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Economic and Regulatory Barriers to Biofuel Growth in Canada

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Through their diverse range of economic, environmental, and policy impacts, biofuels and their use have been routinely polarized by the mass media and in the academic literature. Although the body of literature investigating macro and microeconomic biofuel effects is rapidly growing, there is no clear depiction of the Canadian biofuel industry. Our research identifies the leading economic and regulatory barriers that presently exist for the Canadian biofuel industry. A modified expert Delphi survey was used to collect qualitative information from Canadian public-sector biofuel researchers and private-sector industry managers. The top three barriers to the development of biofuels in Canada include the absence of a coordinated and integrated federal-provincial policy framework, the technical capacity for scale-up is currently lagging, and the lack of integration between the increased use of biofuels and sustainability.

Key words: government policy, innovation, second-generation biofuels, subsidies, sustainable development.

Introduction

Biofuels are frequently championed as an alternative to petroleum-based fuels and a potential climate change mitigation strategy. However, the expansion of biofuel production has raised considerable debate amongst the media and in academic literature about whether biofuels actually lower greenhouse gas emissions, their impact on food security, and the extent of environmental impacts (Bailey, 2008; Farrell et al., 2006; Nuffield Council on Bioethics, 2011; Pimentel & Patzek, 2005; Runge & Senauer, 2007). Bringezu et al. (2009) suggest that the challenges for the global biofuel industry started with land-use change debates and what they view as imprecise life-cycle assessments performed to that point in time. In spite of these criticisms, governments in many countries have implemented both biofuel mandates and policies supporting the development of biofuels. Currently, the United States, Brazil, and the European Union (EU) are the leading biofuel producers (Bringezu et al., 2009; Laan, Litman, & Steenblik, 2009). In the United States, biofuel production consists mainly of ethanol from corn, in Brazil of ethanol from sugar cane, and in the EU of biodiesel from rapeseed oil. Biofuel has been defined as "liquid renewable fuels such as ethanol (an alcohol fermented from plant materials) and biodiesel (a fuel made from vegetable oils or animal fats)" (Laan et al., 2009, p. 1).

In Canada, provincial governments have the right to regulate and manage natural resource development and the environment. However, given the variety of technology options available for biofuel production, both provincial and federal governments play a role in the development and regulation of the biofuel industry. Canada currently has federal biofuel mandates in place, while several provinces have their own mandates, often exceeding the federal mandates. Over the past decade, governments at both levels have invested in biofuel development. Much of this investment has been targeted at ethanol produced from either corn or wheat (Dessureault, 2011). As biofuel mandates come into effect at the federal and provincial level, the domestic gap between supply and demand widens. Imports are a possible short-term strategy to this deficit, but as it is shown below, this option is not as feasible as it might seem.

In essence, what is needed in the long-term to meet existing biofuel mandates is an increase in domestic biofuel production. The objective of this research is to identify the principal economic and regulatory barriers that exist for the domestic biofuel industry regarding first- and second-generation biofuels. The following section provides the background to the development and use of expert Delphi surveys, followed by the methodology for the survey. Then, we present the survey results and analysis, a discussion of the policy implications of the survey findings, and some concluding comments.

Background

The Canadian biofuel industry expanded following the turn of the century, largely due to federal policies targeting solutions for climate change, energy supply diversification, and rural development (Canadian Renewable Fuels Association [CRFA], 2010). Federal renewable

Table 1. Provincial and federal biofuel blend mandates in Canada.

Province	Ethanol	Date of adoption	Biodiesel	Date of adoption
Ontario	5%	January 1, 2007	n/a	n/a
Saskatchewan	7.5%	January 15, 2007	2%	July 1, 2012
Manitoba	8.5%	January 1, 2008	2%	November 1, 2009
British Columbia	5%	January 1, 2010	5%	January 1, 2012
Alberta	5%	April 2011	2%	April, 2011
Quebec	5%	2012*	n/a	n/a
Federal	5%	December 15, 2010	2%	July 1, 2011

** This is not a mandate, it is a target planned to be implemented with second-generation ethanol.*
Sources: CRFA (2010) and Biofleet (2011)

fuels initiatives such as policy redesign, excise tax exemptions, and research grants were implemented to facilitate this growth. Currently, Canadian government renewable fuels strategy has four components (Government of Canada, 2012a). The first, 'increasing the retail availability of renewable fuels through regulations,' is led by Environment Canada and refers to the 5% ethanol and 2% biodiesel mandates implemented in December 2010 and June 2011, respectively. The second, 'supporting the expansion of Canadian production of renewable fuels' (named ecoENERGY for Biofuels), is comprised of investment initiatives (C$1.5 billion) to boost biofuel production, as well as eliminate excise tax exemptions for biofuels. The third, 'assisting farmers to seize new opportunities' (known as ecoAgriculture Biofuels Capital Initiatives [ecoABC]), involves making capital available (C$200 million in repayable capital) to farmers for building or expanding production facilities and for developing business proposals and feasibility studies. The final part of the strategy, 'accelerating the commercialization of new technologies' (NextGen Biofuels Fund), addresses the investment (C$500 million) available for producing next-generation renewable fuels. The ecoENERGY for Biofuels program is considered a key aspect of this strategy, as it was designed to invest C$1.5 billion over nine years (2008-2017) to support the production of renewable fuels and development of a competitive domestic industry (Government of Canada, 2012b).

The C$2.2 billion in funding is part of the Canadian Renewable Fuels Strategy. This strategy is designed to reduce GHG emissions, create jobs, promote second and third generations of biofuel development, diversify Canada's current energy supply, and provide new opportunities in rural Canada and for farmers.

Provincial governments have supported biofuel development through reductions in provincial fuel taxes for gasoline containing ethanol (Manitoba), exemptions from excise taxes (Ontario), grants for ethanol blend distributors (Saskatchewan), refundable tax credits for ethanol production (Quebec), capital assistance for ethanol production facilities, operating grants, and numerous other forms of support. British Columbia does not have any biofuel plants, although it does have two biodiesel plants. British Columbia has a carbon tax that is subjected to all ethanol and biodiesel production. All ethanol mandates are less than five years old, and most biodiesel mandates came into effect in 2011 or 2012 (Table 1). Canadian subsidization for biodiesel has lagged ethanol, so the biodiesel industry has taken longer to develop and it is smaller than the ethanol industry (Laan et al., 2009).

The CRFA annual report (2010) highlights the challenges of building a biofuels industry from scratch, in the absence of, or certainly very limited, market demand. Canadian biofuel subsidies have been provided through a mix of policy regulations and measures such as direct payments, tax exemptions, interest-free loans, grants, and consumption mandates (Table 2). Although information is scarce on subsidized production, sales, and payments that the Canadian biofuel industry has received, Laan et al. (2009) performed a comprehensive analysis of the subsidization process and range of payments.

Compared to investment and support in the United States and Brazil, biofuel subsidies in Canada are more recent and modest. Relatively low subsidies were targeted at ethanol research in the mid-1980s, followed by excise tax exemptions and investment incentives in the 1990s (Laan et al., 2009). A major federal policy strategy, the Ethanol Expansion Program was launched in 2003, offering loans for construction of new ethanol plants. From 2006-2008, biofuel support was directed to virtually all stages of the supply chain, averaging C$300 million per year (Laan et al., 2009).

Table 2. Examples of government biofuel support 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 exemption, 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

Source: Laan et al. (2009)

Canada currently has 15 ethanol plants and 13 biodiesel plants operating. At the end of 2011, seven ethanol plants and nine biodiesel plants were planned to be built or were under construction. The CRFA (2010) identified Canadian ethanol production at 1.7 billion liters per year, with biodiesel production of 300 million liters per year. Based on previous production data, Dessureault (2009) projected that in 2010, 75% of Canadian ethanol was derived from corn, 23% from wheat and 2% from other feedstock. Most biodiesel is produced from animal fats and cooking oils with only a small fraction from canola oil (CRFA, 2010). The main ethanol feedstocks are corn in Ontario, wheat in Western Canada, and wood pellets or waste (for cellulosic ethanol) in Quebec and British Columbia. The 2010 Canadian biofuel production represents 2% of global production and is equivalent to 4% of US production (CRFA, 2010).

The CRFA estimates that once the current federal and provincial ethanol and biodiesel mandates are fully implemented, domestic demand will increase to 2 billion liters of ethanol and 500 million liters of biodiesel per year. Hence, the short-term solution to satisfy this demand is to import 300 million liters of ethanol and 200 million liters of biodiesel. This illustrates that Canada has a small supply gap to address before it can satisfy its domestic demand. The additional plants under construction should narrow this gap considerably.

Due to the difference in biofuel and feedstock prices with the United States, Canada has been importing both. Canada has a renewable fuel tariff on imported ethanol of C$0.05 per liter, however, the tariff does not apply to the United States because of the North American Free Trade Agreement (NAFTA). Unfortunately, the Canadian government does not document detailed trade of biofuel (or feedstocks) imports and exports (Bradley, 2009; Dessureault, 2009; Laan et al., 2009). However, the CRFA (2010, p. 31) acknowledges that Canada imports corn as feedstock for eastern Ontario and Quebec ethanol plants, thus "imported feedstock represents a loss to the Canadian economy." Ethanol plants located in Western Canada will also import American corn when corn prices are lower than Canadian feed wheat (Christensen, Smyth, Boaitey, & Brown, 2012). Most Canadian ethanol plants have been set up to run on feed wheat rather than corn due to greater supply, which is why domestic corn is not a common feedstock for ethanol production. There may be some American corn imported to be used as feedstock; the decision to do so would be based on the price of American corn compared to Canadian feed wheat. As Christensen et al. observe, biofuel subsidies are used to import American corn with no benefits flowing to Canadian producers. There are differing estimates as to the amount of corn that Canada imported from the United States in 2009, ranging from 2.3 million tons (Dessureault, 2009) to 2.9 million tons (Bradley, 2009). The authors do not indicate the percentage of imported corn that is used for the production of ethanol in Canada.

Table 3. Canadian import sources of denatured ethanol (thousand liters).

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

Source: Laan et al. (2009)

There is Canadian information available on denatured ethanol imports. Denatured ethanol category includes other types of ethanol that are used by various industries. Laan et al. (2009) identified that the United States is the main supplier of denatured ethanol, followed by Brazil with much lower quantities (Table 3).

The federal and provincial governments have initiated research and development (R&D) investments for second-generation biofuels (Table 4). The federal Next-Gen Biofuels Fund promotes the development of new

Table 4. Canadian federal government support for second-generation biofuel R&D.

Year	Total amount invested (million)	Program/initiative
Mid-1980s to mid-1990s	$18	National Research Council (NRC), Natural Resources Canada (NRCan), and Agriculture and Agri-Food Canada (AAFC) supported research by Iogen Corporation to develop cellulosic ethanol production technologies.
1999	$18	The federal government provided partial funding for Iogen's $40 million commercial-scale demonstration plant through loans repayable from future profits.
2002	$2.7	Federal government awarded to Iogen a cost-shared research contract.
2004	$550	SD Tech Fund managed by Sustainable Development Technology Canada provided $19 million between 2004-2008 for second generation ethanol.
2009	$145	Agricultural Bioproducts Innovation Program (ABIP) was a multi-year grant program to support new and existing research networks in the areas of bioproducts, bioprocesses, in addition to biofuels and other forms of bioenergy. ABIP funded the Cellulosic Biofuels Network (CBN) with $19.9M in 2009 to develop a network to provide expertise, technology, and processes associated with cellulosic ethanol production.

Source: Laan et al. (2009)

Table 5. Private support for second-generation biofuels.

Province	Program/initiative
Alberta	1. Bioenergy Producer Credit Program ($75 million) for second-generation ethanol obtained from forestry, agricultural, and municipal waste. 2. Greenfield Ethanol and Enerkem plan to operate a $70 million plant with 36 million liters of cellulosic ethanol production.
Atlantic Canada	Pulp and forest companies explore cellulosic ethanol production, biomass availability, and bioenergy technologies.
British Columbia	1. Incentive programs that encourage the use of wood biomass for producing cellulosic ethanol. 2. Lignol Energy Corp. pilot project plant on cellulosic ethanol in Burnaby.
Ontario	Ottawa ethanol plant undergoing R&D on cellulosic ethanol production from waste.
Saskatchewan	Shell and Iogen Energy collaborated on opening a full-scale commercial cellulosic plant. In 2012, both companies halted these activities.

Source: CRFA (2010) and Dessureault (2009)

technologies with an endowed budget of approximately $500 million (Sustainable Development Technology Canada [SDTC], 2011). This fund assists firms by lowering the risks associated with innovation and scale-up. By comparison, the US government provides more than US$1 billion through its 2008 Energy Act, while the EU surpasses this with US$2.5 billion within the Seventh Research Framework Programme of the European Commission (Eisentraut, 2010). However, in North America, due to technological and logistical challenges, the commercial production of second-generation biofuels is not yet economically viable and is limited to pilot projects (Bailey, 2008; Dessureault, 2009; Eisentraut, 2010; Organization for Economic Cooperation and Development [OECD], Food and Agriculture Organization of the United Nations [FAO], 2011; United Nations Conference on Trade and Development [UNCTAD], 2009).

In a similar context, but on a lower investment scale, several Canadian provinces have invested in the development of second-generation biofuels (Table 5). For example, the Quebec government is financially supporting cellulose ethanol production from forest and household waste and has stated that the provincial target will start in 2012 with 5% second-generation ethanol. However, many of the initiatives being undertaken are by private firms.

Government investment in biofuel development has occurred for well over a decade and yet, the growth of the biofuel industry does not seem to match the investment efforts, as compared to other countries. In an effort to delve deeper into the reasons for this, we conducted an expert Delphi survey of biofuel researchers and industry managers. The following section provides the details regarding the development of the Delphi survey and the details of our utilization of this methodology.

Methodology

The Delphi survey method is an adaptable research technique employed as an iterative and interactive process that collects opinions on specific issues or phenomena from an anonymous group of experts (Skulmoski, Hartman, & Krahn, 2007). The method allows for the gathering of information and structuring group communication processes with a large number of experts when there is limited information on specific issues (Rowe & Wright, 1999). The method has been used for understanding problems, opportunities, solutions, and as a forecasting tool (Rowe & Wright, 1999; Skulmoski et al., 2007).

Although this method has proven its reliability in numerous studies, drawbacks, and disadvantages have been pointed out in the literature. Some of the criticisms refer to the anonymity feature, which may lead to lack of accountability (Sackman, 1975). Powell (2003) and Hanafin and Brooks (2005) highlight that employing a consensus approach can lead to diminishing the best opinion occurrence. As the Delphi technique employs sending consecutive rounds of surveys, other comments refer to the time-consuming, labor-intensive, and expensive characteristics of this approach (Fitzsimmons & Fitzsimmons, 2001; Hanafin & Brooks, 2005). Rowe and Wright (1999) question the validity of Delphi results used for forecasting future behavior and suggest that a thorough exploration of the role of feedback and the panelists' interaction can contribute to a better understanding of the technique and interpretation of the results. These criticisms increased our awareness of possible inaccuracies of the research tool and they have been systematically considered during the research development to ensure the reliability of the results. Specifically, we strove to develop a survey that would not require lengthy time periods to complete and we utilized an online survey service to make completion of the survey as user friendly as possible.

The Delphi method has been extensively used to answer research inquiries in various topics—health care, information technology, business, education, engineering, and transportation (Okoli & Paswlowski, 2004). Related to the topics of agriculture, environment, and bioenergy, recent applications of the Delphi method (employed singularly or in combination with other research techniques) can be found in an FAO (Hishamunda, Poulain, & Ridler, 2009) study on aquaculture and environment, renewable energy forecast in Turkey (Celiktas & Kocar, 2010), forest energy business (Patari, 2010), non-conventional energy sources in India (Suganthi & Jagadeesan, 2007), agro-based bioenergy use in Finland (Rikkonen & Tapio, 2008), and numerous others.

The expert Delphi methodology employed in our research comprised of two survey rounds, administered over a time range of six months, from June to December 2010. The University of Saskatchewan Research Ethics Board approved the survey design (BEH #10-54). The survey was conducted using the online survey tool Survey Monkey. Each round of the survey was accessible for four weeks and respondents were sent weekly reminders containing an individualized link to the electronic format of the survey.

The expert group of targeted respondents for this survey consisted of an equal number of participants who were either research scientists within Canadian academia or biofuel industry managers. The reason for choosing the two groups of respondents was to identify any information gaps and contrasting opinions between the public and private sectors of the biofuel industry. Additionally, it was to determine whether there are any disconnects between public-sector researcher and industry. To ensure impartial results, the survey was not sent out to respondents employed by the Canadian government. The contact information database was built by searching Canadian universities, biofuel research networks, and biofuel company websites. In some instances, the surveys sent to industry managers were actually completed by industry research managers, which accounts for the category of private research.

The survey was initially sent out to 88 researchers and 91 managers. The response rate to the first round of the survey was 22 researchers (24.7%) and 15 (16.5%) managers, for a total response rate of 37 persons (20.4%). The demographics of both survey rounds are presented in Table 6. The first round of the survey comprised mainly open-ended questions that sought respondents' opinions on Canadian biofuel industry policy and economic and ethical issues. The survey was comprised of 23 questions and the approximate time to complete the survey was 30 minutes.

The objective of the first round was to collect respondents' views on the current Canadian biofuel policy framework, while the aim of the second round was to rank the first round responses. Prior to the launch of the second round, for each question, participant answers were carefully analyzed and in some instances, grouped into a single response according to similarities. The reason for grouping the answers was, first, to identify the level of consensus among experts and second, to send participants a reasonable number of answers to classify

Table 6. Respondent demographics, Rounds 1 and 2.

	Gender (F-M)	Age range (36-55)	Work	Education
		Managers		
Round 1	6.7%-93.3%	86.7%	Private industry: 60% Public industry: 26.7% Private research: 13.3%	MSc: 46.7% PhD: 20%
Round 2	0-100%	66.6%	Private industry: 77.7% Public industry: 22.2%	MSc: 55.5% PhD: 11.1%
		Researchers		
Round 1	18.2%-81.8%	77.3%	Public research: 100%	PhD: 90.9%
Round 2	8.7%-91.3%	86.6%	Public research: 80% Private research: 20%	MSc: 13.3% PhD: 86.6%

Table 7. Policies that would encourage or facilitate development of Canadian biofuels.

Policy options	Most important	2nd important	3rd important	Top 3 total
Coordinate a long-term federal-provincial biofuels strategy	21.7%	30.4%	30.4%	82.5%
Federal mandates targeted at increasing the blending percentages for ethanol and biodiesel	26.1%	21.7%	0%	47.8%
Limit the support for first-generation biofuels to encourage second-generation biofuels development	13.0%	17.4%	4.3%	36.6%

in the second round of the survey. The second round of the survey was only sent out to the 37 participants that submitted a response to the first survey. The response rate was 65% (24 completed surveys).

In the second round, respondents had the opportunity to find their own and their peers' summarized responses. For each question, the number of responses requiring categorization ranged from 6 to 16. This array of responses can be explained through experts' consensus or disagreement and the number of responses obtained for each question. The difference in the percentage value in the second round of the survey is motivated by the blend of public and private funding, thus, a few researchers switched their research alignment in the second round of the survey. The following section discusses the top three to five responses for each question.

Results and Analysis

The first round of the survey asked 23 questions pertaining to biofuel R&D in Canada. In this section we report the results for the 10 most informative questions concerning economic and regulatory barriers and/or opportunities. Even though participants were asked to rank responses that ranged from 6 to 16 options, for conciseness we present the first three to five responses and their ranking as first, second, or third most important. We also present the cumulative scores. In some instances, the second or third choice might be the highest in terms of total responses, but response choices are ranked according to the sum of the top three choices.

The first question asked respondents to rank policies that would encourage the development of the Canadian biofuels industry (Table 7). More than 80% of respondents consider the development of a long-term federal-provincial biofuel strategy as the most important issue currently facing the industry. The consistency across the ranking of the top three options shows that this is a crucial long-term issue for the Canadian biofuel sector. Nearly 50% of respondents considered the most important policy to be the federal mandates targeted at increasing the blending percentages for biofuels. The explanation for this response is that the survey took place before the implementation of the federal ethanol mandates, when the provincial mandates were the only mandates in place. It is interesting to observe that in terms of first-place ranking, this option received this highest number of votes. The third-ranked policy advocates for limiting the support for the first-generation biofuels for encouraging the development of second-generation biofuels.

While the federal renewable fuels strategy had only been operational for two years at the time of the survey—based on the leading response—survey respondents were either unaware of the strategy or they perceive a need for greater strategic collaboration between the federal and provincial governments. It is unlikely, but not improbable, that some of the respon-

Table 8. Policy barriers facing Canadian biofuels.

Policy options	Most important	2nd important	3rd important	Top 3 total
Lack of long-term policy planning for the Canadian biofuel industry	13.6%	27.3%	27.3%	68.2%
Inferior incentives for the development of the Canadian biofuel industry compared to US and Europe	4.3%	21.7%	26.1%	52.1%
Biofuels are only profitable with subsidies	30.0%	5%	15.0%	50%
Biofuels have to 'prove' that they are sustainable and are compared to fossil fuels, which face no such criteria	9.1%	22.7%	13.6%	45.4%

Table 9. Advantages of biofuel subsidies.

Policy options	Most important	2nd important	3rd important	Top 3 total
Encourage the establishment and development of a new industry in Canada	33.3%	9.5%	9.5%	52.3%
Reduce reliance on fossil fuels	28.6%	9.5%	14.3%	52.3%
Support a renewable energy source	19.0%	23.8%	4.8%	47.6%
Support the production of new forms of clean energy with minimum environmental impact	9.5%	19.0%	19.0%	47.5%
Encourage rural development in Canada	15.8%	15.8%	15.8%	47.4%

Table 10. Disadvantages of biofuel subsidies.

Policy options	Most important	2nd important	3rd important	Top 3 total
Subsidies develop non-viable industry and distribution structures.	11.1%	11.1%	33.3%	55.5%
Subsidies are not sufficient enough to support developing innovative technologies.	9.5%	38.1%	4.8%	52.4%
The duration of subsidies is shorter than needed.	25.0%	10.0%	15.0%	50%

dents would not be aware of the strategy. The biofuels sector of the economy, like any sector, is clearly frustrated by having to face different mandates at different levels of government.

Respondents were next asked to rank the major policy barriers identified in Round 1 (Table 8). Responses to this question reaffirm the response to the first question, as it highlights that the lack of long-term policy planning for the Canadian biofuel industry is the most important policy barrier facing the Canadian biofuel industry (68%). Slightly more than half of respondents considered that the Canadian biofuel industry has received inferior development incentives compared to the United States and EU. The third policy barrier—subsidies and profitability of the biofuels sector—provides a very interesting response. The combined responses result in this option as being the third most important, yet in terms of first-place rankings, this one is by far the most important. In fourth place, with a total ranking of 45%, is the sustainability comparison between biofuels and fossil fuels.

Clearly, there is considerable consternation in the biofuels industry that profitability is directly connected to subsidization. This is also reinforced in Table 10. Subsidies have long been used as a means of supporting industries in their infancy. When the industry matures and the subsidies are either removed or considerably scaled back, there is often a 'correction' in the industry, whereby some firms cease to be economically viable and exit the market. The dissatisfaction with the development incentives for biofuels creates some uncertainty as to whether this is a cumulative or scale concern. It may be directed to the cumulative side of the discussion; for example, Canada is investing $500 million in the NextGen Biofuels fund, while the United States is investing US$1 billion.

To better understand the biofuel industry's perspective on subsides, respondents were asked about the advantages (Table 9) and disadvantages (Table 10) of their use. In Table 9, the top two responses are ranked with equal importance. Respondents equally concluded (52%) that subsidies encourage the establishment and development of a new domestic industry and that they

Table 11. Impacts of importing feedstocks and biofuels on Canadian biofuel development.

Policy options for feedstock importing	Most important	2nd important	3rd important	Top 3 total
Does not support Canadian producers	23.8%	33.3%	14.3%	71.4%
Indicates that the Canadian biofuel industry is not competitive	21.1%	15.8%	26.3%	63.2%
Is an alternative for producing biofuels in Canada	25.0%	15.0%	15.0%	55%
Policy options for biofuels importing	**Most important**	**2nd important**	**3rd important**	**Top 3 total**
Canadian biofuel industry is still developing new technologies.	11.1%	38.9%	22.2%	72.2%
Subsidized biofuels in exporting countries makes imported biofuels cheaper.	21.1%	26.3%	21.1%	68.5%
Importing biofuels is expected given the Canadian cost structure for producing biofuels.	5.9%	23.5%	23.5%	52.9%

help reduce reliance on fossil fuels. However, the former is ranked first as more respondents ranked it as the leading advantage. Table 9 presents the top-five ranked responses as the last three were very closely ranked. The responses indicated that subsidies are seen as a way of supporting a renewable energy source, but of equal importance is that they support producing clean energy and encourage rural development in Canada.

These responses align nearly perfectly to the federal government's renewable fuel strategy, with energy diversification, new jobs, and rural development all matching. With the five responses so closely grouped, it is possible to detect a theme where biofuel subsidies are seen as a way of promoting economic development in rural parts of Canada. Subsidies are seen as beneficial in that they begin to move Canadian energy consumers away from fossil fuels, towards new, environmentally-friendly energy options, created by firms that are located in the rural parts of Canada.

With respect to the economic disadvantages of subsidies, Table 10 shows a closely ranked consensus regarding the top three responses. The leading disadvantage of biofuel subsidies is that subsidies lead to the development of non-viable biofuel industries. In second place, marginally below the first, is that developing innovative technologies in the biofuel industry is not an issue that can be solved through the use of subsidies. The majority of respondents to this question ranked this as their second most important. Finally, half of the respondents agree that government initiatives take place over a shorter period of time than is needed for real benefits to take effect. This response received the greatest number of first-place rankings but ends up being ranked third due to the lower second- and third-place rankings. Due to the very close percentage proximity, all three of these options can be viewed as being of virtually equal importance.

While the leading response indicates that the biofuel industry should be concerned about receiving subsidies and their ability to allow the sustained operation of uneconomical business, the second and third responses indicate the other side of the coin, so to speak, of subsidy use. The insufficient subsidy support and duration are indicative of increasing the fiscal supports used to develop the industry and to ensure that the programs developed for the fiscal supports are extended further into the future. In essence, these two reasons can be viewed as means of supporting the use of subsidies.

The next two questions explore participant views on the importing of feedstocks and biofuels in Canada (Table 11). As discussed above, Canada will need to import about 300 million liters of ethanol and approximately 200 million liters of biodiesel on an annual basis to meet existing mandate requirements. As well, some 2.5-3.0 million tonnes of feedstock (predominantly corn) are imported into Canada each year, largely from the United States. Regarding feedstock imports, most respondents (71%) agreed that importing feedstock is detrimental to domestic producers. The second- and third-ranking options highlight that feedstock imports indicates that the Canadian biofuel industry is not yet competitive; still, given the current state of the Canadian industry, imported feedstock can be an alternative for biofuel production. Meanwhile, a majority of respondents agreed that importing the final product is expected since Canadian biofuel-producing technologies are currently under development. Second, survey participants believe that the rationale for importing biofuels in Canada is the stronger subsidization that biofuels receive in exporting countries, thus making biofuels cheaper than domestic production. Third, Canadian biofuel production has not reached a competitive scale.

In the instances where American corn is being imported for feedstock use in Canadian biofuel plants,

Table 12. Policies that support second-generation biofuel research and/or development.

Policy options	Most important	2nd important	3rd important	Top 3 total
Coherent and long-term federal Canadian policy	65.0%	20.0%	5.0%	90%
Greater financial support for developing enabling technologies	25.0%	45.0%	15.0%	85%
Increase funding available from NRC-IRAP	4.8%	23.8%	33.3%	61.9%

Table 13. Challenges for the development of second-generation biofuels.

Policy options	Most important	2nd important	3rd important	Top 3 total
Technological processes are not yet fully developed	45.0%	30.0%	5.0%	80%
Canadian regulatory incoherence on second-generation biofuels development	11.1%	22.2%	27.8%	61.1%
Insufficient government funding for second-generation biofuels development	15.8%	31.6%	10.5%	57.9%

the farmer benefits of subsidies for biofuel production in these cases are flowing to the American corn farmers and not Canadian corn farmers. The reality of the market is that firms will buy inputs based on price and quality and if the quality of Canadian- and American-produced corn is roughly equivalent, then purchase decisions will be based on price. Subsidizing Canadian ethanol plants to import American corn does not match up well with the federal government's renewable fuel strategy. This indicates that Canadian feedstock producers might be less competitive than their American counterparts; some of this is simply due to geography. For example, miscanthus yields in the southern United States are in excess of 20 tons per acre, while yields of one ton per acre for most feedstock options in Canada would be normal. Importing of biofuels on the other hand is perceived by respondents as a routine part of standard business practices.

The next two questions sought to identify policies that would facilitate (Table 12) or restrict (Table 13) the development of second-generation biofuels. The response is nearly unanimous (90%) that a long-term federal policy is crucial. The second and third rankings show that greater financial support for research and development is required to develop the enabling technologies and thus commercially produce second-generation biofuels. In the first round of the survey numerous participants indicated that the support offered by the National Research Council Canada's (NRC) Industrial Research Assistance Program (IRAP) is effective. The government funded NRC-IRAP provides technology assistance to small- and medium-sized enterprises at all stages of the innovation process to build their innovation capacity. NRC-IRAP helps enterprises understand the technology issues and opportunities and provides linkages to the best expertise in Canada (NRC, 2010). The consistency of their answers was shown in the second round of the survey, when respondents ranked this support as the third most important initiative. These responses correlate with those provided above about the disadvantages of subsidies, when it was shown that support programs need to provide greater levels of support and for longer time frames.

The challenges identified for the development of second-generation biofuels clearly points out, with very high percentages, that the most important barrier is the current underdevelopment of the technological processes (Table 13). Virtually identical second (61%) and third (58%) rankings reflect the regulatory incoherence of the federal policy and the insufficient funding provided so far for the development of second-generation biofuels.

Iogen recently withdrew from further business pursuit of cellulosic biofuel production in Western Canada (Iogen, 2012). While the economic and regulatory barriers are important for the support of second-generation biofuel development, it cannot be overlooked that technological advances need to be realized as well. Furthering the technological advancement of second-generation biofuels will require additional fiscal resources and time.

To be able to compare existing feedstock imports with desired feedstock options, participants were requested to rank the feedstock options that have the greatest economic potential (Table 14). It is interesting to observe that wood waste is seen as the most important feedstock, although currently in Canada there is only one demonstration plant with a 5-million-liter capacity (located in Quebec). While wood waste is clearly the preferred feedstock, post-harvest residues, cellulosic crops, and municipal waste are ranked closely behind.

Table 14. Biofuel feedstock options with the greatest economic potential.

Policy options	Most important	2nd important	3rd important	Top 3 total
Wood waste	25.0%	35.0%	20.0%	80%
Post-harvest residues	25.0%	15.0%	10.0%	50%
Municipal waste	20.0%	10.0%	15.0%	45%
Cellulosic crops (switchgrass, other perennials)	15.0%	15.0%	15.0%	45%

Table 15. Ethical issues for biofuel development in Canada.

Policy options	Most important	2nd important	3rd important	Top 3 total
Biofuel industry should clearly appear as part of a sustainable development vision.	43.5%	26.1%	17.4%	87%
A thorough life-cycle assessment of biofuels would clarify whether ethical issues exist.	19.0%	19.0%	14.3%	52.3%
Food versus fuel is an artificially created debate.	20.0%	15.0%	10.0%	45%

The use of food crops is not identified as a preferable source of feedstocks.

Finally, respondents were asked to rank the ethical issues existing in the Canadian biofuel industry (Table 15). The most important ethical issue is that the Canadian biofuel industry should play a key part in sustainable development. The second and third responses are once again closely grouped, indicating that a comprehensive life-cycle assessment is crucial for clarifying the existence of ethical issues and that the food-versus-fuel debate is an artificially created ethical issue.

The following section discusses some of the policy implications for Canada regarding the barriers that have been identified from the expert Delphi survey.

Policy Implications

Canada needs to annually import an expected 300 million liters of ethanol and 200 million liters of biodiesel in the short-term to address the supply gaps that will exist with the various blend mandates coming into force. The ethanol and biodiesel plants that are under construction or planned should address this gap, as the average ethanol plant production is about 100 million liters per year, with average biodiesel production of 25 million liters. As noted above, seven new ethanol plants and nine biodiesel plants are being built or are planned. However, Iogen has announced that it is no longer planning to proceed with one of these ethanol plants. Some critical policy issues have been highlighted in the survey responses.

Clearly, the lack of a long-term national biofuel strategy is a concern. While the federal government's renewable energy plan was in place prior to the launch of the survey, it would appear to not live up to the expectations of the industry. Table 7 establishes this as the primary policy issue and it is reinforced in Tables 8 and 12. The variation in blend mandates between federal and provincial jurisdictions may be part of this, but the sentiment that a long-term strategy is lacking, goes far beyond aligning provincial blend mandates.

It is quite possible that the biofuel industry sees the lack of a co-ordinated national renewable energy strategy as a less-than-firm commitment to biofuels on behalf of federal and provincial governments, which in turn signals industry to hold off on further infrastructure investments. The federal renewable fuel strategy provides funding and support until 2017. Drawing on the responses indicating that two of the biggest problems with subsidies are that they are not big enough nor long enough, the biofuel industry is expressing a desire to have governments share in the capital costs of constructing new biofuel plants. It may be that the industry feels there is just enough market uncertainty to raise the risk of investing in new biofuel plants to the point of deciding to forego further expansions. Given the previous levels of support, it might be that the biofuel industry will continue to forego these investment decisions until such time as a firmer commitment is evident from governments, especially in the form of continuation of tax breaks, grants, and other exemptions.

Subsidies and their role and use raise two interesting policy implications. First, in the move towards increased use of second-generation biofuels, there are no economic or policy barriers holding the technology back; what is holding it back is simply that the technology itself has not advanced to the point of large-scale commercial application. Cellulosic biofuel technology is not at the point of being commercialized for large-scale biofuel production. The policy implication that does play a role here is to what extent governments should be prepared to further the development of the technology. It could possibly take another decade of sus-

tained funding to advance cellulosic technology to the point of commercial viability. Second-generation biofuels are seen by most involved in the debate about biofuels as the preferred method of production, yet the cost of getting there will be substantial. Support for both more R&D on cellulosic biofuels as well as scale-up of the technology will likely be required to bring this technology into the mainstream.

A second policy implication from the use of subsidies in the production of biofuels to date is that some of the firms receiving production subsidies from Canadian governments are using American corn to produce their biofuel. Hence, Canadian tax dollars are being used to support American corn growers. This is one of the policy challenges of the use of subsidies. The challenge is that not all of the benefits of the subsidies will remain in Canada. This is a symptom of the free market and the fact that American corn is imported is no different than a grant to offset construction costs being used to import equipment from another country when identical, but more costly, equipment exists in Canada.

A final important policy issue that requires consideration is the sustainability aspect of producing biofuels. Eighty-seven percent of survey respondents identified this as an important issue for the biofuel industry. Many of the critics of ethanol production claim that it is not a sustainable technology and, while that has not been to focus of this paper, it is clear that the biofuel industry sees sustainability as a factor of increased importance. In terms of policy support, the support for increased sustainable production of biofuels identified in Table 15 received the second-highest level of support in our survey. This, however, is less of a policy issue that can be dealt with by government and is a responsibility of industry to develop operating standards or production guidelines that support more sustainable production methods.

Conclusions

Based on the data provided by experts in the Canadian biofuel sector, the top three barriers to the development of the Canadian biofuel industry can be summed as the following. First, a long-term, co-ordinated and integrated federal-provincial policy framework for the production and use of biofuels is vitally important. The lack of a clear national policy for biofuel development will create uncertainty for firms and could have a negative impact on industry investment. Second, the lack of technological development for second-generation biofuels will dramatically limit the potential scale and scope of the industry. With the sustainability and the economic benefits of ethanol production being seriously questioned, the future of biofuels lies in its ability to successfully transition to second-generation technologies. Substantial investment programs need to be targeted to meeting this need. Third, an integrated biofuel industry vision within sustainable development policies is needed. Sustainability is crucial for biofuels and this is reflected above and in the literature on biofuels. In essence, the third observation clearly identifies and inter-connects the idea that a long-term policy plan that includes funding for basic R&D is what is required for the development of the Canadian biofuels industry.

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