. This structure meant that cellulosic plants

would have received funding preference. However, no proposals for cellulosic plants were submitted. As a result of industry lobbying, likely GHG impacts were reported but did not finally affect awards (Bryan and Moore, 2004; personal communication with Chris Johnstone, EEP program manager, 22 May 2008).

Funding was discontinued as of 31 March 2007. NRCan reports the total investment associated with all of the projects they supported through the EEP are worth C$ 900 million, and will produce a total of 1.2 billion litres of ethanol per year (Office of the General Auditor of Canada, 2006).

The EEP allows for a seven-year repayment schedule (starting three years after the plant goes into operation) based on each plant's annual profitability. A three-year rolling average profitability is used in the calculations to smooth out year-to-year variation in performance. Plants that do not generate a profit are not obliged to repay the loans. Plants which are profitable must make loan repayments equivalent to 20 per cent of profits, but that obligation ends at the end of the seven-year agreement. If loans are not fully repaid, but plants continue to be profitable after that period, the government is not reimbursed (Robert, 2007).

In its 2006 report, Canada's Office of the General Auditor expressed concern that the program lacked controls to properly collect repayments even when they were due (Office of the General Auditor of Canada, 2006). Repeated requests for updated information on this audit from the EEP administrators were unsuccessful, nor were aggregate repayment data made available from NRCan, when requested. Program officials have confirmed that repayments have begun to be made, though they would not provide details on the specific amounts received (personal communication with Chris Johnstone, 22 May 2008).

The EEP subsidizes producers in several ways. First, the core loan accrues no interest so long as no payments are due according to the profit formula in the agreement with recipients. Late payments alone accrue interest (at three per cent above the Bank Rate for all outstanding agreements), although this applies only to the missed interest payments, not the remaining principal. Second, the government provides subordinated loans, having the lowest claim on repayment in the case of financial stress or bankruptcy. This type of loan normally carriers a higher interest rate, since it is the first that companies will default on. Third, the program forgives the payments entirely after the 10th year should the calculated profit-based repayments not have repaid the initial principal in its entirety.

One of the innovative features of the EEP was a "stacking provision." This provision required that total assistance from all federal, provincial or territorial and municipal government sources represent no more than 50 per cent of total project costs as defined in the *Invitation to Proponents* (the document setting out the terms of the assistance) (EEP, 20 October 2003: 15). Moreover, successful recipients of EEP assistance had to disclose all sources of funding required for their project before entering into an agreement with the government. Further, upon completion of the Project, the recipients were required to disclose all sources of funds received. Although this indicates that total subsidies from all sources had to be revealed in EEP applications, these submittals have not been made public.

Despite the lack of specific information on the contracts, it is possible to bound the value of the program. At the lower end, the annual subsidy-equivalent value is assumed to be the opportunity cost to the government of providing the loan interest-free, when it could have been earning interest. A highly conservative 10-year Canadian Treasury bond rate of four per cent is used. On that assumption, the opportunity cost to government is around C$ 2.48 million per year.

At the upper end, the capital of the loan is assumed to roll over year-after-year, as the plant is never profitable to repay the debt. The full debt is forgiven in year 12. Under this scenario, the annual subsidy-equivalent value—in terms of the opportunity cost to government—is the full annual repayment (capital and interest) that must be written-off: C$ 11.4 million per year.

The above approach estimates, conservatively, the opportunity cost to government of providing zero interest loans. The value of the subsidy for the biofuel producer would be much higher. A commercial loan to develop a biofuel facility would likely cost more than the four per cent bond rate used in the calculation.

3.3.1.3 The ecoAgriculture Biofuels Capital Initiative (ecoABC)

Funding for the federal ecoAgriculture Biofuels Capital (ecoABC) Initiative was initially announced in December 2006 under the name of the Capital Assistance Formation Program (CFAP). The renamed program, launched in April 2007, commits C$ 200 million over four-years (2007–11) and is administered by Agriculture and Agri-Food Canada. It follows the Ethanol Expansion Program and expands federal support to transport biofuels other than ethanol.[31]

The ecoABC program makes repayable capital contributions—essentially, conditional loans—for the construction or expansion of transportation-biofuel production facilities using agricultural feedstocks. The new facility or expansion must produce at least an additional five million litres per year to be eligible.

The ecoABC contribution is calculated by multiplying an incentive rate (in cents per litre) by the increase in the annual nameplate capacity of the renewable fuels facility (in litres). Support rises with the share of agricultural producer equity in the project's total cost. The minimum eligible agricultural producer investment in the project is five per cent of the Eligible Project Costs, which delivers support of C$ 0.08 per litre, rising up to a maximum of C$ 0.20 per litre. [32]

The ecoABC contribution cannot exceed 25 per cent of total project costs, or C$ 25 million per project, whichever is smaller. Moreover, payment of the ecoABC contribution is made to the recipient only after the biofuel facility has commenced producing the biofuel at its certified nameplate capacity, and after it has submitted a final project report.

The total amount loaned to a recipient is repayable under conditions of profit after a three-year grace period. The first repayment is due by 30 January in the fifth calendar year after the year in which the funded facility commences production at its nameplate

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[31] For the purposes of ecoABC, transportation biofuels are substances such as ethanol, biodiesel, and cellulosic ethanol that are produced from agricultural feedstocks and can be blended into traditional fuels. See the ecoABC eligibility requirements at www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1195677735324&lang=eng#projad

[32] The actual formula is: $IR = 100 \times (0.8 \times APEI\ \%) + C\$\ 0.04$ where IR = incentive rate, in cents per litre and *APEI%* = the agricultural-producer share of the project (i.e., total equity investment by agricultural producers divided by the eligible project costs).

capacity. Repayments then continue for six subsequent years, or until the loan has been entirely paid back, whichever comes first.[33]

Applications for the repayable contributions began to be accepted starting 1 April 2007. As of April 2009, a total of 19 per cent of the available funds had been allocated for four projects, three of which were ethanol producers (Table 3.6).[34]

Table 3.6 Recipients of ecoAgriculture Biofuels Capital Initiative grants to ethanol producers, to April 2009

Corporation	Province	Nameplate Capacity (million litres)	Biofuel	ecoABC Contribution (C$)
North West Terminal Ltd.	Unity, Saskatchewan	25	Ethanol	5.050 000
Integrated Grain Processors Co-Operative Inc.	Aylmer, Ontario	150	Ethanol	3 904 712
Suncor Energy Products Inc.	Toronto, Ontario	200	Ethanol	25 000 000

Source: Department of Agriculture and Agri-Food Canada, 2009: www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1195679783268&lang=eng

Using the same method applied to calculate the subsidy-equivalent value for the EEP (Section 3.3.1.2), the lower-range subsidy value of the ecoABC program is around C$ 5 million per year for 10 years. This assumes that all loans are repaid. However, both ethanol and biodiesel are eligible for program funds, and therefore we attributed half of the subsidy value to ethanol: around C$ 2.3 million.

The upper-bound estimate assumes that none of the loans are repaid, resulting in an annual cost to government for the whole program of around C$ 25 million (of which one half, or C$ 12.3 million, can be attributed to ethanol). The subsidy value for grant recipients would be much higher, given that the likely interest rate for biofuel capital projects would be significantly higher than four per cent.

3.3.1.4 Biofuels Opportunities for Producers Initiative (BOPI)

The Biofuels Opportunities for Producers Initiative (BOPI) was a two-year, C$ 20 million grant program created in July 2006—twice the amount original stipulated, due to high demand (U.S. Department of Agriculture, 2008). BOPI assisted farmers and rural communities to develop business proposals and undertake feasibility studies necessary to create and expand biofuels production capacity. Projects required involvement of greater than one-third ownership by agricultural producers. The program was provided under

[33] For each calendar year, the recipient repays an amount (RP) calculated as of 31 December of the previous year as follows: $RP = (0.25 \times TP) \times (AGIPL - C\$\ 0.20)$, where $AGIPL$ = average gross income per litre and TP = total biofuel production in the previous twelve months. If AGIPL is C$ 0.20 or less, the repayment for that year will be zero.

[34] Information obtained from the Department of Agriculture and Agri-Food Canada's website, accessed on 21 August 2008, on the following link: www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1195679783268&lang=e

the Advancing Canadian Agriculture and Agri-Food (ACAAF) Program and administered by regional Industry Councils. Approximately half of the grants were provided to ethanol projects and half for biodiesel projects.[35] The program closed as of 31 March 2008 (U.S. Department of Agriculture, 2008).

3.3.1.5 Accelerated depreciation

Normal accounting rules allow capital investments to be deducted from taxable income over the service life of the investment. When deductions are accelerated, corporations receive higher-than-normal deductions in the early years of the investment. Funds that would otherwise have gone to the Treasury are retained as additional cash within the firm, and can be used for other purposes. The provision acts as an interest-free loan from the government. Because depreciation is normally capped at 100 per cent of the invested funds, higher deductions in the early years of an investment reverse in the later years, with deductions lower than the baseline. However, due to the time value of money, accelerated deductions still generate substantial financial benefits to the firms on a present-value basis.

Governments routinely tinker with both the time period of depreciation and the size of the deductions that can be taken within that period. This tinkering is evident in the Canadian depreciation system as well. Known as the *Capital Cost Allowance (CCA)*, Canadian Income Tax Regulations include more than 40 classes of capital, defining the rules for specific types of investments (Starky, 2006).

Since at least 2000, Canada has been accelerating depreciation on a variety of energy-related investments, including both renewable and conventional resources (Starky, 2006). Investments in class 43.1 allow accelerated write-off of up to 30 per cent per year, compared with typical rates of four or 20 per cent (Brown, 2007). As of 2000, class 43 (also a 30 per cent per year CCA) included "facilities to produce alternative transportation fuels, such as ethanol" (Canada Commissioner of the Environment and Sustainable Development, 2000: 3–34).

Class 43.2, introduced in 2005, provides even more generous write-offs, with a CCA of 50 per cent for a wide variety of energy-related equipment. The provision has been extended through 2012, and efforts were underway to extend it out to 2020 (Department of Finance Canada, 2007).[36] The CCA for a wider set of machinery and equipment used in manufacturing or processing has also been stepped up from 30 to 50 per cent. The rules also allow straight-line depreciation for many of these investments (Canada Budget, 2008), which would effectively write-off in roughly two years[37] plant infrastructure that can be expected to last for decades. Under the Canadian renewable conservation expense (CRCE) provisions, intangible costs to develop renewable energy projects can be written

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[35] Compiled from various official government press releases from websites: www.agr.gc.ca, www.omafra.gov.on.ca and www.mrac.ca

[36] McIlveen (14 January 2009) notes that there is ambiguity in the statutory language of investments qualifying for Class 43.2 treatment, and that 43.2 might be limited to biomass-related generation of electricity. However, he notes that benefits under class 43 (where he would place biofuels) are even more generous at present.

[37] To the extent half-year conventions are required for the initial year capital is placed in service, full write-off would occur in year three rather than year two.

off (expensed) immediately, rather than included in the capital cost of the related facility, as would need to be done in the United States. Examples of these costs include feasibility studies and site-acquisition costs (Blommaert, 2008).

Table 3.7 provides a summary of the write-off periods for biofuels-related capital under present law relative to estimated actual service life based on an analysis of capital resale markets. Table 3.8 provides a summary of the subsidy value of these provisions for capital investments during the build-up of the ethanol sector in recent years. These have been calculated by estimating the incremental write-off allowed under favourable CCA rules, and estimating the associated reduction in corporate taxes from the higher deduction.

The estimated revenue loss during the 2006–12 period is expected to amount to around C$ 210–C$ 365 million during the 2006–12 period. The range reflects a spread in the estimated cost per litre of plant capacity built. Subsidies via accelerated depreciation will level off in the face of the construction slow-down. However, the rise of federal and provincial consumption mandates is likely to drive increased construction over the longer term.

Table 3.7 Write-off periods for biofuels-related capital under present law relative to estimated actual service life

Asset Type	CCA Depreciation	Service Life in Tax Code	Estimated Real Service Life
		Years	Years
Biofuels plant	Class 40	2–4[1]	30
Distribution Infrastructure			
Heavy trucks	16(g)	2.5	10
Other trucks, trailers	10(a)	2.5	17
Rail cars	7(h)(ii)	7	27

Notes: [1] Allowable method shifted from 30 per cent declining balance to 50 per cent straight line in March 2007; reversion to the old method is scheduled in 2011 but may be delayed.

Sources: CCA depreciation and service life in tax code: Neil McIlveen, ENTRANS Policy Research Group, e-mail to Tara Laan, IISD, 13 January 2009. Estimated real service life: U.S. Bureau of Economic Analysis, "BEA rates of Depreciation, Service Lives, Declining-Balance Rates, and Hulten-Wykoff Categories," February 2009. www.bea.gov/national/FA2004/Tablecandtext.pdf

Table 3.8 Estimated subsidy value of accelerated depreciation to the ethanol sector: revenue loss (C$ millions)

	2006	2007	2008	2006–12
Low Estimate (capital cost = C$ 0.47 per litre)				
Revenue loss	4	17	35	211
Present value				123
High Estimate (capital cost = C$ 0.82 per litre)				
Revenue loss	7	30	60	364
Present value				212

Source: GSI estimates

3.3.2 Provincial programs for capital

Several provinces have also introduced measures to support the development of ethanol-producing infrastructure. These have generally been provided in the form of capital grants.

Ontario

The C$ 520 million *Ontario Ethanol Growth Fund* (OEGF) included C$ 32.5 million in assistance in the form of capital grants, available to eligible new or expanding ethanol plants being built in Ontario (Ontario Ministry of Agriculture, Food and Rural Affairs—OMAFRA, 2005).

Capital grants are awarded in competitive rounds. The first round, which ended with the announcement in June 2006 of C$ 32.5 million worth of capital grants, supported the development of 485 million annual litres of ethanol production capacity.[38] Out of 12 applicants, four were awarded grants:

- GreenField Ethanol, for a 190 million litres per year facility in Hensall (C$ 12.5 million).
- Integrated Grain Processors' Co-operative, for a 145 million litres per year plant at Aylmer (C$ 14 million).
- Seaway Valley Farmers Energy Co-Operative, for a 65 million litres per year plant at Cornwall (C$ 6 million).
- Collingwood Ethanol, Collingwood, for a 50 million litres per year ethanol facility (unknown funding amount).

The Seaway Valley plant was abandoned in June 2007, however, and in July 2007 OMAFRA invited other producers to compete for the C$ 6 million thus liberated. The majority of this funding was allocated to Kawartha Ethanol, Ontario, in December 2008 (C$ 4.9 million).

The Integrated Grain Processors' Co-operative also received a C$ 600 000 grant from Ontario under its Community Transition Program (IGPC, 11 February 2008).

Alberta

In October 2006, as part of its Nine Point Energy Plan, Alberta announced a C$ 30 million BioEnergy Program that included a C$ 6 million BioEnergy Infrastructure Development Program. The program aims to: expand the distribution infrastructure for biofuels; connect biorefining processing projects to the market place; and facilitate major new investment in biorefining.[39]

At the same time, the Agriculture Financial Services Corporation (AFSC, a provincial crown corporation) created a C$ 20 million BioIndustrial Loan Program (BLIP) to provide preferential loans at rates of between five per cent and nine per cent. Investments (up to C$ 2 million for a single company or consortium) are typically made

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[38] http://ogov.newswire.ca/ontario/GONE/2006/06/15/c9491.html?lmatch=&lang=_e.html

[39] See the program's guidelines at www.energy.gov.ab.ca/BioEnergy/pdfs/BIDP_program_guidelines.pdf

to commercialize products, initiate product roll-outs, expand distribution and market presence, or fund expansion.[40]

Quebec

For a brief period, the province of Quebec had an accelerated capital cost allowance program on specific capital equipment used in fuel ethanol production.[41] The 120 million litres per year GreenField Ethanol plant, completed early in 2007 in Varennes, is the only plant to have benefitted from this aid. In November 2007, Quebec's Minister for Natural Resources promised that the Varennes plant would be the last of its kind, stating that "It is necessary to turn to other [feedstock] sources" (Cardinal, 2007). The province intended in the future to support cellulose ethanol production from forest and household waste.

Saskatchewan

In June 2007, Saskatchewan's Ministry for Enterprise and Innovation Minister created the Saskatchewan Biofuels Investment Opportunity (SaskBIO) program to encourage investment in locally-owned biofuel production capacity. A total of C$ 80 million was made available for the program over a four-year period, beginning on 1 April 2008.

Funding is to be provided in the form of a one-time repayable capital contribution to new and expanding eligible biofuel facilities. The amount of the loan is calculated according to a formula based on the facility's nameplate capacity and the percentage of equity investment provided by eligible Saskatchewan investors. Funding is provided to the successful applicant on a sliding scale at a rate of up to 10 cents per litre, or C$ 10 million, whichever is less.

Initially, the scale of eligible Saskatchewan investment was set at a minimum of two per cent and a maximum of 50 per cent of the organization's share holdings. To qualify as an eligible investor, the investor had to live within a 100-km radius of the plant. In February 2008, in an effort to revive several stalled ethanol projects in the province, the Enterprise and Innovation Minister lowered the share of local investment benefitting from the maximum contribution rate to 20. At the same time, he announced that eligible projects could draw investors from across the province.

The payment is contingent on an eligible project commencing production of biofuels and verifying its certified nameplate capacity. It is then repayable by the applicant under conditions of profit.

Assuming that all loans are repaid, the annual opportunity cost to government can be conservatively estimated to be around C$ 0.9 million for ethanol. If none of the loans are repaid, the subsidy value would rise to around C$ 4.9 million per year.[42]

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[40] See AFSC BioIndustrial Loans Program site at http://afsc-dev.claritydemo.net/Default.aspx?cid=3-16-111

[41] Pembina Institute, *EFR Policies in Canada*, Fiscally Green, Environment Canada <www.fiscallygreen.ca/experience.html>.

[42] See Section 3.3.1.2 for a description of the methodology and assumptions used for the calculation.

3.3.3 Support for services

Technical assistance to the industry also exists. The *Biofuels Quality Registry* (BQR), a joint endeavour by Natural Resources Canada, Environment Canada, and provincial agencies, is an online national database set up to develop an industry protocol and standard for fuel analysis. NRCan provides up to C$ 200 000 (up to C$ 100 000 annually over a two-year period) to help pay for laboratory testing of biofuels.[43]

The Federal Government has also provided general services in the form of information and promotional activities. For example, the *Future Fuels Initiative* (FFI) provided C$ 3 million over five years, starting in 2001,[44] for public outreach to promote alternative fuels to consumers.[45] The FFI Initiative was concluded in March 2007 and has been succeeded by the ecoEnergy Biofuels Initiative.

3.3.4 Subsidies to by-product utilization

Manitoba is researching ways to enhance the feedstock value of distiller's dried grain, with the provision of C$ 0.2 million via the Canada-Manitoba Economic Partnership Agreement (Hooper, 16 August 2008).

3.4 Research and development

3.4.1 Federal programs

The Canadian Government, like many governments around the world, is anticipating a major breakthrough in "second-generation" ethanol technologies, particularly technologies that break down cellulose with enzymes, which significantly expands the range of plant material that could be converted to ethanol. The federal government has supported research on second-generation ethanol for almost three decades.

3.4.1.1 Early support for cellulosic ethanol

Since the mid-1980s, the government has supported research by the Iogen Corporation to develop cellulosic ethanol production technologies. Approximately half of the costs of developing this technology came from research partnerships with government institutions such as the National Research Council Canada (NRC), Natural Resources Canada (NRCan), and Agriculture and Agri-Food Canada (AAFC). Total government funding between the mid-1980s and mid-1990s is estimated to have been about C$ 18 million (Hester, 2008).

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43 NRCan, *ARC and Government of Canada Launch Biofuels Analysis Incentive Program*, Natural Resourced Canada <www.nrcan.gc.ca/media/newsreleases/2005/200570_e.htm>, 7 September 2005.

44 Accessed from the International Energy Association (IEA) website on 13 June 2008 on the following link: www.iea.org/textbase/pm/?mode=re&id=663&action=detail

45 A description from NRCan's website states that the Future Fuels Initiative "provides for activities such as public education on fuel ethanol, analysis of fuel ethanol markets and producer economics and provides a liaison with provinces/territories and industries that are interested in ethanol plant expansion." http://oee.nrcan.gc.ca/transportation/fuels/ethanol/future-fuels-initiative.cfm?attr=16

In 1997 Iogen began constructing a C$ 40 million commercial-scale demonstration plant capable of converting 25 tonnes of straw a week into bioethanol. In January 1999, the federal government provided nearly C$ 18 million in loans repayable from future profits from Technology Partnerships Canada, a branch of Industry Canada.[46] The remainder of the C$ 30 million came from private investors, including Iogen and industry partners such as Petro-Canada, which contributed C$ 15.8 million. In February 2007, Technology Partnerships Canada announced that it would be contributing another C$ 7.7 million in repayable loans to help pay the C$ 25.8 million required for technology upgrades at the demonstration plant. Prior to this, in March 2002, the federal government awarded the company a three-year, C$ 2.7-million, cost-shared research contract to develop improved enzymes, with Iogen investing a matching C$ 2.7 million. Government participants in the project included NRCan, AAFC, and Technology Early Action Measures (TEAM), a component of the Federal government's *Climate Change Action Fund* (CCAF).

Iogen is expanding commercialization, and plans to construct a C$ 350 million cellulosic ethanol plant in North America capable of producing 40 million litres a year. Site selection has been narrowed down to north-central Saskatchewan, east-central Alberta or south-eastern Idaho. Iogen has partnered with the Royal Dutch-Shell Group, which invested C$ 46 million in Iogen, and Goldman Sachs & Co., which invested C$ 30 million.

Syntec Biofuel Research Inc., a scientific research company established at the University of British Columbia in 2001, is developing an advanced process of producing ethanol from syngas (including syngas derived from cellulosic feedstocks). Syntec's research efforts have been funded through private equity, as well as Canadian government agencies, the National Research Council of Canada and Natural Resources Canada.

3.4.1.2 Agricultural Bioproducts Innovation Program (ABIP)

The Agricultural Bioproducts Innovation Program (ABIP) is a C$ 145 million, multi-year grant program designed to support new and existing research networks and encourage the development of clusters "for the advancement of a sustainable and profitable Canadian bio-economy." The program seeks to develop new economic opportunities for agriculture in the areas of bioproducts and bioprocesses such as biochemicals and biopharmaceuticals, in addition to biofuels and other forms of bioenergy.[47] Funding is capped at C$ 25 million per network and C$ 15 million per project.

As of end February 2009, only one ethanol-related project had been approved for funding under this program. The Cellulosic Biofuels Network (CBN) was granted C$ 19.9 million over three years develop a network that would provide expertise, new technologies and processes that promise to increase the efficiency and reduce the economic costs associated with the production of cellulosic ethanol, especially from agricultural biomass (Government of Canada, 2009).

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46 As of February 2009, these loans have not been repaid (Industry Technologies Office, 2008).

47 "Agricultural Bioproducts Innovation Program", www.agr.gc.ca/sci/abip-piba/index_e.php

3.4.1.3 NextGen Biofuels Fund

Announced in September 2007, the C$ 500 million NextGen Biofuels fund provides interest-free loans for large-scale demonstration facilities producing second-generation biofuels. The program is administered by Sustainable Development Technology Canada (SDTC), a not-for-profit foundation created by the Government of Canada.

The funding is available for first-of-a-kind plants, located in Canada (NRC, 29 October 2007). Contributions to individual companies are limited to 40 per cent of eligible project costs or C$ 200 million per project, whichever is less (SDTC, May 2008). Once a project begins operation, that same percentage of free cash flow must be repaid to the federal government for a period of 10 years or until the nominal value of the grant is repaid. A significant impetus for this program seems to have been to lure Iogen to build a major cellulosic plant in Canada (Saskatchewan) (EC, 14 March 2008).

Repayment will not commence until 10 years after the loan is made, and loan repayment will be over a 10-year period. The annual opportunity cost to government, using the method described in Section 3.3.1.1, is C$ 5.9 million, assuming that half of project funds are allocated to ethanol-related research and all loans are repaid. The upper subsidy estimate is C$ 18.4 million per year, on the assumption that none of the loans are repaid.

3.4.1.4 SD Tech Fund

A separate "SD Tech Fund" is also run by Sustainable Development Technology Canada, but not expressly focused on biofuels. The C$ 550 million fund supports late-stage development and pre-commercial demonstration of clean technologies. It offers support through grant contributions and business services.

To mid-2008, SDTC had provided 12 rounds of funding, with total allocation to biofuel-related projects totalling C$ 114.4 million (including biogas projects for electricity generation). [48] Approximately C$ 33.6 million was allocated to ethanol projects (Table 3.9). The 13th round of funding was announced in March 2009, with only one ethanol project funded. An undisclosed amount was awarded to GreenField Ethanol to demonstrate a biochemical technology process for cellulosic ethanol production.

Table 3.9 SD Tech Fund allocation to ethanol projects to end 2008

(millions of C$)

	2004	2005	2006	2007	2008	Total
First generation	2.6	4.3	—	—	6.7	13.7
Second generation	4.4	0	3	12.5	0	19.9
Total	7.0	4.3	3	12.5	6.7	33.6

Source: Sustainable Development Technology Fund (2008)

[48] Personal correspondence between C. Charles (GSI) and P. Nadeau, Sustainable Development Technology Canada (SDTC) on 26 August 2008.

3.4.1.5 Green Municipal Fund

The *Green Municipal Fund* (GMF), administered by the Federation of Canadian Municipalities (FCM), provides funding for municipalities seeking to improve their environmental performance. The Town of Rimbey in Alberta received C$ 347 500 in FY 2003–04 for a feasibility study of a gasification plant which would convert organic waste to synthesis gas and then finally into ethanol. Similarly, the New Generation Cooperative (a partnership between the Town of Nipawin, SK, and 10 development partners) received C$ 350 000 in FY 2003–04 to fund a commercialization study of a cellulosic ethanol facility in the Nipawin area.

3.4.1.6 Agri-Opportunities Program

Agri-Opportunities Program provides C$ 134 million for commercialization of new agricultural products, processes, or services (NRCan, 29 October 2007). Contributions are repayable, targeted at no more than 33 per cent of project costs, and limited to a maximum of C$ 10 million per project and recipient (U.S. Department of Agriculture, 2007: 10). However, as of April 2009, the Agri-Opportunities Program had not yet funded any biofuel projects, as they tend not to fit with the eligibility criteria of the program.[49]

3.4.1.7 Canadian Biomass Innovation Network (CBIN)

The Canadian Biomass Innovation Network (CBIN) coordinates the federal government's interdepartmental research, development and demonstration (RD&D) activities in the area of bioenergy, biofuels, industrial bioproducts and bioprocesses.[50] It sits under NRCan's Office of Energy Research and Development (OERD), which coordinates energy RD&D activities. OERD funding for approved projects is provided under Memoranda of Understanding signed between NRCan and participating departments. The following federal funding programs are managed by OERD and CBIN.

The Program of Energy Research and Development (PERD) has been in operation for over 30 years. It is an interdepartmental science and technology program. The program is currently funded at C$ 55 million per year, divided across nine R&D technology areas. The PERD Bio-based Energy Systems and Technologies (PERD BEST) fund energy from biomass R&D. Of the total 32 PERD BEST projects between FY 2004–05 and FY 2008–09, six were ethanol-related.

The ecoENERGY Technology Initiative (ecoETI), announced in January 2007, provides C$ 230 million over four years for RD&D for low-emission energy technologies, whether from clean fossil fuels or other sources, such as renewables and bioenergy. In FY 2008–09, of a total of 11 projects, three were ethanol-related.

The Technology and Innovation Research and Development (T&I R&D) Initiative is a research program created by the Climate Change Plan for Canada in 2003 to advance long-term GHG technologies and to strengthen Canada's technology capacity through

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[49] Personal communication between T. Laan (GSI) and B. Larocque (Senior Programs Officer, Agriculture and Agri-Food Canada), 14 October 2008. Updated by consulting the program's website.

[50] See CBIN website at www.cbin-rcib.gc.ca/index-eng.php

early-stage R&D. Total funding for the program was C$ 115 million; it ended in March 2008. During this time, four projects were ethanol-related, out of a total of 48.

3.4.1.8 Technology Early Action Measures

Technology Early Action Measures (TEAM) was established in 1998 to support late-stage development projects and first-time demonstration projects designed to reduce GHG emissions that at the same time support economic and social development. TEAM was transferred to the Office of Energy Research and Development (OERD) in 2007. Funding for the program was C$ 95 million between 1998 and 2004, and C$ 63 million between 2004 and 2008. Since its inception, TEAM has supported four ethanol-related projects, totalling C$ 8.9 million.

3.4.2 Provincial research and development programs

Alberta

The Alberta Bio-refining Commercialization and Market Development Program will provide C$ 24 million between 2006 and 2009 for business plan development, feasibility studies, worker training costs, adoption of new technology, as well as market research, development and advocacy. Ethanol-related projects received C$ 627 500 in 2007 and C$ 8.1 million in 2008.

British Colombia

The BC Bioenergy Network, announced as part of the BC Bioenergy Strategy, will provide C$ 25 million over three years from 2009 to establish an industry-led association to encourage research, development, demonstration and deployment of new bioenergy technologies that could be applied in British Colombia.[51]

Ontario

Part of the C$ 520 million Ontario Ethanol Growth Fund provides C$ 7.5 million for an *Alternative Renewable Fuels Research and Development Fund*, a competitive research fund to promote the renewable fuels industry and related agricultural sectors. It is open to universities, research institutions, industry, governments, organizations or partnership networks. The research fund is also supported by Agriculture and Agri-Food Canada (AAFC) and GreenField Ethanol.

Saskatchewan

The Western Diversification Program (WDP) supplies Western Economic Partnership Agreement research and development grants to organizations promoting biofuels in Saskatchewan. Beginning in 2005, the Saskatchewan Ethanol Development Council was budgeted to receive C$ 50 000 from WDP and another C$ 50 000 from Saskatchewan Industry and Resources, WDP's partner in the Province.

[51] See BC Bioenergy Strategy website http://bcbioenergy.ca/

3.5 Subsidies related to consumption

The federal and some provincial governments provide incentives to promote the purchase of biofuels, encourage the purchase of vehicles that operate on biofuels, and encourage the distribution of biofuels. Federal agencies are mandated by law to purchase alternative fuel vehicles, and to subsidize the purchase of alternative fuels and flexible-fuel vehicles.

The formula used to calculate corporate average fuel efficiency (CAFE) in Canada, as in the United States, offers a significant benefit for alternative and flexible fuel vehicles, allowing manufacturers to avoid increasing the actual fuel efficiency of the vehicles they sell.[52]

3.5.1 Subsidies to capital-related fuel distribution and disbursement

The federal Budget 2008 announced up to C$ 3 million for an *E85 Infrastructure Initiative*, a two-year pilot program intended to demonstrate E85 fuelling infrastructure and promote the commercialization of E85 fuels (Department of Finance, 2008).

Alberta's C$ 239 million BioEnergy Program, announced in October 2006, included a C$ 6 million Bioenergy Infrastructure Development Grant Program (BIDP). The maximum available for any individual project is C$ 5 million. As of October 2008, no funds had been provided for ethanol-distribution infrastructure or other ethanol-related capital. The deadline for applications under the BIDP had originally been due to expire on 31 March 2009. However, in December 2008 the Alberta Government extended the application deadlines for another two years, to 31 March 2011.

3.5.2 Support for vehicles capable of running on biofuels

3.5.2.1 Federal

On 22 June 1995, the *Alternative Fuels Act* (AFA) became law in Canada. AFA set aggressive targets for the use of alternative fuel vehicles by all federal government departments and agencies. Under the Act, federal government departments and Crown Corporations had to purchase vehicles that could run on alternative fuels, where they are cost-effective and operationally feasible, according to the following schedule:

- 50 per cent of all vehicle purchases in 1997–98
- 60 per cent of all vehicle purchases in 1998–99
- 75 per cent of all vehicle purchases in 1999–2000 and thereafter.

By 2004, 75 per cent of all federal vehicles for which alternative fuel vehicles were considered to be a cost-effective option were supposed to be operating on alternative fuels.[53] By 2007, only a small portion of the federal government's 2 898 E85 FFVs had

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52 Personal communications with P. Khanna of Natural Resources Canada's Office of Energy Efficiency. Canadian vehicle fuel efficiency standards are harmonized with those established by the United States.

53 The alternative fuels identified in the Regulations (T.B. 824505, dated 19 September 1996) include ethanol, methanol, propane, natural gas, hydrogen, and electricity. Biodiesel is not currently included on the list. A 2005 audit found the federal government in compliance with this law (TBC, 2005). Of

immediate access to E85 fuel (Hammond, 2009). Those that had access to this fuel consumed approximately 573 900 litres.

Many Canadian FFVs—government and privately owned—continue to run on 100 per cent gasoline given the limed numbers of E85 pumps. As of February 2009, there were only approximately 14 private federal E85 refuelling stations (Hammond, 2009) and four public stations (Canadian Renewable Fuels Association, n.d.).

More recently, the federal government's ecoAuto Rebate Program provided rebates of between C$ 1000 and C$ 2000 to people who, between 20 March 2007 and 31 December 2008, bought or leased (for 12 months or more) a new vehicle that met certain fuel-economy criteria. FFVs from the 2007 and 2008 model years qualified for the rebate if their combined fuel consumption when tested on E85 was no more than 13.0 litres per 100 kilometres.[54] When adjusted for the lower energy density of ethanol compared with gasoline, this is equivalent to a Combined Fuel Consumption Rating of 9.75 litres per 100 kilometres for a vehicle operating on pure gasoline. By comparison, non-flex-fuel cars had to achieve at least 6.5 litres per 100 kilometres, and new light trucks 8.3 litres per 100 kilometres, in order to be eligible for a rebate. In short, several models of FFVs (most of which currently are being operated mainly on gasoline) qualified for a rebate even though their fuel economy was considerably poorer than for non-FFVs.[55]

3.5.2.2 Provincial measures

Only British Columbia offers incentives to consumers seeking to own or operate vehicles which can run on biofuels. Since mid-February 2005, purchases and leases of qualifying alternative fuel vehicles, including vehicles designed to be able to operate on high-percentage blends of ethanol or biodiesel, are eligible for a 50 per cent reduction in provincial vehicle sales tax, up to C$ 1 000 (MSBR, 2005b). Assuming the full C$ 1 000 is depreciated over a six-year period at a 10 per cent interest rate, this equates to a C$ 180 annual savings, which is equal to about C$ 0.09 per litre of fuel if the vehicle is driven 20 000 kilometres and consumes 10 litres per 100 kilometres.

The Royal Canadian Mounted Police in Nanaimo, British Columbia, introduced several Chevrolet Tahoe's to its fleet of police vehicles in 2007. However, these vehicles are reported to be running on 100 per cent gasoline due to limited access to E85 pumps (Hammond, 2009).

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25 778 total federal vehicles in operation as of end-2004, 365 were hybrids, 255 were fuelled by compressed natural gas, 306 were fuelled by propane, seven were electric, and 1 187 were capable of running on E85 — *i.e.,* fuel containing a blend of 85 per cent ethanol and 15 per cent gasoline. These totals clearly represent far less than 75 per cent of the total federal vehicles fleet. However, the law only applies to those cases in which alternative fuel vehicles are cost effective.

[54] See www.tc.gc.ca/programs/environment/ecotransport/ecoautoeligiblevehicles.htm

[55] The best of the four qualifying FFV models in 2008 had a Combined Fuel Consumption Rating of 12.3 litres per 100 kilometres. See www.tc.gc.ca/programs/environment/ecotransport/2008ecoautoeligibility.htm

4 Current support for biodiesel

Government support for biodiesel in Canada developed on a similar path to that of ethanol, but it started later and on a smaller scale. Initial support, from the mid-1990s, encouraged the consumption of biodiesel through federal and provincial government-procurement schemes.

The first major subsidy for biodiesel was established in 2003 when the federal government exempted the biodiesel portion of diesel blends from the C$ 0.04 per litre federal excise tax. Even more important was exemption from some provincial and municipal fuel taxes. These taxes, which continue to apply fully to petroleum diesel, exceed C$ 0.16 per litre in several localities. Ontario was the first to exempt biodiesel from its fuel tax, followed by Quebec, British Columbia, Manitoba, Alberta and Nova Scotia.[56]

Capital grants followed. In 2003 the federal government *Biodiesel Initiative* (part of the Climate Change Plan for Canada) provided C$ 11.9 million in grants over four years to address technical and market barriers to the development of a Canadian biodiesel industry.[57] Funding went largely to support pilot projects involving municipal bus fleets. The federal government set a target of having 500 million litres of biodiesel in the nation's fuel mix by 2010. Alberta and Manitoba were the first provinces to implement capital grant programs.

The extent of government support grew rapidly from 2006, as the federal government opened its major biofuel programs to biodiesel, as well as ethanol. These included the Biofuel Opportunities Producers Incentive, the ecoAgriculture Biofuel Capital Initiative and the NextGen research and development funding.

Since 2005, Canadian biodiesel producers have also been able to take advantage of the business created by the US$ 1.00 a gallon (C$ 0.29 per litre) tax credit paid to companies that blend biodiesel with diesel in the United States. Although the tax credit is earned by the blending companies, it increases the price those companies are willing to pay producers of biodiesel.

Saskatchewan was the first to introduce a biodiesel blending mandate, which came into effect in 2008. Mandates in Alberta, British Colombia and possibly Manitoba (still under consideration) are expected to come into effect from 2010, and the federal requirement from 2012.

Support for producing biodiesel feedstock— vegetable oils such as canola, tallow, fish oil and used cooking oil—is not likely to have been significant in Canada. Tallow, fish oil and used cooking oil are by-products and receive no government production assistance. Farm sector support is de-linked from production in Canada and therefore unlikely to be a significant source of support for vegetable oil production.

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[56] Quebec offers a tax refund on pure biodiesel. An industry group, *Le Conseil Québecois du Biodiesel* (CQB) is lobbying to extend this exemption to blends <www.oleotek.org/publications/CQB_en.pdf>.

[57] <www.biofuels.arc.ab.ca/BTSC/NRCan/default.ksi>

4.1 Output-linked support

4.1.1 Market price support

As was the case with ethanol, biodiesel can also benefit from tariffs and mandates that drive domestic biodiesel prices above those prevailing at the border. More detail on how market price support (MPS) works can be found in section 3.1.1. A discussion of policies contributing to MPS for biodiesel is provided below.

4.1.1.1 Tariffs

A small amount of support is provided to domestic production of biodiesel through tariffs. Canada applies no tariff on imports of biodiesel (HS 3824.90 90 81, "Fatty acids, dimerized, trimerized, esterified or epoxidized") from countries with which it has a free-trade agreement (FTA)—Chile, Costa Rica, Israel, Mexico and the United States. As of 1 January 2009 Canada's tariffs for biodiesel were 6.5 per cent from countries with most-favored nation (MFN) status, and three per cent from countries covered by Canada's General Preferential Tariff (GPT), which applies to over 180 developing countries and customs territories, including economies in transition.[58] To the extent that the MFN or GPT tariff is applied, it gives domestic producers and the farmers who provide inputs a slight economic advantage over foreign producers. However, given that tariffs on the most likely exporters of biodiesel to Canada are zero or three per cent, the trade-weighted tariff rate is low by world standards.

4.1.1.2 Renewable fuels standards (RFS)

Saskatchewan was the first to institute a biodiesel blending mandate, in 2006. The mandate requires that vehicle diesel fuel sold in the province must contain no less than 2.5 per cent biodiesel blended fuel in 2008 and no less than five per cent after 1 January 2010, provided that the responsible provincial minister is satisfied that Saskatchewan's biodiesel production is sufficient to meet provincial needs. [59] However, there is no tax exemption or rebate. The fuel mandate exceeds that of the federal blending mandate of two per cent by 2012 signed into law in March 2007.

Manitoba introduced legislation in 2007 that will allow a biodiesel mandate to be introduced in the future. The legislation required the existence of at least 20 million litres of annual licensed production in the province before the mandate goes into force, originally anticipated in 2010. The provincial government is considering introducing the mandate early, as the province's first biodiesel facility began production in 2009 (Kusch, 2008). As of April 2009, the mandated consumption level had not been finalized, but it would likely start at 2 per cent (B. Brennand, personal communication). The Biodiesel (General) Regulation to the Manitoba *Biofuels Act* also requires that any producer of biodiesel operating in the province must be licensed.

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58 Canada Border Services Agency: www.cbsa-asfc.gc.ca/trade-commerce/tariff-tarif/2009/01-99/ch38-eng.pdf

59 Information taken from the Saskatchewan Party website on the 13 June 2008 accessed on the following link: www.saskparty.com/news.html?news_action=details&news_id=CD721014-C297-37EA-7EB46F6DB970F78F

On 27 February 2007 the government of British Columbia introduced the BC Energy Plan, which requires that petroleum diesel sold in the Province contain five per cent biodiesel by 2010.

Alberta's December 2008 Provincial Energy Strategy sets out the province's plan to mandate two per cent renewable content in diesel fuel by 2010 (Alberta Energy, 11 December 2009). Regulations will be required for the province's RFS. The expected implementation date is set for July of 2010.

Perhaps most importantly, the federal government amended its *Canadian Environmental Protection Act* (CEPA) *of* 1999 in June 2008 to allow for the introduction of a renewable fuels mandate for diesel (Banks, 2008). Regulations under the legislation—under development as of February 2009—are expected to require a two per cent blend by 2012, including all distillate blends used in both transport and other sectors (Banks, 2008).

The national mandate would require blending of almost 600 million litres per year of biodiesel in 2012 (Environment Canada, 2006). This would require a threefold increase from the current level of production capacity. If all biodiesel plants currently in the advanced planning and construction phase come on-line, then Canada should have capacity to meet the national mandate domestically.

Several factors suggest that the biodiesel blending mandate in Canada is likely to provide substantial support to producers by increasing both demand and producer prices. First, the mandate is significantly higher than current domestic production, even ignoring that other industries (such as soaps and detergents) are already significant users of animal fats. Second, modelling of the biodiesel sector in the United States (Westhoff, Thompson, and Meyer, 2008) suggests the core industry economics are weak and the industry would disappear in the absence of government support. These core factors are likely to be true in Canada as well. Third, the small scale of the industry will help constrain the total support levels, but support per litre will still be quite high.

Table 4.1 Canadian biodiesel mandates

Jurisdiction	Mandated requirement	Announced	Implied consumption by 2012 (million litres)
Federal	2% by 2012	2007	585
Alberta	2% by 2010	2008	145
British Colombia	2.5% in 2008	2007	180
Manitoba	2% by 2010[1]	2007	22
Saskatchewan	2.5% in 2008 and 5% in 2010	2006	57

[1] Timing of introduction and mandated level not finalized, as of April 2009, but likely to commence at 2 per cent (B. Brennand, personal communication).

Source: **Mandates:** Government press announcements; Alberta Energy (2008); Canada Gazette (2006); U.S. Department of Agriculture (2008); Walburger *et al.* (2006). **Motor fuel demand:** Statistics Canada (www.statcan.gc.ca/pub/45-004-x/2008010/tablesectlist-listetableauxsect-eng.htm); assumed to increase by one per cent per year (Auld, 2008).

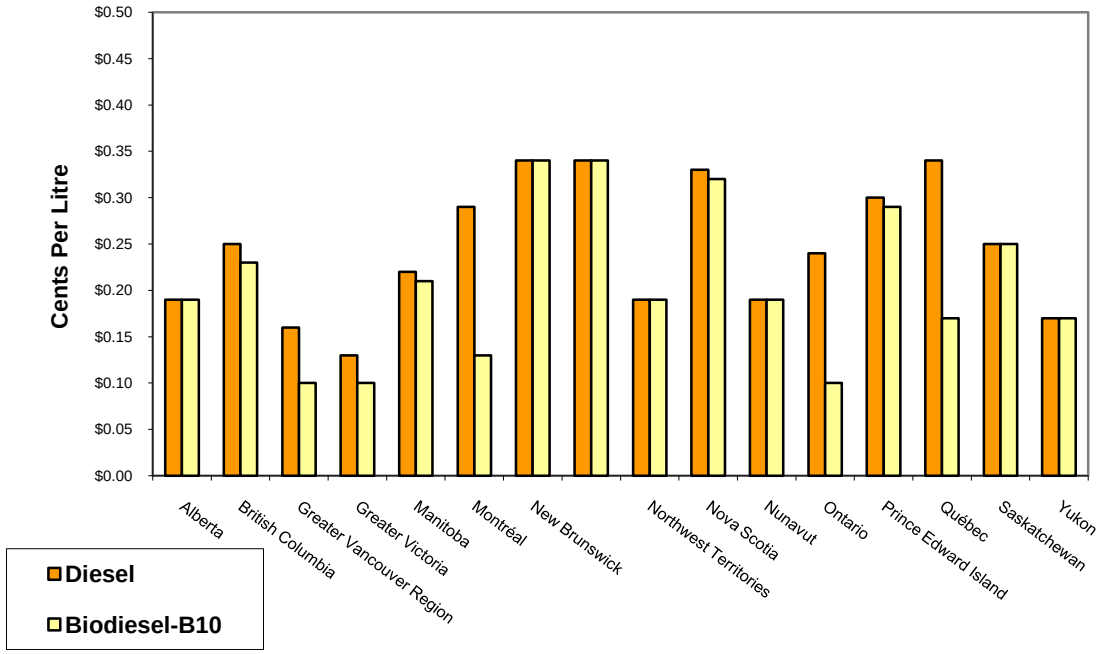
4.1.2 Federal and provincial exemption from excise taxes

Diesel fuel used by road vehicles is taxed by Canadian federal, provincial and territorial governments (Department of Finance Canada, 2005). Currently, at the federal level, there is:

- an excise tax on diesel of C$ 0.04 cents per litre, and
- a Goods and Services Tax (GST) equal to five per cent (seven per cent before July 2006) of the final price paid for fuel, including federal and provincial excise taxes. The GST is levied at the producer or wholesaler level, and is embedded in the retail price. The GST does not apply to provincial sales taxes levied at the pump as a percentage of the final price.

At the provincial level, diesel fuel tax rates average about C$ 0.145 per litre, ranging from C$ 0.072 per litre in the Yukon Territory to about C$ 0.20 per litre in Prince Edward Island. Additional surtaxes are levied on vehicle fuel in Victoria (C$ 0.025 per litre), Vancouver (C$ 0.06 per litre) and Montreal (Fuel Focus, 2007). In New Brunswick, Nova Scotia, and Newfoundland and Labrador, the provincial portion of the harmonized sales tax (HST) is levied on the final price of fuel at the pump (excluding GST), and in Quebec, the Quebec Sales Tax is levied on the final price of fuel at the pump (including GST), which provides additional tax discounts to excise tax exempt fuels. In Vancouver and Victoria, municipalities also collect a tax on the purchase of diesel fuel.

Figure 4.1 Taxes on diesel and 10 per cent biodiesel



Note: During 2007, retail petroleum diesel prices averaged C$ 1.00 per litre.

Source: Natural Resources Canada 2007
www2.nrcan.gc.ca/eneene/sources/pripri/prices_byyear_e.cfm?ProductID=5

In February 2003, the federal government exempted biodiesel from its C$ 0.04 per litre excise tax on diesel fuels. Several provinces have also exempted the biodiesel component of biodiesel blends (Table 4.2). Since 2002, Ontario has fully exempted the biodiesel component of any biodiesel blend. British Colombia exempted biodiesel, as of July 2004, from provincial motor-fuel taxes in blends between five per cent and 50 per cent (Lagacé, 2007). Quebec introduced its biodiesel tax exemption in 2006. In its 2006 budget, Manitoba eliminated all provincial taxes (both excise and sales taxes) on biodiesel produced within the province (FCC, 2006). The incentive is intended to remain in place for at least five years to give the industry time to grow. Manitoba also exempts biodiesel from its seven per cent provincial sales tax.

Table 4.2 Excise tax exemptions for biodiesel in Canada

Jurisdiction	Value of exemption (C$ per litre biodiesel)	Duration of exemption
Federal	0.04	2003 to 2008
Alberta	0.09	2006 to 2007
BC	0.15	2006 onwards
Manitoba	0.115	2006 (to be reviewed after five years)
Nova Scotia	0.154	2006 onwards
Ontario	0.143	2006 onwards
Quebec	0.162	2006 onwards

Sources: U.S. Department of Agriculture (2008); provincial tax and biofuel legislation; press releases.

4.1.3 Support based on current output

The ecoENERGY for Biofuels Initiative, announced by the federal government on 5 June 2007, contained for the first time a volumetric producer payment for production from eligible facilities producing "renewable alternatives to diesel" (including biodiesel). The payments, which replace the federal tax exemption on biodiesel, started in April 2008 and continue through 31 March 2017. For the program as a whole, payments may be made on up to 0.5 billion litres of biodiesel in total, though the federal government indicated that the eligible volume could be increased over time if sufficient funds become available. Payments will be limited to seven years for any given facility. Volumetric payments may be as high as C$ 0.20 per litre during the first three years of the program, and then decline over the following six years according to the schedule described in Table 4.3.

Table 4.3 Federal ecoEnergy for Biofuels incentive rates payable on "renewable alternatives to diesel"

	Fiscal Year[1]								
	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17
Maximum payment rate (C$ per litre)	0.20	0.20	0.20	0.16	0.14	0.12	0.10	0.08	0.08
Projected eligible or maximum volume (millions of litres)	240	500	500	500	500	500	500	500	500
Total maximum annual payment (millions of C$)	48	100	100	80	70	60	50	40	40

Note: * April 1 of a year to March 31 of the following year.

Source: ecoEnergy for Biofuels, http://oee.nrcan.gc.ca/transportation/ecoenergy-biofuels/incentive.cfm?attr=16

Based on existing and announced capacity, it would appear that the annual threshold of 0.5 billion litres per year could already be reached by FY 2009–10, implying total payments for biodiesel over the nine years of the program of as much as C$ 630 million. However, given that the government has set an upper limit of C$ 1.5 billion for combined payments to ethanol and biodiesel, a more likely nine-year total for biodiesel, pro-rated among the two fuels, would be C$ 0.5 billion.

As of April 2009, no provinces had signalled an intention to introduce biodiesel producer payments.

4.1.4 Policies affecting the cost of intermediate inputs

As discussed in Section 3.2.1, Canada's federal government historically subsidized farmers with cash payments and transportation subsidies (AAFC, 2005a). However, as a result of trade commitments and government budgetary pressures, farm support has declined since the 1990s. No direct payments are made for growing feedstock crops and, indeed, most farm support is not linked to production. The overall effect on feedstock prices of these payments is likely to be nil.

4.2 Subsidies to factors of production

Several of the major federal biofuel programs support both ethanol and biodiesel. Generic aspects of the programs that were discussed in Section 3 will not be repeated here. Please see the relevant sections of the previous section for more information.

4.2.1 Capital infrastructure

4.2.1.1 The ecoAgriculture Biofuels Capital Initiative (ecoABC)

The federal ecoAgriculture Biofuels Capital (ecoABC) initiative makes repayable capital contributions for the construction or expansion of facilities using agricultural feedstocks to produce biofuels for transport. As noted in Section 3.3.1.3, ecoABC requires payback of principal only to such extent as plant profit levels in years three through nine of operation can support it. Any residual amounts due are then written off. As of April 2009, a total of 19 per cent of the available funds had been allocated to four projects, one of which was a biodiesel producer (Table 4.4).[60]

Table 4.4 Recipients of ecoAgriculture Biofuels Capital Initiative grants (to April 2009)

Corporation	Province	Nameplate capacity (million litres)	Biofuel	Start date	ecoABC contribution (C$ millions)
Western Biodiesel Inc.	Alberta	19	Biodiesel	December 2007	638 559

Source: Department of Agriculture and Agri-Food Canada, 2009: www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1195679783268&lang=eng

[60] Information obtained from the Department of Agriculture and Agri-Food Canada's website, accessed on 21st August 2008, on the following link: www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1195679783268&lang=e

Assuming that half of the ecoABC funds are allocated to biodiesel-related projects, the subsidy-equivalent value of the program is estimated to be—at the lower end—C$ 2.3 million per year over 10 years. This assumes that all loans are repaid and the cost to government is only the foregone interest of the providing the loan interest-free (see Section 3.3.1.1 for further discussion). At the upper end (assuming no loans are repaid), the cost to government for the biodiesel portion of the program is estimated to be C$ 12.3 million per year over 10 years.

4.2.1.2 Biofuels Opportunities for Producers Initiative (BOPI)

The Biofuels Opportunities for Producers Initiative (BOPI) was a two-year, C$ 20 million grant program created in July 2006 to assists farmers and rural communities to prepare business proposals and feasibility studies for biofuel projects. Projects had to involve greater than one-third ownership by agricultural producers. A total of C$ 13 million was allocated in FY 2006–07 and C$ 7 million in FY 2008–09. Approximately half of the grants were provided to ethanol projects and half for biodiesel projects.[61]

4.2.1.3 Accelerated depreciation

Biodiesel infrastructure would benefit from the same depreciation provisions available to capital investments in the ethanol sector. One distinction that may come into play between the two sectors involves the allocation of capital associated with energy production versus that used for producing oil and soy meal. For example, the Saskatchewan Bio-diesel Development Council "warned bio-diesel proponents that crushing components of bio-diesel ventures would not be eligible for the repayable contributions" on offer from the Province (U.S. Department of Agriculture, 2008).

The estimated revenue loss due to favourable CCA rules during the 2006–12 period is expected to total roughly C$ 85 million for biodiesel (or C$ 46 million if expressed in present value terms (Table 4.5). Subsidies via accelerated depreciation will level off in the face of the construction slow-down. However, the rise of federal and provincial consumption mandates is likely to drive increased construction over the longer term. Section 3.3.1.5 provides further information about the calculation of these data.

Table 4.5 Estimated subsidy value of accelerated depreciation to the biodiesel sector: revenue loss (C$ millions)

	2006	2007	2008	2006–12
Capital cost = C$ 0.39 per litre				
Revenue loss	1	4	7	85
Present value				46

Source: GSI estimates

[61] Compiled from various official government press releases from websites www.agr.gc.ca, www.omafra.gov.on.ca, www.mrac.ca

4.2.2 Provincial programs for capital

Alberta

The Alberta C$ 30 million BioEnergy Program included a C$ 6 million BioEnergy Infrastructure Development Program. The program aims to: expand the distribution infrastructure for biofuels; connect biorefining processing projects to the market place; and facilitate major new investment in biorefining.[62] As of October 2008, C$ 2.6 million had been provided for biodiesel-related capital.

British Colombia

As part of its 2008 BC Bioenergy Strategy, the provincial government announced up to C$ 10 million in funding over three years, commencing in 2009, to support the expansion of biodiesel production capacity in the province.[63]

In the same year, new funding of C$ 10 million was announced for an Innovative Clean Energy Fund – liquid transport fuels program. Eligible projects include those applying both conventional and second-generation technologies. New production capacity using conventional biodiesel technology will also be eligible. All projects must demonstrate that the fuel will result in significant reductions in greenhouse gas emissions, relative to conventional petroleum-based fuels, based on a full life-cycle assessment. Project applications must show they are past the R&D stage, and in the first time production or expanded production stage.

Manitoba

In 2005 Manitoba established the Manitoba Biodiesel Production Program and budgeted C$ 1.5 million to subsidize the development of small and medium-size biofuel plants.

The Community Enterprise Development (CED) Tax Credit Program provide tax credits of 30 per cent for rural investments, and in some cases capital grants and loans for biodiesel facility investments. Under this program, qualifying community enterprises or registered Community Development Investment Funds (CDIFs) can raise up to C$ 1 million, the maximum amount eligible for tax credits.[64]

Saskatchewan

The C$ 80 million Saskatchewan Biofuels Investment Opportunity (SaskBIO) program encourages investment in locally-owned biofuel production capacity by providing one-time repayable capital contributions to new and expanding eligible biofuel facilities. The program began in April 2008 and will close in 2012.

Applying the method described in Section 3.3.2, the subsidy-equivalent value for each biofuel—assuming that half of the program funds were allocated to each fuel—are

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62 See the program's guidelines at www.energy.gov.ab.ca/BioEnergy/pdfs/BIDP_program_guidelines.pdf

63 See the BC Bioenergy Plan at www.energyplan.gov.bc.ca/bioenergy/#bcep_bgrdr

64 Manitoba Agriculture, Food and Rural Initiatives (http://web2.gov.mb.ca/agriculture/programs/index.php?name=aaa21s04)

conservatively estimated at C$ 0.9 million, if all loans are repaid. If none of the loans are repaid, the subsidy value would rise to around C$ 4.9 million per year.[65]

4.2.3 Support for services

The *Biofuels Quality Registry* (BQR), a joint endeavour by Natural Resources Canada, Environment Canada, and provincial agencies, is an online national database set up to be develop an industry protocol and standard for fuel analysis. NRCan provides up to C$ 200 000 (up to C$ 100 000 annually in a two-year period) to help pay for laboratory testing of biodiesel (NRCan, 2005).

The *Future Fuels Initiative* (FFI) provided C$ 3 million over five years, starting in 2001,[66] for public outreach to promote alternative fuels to consumers.[67] The FFI Initiative was concluded in March 2007 and has been succeeded by the ecoEnergy Biofuels Initiative.

4.3 Research and development

4.3.1 Federal programs

4.3.1.1 Agricultural Bioproducts Innovation Program (ABIP)

As noted in Section 3.4, the Agricultural Bioproducts Innovation Program (ABIP) is a C$ 145 million program to support research networks to advance of "a Canadian bio-economy."[68] First- and second-generation ethanol and biodiesel projects are eligible.

The only program to have been announced so far is the C$ 3 million for the Industrial Oil Seed Network (IOSN).[69] The network aims to facilitate a group of experts to work together to develop a new type of oilseed that is optimized for the production of petroleum substitutes. Of the total C$ 3 million in funding, Linnaeus Plant Sciences Inc., in Vancouver, British Columbia, will receive C$ 2.6 million to administer the network and fund non-government research activities. A Thetford Mines-located company, OLEOTEK, will receive C$ 235 000 to participate in the network.

4.3.1.2 NextGen Biofuels Fund

The NextGen Biofuels Fund is open to both ethanol and biodiesel. The C$ 500 million fund will provide interest-free loans from 2007 for large-scale demonstration facilities producing second-generation biofuels. Once a project begins operation, the same

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65 See Section 3.3.1.2 for a description of the methodology and assumptions used for the calculation.

66 Accessed from the International Energy Association (IEA) website on 13 June 2008 on the following link: www.iea.org/textbase/pm/?mode=re&id=663&action=detail

67 A description from NRCan's website states that the Future Fuels Initiative "provides for activities such as public education on fuel ethanol, analysis of fuel ethanol markets and producer economics and provides a liaison with provinces/territories and industries that are interested in ethanol plant expansion." http://oee.nrcan.gc.ca/transportation/fuels/ethanol/future-fuels-initiative.cfm?attr=16

68 "Agricultural Bioproducts Innovation Program," www.agr.gc.ca/sci/abip-piba/index_e.php

69 www.agr.gc.ca/cb/index_e.php?s1=n&s2=2008&page=n80829

percentage of free cash flow must be repaid to the Government for a period of 10 years or until the nominal value of the grant is repaid.

Applying the method described in Section 3.4.1.3, the subsidy-equivalent value for each of ethanol and biodiesel is estimated to be, at the lower end, C$ 5.9 million per year, and C$ 18.4 million per year at the higher end.

4.3.1.3 SD Tech Fund

A separate C$ 550 million SD Tech Fund is also administered by Sustainable Development Technology Canada but is not expressly focused on biofuels. However, the fund has supported some biodiesel-related projects in the past (Table 4.6).

Table 4.6 SD Tech Fund allocations to biodiesel projects 2004 through 2008 (C$ millions)

	2004	2005	2006	2007	2008[1]	Total
Biodiesel	5	0	8.25	1.1	6.8	**21.15**

1. First three quarters.

Source: Sustainable Development Technology Canada (2008).

4.3.1.4 Agri-Opportunities Program

The Agri-Opportunities Program has made available C$ 134 million for commercialization of new agricultural products, processes, or services (NRCAN, 29 October 2007). Contributions are repayable, targeted at no more than 33 per cent of project costs, and limited to a maximum of C$ 10 million per project and recipient (U.S. Department of Agriculture, 2007: 10). However, as of April 2009, the Agri-Opportunities Program had not funded any biofuel projects, as such projects tend not to meet the eligibility criteria of the program.[70]

4.3.1.5 Industrial Research Assistance Program

In 2001, the BIOX Corporation received a C$ 250 000 contribution from the Industrial Research Assistance Program (IRAP), a public non-profit business services program administered by Natural Resources Canada.

4.3.1.6 Canadian Biomass Innovation Network (CBIN)

See Section 3 for further discussion of the Canadian Biomass Innovation Network (CBIN). Several federal funding programs are managed by CBIN.

The Program of Energy Research and Development (PERD) Bio-based Energy Systems and Technologies (BEST) funded five biodiesel-related projects between 2004–05 and

[70] Personal communication between T. Laan and B. Larocque (Senior Programs Officer, Agriculture and Agri-Food Canada), 14 October 2008.

2008–09 of a total 32 projects. Funding for PERD is approximately C$ 55 million per year across nine technology areas.

In FY 2008–09, the ecoENERGY Technology Initiative (ecoETI) funded one biodiesel-related project out of a total of 11 projects. During the five year lifespan of the Technology and Innovation Research and Development (T&I R&D) Initiative (2003 to 2008), five biodiesel projects were funded out of a total of 48. Total funding for the program was C$ 115 million.

4.3.1.7 Technology Early Action Measures

Since its inception in 1998, TEAM has funded four biodiesel related projects with a total value of C$ 2.6 million. See Section 3 for discussion of the program.

4.3.2 Provincial research and development programs

British Columbia has supported several R&D initiatives. The provincial government funded a feasibility study which concluded that community-based production of biodiesel (from waste cooking oil) presents good opportunities for the province, given that BC does not have the agricultural capacity to produce large volumes of vegetable oils (BC, 2006). BC also gave C$ 25 000 to the Fraser Basin Council to support market development.

The Alberta Bio-refining Commercialization and Market Development Program provides C$ 24 million between 2006 and 2009 for business plan development, feasibility studies, worker training costs, adoption of new technology, as well as market research, development and advocacy. Biodiesel-related projects received C$ 1 million in 2007 and C$ 7.3 million in 2008.

4.4 Subsidies related to consumption

Federal and provincial government programs to promote the purchase of biofuels, encourage the purchase of vehicles that operate on biofuels, and encourage the distribution of biofuels are generally directed towards ethanol. Unlike ethanol, biodiesel does not require dedicated distribution infrastructure and can be used in unmodified engines.

Alberta's C$ 30 million BioEnergy Program included a C$ 6 million Bioenergy Infrastructure Development Grant Program, to expand the biofuel distribution structure in Alberta. As of October 2008, approximately C$ 2.6 million had been provided for biodiesel infrastructure. However, the funding was provided for the establishment of new biodiesel facilities rather than distribution infrastructure (Alberta Government, 2007).

4.4.1 Support for vehicles capable of running on biofuels

4.4.1.1 Federal

As noted in Section 3.5, the *Alternative Fuels Act* (AFA) set targets for the use of alternative fuel vehicles by all federal government departments and agencies. The focus of the program was ethanol, as there was no biodiesel production in Canada in the mid-1990s, when the Act was passed. Also, biodiesel can be used in unmodified diesel engines.

4.4.1.2 Provincial

Several provinces and municipalities have supported the use of biodiesel in their municipal vehicles. The cities of Montreal, Quebec and Vancouver demonstrated early support. Regional and local tax exemptions for biodiesel, as well as a number of demonstration projects and outreach programs, have all led to an increased use of the fuel in municipal fleets.

Alberta

The *Alberta Renewable Diesel Demonstration Project*, which commenced in January 2008, is a multi-million dollar joint project designed to conduct laboratory and field tests of biodiesel in long-haul fleet engines.[71] Total government funding is expected to total C$ 2.6 million, shared between federal and provincial sources (Green Car Congress, 2008). The City of Calgary, Alberta, has a program in place which supports 77 vehicles. Approximately 75 per cent of the blend is B5 and 25 per cent of the blend is B20.

British Colombia

BC Biofleet is a regional biodiesel market-development project created by British Columbia's *Biodiesel Working Group* (BWG) in 2003. The outreach and advocacy group has 55 commercial fleets signed up as members, accounting for between 2000 and 3000 vehicles (though use of biofuels in vehicles is not a criterion for membership) (Rogoza, 2007). Through 2007, BC Biofleet received C$ 235 000 from the Federal Government, C$ 70 000 from the Province of British Columbia, and C$ 10 000 from the City of Vancouver to support its biodiesel workshops, demonstrations, and educational campaigns (Vanderwal, 2007).[72]

The City of Vancouver runs over 1000 of its fleet vehicles on either B5 or B20.

Manitoba

In January 2009, the federal government provided C$ 185 325 from Transport Canada's Urban Transportation Showcase Program for a new biodiesel fuels station to supply Winnipeg's municipal fleet with B10 biodiesel (Transport Canada, 2009).

Quebec

The City of Montreal ran 155 of its city transit buses on B5 and B20 as a demonstration project from March 2002 until March 2003. The project, dubbed *BioBus,* received C$ 115 000 in federal funding from Canada Economic Development (CED) and C$ 400 000 from Technology Early Action Measures (TEAM), a branch of the Climate Change Action Fund (CCAF). Funding, which came from provincial sources such as the ministries of Environment and Transportation, totalled C$ 375 000. The City of Montreal contributed C$ 368 700 in an in-kind contribution (Lagacé, 2007).

Following the *BioBus* project, in 2004 Montreal conducted a pilot project, called *BioMer*, on a fleet of 12 cruisers. Eleven of the boats were fuelled with B100 while one ran on B5.

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[71] www.renewablediesel.ca

[72] Government funding for fiscal year 2005–06 are the following: Western Economic Diversification Canada (C$ 150 000), Natural Resources Canada (C$ 75 000), Environment Canada (C$ 75 000), Province of British Columbia (C$ 20,000), and the City of Vancouver (C$ 10 000). The Province of BC budgeted an additional C$ 50 000 in fiscal year 2006–07.

Federal funding for the program was C$ 323 000 and provincial funding was C$ 25 000. In the third quarter of 2004, the *BioPeche* project received C$ 60 000 in federal funding. The purpose of the demonstration project was to run several tour boats and a fishing vessel on biodiesel. *BioShip*, a related project in 2006, involved a trial run of a large merchant vessel powered partially by B20. The project, conducted by several government agencies and industry groups, received C$ 200 000 in federal funding (Lagacé, 2007).

Saskatchewan

The Saskatchewan Canola Development Commission has been conducting tests using B5 blends in transit buses operated by the City of Saskatoon (Jones, 2007). The Western Diversification Program (WDP) provided almost C$ 200 000 out of the approximately C$ 240 000 in WEPA (Western Economic Partnership Agreement) grants budgeted for the bus project.[73]

Nova Scotia

In FY 2004–05, the city of Halifax tested biodiesel in municipal vehicles and boilers for municipal building heating systems, as part of their Halifax Harbour Solutions Project.

[73] Funds provided by fiscal year are the following: C$ 89 629 (2004–05), C$ 71 127 (2005–06), and C$ 38 284 (2006–07).

5 Aggregate support to ethanol and biodiesel

Assessing how effectively Canadian biofuels policies are meeting broader energy security and environmental goals requires a good picture of what policies are in place at the provincial and federal levels, how much they are worth to industry, and how these levels of support compare with alternative venues to achieve core goals. This section pulls together the individual programs discussed thus far in the report into aggregate metrics of support. Despite the large number of programs included here, GSI recognizes it has not captured everything, and hopes other researchers will be able to build further on this work.

To develop a better sense of how all of the individual subsidy programs affect the overall environment for biofuels, several aggregate measures of support have been compiled. Among arguments put forth in support of biofuel subsidies are that they help a country to diversify from fossil fuels in general, and petroleum in particular; and that they have a better environmental profile than fossil fuels. Metrics below assess how cost-effective the complex array of federal and provincial subsidies is in achieving these endpoints. The report discusses in turn total financial support to the sectors; subsidies per unit of energy output; subsidies per unit of fossil energy displaced; and the subsidy cost for greenhouse gas reductions. Policy implications and recommendations, as well as areas for additional research, are discussed in the final section of the report.

5.1 Total support estimates

Total support to the Canadian biofuels sector has been growing in recent years along with consumption of biofuels. This support reached between C$ 380 million and C$ 470 million in 2008.[74] Subsidies per litre produced ranged between 20 and 80 cents during this time. Total support to ethanol is presented in Table 5.1 and biodiesel support presented in Table 5.2.

Subsidies have roughly doubled since 2006 on a total support basis, though declined on a per litre basis. There is a strong shift from excise tax relief to producer tax credits evident in Tables 5.1 and 5.2. Since the producer credits do not scale linearly without limit (i.e., the per-litre payments reduce over time or are capped), this is likely a major factor in the observed decline in subsidies per litre in 2008 (Box 5.1). Research and development support, capital grants and tax breaks for accelerated depreciation were also important sources of subsidy.

The majority of support is associated with ethanol rather than biodiesel (C$ 305–365 million per year versus C$ 75–100 million per year for biodiesel). In large part, this reflects the fact that the ethanol sector is larger than biodiesel. However, subsidies per litre produced were higher for biodiesel (around C$ 0.60–0.85) than for ethanol (around C$ 0.20–0.25). A similar pattern exists in the United States.

[74] The high and low estimates reflect upper- and lower- range calculations of accelerated depreciation and the subsidy-equivalent value of interest-free loans for capital and research and development. See Box 5.1 for further explanation.

Table 5.1 Total transfers to ethanol, 2006–2008 (C$ million)

Support element	2006	2007	2008
Output-linked support (federal and provincial)			
Fuel tax exemptions	70	120	38
Producer incentives	34	72	195
Factors of production – capital			
Capital grants – low estimate	33	28	41
Capital grants – high estimate	45	59	89
Feasibility studies	7	4	8
Accelerated depreciation – low estimate	4	17	35
Accelerated depreciation – high estimate	7	30	60
Factors of production – feedstock	0	0	0
Other value-added support			
Market development	0	1	8
Support for blending & distribution	16	0	0
Consumption			
Support for biofuel-consuming vehicles	0	0	0
Other	0	0	0
R&D			
R&D – low estimate	8	17	23
R&D – high estimate	8	17	36
Total support estimate			
Low estimate	167	241	305
High estimate	179	272	366
Consumption (millions of litres)	*333*	*1 173*	*1 531*
Total transfers per litre (C$ per litre)			
Low estimate	0.50	0.21	0.20
High estimate	0.54	0.23	0.24

Notes: The high and low estimates reflect upper- and lower- range calculations of accelerated depreciation and the subsidy-equivalent value of interest-free loans for capital and research and development. See Box 5.1 for further explanation.

Source: GSI estimates.

Table 5.2 Total transfers to biodiesel, 2006–2008 (C$ million)

Support element	2006	2007	2008
Output-linked support			
Fuel-tax exemptions (federal and provincial)	7	15	17
Producer incentives	7	15	17
Factors for factors of production – capital			
Capital grants – low estimate	2	13	18
Capital grants – high estimate	2	27	32
Feasibility studies	7	4	0
Accelerated depreciation	1	4	7
Other value-added support			
Market development	0	1	7
Factors for factors of production – feedstock	0	0	0
Support for blending & distribution	0	0	0
Consumption			
Support for biofuel-consuming vehicles	0	0	0
R&D			
R&D – low estimate	12	14	19
R&D – high estimate	12	26	32
Total support estimate			
Low estimate	31	46	73
High estimate	31	72	100
Consumption (millions of litres)	*40*	*90*	*120*
Total transfers per litre (C$ per litre)			
Low estimate	0.78	0.51	0.61
High estimate	0.78	0.80	0.83

Note: See notes for Table 5.1 and Box 5.1 regarding high and low estimates.

Source: GSI estimates.

Box 5.1 Assumptions relating to subsidy estimates

Excise tax exemption estimates were calculated based on production levels. Ethanol facilities were assumed to be operating at full capacity and provinces were assumed to consume all of the ethanol produced within their jurisdiction. Net imports of ethanol were allocated to Ontario, as the largest ethanol-consuming province. Biodiesel consumption was estimated to be 50 per cent of potential production capacity within each province. This assumption takes into account the uncertainty about trade (there are media reports that some biofuel facilities were exporting to the United States in 2008 and 2009) and that many biodiesel facilities have been operating below capacity in recent years due to high feedstock prices or low oil prices. However, from 2010 onwards, the commencement of provincial mandates is assumed to stimulate production of biodiesel at full capacity and consumption of all biodiesel domestically within the producing province.

In several jurisdictions, **producer payment programs** provide variable amounts of support depending on the profitability of the industry (factors taken into account include the price of biofuel, feedstock and crude oil prices). The GSI sought actual data of subsidies paid in recent years, but these data were not made available for all jurisdictions. Estimates were therefore made of producer payments in 2006 to 2008. Quebec, for example, only provides a producer payment when crude oil is less than US$ 60 per barrel. This occurred for two months in each 2007 and 2008. Thus payments were included for those months. For other jurisdictions, it was assumed that the full producer payments were made in 2006–08, given that high feedstock prices or low oil prices during these years made biofuels unprofitable without subsidies. During those years, biofuels have consistently been more expensive to produce than petroleum-equivalent fuels in all OECD countries (Steenblik, 2007).

A low- and high-range was estimated for producer payments between 2009–2012, given the uncertainty about commodity prices and therefore payment rates. The low value includes only payments that do not vary with profitability factors. The high range assumes that all jurisdictions provide full payments.

Energy content of biofuel relative to tax levels. Ethanol and biodiesel contain less energy than petroleum gasoline and diesel. Fuel excise tax is based on volume rather than energy content. Thus tax-payers are required to pay more tax per kilometre than for petroleum fuels. This potentially increases tax revenue for the government and could be said to offset some subsidy expenditure for biofuels. This study does not make an allowance for this, for two reasons.

First, when used in a five or 10 per cent blend with petroleum fuel, the energetic content of the blended fuel is not significantly different from a pure petroleum fuel. Most biofuel in Canada is sold in such a blend. Second, if there were a higher taxation rate per kilometre but consumers were forced to choose blended fuel due to biofuel mandates, then this higher cost remains a transfer of wealth from fuel consumers to biofuel producers. Hence it would be appropriate to include it as a biofuel support measure.

High and low ranges were also estimated for **interest-free loans for capital and R&D**. The low value estimates the opportunity cost to government of providing the loan at zero interest over the life of the loan, compared with a conservative Treasury bond rate of four per cent. It assumes all loans are fully repaid. The high value reflects the cost to government of foregone interest (at four per cent) and an annualized value of the capital of the loan, assuming none of the loans are repaid.

The high and low ranges for **accelerated depreciation** in the ethanol sector reflect the range of capital costs in Canada. At the low end, capital costs averaged C$ 0.47 per litre. At the high end, capital costs were C$ 0.82 per litre.

5.2 Subsidy intensity

Estimates of total support provide only a crude measure of a potential market distortion. Large subsidies, spread across a very large market, can have less of an effect on market structure than much smaller subsidies focused on a small market segment. Subsidy intensity metrics normalize subsidies for the size of particular energy markets, and for differential heat rates of similar volumetric units (i.e., litres).

5.2.1 Subsidy per unit energy output and as a share of retail price

One measure of the degree to which a product is supported is the share of support as a percentage of its market value. As shown in Table 5.3, values in Canada are quite high, more than 18 per cent in all cases for 2008. In the high estimates, subsidies per litre approach 30 per cent for ethanol and over 70 per cent for biodiesel. Since none of the support elements decline as prices of either ethanol or biodiesel fuels fall, the recent declines in the prices of petroleum fuels would have generated higher levels of support as a share of market prices than indicated here.

To provide a better comparison across fuels, it is useful to normalize support levels by the relevant energy content of the fuels. This is important since ethanol has a lower heat rate than conventional gasoline, and both ethanol and gasoline have lower heat rates than diesel.

On a heat-rate-adjusted basis, ethanol subsidies are C$ 9.40 to C$ 11.30 per GJ versus C$ 18.70 to C$ 25.50 per GJ for biodiesel. Per litre of fuel-equivalent, the subsidies amount to C$ 0.30–0.36 for ethanol and C$ 0.67–0.92 for biodiesel.

These levels of support are between 20 and 70 per cent of the pre-tax *market prices* of the fuels they replace, which averaged C$ 0.85 for premium unleaded gasoline and C$ 1.00 for automotive diesel in 2008.

Table 5.3 Subsidy intensity metrics for ethanol and biodiesel, 2008

Indicator	Unit	Ethanol		Biodiesel	
		Low	High	Low	High
Assistance per litre	C$/litre	0.20	0.24	0.61	0.83
Estimated market value, average 2008	C$/litre	0.75	1.13	1.09	1.20
Assistance as a % of market value	%	18%	27%	56%	69%
Assistance per gross GJ of biofuel produced	C$/GJ	9.40	11.30	18.70	25.50
Assistance per litre of petroleum or diesel equivalent	C$/litre equiv.	0.30	0.36	0.67	0.92

Notes:

(1) The higher reference market value for ethanol is the price of RON (98) unleaded gasoline, including excise taxes but not including VAT. The lower reference value assumes the price for ethanol would be proportional to the relative thermal value (65 per cent) of ethanol compared with RON (98) unleaded gasoline. The average price for biodiesel is assumed to be proportional to the relative thermal value (90 per cent) of biodiesel compared with non-commercial petroleum diesel sold for non-commercial purposes, including excise taxes but not including VAT.

(2) The range for ethanol reflects support per litre divided by, respectively, the highest and lowest market values in the previous line.

(3) For ethanol, the lower value in the range is based on an assumption that there would be no loss in vehicle performance if used in an E5 blend; the higher value assumes a penalty proportional to the ratio of the heating values of ethanol (21.06 MJ/litre) and gasoline (32.48 MJ), which is more typical of vehicle performance when used in a high ethanol blend, such as E85. For biodiesel, the support per litre estimates are both grossed up by the ratio of the heating values of biodiesel (32.65 MJ/litre) and petroleum diesel (35.87 MJ per litre). The range in values thus represents the range in support per litre between 2005 and 2006.

Sources: •support estimate: GSI; • heat values: Zah *et al.*, 2007; • prices of petroleum fuels: International Energy Agency, *Energy Prices & Taxes—Quarterly Statistics: Third Quarter 2008*, Paris: OECD Publications, 2008.

5.2.2 Support per unit of fossil-fuel-equivalent displaced

Public financial support for biofuels is often proposed as a way to wean a country from its dependence on fossil fuels. The cost effectiveness of these arguments can be tested by comparing fossil-fuel displaced by Canadian biofuel production with baseline patterns of reliance on conventional fuels. Values based on life-cycle modelling need to be used because even biofuels require substantial inputs of fossil fuels (see Table 5.4 and Annex 1). The displacement values shown represent high and low estimates for feedstocks most similar to what is being produced in Canada today. Use of a range avoids having to address the controversies around how fuel cycles are being modelled.

Table 5.4 Simple schematic of life-cycle greenhouse gas emissions in the stages of biofuel production

Biofuel production stage	Energy demand	Energy creation	GHG impact	GHG sequestering	Other environmental impacts
Direct or indirect land use change	Clearing vegetation, tilling soil		Carbon release from vegetation removal and soil disturbance		Erosion, biodiversity loss, water pollution
Growing and harvesting feedstock	Fertilizer and pesticide production, harvesting equipment fuel		Farm-vehicle exhaust, nitrogen release from fertilizer	Feedstocks during growth	Pesticides and herbicide residue and run-off soil erosion, water demands
Processing feedstock	Equipment fuels		Fuels used in process	Co-product emissions offset	
Transportation to biofuel facility			Vehicle emissions		Infrastructure demands
Refining process	Refinery energy, heat, electricity, production of inputs (chemicals, enzymes)	Cogeneration of heat energy	GHG emissions from process		Liquid waste disposal
Transportation to blending process	Haulage by truck or rail		Vehicle emissions		Infrastructure demands
Burning of fuel by consumer			Vehicle emissions		

Source: Adapted from Auld (2008).

The case for biofuels improves as displacement values from the fuel chain grow for a given subsidy level. However, as shown in Tables 5.5 and 5.6 below, even with high displacement values, biofuels are a fairly expensive way to conserve fossil energy.

Corn-based ethanol production requires subsidies of C$ 0.49–0.69 per litre of petroleum-fuel displaced. Values for wheat-based ethanol were even higher at between C$ 0.55 and C$ 0.74 per litre gasoline-equivalent displaced. During parts of 2008, the subsidy cost alone exceeded the market value of the petroleum fuels being displaced.

Even cellulosic ethanol (a hypothetical scenario that assumes all domestic production were cellulosic ethanol—with its better displacement profile—could be had for the same subsidies given to convention biofuels) and biodiesel, though better than conventional ethanol, remain expensive relative to the value of the fuels displaced. As noted above, falling prices for conventional fuels, rising subsidies, or worsening displacement values indicated by more refined life-cycle models all reduce the case for biofuel subsidies.

Biofuels are not the only course of action to diversify away from fossil fuels. It is therefore very important that subsidies to biofuels be evaluated carefully against alternative strategies, especially those that take into consideration the potential for demand-side measures.

Table 5.5 Support for ethanol per litre fossil-fuels displaced, 2008

Indicator	Unit	Corn-based		Wheat-based		Cellulosic	
		Low	High	Low	High	Low	High
Assistance per litre of gasoline equivalent	C$/litre	0.20–0.24					
Net fossil inputs	GJ fossil-fuel input/GJ output	0.69	0.77	0.75	0.81	0.07	0.23
Net gain in non-fossil energy	%	23%	32%	19%	25%	77%	93%
Support per litre of gasoline-equivalent of fossil fuels displaced	C$/litre equiv.	0.49	0.69	0.55	0.74	0.24	0.33

Notes: (1) Fossil fuel ratio ranges reflect varying life-cycle analyses in literature for ethanol.

(2) Equals support per litre of gasoline equivalent divided by the percentage net gain in non-fossil energy.

Sources: •support estimate: GSI; • net fossil inputs: GSI estimates based on: ChemInfo, 2008; Farrell *et al.* 2006, JEC, 2008, Felming *et al.*, 2006; MacLean and Spatari, 2009, S&T, 2008. See Annex 1 for more information.

Table 5.6 Support for biodiesel per litre fossil-fuels displaced, 2008

Indicator	Unit	Recycled oil		Canola	
		Low	High	Low	High
Assistance per litre of diesel equivalent	C$/litre	0.67–0.92			
Net fossil inputs	GJ fossil-fuel input/GJ output	-0.03	0.27	0.25	0.35
Net gain in non-fossil energy	%	73%	103%	65%	75%
Support per litre of gasoline-equivalent of fossil fuels displaced	C$/litre equiv.	0.41	0.73	0.53	0.80

Notes: (1) Displacement factor ranges reflect varying life-cycle analyses in literature for biodiesel.

(2) Equals support per litre of gasoline equivalent divided by the percentage net gain in non-fossil energy.

Sources: •support estimate: GSI; • Net fossil inputs: GSI estimates, based on JEC, 2008; Farrell *et al.*, 2006; S&T, 2008 and Zah *et al.*, 2007. See Annex 1 for more information.

5.2.3 Subsidy per tonne of CO_2-equivalent displaced

Given that biofuel subsidies are frequently justified on the grounds that they a core strategy to address greenhouse gas mitigation, this study measures the cost-effectiveness of those policies to reduce GHG emissions. This is done by dividing the value of support (Canadian dollars) per tonne of CO_2-equivalent avoided. The amount of CO_2 avoided is derived from published life-cycle assessments (LCA) for the fuels concerned. These assessments can vary widely in their results, even for biofuels produced from similar crops and in similar regions. The differences often arise from different input data regarding farm processes (such as tilling practices, fertilizer application and take-up, irrigation and harvesting methods), biofuel processing technologies (particularly whether fossil fuels are used as a heat source in the refinery) and allocations of final emission rates

between the biofuel product and co-products. See Annex 1 for further discussion of the GSI's method and sources.

The key policy question is whether these investments are efficient with regards to other GHG mitigation options, for which we used the cost of purchasing carbon credits as a proxy.

As shown in Tables 5.7 and 5.8, buying GHG reductions by subsidizing biofuels turns out to be quite inefficient. Reducing emission through canola-based biodiesel production, for example, is not very efficient, costing over C$ 265 per tonne of CO_2-equivalent avoided; even recycled oil was above C$ 200. Corn-based and wheat-based ethanol were both over C$ 200 per tonne. Using a hypothetical cellulosic example, the more favourable GHG profile of cellulosic ethanol generated the only values below C$ 100 tonne, with a range covering C$ 90 to C$ 160 per tonne (assuming current output had the higher displacement values of cellulosic ethanol for the same subsidies).

Even the lowest values are extremely expensive when compared with the cost of buying carbon offsets. Best-case scenarios are more than three times as expensive as purchasing emissions on the carbon markets. At the high-end, for example, stripping subsidies to wheat- or corn-based ethanol or canola biodiesel and simply buying offsets could generate nearly 100 times the climate benefits as the current subsidy system.

Table 5.7 Assistance per tonne CO_2-equivalent avoided from using ethanol

Indicator	Unit	Corn-based		Wheat-based		Cellulosic	
		Low	High	Low	High	Low	High
Baseline emissions (from gasoline)	kg of CO_2 equiv./GJ	86					
Percentage reduction from baseline		30%	54%	30%	53%	82%	122%
Support per GJ of ethanol produced	C$/GJ	9.40 – 11.30					
Support per tonne of CO_2-equivalent avoided	C$/tonne of CO_2 equiv.	200	430	205	430	90	160
for a CO_2-equivalent offset, Chicago and European Climate Exchanges	C$/tonne of CO_2 equiv.	4.23 – 33.83					
Offset multiple foregone by subsidies		6x	100x	6x	100x	3x	38x

Notes: (1) Calculated as support per GJ divided by the product of the baseline emissions and the percentage reduction. Ranges reflect the combination of ranges of subsidy values and estimated emission reductions.

(2) The low-end offset multiple takes the low subsidy estimate divided by the high-end carbon cost; the high-end offset multiple is the opposite.

Sources: Average of daily trades of futures contracts on the European Climate Exchange and Chicago Climate Exchange for December 2008 settlement. *Sources:* •support estimates: GSI; • CO_2-equivalent reduction values: GSI estimates, based on Farrell *et al.*, 2006; S&T, 2008 (see Annex 1 for more information); • CO_2-equivalent futures prices: www.europeanclimateexchange.com/index_flash.php

Table 5.8 Assistance per tonne CO_2-equivalent avoided from using biodiesel

Indicator	Unit	Recycled oil		Canola	
		Low	High	Low	High
Baseline emissions (from petroleum diesel)	kg of CO_2 equiv./GJ	89			
Percentage reduction from baseline	%	87%	103%	49%	79%
Support per GJ of biodiesel produced	C$/GJ	18.70 – 25.45			
Support per tonne of CO_2-equivalent avoided	C$/tonne of CO_2 equiv.	205	330	265	580
for a CO_2-equivalent offset, Chicago and European Climate Exchanges	C$/tonne of CO_2 equiv.	4.23–33.83			
Offset multiple foregone by subsidies		6x	78x	8x	137x

Notes and sources: See table 5.7.

5.3 Estimates of future subsidies

5.3.1 Projections based on current programs

Using information on in-process construction and existing and pending subsidy policies, subsidies for the 2009–2012 period were estimated. Production levels rise sharply, from around 1 billion litres per year of ethanol in 2008 to over 2.2 billion litres per year in 2012; and from around 200 million litres per year to 670 million litres per year for biodiesel in that same period (Table 5.9 and Table 5.10). The decline in per-litre support is due to rising production, with falling per-litre payment rates. For example, in 2012, the federal ecoABC maximum per-litre payment falls from C$ 0.10 to C$ 0.08, resulting in a major drop in total subsidies. Production is not expected to also drop, therefore average per-litre support falls. It remains to be seen whether high production could continue with lower per-litre subsidies.

Two key factors contribute to this slowing of government support. First, the shift away from unlimited excise tax exemptions applied to all consumption to production tax credits that are limited and support only domestic producers constrains the growth in subsidy outlays. These trends differ sharply from projected subsidies in the United States.

Second, two of the major producer payment programs cap support at the estimated level required to meet the government's mandates. The federal ecoEnergy for Biofuels provides per litre payments on up to two billion litres of ethanol and 500 million litres of biodiesel and total funding limits of C$ 1.5 billion over the life of the program. The Ontario Ethanol Growth Fund limits support to 60.5 million litres of ethanol. Therefore, as production rises, total levels of support do not and the average per-litre subsidy declines. Both of these jurisdictions have indicated that the cap could be raised in the future if additional funding was available.

Given that domestic production is expected to exceed demand (driven by mandates) in 2009–2012, these projections assume that no imports will be required to meet consumption. The majority of support is derived from producer payments (not available for imported product), and therefore will not be affected by import or export levels. Of

the new capacity expected to come into production by 2012, only one planned new ethanol plant is expected to use cellulosic technology, using municipal waste as a feedstock.

Table 5.9 Estimates of future support – ethanol

Support element	2009	2010	2011	2012
Output-linked support				
Fueltax exemptions	0	0	0	0
Producer incentives and operating grants – low estimate	83	76	76	71
Producer incentives and operating grants – high estimate	309	303	340	314
Factors for factors of production				
Capital grants – low estimate	62	63	42	16
Capital grants – high estimate	122	128	92	46
Feasibility studies	3	0	0	0
Accelerated depreciation – low estimate	51	57	37	10
Accelerated depreciation – high estimate	88	99	63	17
Factors for factors of production – feedstock	0	0	0	0
Other value-added support				
Market development	3	0	0	0
Support for blending & distribution	0	0	0	0
Consumption				
Support for biofuel-consuming vehicles	0	0	0	0
Other	0	0	0	0
R&D				
R&D – low estimate	16	15	15	6
R&D – high estimate	28	28	28	19
Total support estimate				
Low estimate	163	154	134	93
High estimate	462	458	460	379
Production capacity (millions of litres)	*1427*	*1437*	*1812*	*2267*
Total transfers per litre (C$ per litre)				
Low estimate	0.11	0.11	0.07	0.04
High estimate	0.32	0.32	0.25	0.17

Note: Any imports or exports are not included, as the above subsidies would only be applied to domestically-produced biofuels.

Source: GSI estimates.

Table 5.10 Estimates of future support – biodiesel

Support element	2009	2010	2011	2012
Output-linked support				
Fuel tax exemptions	22	55	55	55
Producer incentives and operating grants – low estimate	0	0	0	0
Producer incentives and operating grants – high estimate	20	29	54	47
Factors for factors of production – capital				
Capital grants – low estimate	18	35	31	3
Capital grants – high estimate	32	49	45	17
Feasibility studies	0	0	0	0
Accelerated depreciation	6	11	28	28
Factors for factors of production – feedstock	0	0	0	0
Other value-added support				
Market development	3	0	0	0
Support for blending & distribution	0	0	0	0
Consumption				
Support for biofuel-consuming vehicles	0	0	0	0
R&D				
R&D – low estimate	14	8	8	6
R&D – high estimate	26	20	20	18
Total support estimate				
Low estimate	57	97	94	64
High estimate	104	153	174	137
Production capacity (millions of litres)	*201*	*290*	*671*	*671*
Total transfers per litre (C$ per litre)				
Low estimate	0.28	0.34	0.14	0.10
High estimate	0.52	0.53	0.26	0.20

Note: It is assumed that there would be no exports or imports. Producer payments – the majority of per-litre support at the federal level, would apply only to domestically produced biofuel. Imports in some jurisdictions could be eligible for excise tax exemptions but there has been no history of significant imports of biodiesel into Canada.

Source: GSI estimates.

5.3.2 Other potential costs to government and the economy

The above projections of future subsidies are likely to be underestimates. They include only the direct costs to governments of the continuation of current programs and policies. These policies are likely to have consequential costs that have not been captured in our analysis.

5.3.2.1 Infrastructure requirements

Increased biofuel consumption due to mandates will have implications for fuel blending, transport, storage and distribution, which are likely to lead to calls for new subsidies. Ethanol is both a solvent and hydroscopic, therefore requires specialized infrastructure.

Governments are likely to be called upon to develop and fund the infrastructure necessary to ensure that biofuels (and possibly co-products) can get out to their intended customers.

The costs are likely to be significant. Renewable fuels and petroleum refining industries must integrate operations. Refiners must retool to produce special petroleum stocks for downstream blending with renewable fuels. Rail and truck shipments will increase as ethanol blends cannot be run through normal steel pipelines (and there are significant distances between where biofuel is being produced and the Canadian market where the products and co-products are likely to be utilized). Distribution systems and storage tanks must be cleaned and dewatered (due to the hydroscopic nature of ethanol), including thousands of service stations. Some tanks at retail outlets may require replacing as plastic tanks manufactured prior to 1979 are not compatible with ethanol-blended fuels.

In addition, most energy infrastructure in Canada runs north to south, with little infrastructure extending eastward from Quebec (see McColl, 2009). Thus provinces in the Atlantic Region could be disadvantaged by biofuel mandates, as they have little ability to produce the sufficient feedstocks to meet biofuel threshold levels and, in the case of Newfoundland, no access to rail infrastructure to bring in biofuels. Imports may thus be required.

5.3.2.2 Indirect economic effects

The distortions created by support policies for biofuels have the potential to cause negative impacts on other industries, with implications for Canada's net productivity and exports. Canadian livestock producers have experienced reduced access to grain and higher prices (Klein and Le Roy, 2007). Were these higher prices to have come about due to market conditions, then grain could be said to be allocated to a higher value end-use, producing net economic benefits for the Canadian economy due to greater value-adding. However, subsidization of biofuels has skewed the market, and grain could be flowing to a lower value end use (biofuels), compared with livestock production.

In Australia, a study found that mandatory blending of ethanol at 10 per cent for petrol and 15 per cent for diesel would permanently increase the average price of grain in Australia by over 25 per cent (Centre for International Economics, 2005). This would reduce the international competitiveness of Australia's livestock industry, which relies on grain for finishing (fattening) stock. If prices rose sufficiently, other grain users could seek to import more expensive grain. A mandatory blending policy could therefore have an overall negative impact on Australia's balance of payments because of lower exports of livestock products, a contraction in grain exports, and increased imports of grain.[75] A similar pattern could develop in Canada.

[75] The analysis in the CIE report suggests that in a non-drought year, mandatory blending of locally produced ethanol would lead to a reduction in imports of petrol and diesel valued at around A$ 1.3 billion (at a US$ 40 per barrel price of oil). But the economy would forego exports valued at around A$ 2.1 billion and incur additional imports of A$ 380 million to achieve this saving.

5.3.2.3 Marginal cost curves

The on-going dependence of the biofuel industry on subsidies will depend, in part, on the long-run marginal and average cost curves for this industry. Significant economies of scale have been demonstrated to exist for both first- and second-generation biofuel facilities (e.g., see Walburger *et al.* 2006; Searcy and Flynn, 2009). Access to the cheapest feedstock will also improve the profitability of production.

However, several Canadian subsidy programs could work against these objectives by encouraging smaller facilities, those owned by agricultural producers and using local feedstocks. Saskatchewan regulations require that distributors purchase 30 per cent of their ethanol from plants that produce less than 25 million annually (Walburger *et al.*, 2006). Such requirements could restrict the efficiency of production, leading to long-term subsidy dependence. Rather than phasing out subsidy programs, as intended, governments could be faced with the choice of renewing support or allowing the closure of small biofuel producers, if these are not profitable without subsidies.

Sub-national laws that restrict certain subsidies or tax breaks to domestically produced biofuels, or to biofuels made from domestically grown feedstocks, are questioned in the light of national treatment provisions of the World Trade Organization.

6 Key findings and recommendations

A review of federal and provincial programs has identified many direct and indirect subsidies for the production and sale of biofuels. These programs include most stages of the biofuels production chain, including research, capital investment, fuel production, marketing and sales; and vehicle purchases.

- **Subsidies are a significant factor in transport fuels in Canada.** Although Canadian biofuel subsidies started later than in the United States, they have grown steadily, and now constitute a significant subsidy per litre of fuel produced. The industry is unlikely to survive without these subsidies.[76]

- **Biofuel subsidies are an expensive way to conserve fossil-fuels use and achieve GHG mitigation goals.** This finding is consistent with the results of the GSI's research on other countries. For corn- and wheat-based ethanol, Canadian governments could achieve between six and one hundred times more reductions in carbon emissions by simply purchasing carbon offsets in the market, rather than by subsidizing ethanol production. The results were similar for biodiesel. Subsidizing cellulosic ethanol may not be the most cost-effective option, either. Under a hypothetical best-case scenario, where cellulosic ethanol replaces conventional ethanol production at our lowest subsidy estimates, subsidizing cellulosic ethanol was found to be approximately three times more expensive as a way to reduce carbon than purchasing offsets.

- **Biofuel mandates have yet to reduce fuel prices or increase international trade.** Rising mandates, especially in the face of low oil prices, may result in larger pricing distortions in coming years than what has been observed in the past. In addition, some provincial feedstock mandates may raise questions regarding compatibility with WTO rules.

- **Canada has done a better job than other countries targeting and limiting its biofuel subsidies.** A number of policy constraints adopted within Canada have been effective in mitigating the financial cost of the programs. The federal Ethanol Expansion Program for capital assistance contained innovative "anti-stacking" provisions that required that total government funding—whether federal, provincial or municipal—could not make up more than 50 per cent of the total project costs. A broad shift from excise tax reductions to production tax credits in recent years has greatly reduced the share of public money supporting biofuels manufactured outside of Canada. This shift has occurred at both the provincial and national levels. Similarly, production tax credits and other subsidies to manufacturers have tended to have caps on total outlays or years of eligibility. Some adjust payouts based on profit levels within the sector. These approaches help contain payouts to producers or consumers during times when they are not needed to bolster production.

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[76] USDA notes that "A large body of evidence seems to suggest that without government support, a Canadian grains-based ethanol industry (1st generation ethanol) is, and will remain, uncompetitive compared to oil, due to the costs of the necessary inputs" (U.S. Department of Agriculture, 2008: 6).

- **However, existing biofuel policies are likely to impose further, as yet unquantified, costs on the Canadian economy.** Increased biofuel consumption, due to mandates, will likely lead to calls for further government assistance for the development of necessary infrastructure to support biofuel blending, storage, transport and distribution. The distortions created by biofuel subsidies will also have flow-on effects to other sectors that were not evaluated in this study but could be significant.

- **Nor do the programs favour environmentally-superior biofuels.** The federal government's rationale for supporting biofuels is predicated on there being significant environmental benefits in the form of GHG reductions throughout the use of LCA for biofuels. The problem is that the LCA currently employed in Canada for the RFS does not routinely consider a more representative range of environmental parameters representative of the real and likely impacts. As evidenced by the Environment Commissioner's 2008 audit of federal government environment programs, it appears that the government does not have the architecture or framework in place to conduct a systematic assessment of the sustainability of federal government activities. While there is increasing recognition that only second-generation biofuels are likely to provide significant environmental benefits (U.S. Department of Agriculture, 2008), policy eligibility has yet to be limited to these more advanced fuels. Similarly, there are as yet no efforts to require a positive GHG impact to qualify for particular subsidy programs. These gaps undermine core justifications for biofuels subsidization within Canada.

- **Biofuel subsidies provide limited benefits to farmers.** Although biofuel subsidies increase demand for corn, wheat and oil seeds, demand and prices for these products are rising in any case in response to growing human food demands. Much of the value of these subsidies is likely to be ultimately capitalized into farmland values, providing little net increase in income to most farmers.[77]

- **Efforts to encourage subsidies to small producers are counter-productive**. Canada has also attempted to restrict some subsidies to smaller producers, despite evidence from other countries that larger producers are more competitive as a result of economies of scale. Providing larger per-unit subsidies to smaller producers risks building plants that are less competitive internationally at such time as subsidies end.

- **Better transparency on actual payments made by governments to the biofuels sector is needed.** The amount of available data on the volume of subsidized production and sales, and on payments, is surprisingly sparse, especially given the scale of the subsidies. The Ethanol Expansion Program required applicants to disclose to federal government all subsidies received by

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[77] Walburger *et al.* (2006) note that, due to the competitive market structure of the grains and oilseeds sector in Canada, most improvements in commodity prices—including those brought about by subsidy programs—result in higher prices for land with little or no improvements in the returns for agricultural labour. Increases in equity (through higher farmland values) can have some benefits for rural economies, however.

specific plants. This information has not been made publicly available, but would be helpful in understanding the full picture of subsidies within Canada. Similarly, a number of potentially large tax expenditures may benefit the sector and need to be further characterized. Concerns that disclosure of information regarding specific recipients could negatively affect these firms, by affecting the behaviour of rivals, are presented as a justification for a lack of public information. But that is no excuse for failing to disclose this information. There are ways to release appropriate levels of information without compromising confidential business information. Legal precedent in other economies (like the United States, notably Minnesota, and several EU Member States) has established the public's right to know to whom their money is being given and how it is being spent.

- **Canada's biofuel support policies are poorly coordinated.** Canada does not have a national biofuel strategy, but a federal strategy and six provincial ones. Many programs are overlapping, with little apparent coordination between governments. It is also unclear how new policy measures, such as Ontario's low-carbon fuel standard or provincial carbon taxes, will interact with biofuel policies.

- **Policy neutrality is needed.** Policy neutrality for all methods to reduce reliance on oil in the transport sector is needed. "Picking winners" for the best technology to reduce GHG outcomes or encourage rural development tends to reward political connections and sophistication in lobbying, rather than technical merit. Canada has financially supported cellulosic ethanol technologies relative to alternative strategies to reduce petroleum consumption or GHG emissions in the transport sector. R&D research during initial phases of technological development can deliver breakthroughs that can be applicable across several sectors of the economy, thus subsidies towards such research can be said to deliver a public good. However, this argument breaks down as subsidies become more specific to the sector. Subsidies for demonstration plants, for example, are unlikely to deliver benefits to any but the sector targeted. R&D tax credits that still allow the private investor to choose the projects can be more efficient mechanisms. If the primary policy objective is to reduce GHG emissions, then governments should encourage innovation and competition in the marketplace to find the best solutions. A carbon tax would directly penalize carbon emissions, leaving industry and consumers to decide how to most effectively avoid the costs, such as reducing their use of fuels, improving vehicle efficiency, or developing and using innovative technologies. Such approaches are generally favoured by economists as more effective and less distorting than subsidies. While subsidies encourage new industries dependent on taxpayer support, taxes discriminate against the offending product or behaviour, encouraging its removal from the economy.

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Annex 1 — A comparison of life-cycle estimates for greenhouse-gas emissions and net energy balance for biofuels made from feedstocks used in Canada

Comparisons of the net energy flows and GHG emissions generated through the production and use of an energy technology or fuel are nowadays made on the basis of life-cycle assessments (LCAs). When the LCAs are formalized in a spreadsheet or other computer-based accounting framework they are usually referred to as LCA models. These models circumscribe the inputs and emissions within a system, usually comprising the primary production stage, any intermediate processing stages, and distribution to the final consumer. For petroleum fuels and biofuels, the final consumer would normally be operators of vehicles. LCAs of liquid transport fuels often describe analyses that relate to the final delivered fuel itself. These are typically called "well-to-tank" (WTT) analyses, wherein the "well" refers to an oil well or farm, and the "tank" is the fuel tank of a vehicle.

Because the actual performance of vehicles using different fuels is not solely a function of the energy contained in the each fuel, some analysts prefer to go one step further and compare net energy balances and life-cycle emissions in actual vehicles. This extra step is called a "tank-to-wheels" assessment, and the whole LCA is called a "well-to-wheel" (WTW) analysis. The limitation of WTW analyses is that they are hard to compare, as usually the vehicles used differ from one study to another. However, the results of these analyses provide an important caveat for WTT analyses in respect of biofuels: often the results suggest that, with low- or moderate-concentration blends (i.e., up to E20 or B20), the performance of biofuel blends, as measured by km per unit of energy, is slightly better than would be the case if they were proportional to the energy contained in the fuel. In the case of ethanol, this phenomenon is explained by the higher octane rating of ethanol (115) than gasoline (85), and in the case of biodiesel by the better lubricity of biodiesel compared with petroleum diesel.

For the purposes of this study (as with other GSI studies) WTT results are used as the basis for comparison. These are derived from published LCAs for the fuels concerned. Most LCA models follow the guidelines of the International Office for Standardization (ISO), particularly ISO 14040:2006 and 14044:2006. The official LCA model used by the Government of Canada is GHGenius.[78] Its documentation is extensive, and publicly available on the Internet (see, e.g., (S&T)^2, 2008a and 2008b). Other notable LCA models that have been developed over a number of years and are used to inform policy making in the area of transport fuels are the GREET model in the United States (Wang *et al.*, 2007), the JEC model in the European Union (JEC, 2008), and EMPA's LCA model in Switzerland (Zah *et al.*, 2007a and 2007b). The GREET model has been used extensively by modellers other than its custodian, Argonne National Laboratory; notably, a modified

[78] www.ghgenius.ca

version, called CA_Greet is now being used by the California Air Resources Board (CARB).[79] Numerous other LCAs have been developed by University researchers and consulting companies; some of these are updated and used on an on-going basis.

Menichetti and Otto (2009) recently reviewed the energy balances and greenhouse-gas emissions of biofuels reported by 30 different studies. This Annex draws in part on that study, but reports the absolute values of energy balances and emissions, rather than percentage improvements compared with petroleum fuels. This approach was preferred because the estimates for energy use and emissions of petroleum fuels reported in the studies vary, generally by ±10 per cent from the median value. Also, with one exception (for Australia), the scope of this review is confined to studies published since 2006.

Choosing a reference value for net fossil energy inputs

Ethanol from grains

For ethanol made from grains, the main parameters influencing fossil-fuel inputs are the use of farm chemicals, particularly nitrogenous fertilizers (which use natural gas in their production); fuel used by farm machinery and to transport the crop to the processing plant; and the fuel and electricity used to ferment, distil and dehydrate the ethanol. These inputs, in turn, depend in part on the average size of the farms, local tilling practices, soil type, yields, and the proportion of fossil fuels in the electricity supply of the country or region. Energy credits are typically given for co-products, particularly distillers grains with solubles.

Table A1 lists the estimates of net fossil inputs for ethanol made from corn and wheat. The net fossil input ratio expresses the amount of fossil energy, measured in some multiple of joules (typically 10^6 joules, or megajoules), involved in producing a fuel per unit of useful energy contained in the fuel. Properly, the MJ of any fuel used in a standard internal-combustion engine should be the lower heating value (LHV). However, some LCAs refer to the high heating value, which includes the heat that could be recovered through the condensation of steam in the exhaust vapour to water — something that few internal-combustion engines are equipped to do.

These values may be compared with a net fossil energy input of 1.2 to 1.3 for gasoline. The model designated by the Canadian federal government for its life-cycle analyses, GHGenius, gives a ratio of 1.287. This value is slightly higher than the value reported by, for example, Farrell *et al.*, which estimated a fossil energy input ratio of 1.19. The higher value for Canada, which is a net exporter of crude petroleum oil, is presumably attributable to the energy required to extract and process bitumen from its oil sands, which constituted 46 per cent of its total production of crude petroleum and natural gas condensate in 2008.

[79] www.arb.ca.gov/homepage.htm

Table A1 Comparison of life-cycle assessment estimates of net fossil energy inputs to grain-based ethanol

(MJ of fossil fuel needed for each MJ of ethanol produced)

LCA Analysis	Country of production	Corn (dry mill)	Wheat
GHGenius [(S&T)^2, 2008]	Canada	0.685	0.7517
GHGenius (NRCanada, 2009)	Canada	0.6335	0.6819
Beer *et al.* (2001)	Australia	Not calculated	0.85
JEC (2008)	EU	Not calculated	0.81
Zah *et al.* (2006)	N. America (corn) Europe (rye)	0.84	0.82
CA_GREET (Prabhu *et al.*, 2009)[1]	United States	0.82	Not calculated
BESS (Liska *et al.*, 2009)	United States (Nebraska)	0.61	Not calculated
Groode & Heywood (2008)	United States	0.66 (Iowa) +1.09 (Georgia)	Not calculated
GHGenius [(S&T)^2, 2008]	United States	0.885	Not calculated
GREET (Wang *et al.*, 2007)	United States	0.767	Not calculated
Farrell *et al.* (2006)	United States	0.774	Not calculated

1. Includes energy to transport ethanol from the Midwest to California.

Sources: For full list of references, see bibliography at end of this Annex.

Ethanol from lingo-cellulosic material

Table A2 lists the estimates of net fossil inputs for ethanol made from two major types of lingocellulosic feedstock materials: dried biomass residue (usually corn stover, wheat straw or a purpose-grown grass) and from woody biomass. For ethanol made from lingocellulosic materials, the main parameters influencing fossil-fuel inputs are the use of nitrogenous fertilizers; fuel used by machinery to harvest and transport the biomass to the processing plant; and the energy used to produce the enzymes and other chemicals used in the pre-fermentation process (where applicable). With respect to the latter, MacLean and Spatari (2009) note that life-cycle studies of lingo-cellulosic technologies are highly sensitive to assumptions made regarding the energy requirements for producing enzymes, and their dosage, and that these parameters have not been thoroughly examined. For non-woody biomass, the energy inputs depend in part on yields (which affect the distance that has to be covered by harvesting machinery), and average distance to the ethanol plant.

Table A2 Comparison of life-cycle assessment estimates of net fossil energy inputs to ligno-cellulosic ethanol

(MJ of fossil fuel needed for each MJ of ethanol produced)

LCA Analysis	Country of production	Grasses or straw	Wood
GHGenius (NRCanada, 2009)	Canada	0.6236 (corn stover) 0.2127 (grass)	0.2127 (wood)
MacLean & Spatari (2009)	North America	~ 0.30 (switchgrass)	Not calculated
JEC (2008)	EU	0.10 (wheat straw)	0.28
Zah *et al.* (2006)	Europe	0.17 (grass)	0.32
CA_GREET (Prabhu *et al.*, 2009)[1]	United States	Not calculated	0.06 – 0.19
Groode & Heywood (2008)	United States	0.20 (Iowa corn stover) 0.06 (Alabama switchgrass)	Not calculated
GREET (Wang *et al.,* 2006)	United States	0.09 (corn strover in 2030)	0.17 (woody residue in 2030)
Farrell *et al.* (2006)	United States	0.08	Not calculated

1. The range in values represents, at the low end, ethanol from farmed trees and at the high end ethanol from forest waste; in both cases the biomass is assumed to be grown outside of California, and the energy use includes transport by rail to blending terminals in California. Ratios refer to fossil-energy use only.

Sources: For full list of references, see bibliography at end of this Annex.

Biodiesel

Table A3 lists the estimates of net fossil inputs for biodiesel made from two major types of feedstock: virgin canola oil and yellow grease (waste cooking oil). For biodiesel made from canola the main fossil-fuel inputs relate to the fuels used by farm machinery; the energy used to create fertilizers (which use natural gas in their production) and pesticides; the fuel used to transport the crop to the processing plant; and the methanol used in transesterfying the oil into biodiesel. These inputs, in turn, depend in part on the average size of farms, tilling practices, and soil type. For biodiesel made from yellow grease, the main fossil-fuel inputs relate to the fuels used by vehicles collecting the yellow grease, and the methanol used in transesterfying the grease into biodiesel. The values in the table may be compared with a net fossil energy input ratio of 1.227 reported by the GHGenius model for diesel transport fuel (NRCanada, 2009).

Table A3 Comparison of life-cycle assessment estimates of net fossil energy inputs to biodiesel

(MJ of fossil fuel needed for each MJ of biodiesel produced)

LCA Analysis[1]	Country of production	Canola or rapeseed oil	Waste cooking oil
GHGenius [(S&T)[2], 2008]	Canada	0.25	-0.03
GHGenius (NRCanada, 2009)	Canada	0.29	0.062
JEC (2008)	EU	0.35	Not calculated
Zah *et al.* (2006)	EU	0.64	0.26
Zah *et al.* (2006)	Switzerland	0.51	0.27

Sources: For full list of references, see bibliography at end of this Annex.

Choosing a reference value for GHG emissions

As with previous GSI analyses of biofuel policies, this study measures the cost-effectiveness of those policies to reduce GHG emissions by dividing the value of support (Canadian dollars in this study) per metric ton (tonne) of CO_2-eq. avoided. The amount of CO_2-eq. avoided is derived from published LCAs for the fuels concerned. As with energy balances, even for the same feedstock crop produced in a narrowly defined geographic region, estimates of life-cycle GHG emissions can differ widely from one study to another. These differences arise often because of different vintages of data on farm inputs and processing technologies, differences in allocation methods between the biofuel and its co-products, and differences in assumptions about tilling practices, fertilization rates and emissions of nitrous oxide (N_2O), a potent greenhouse gas. When comparing the results of LCAs across countries, differences in climates and soils play an important role as well.

The common unit of measurement for GHG emissions is grams of CO_2-equivalent per megajoule (MJ) of fuel. A CO_2-equivalent standardizes the greenhouse-forcing potential of different gases in the atmosphere by expressing them in terms of the weight of carbon dioxide required to obtain the same greenhouse-forcing effect.

Ethanol from grains

The two main feedstocks used for producing starch-based ethanol in Canada are field corn (maize) and wheat. In the future, ethanol may be produced in Canada from feedstocks such as wood chips, grasses and municipal solid waste.

The estimates that GHGenius has produced of GHG emissions from corn- and wheat-based ethanol are generally the lowest in the world. Table A4 compares the central results published in a sensitivity analysis of the GHGenius model in March 2008 ((S&T)[2] *et al.*, 2008) and in the most recent version of the model (NRCanada, 2009) with those from studies published in Australia, the EU, Switzerland and the United States.

Table A4 Comparison of life-cycle assessment estimates of GHG emissions from grain-based ethanol (gCO_2-eq/MJ)

LCA Analysis	Country of production	Corn (dry mill)	Wheat
GHGenius [(S&T)[2], 2008]	Canada	39.45	40.43
GHGenius (NRCanada, 2009)	Canada	52.01	36.01
Beer *et al.* (2001)	Australia	Not calculated	63.3
JEC (2008)	EU	Not calculated	61
HGCA (2009)	EU (U.K.)	Not calculated	64.3
GMU (2007)	N. America (corn) Europe (wheat)	48.2	57.7
Zah *et al.* (2006)	N. America (corn) Europe (rye)	83.3	85.5
CA_GREET (Prabhu *et al.,* 2009)[1]	United States	67.6	Not calculated
BESS (Liska *et al.*, 2009)	United States (Nebraska)	48	Not calculated
Groode & Heywood (2008)	United States	72 (Iowa) 101 (Georgia)	Not calculated
GHGenius (2008)	United States	57	
GREET (2007)	United States	64.5	Not calculated
Farrell *et al.* (2006)	United States	77	Not calculated

1. Includes emissions associated with the transport of ethanol from the Midwest to California.

Sources: For full list of references, see bibliography at end of this Annex.

Numerous obvious reasons can explain the large differences in these results. Differences in climate, which influences crop yields, inputs (especially irrigation water) and N_2O emissions, are clearly important factors. Generally, also, the more recent the data on crop yields (which generally increase with time) and on ethanol production plants (which generally have become more energy-efficient over time), the lower will be the estimated LCA emissions.

Consideration of any results for Canada must take into account the following characteristics of its ethanol industry:

- Canada produces most of its own nitrogen fertilizer, hence emissions associated with the transport of fertilizer to farms (especially in the western half of the country) are relatively low.

- Because of Canada's relatively cool and (outside the Prairie provinces) wet climate, emissions of N_2O from the soil are believed to be lower than in most other countries, notably the United States.

- The majority of Canada's ethanol-producing capacity has come on stream since 2006, and therefore tends to make use of the latest, most efficient technologies.

- No ethanol plants in Canada use coal as a process fuel; all use natural gas.
- The energy source of electricity in most Canadian provinces is hydroelectric power or nuclear energy, neither of which emits carbon.

The lower GHG emissions for grain-based ethanol in the GHGenius model also reflect relatively high co-product credits given to GHG emissions associated with the substitution of distillers grains for soybean meal.

Ethanol from lingo-cellulosic material

The number of published studies that estimate life-cycle GHG emissions for ethanol made from lingo-cellulosic materials have been fewer than for ethanol made from grains. For one, experience in making ethanol from such materials has been shorter, and the largest operating plants are still one-off demonstration plants. Similarly, data for assessing the energy and material flows associated with the large-scale production of biomass for biofuels are scarce.

Among the feedstocks most commonly studied are corn stover, wheat straw, various grasses native to North America (switchgrass and mixed prairie grasses) and Europe (*Miscanthus*), coppiced wood (e.g., poplar), "waste" wood from the forest industry, and municipal solid waste. In Canada, the main feedstocks likely to form the basis of lingo-cellulosic production are wheat straw, prairie grasses and woody biomass.

Table A5 shows the results of several life-cycle assessments of GHG emissions from the production of ethanol from ligno-cellulosic materials. For ethanol made from grasses or straw, the estimated emissions fall within the range of 5–50 gCO_2-eq per MJ, with most studies finding between 5–10 gCO_2-eq per MJ. That the numbers are lower than ethanol made from grains is not surprising, as the GHGs associated with the growing of the feedstock are normally assumed to be very low. Typically, no or very little in the way of nitrogenous fertilizers are applied, and the crops are assumed to not need irrigation. Likewise, most of the process energy is assumed to come from biomasss.

Table A5 Comparison of life-cycle assessment estimates of GHG emissions from ethanol made from lingo-cellulosic sources (gCO_2-eq/MJ)

LCA Analysis	Country of production	Grasses or straw	Wood
GHGenius (S&T)[2] (2008)	Canada	50 (wheat straw)	
JEC (2008)	EU	9 (wheat straw)	19–22
CA_GREET (Prabhu *et al.,* 2009)	United States	Not calculated	1.6 (farmed trees) 21.4 (forest waste)
Hill *et al.* (2009)	United States	7 (prairie biomass) 9 (corn stover) 10 (*Miscanthus*) 21 (switchgrass)	Not calculated
Groode & Heywood (2008)	United States	27.6 (corn stover) 6.0 (switchgrass, Iowa) 5.4 (switchgrass, Alabama)	Not calculated
GREET (Wu *et al.*, 2006)	United States	13.3 (corn strove in 2013)	14.2 (in 2030)
Farrell *et al.* (2006)	United States	11	Not calculated

Sources: For full list of references, see bibliography at end of this Annex.

Biodiesel

Currently, biodiesel in Canada is produced from a variety of lipids, all using the transesterfication process. Early biodiesel plants used waste cooking oils and fats, and one plant used fish oil. Plants built in the last five years use waste cooking oils and fats (yellow grease), animal fats (tallow) and virgin vegetable oils, mainly canola (rapeseed) oil.

As for starch-based ethanol, the estimates that GHGenius has produced of GHG emissions from canola-based biodiesel are generally the lowest in the world. Table 2 compares the central results published in Version 3.14b of the GHGenius model (NRCan, 2009) with those from studies published in Australia, the EU and Switzerland. The table also lists estimates of GHG emissions from biodiesel produced from yellow grease. Because yellow grease is considered a waste product, the only GHG emissions attributed to it in LCAs are those associated with fossil fuels used in the collection and processing of the grease, and particularly to produce the methanol, which is normally derived from natural gas, used in the transesterfication stage.

Table A6 Comparison of life-cycle assessment estimates of GHG emissions from biodiesel (gCO_2-eq/MJ)

LCA Analysis[1]	Country of production	Canola or rapeseed oil	Waste cooking oil
GHGenius (NRCanada, 2009)	Canada	18.87	-2.8
Beer *et al.* (2007)	Australia	45	11
JEC (2008)	EU	42	Not calculated
BMU (2007)	EU (Germany)	45.3	Not calculated
HGCA (2009)	EU (U.K.)	66	Not calculated
Zah *et al.* (2006)	EU	71.5	11.1
Zah *et al.* (2006)	Switzerland	52.1	15.6

Sources: For full list of references, see bibliography at end of this Annex.

The reasons why GHGenius results in much lower estimates of GHG emissions for canola-based biodiesel than studies conducted elsewhere is less apparent than for grain-based ethanol. Biodiesel production using the transesterfication process is a mature technology, so it is unlikely that there would be large differences across countries in the GHG emissions associated with that stage of biodiesel production. The differences therefore likely lie in the production of the feedstock, and assumptions regarding the allocation of energy use and emissions to co-products.

Accounting for land-use change

An important qualification is that the data presented in the above tables refer only to the direct emissions associated with crop cultivation. They do not consider emissions associated with the conversion of land to grow crops—either as feedstock for biofuels or to replace crops diverted to the production of biofuels.

The default assumption in GHGenius is that all the feedstock for biofuel production comes from land that is already producing agricultural commodities. This is a reasonable assumption for Canada as, to date, the use of grains and oilseeds for the production of biofuels is believed to have involved very little conversion of land. In the western provinces, most of the developments so far have been based on production from existing producers. In the eastern provinces, much of the corn used for ethanol production was until around 2006 imported from the United States.

Nonetheless, the increased demand for agricultural feedstock as a result of biofuel production could contribute to land-use change both in Canada and elsewhere, through displacement effects (e.g., the need to import more food as more domestic agricultural production is converted to fuel) and higher commodity prices. A recent assessment of the land-management risks associated with biofuel production in Canada (Baron, 2008), for example, concluded that the demand for biofuels *will* put pressure on and compete for lands currently used in food and feed production in both Canada as well as the United States. This will cause both changes in land management (particularly intensification of production on existing lands), and changes in land use. The study notes:

> Management for high yields will be necessary in feedstock, feed grain and food production as high producing crop land will be at a premium. High-intensity

cropping systems with requisite high inputs will be required. Forage and pasturelands will be sacrificed to grain and biomass production.

The conversion of former pastureland or former forests to growing crops can lead to significant releases of carbon into the atmosphere for several decades after the land has been converted. One way of expressing this carbon release is in terms of the number of years that substituting the biofuel for petroleum fuel needs to take place before the soil-carbon debt is "repaid". Fargione *et al.* (2008) found that land use change effects can range anywhere less than one year (when converting fertile cropland to prairie grasses) to several hundred years (when converting peatland rainforest or tropical rainforest to palm oil plantations or soybeans). Beer *et al.* (2007) estimated that the GHG emissions for palm biodiesel sourced from cleared rainforest or peat swamp were 8 to 21 times higher than those of petroleum diesel.

More controversial has been the notion of indirect land-use change (iLUC). This refers to changes in land-use induced by farmers responding to higher prices for crops as a result of the diversion of crops or arable land to biofuel production. Unlike estimating GHG emissions associated with the conversion of a particular area of land to crop production, the estimation of iLUC requires use of partial or comutable general-equilibrium (CGE) models to capture the interplay of supply, demand and prices in different regions of the world. Searchinger *et al.* (2008) were the first to attempt such a measurement, and concluded that taking into account iLUC in the case of a large increase in the use of corn for ethanol production in the United States could negate corn-ethanol's lower direct life-cycle emissions compared with gasoline, and indeed lead to higher global emissions than from the production and use of the gasoline that the ethanol would displace. More recently, looking at a more modest increase in corn-ethanol production in the United States, a study by Darlington (2009) concluded that meeting the U.S. mandate of 15 billion gallons of corn-ethanol production by 2015 "should not result in [any] new forest or grassland conversion in the U.S. or abroad."

Numerous other studies are now underway to try to estimate the significance and scale of iLUC associated with particular biofuels. It is too early to conclude what significance these studies could have for the assessment of GHG emissions, and emission savings, from Canada's biofuels. But the fact that the phenomenon is now recognized, even if the degree of the effects is disputed, suggests that policies guided by current assumptions regarding GHG emssions from Canada's biofuel programme may have to be re-evaluated in the future.

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About the Global Subsidies Initiative

The International Institute for Sustainable Development (IISD) launched the Global Subsidies Initiative (GSI) in December 2005 to put a spotlight on subsidies—transfers of public money to private interests— and how they undermine efforts to put the world economy on a path toward sustainable development.

Subsidies are powerful instruments. They can play a legitimate role in securing public goods that would otherwise remain beyond reach. But they can also be easily subverted. The interests of lobbyists and the electoral ambitions of office-holders can hijack public policy. Therefore, the GSI starts from the premise that full transparency and public accountability for the stated aims of public expenditure must be the cornerstones of any subsidy program.

But the case for scrutiny goes further. Even when subsidies are legitimate instruments of public policy, their efficacy—their fitness for purpose—must still be demonstrated. All too often, the unintended and unforeseen consequences of poorly designed subsidies overwhelm the benefits claimed for these programs. Meanwhile, the citizens who foot the bills remain in the dark.

When subsidies are the principal cause of the perpetuation of a fundamentally unfair trading system, and lie at the root of serious environmental degradation, the questions have to be asked: Is this how taxpayers want their money spent? And should they, through their taxes, support such counterproductive outcomes?

Eliminating harmful subsidies would free up scarce funds to support more worthy causes. The GSI's challenge to those who advocate creating or maintaining particular subsidies is that they should be able to demonstrate that the subsidies are environmentally, socially and economically sustainable— and that they do not undermine the development chances of some of the poorest producers in the world.

To encourage this, the GSI, in cooperation with a growing international network of research and media partners, seeks to lay bare just what good or harm public subsidies are doing; to encourage public debate and awareness of the options that are available; and to help provide policy-makers with the tools they need to secure sustainable outcomes for our societies and our planet.