NOVEMBER 2010

Growing Beyond Oil
Delivering Our Energy Future

A REPORT CARD ON THE CANADIAN RENEWABLE FUELS INDUSTRY

Canadian Renewable Fuels Association
Association Canadienne Des Carburants Renouvelables

www.greenfuels.org

A MESSAGE FROM GORDON QUAIATTINI
PRESIDENT, CANADIAN RENEWABLE FUELS ASSOCIATION

Since 1984, the Canadian Renewable Fuels Association (CRFA) has overseen dynamic growth in the domestic biofuels sector. Ours is a story of a uniquely successful partnership between industry and government. Of jobs and growth. Of technological innovation and leadership. Of opportunity for agriculture and rural communities. And of environmental gains in the form of rapidly decreasing greenhouse gas (GHG) emissions. We are truly delivering on our energy future.

Above all else, the story of Canada's biofuels sector – of ethanol, biodiesel and advanced biofuels including cellulosic and other new technologies – is one of keeping our commitments and delivering on our word. With generating capacity of almost two billion litres per year, Canada is on its way to Growing Beyond Oil.

With a total investment of some $2.3 billion and bio-refineries that are among the world's most energy and cost-efficient, our industry has created the foundation for substantial future growth as we compete to increase our share of the world's renewable fuels marketplace.

This Report Card offers an accounting of progress to date and proposals for the future. It begins by cataloguing a list of benefits that is impressive, extensive and detailed including:

- *An employee base that is knowledgeable and innovative.*
- *A critical base of production capacity to supply the majority of domestic demand.*
- *A logistics infrastructure for procurement of feedstock and delivery of biofuels and related co-products to the domestic market.*
- *A new R&D capacity focused on both process improvements within first generation biofuels plants and, significantly, on advanced biofuels feedstock's and new technologies.*
- *An emerging pattern of collaboration between Canadian advanced biofuels innovators, global biotechnology and crop science leaders as well as global biofuels and bio-chemical participants.*
- *An established network of relationships between biofuels producers and the financial community.*
- *A track record of profitability.*
- *A strong partnership with government both at the federal and provincial levels.*
- *An assured level of market access provided by provincial and now federal legislation.*
- *A high level of product acceptance in the marketplace, as all auto and truck manufacturers now warrant ethanol and biodiesel blends.*
- *A widespread penetration of biofuels into the national transportation fuel system, as all Canadian oil companies now blend biofuels.*

To be certain, there remains much more to be accomplished. In particular, priority must be given to timely implementation of the biodiesel mandate and supporting worthy construction of production capacity. We must concentrate on new opportunities to expand our leadership in the field of advanced biofuels where additional economic, environmental and energy gains can be achieved.

In charting the course forward, the CRFA believes partnership between industry and government must remain as the cornerstone of our efforts. Similarly, in times of such strained fiscal means, we must endeavour more than ever to place a rigorous focus on value.

From a practical standpoint, the CRFA and its members believe the way forward presents both near term and longer term challenges and opportunities that require tailored policy approaches.

In the near term, a recommended emphasis on the following goals will best ensure continued growth and public benefits:

- *Foster additional market access and production capacity for biodiesel and other renewable diesel alternatives with a firm start date of April 1, 2011 and a first compliance period ending December 31, 2012 for the 2% renewable diesel mandate, re-profiling of unallocated ecoEnergy for Biofuels funds and targeted build-out of canola oilseed biodiesel production.*
- *Extend efforts to commercialize targeted next generation biofuels technologies with a particular emphasis on the Sustainable Development Technology Canada's (SDTC) Tech Fund which has proven both effective and successful and the SDTC NextGen Biofuels Fund..*
- *Appointment of an Interdepartmental Working Group on Advanced Biofuels.*
- *Implement targeted incentives to help foster development of advanced biofuels.*
- *Formal inclusion of advanced biofuels within the federal government's Renewable Energy Agenda.*
- *Coordination of federal government biofuels research.*

In the longer term, the industry believes future policy action will be required in the following areas:

- *Further expand market access, economic opportunities and environmental benefits by enhancing existing renewable fuels standards.*
- *Incentivize expanded advanced biofuels investment and production through the use of revenue neutral targeted tax measures.*
- *Monetize the value of the industry's carbon advantage with a rational system of carbon credits.*
- *Expand opportunities for flex-fuel vehicles and higher biofuels blend levels.*
- *Maximize opportunities for cellulosic and other next generation technologies.*

In short, Canada's renewable fuels sector is a working success that merits increased effort and engagement. The dividends of past commitments have been harvested in the form of new jobs, expanded opportunities and increased economic activity. With smart, shrewd decisions we can build upon this track record and develop an even more vibrant, sustainable and world-leading industry in the years ahead.

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Introduction

Over the past 15 years, the renewable fuels industry in Canada has grown exponentially. Federal and provincial governments alike, together with renewable fuels producers, agriculture producers and others, have cooperated to build this sector. As a result, Canada is now a leader in the worldwide effort to create clean, renewable sources of transportation fuel. Just as importantly, it is now leading the way in the development and commercialization of advanced biofuels, which promise even greater benefits for our economy and our environment.

Overall, the industry has invested $2.3 billion towards the construction of new production facilities across the country, generating almost 2 billion litres per year of domestic production capacity. This is a significant amount, though still only 2% of biofuels produced worldwide and only 4% of US production. In other words, there remain tremendous opportunities for growth.

The sector is a textbook case of industry and policymakers working hand-in-glove to create the room for a new market entrant to succeed. Federal and provincial governments in Canada created the market by introducing requirements for renewable fuel content in transportation fuels. Governments also provided capital and operating grant support to help build capacity.

These government program efforts were well subscribed and, together with private investment, have seen this industry grow toward maturity and strength.

Ethanol and biodiesel are blended across the country by all major oil companies. The new plants providing these biofuels are operated by a workforce that is well-paid and generates added value. All this occurs in an environment characterized by a green entrepreneurial pioneering spirit, where innovation prevails, where engineering know-how and smart agricultural practices abound.

Overall, the industry has invested $2.3 billion towards the construction of new production facilities across the country, generating almost 2 billion litres per year of domestic production capacity. This is a significant amount, though still only 2% of biofuels produced worldwide and only 4% of US production. In other words, there remain tremendous opportunities for growth.

This foundation provides a solid base on which to build future growth. A number of world-leading companies in Canada are developing the next generation of advanced biofuels, such as the production of ethanol from municipal waste and other cellulosic biomass, and the production of biodiesel from a variety of biomass and waste feedstocks. With even greater GHG reductions and higher value-added, the next growth phase for the biofuels industry will come from the commercialization of these new technologies.

Purpose of this Report

This report provides a detailed review of the accomplishments of the Canadian renewable fuels industry to date, identifies key opportunities and challenges that lie ahead, and begins to shape a vision for the future – including short-term policy and fiscal priorities and long-term objectives. Our purpose is to lay the groundwork for an informed discussion with governments and other stakeholders; to ensure a clear account of the facts about our industry's contribution and to maintain the path towards commercialization of advanced biofuels technologies.

Why "Grow Beyond Oil"?

Energy represents one of the defining challenges of the 21st century – for governments, for business and for civil society. Many experts anticipate the global supply will tighten in the years ahead, and that energy prices will inevitably escalate. The International Energy Agency (IEA) is predicting a 40% increase in global crude demand by 2030.

There is some debate as to how hard it will be to find oil in the years to come. There is little debate about the difficulties associated with using that oil.

Combustion of fossil fuels to fulfill the world demand for energy is the most significant source of GHG emissions. The transportation sector accounts for 25-30% of all GHG emissions.

How will we meet our energy needs as oil supplies become increasingly inaccessible – or limited to places of sensitive ecology? How do we meet our energy needs while working to reduce the emissions that contribute to climate change? How do we supplement the supply of transportation fuel in a more sustainable but still economic way?

There is little doubt that we need to grow beyond oil – to pursue alternatives that are good for our economy, for our environment, and for Canadians. In speaking about the transportation sector, there is only one viable, practical and commercialized alternative: renewable fuels.

In doing its part to grow beyond oil, the CRFA is guided by the following key principles:

- **Support for Advanced Biofuels:** among developed nations there is a global race underway to establish leadership in the development and production of advanced biofuels. Those who succeed will lead the world in drawing the benefits of clean energy, new economic growth and a reduced carbon footprint. Canada is among a handful of nations that have invested in building the critical mass that will lead to success.

- **Building a Sustainable Industry:** Renewable fuels produced and consumed in Canada are generating significant GHG emission reductions, and contributing to the social and economic well being of Canadians. These are benefits that grow consistently with increased acceptance of renewable fuels. As the industry shifts toward advanced biofuels, GHG reductions are poised to reach even greater margins. The CRFA welcomes measurable standards to objectively confirm the sustainability of our industry performance. Moreover, these same standards of measurement should be applied to all transportation fuels, including oil.

- **Building a Competitive Industry:** Throughout the world the renewable fuels sector is confronted by the reality that refiners and marketers of gasoline and diesel control the distribution of motor fuels. Historically, the oil industry has received extensive public subsidies and support. This serves to intensify their existing structural advantages and discourage genuine competition. Policies should encourage the creation of an efficient and competitive Canadian biofuels industry that can compete in a North American market place.

JOE PRESTON, MP, ELGIN-MIDDLESEX-LONDON

"The Government of Canada is committed to home-grown renewable fuels production. Biofuels not only offer new markets for farmers, and a new source of clean renewable energy, but new jobs for our cities and towns. This is especially the case in my riding of Elgin-Middlesex-London that is home to a farmer owned co-op plant (IGPC Ethanol Inc.) that creates local jobs, produces clean burning ethanol from local corn, and provides much needed economic activity for the rural area."

- **Fiscal Responsibility:** Industry and government must fashion their partnership going forward in the context of changing fiscal times. Claims against the public treasury must be justified by the tangible promise of a multi-fold return. Recognizing the need for fiscal restraint, any programs or measures designed to encourage the production and use of biofuels must be able to withstand rigorous cost-benefit analysis.
- **Feedstock Neutrality:** Government programs designed to support the industry should be feedstock "neutral". Biasing one feedstock over another will inevitably lead to market distortions and thwart innovation. This will also encourage the rapid development of exciting and innovative alternatives such as municipal waste, discarded corn cobs, forest waste and so forth.
- **Investment in Technology:** Advanced Biofuels rely on technological innovation. Policies should support investments that help industry remain at the forefront of innovation in the race to commercialize next-generation technologies. This is how new jobs and economic leadership are fostered.
- **Quality and Safety:** The CRFA supports the CGSB process for establishing fuel quality standards in Canada. We also support and willingly assume the obligations of quality specifications for renewable fuels entering the Canadian marketplace.

CRFA is also guided by a set of sustainability principles, which are contained in Appendix A.

Governments Have Responded

Federal and provincial governments have supported and promoted the expansion of renewable fuels in recent years for sound and demonstrated policy reasons. Renewable fuels make solid public policy sense from an economic, environmental, and societal point of view, and Canada is well equipped to provide them. They also constitute a critical aspect of Canada's determination to be not just an energy superpower but a clean energy superpower.

Federal Renewable Fuels Strategy

The federal government has created a Renewable Fuels Strategy to support the development of renewable fuels in Canada.[1] The strategy is designed to:

- Reduce GHG emissions resulting from fuel use,
- Encourage greater production of biofuels,
- Accelerate the commercialization of new biofuels technologies, and
- Provide new market opportunities for agricultural producers and rural communities.

Regulatory tools are critical to the success of this approach. The Renewable Fuels Regulations have proven to be a crucial initiative in support of the federal commitment to reduce Canada's total GHG emissions by 17% from 2005 levels by 2020. The objective of these regulations is to reduce GHG emissions by mandating an average 5% renewable fuel content based on the gasoline volume[2] and 2% renewable fuel content in the distillate pool.

When fully implemented, the Strategy's two regulatory requirements will ensure a cumulative volume of renewable fuel that translates into the annual reduction in GHG emissions of over four megatonnes – the equivalent of taking one million vehicles off the road. The Regulations also promote an integrated and nationally consistent approach to biofuels across Canada and set the stage for development of a commercially viable industry capable of expanding into use of advanced biofuels.

The federal Renewable Fuels Strategy also includes a number of important incentive programs:

1. **Supporting the expansion of Canadian production of renewable fuels.** The ecoENERGY for Biofuels Initiative will invest up to $1.5 billion over 9 years to boost Canada's production of renewable fuels.
2. **Assisting farmers.** The ecoAGRICULTURE Biofuels Capital Initiative (ecoABC) is providing $200 million in repayable contributions of up to $25 million per project to help farmers raise the capital necessary for the construction or expansion of biofuels production facilities
3. **Accelerating the commercialization of new technologies.** A Sustainable Development Technology Canada (SDTC) initiative provides $500 million over eight years to leverage private sector investment in establishing first-of-kind commercial facilities for the production of next-generation renewable fuels.[3]

1 See Renewable Fuels Strategy at http://www.ecoaction.gc.ca/ecoenergy-ecoenergie/renewablefuels-carburantsrenouvelables-eng.cfm

2 This 5% requirement is expected to generate an incremental reduction of GHG emissions of about 1 MT CO2e per year over and above the reductions attributable to existing provincial requirements already in place. The second, upcoming, regulatory requirement, a 2% equivalent requirement for diesel, is expected to result in additional reductions in GHG emissions of approximately 1.7 MT CO2e per year over and above the reductions attributable to existing provincial requirements.

3 Next-generation renewable fuels, produced from non-food feedstocks such as wheat straw, corn stover, wood residue and switchgrass, have the potential to generate even greater environmental benefits than traditional renewable fuels. Canada is well positioned to become a world leader in the development and commercialization of next-generation fuels.

Provincial Renewable Fuels Strategies

Canada has a number of provincial renewable fuel mandates. Four provinces that collectively account for roughly 60% of all the retail sales of gasoline in Canada have ethanol mandates. These include a 7.5% mandate in Saskatchewan, 8.5% mandate in Manitoba and 5% mandates in British Columbia and Ontario. Alberta has a program that will start in 2011 and Quebec is targeting a 5% renewable fuel content in its gasoline pool for 2012. BC and Manitoba have implemented biodiesel mandates and Alberta has a program scheduled to start in 2011.

RENEWABLE FUELS STANDARDS, BY PROVINCE

Province	Gasoline (ethanol)	Distillate (biodiesel)
British Columbia	5%	3%, 5% in 2012
Alberta	5% in April 2011	2% in April 2011
Saskatchewan	7.5%	n/a
Manitoba	8.5%	2%
Ontario	5%	n/a

Provinces have also instituted a number of programs and policies to stimulate development and spur expansion of the renewable fuels sector. Encouragingly, these programs have been shown to be highly effective in generating industrial expansion, job creation and commercial benefits. More details on provincial RFS programs can be found in the Technical Annex to this paper.

ED STELMACH, PREMIER OF ALBERTA

"Alberta is an energy province," said Premier Ed Stelmach. "This project is another example of how our government is helping develop leading-edge renewable and non-renewable energy technology. I applaud the vision and dedication the partners have shown to make this pioneering project a reality." In reference to the Enerkem, Inc. waste-to-ethanol plant in Edmonton.

AUGUST 31, 2010

Canadians Support Government Action on Renewable Fuels

Expansion of renewable fuels is not only sound public policy – it is also popular amongst Canadians.

Over the past fifteen years, governments in Canada have worked to promote the development of the renewable fuels sector. This reflects the support among Canadians for government action. A recent independent survey of public attitudes[4] demonstrates the breadth of support:

- 89% of Canadians believe we should move toward a low-carbon economy with renewable fuels replacing at least some of our fossil fuels;
- 85% of Canadians see renewable fuels as a source of value-added production and new high-tech employment;
- 78% of Canadians support an ongoing renewable fuels standard that mandates some blend of renewable fuels in the gasoline sold in Canada; and
- 86% of Canadians believe we need a long term plan to boost production of renewable fuels here in Canada.

4 Independent public opinion survey by Praxicus Public Strategies conducted in November 2009

Solid Results Delivered by Our Industry

A Decade of Growth

Thanks to fifteen years of concerted partnership between government and industry, Canada enjoys a vibrant renewable fuels industry and is moving to establish an equally forceful lead in advanced biofuels.

In the last five years, $2.3 billion has been invested in the construction of new production facilities across the country representing almost 2.0 billion litres per year of domestic production capacity.

Federal and provincial governments in Canada helped to make this commercial success possible by creating some measure of competitive equity by introducing requirements for renewable fuel content in transportation fuels. With programs aimed at leveraging private sector capital, governments have also successfully created production capacity which in turn has generated jobs and a multiplying effect of economic activity. These programs were well subscribed and attracted private investment to help build Canada's biofuels industry.

Currently, ethanol and biodiesel are blended across the country by all the major oil companies. New state of the art plants have been built and a new workforce has been created and trained in only a few years. This platform has spurred innovation and investment that will create opportunities that would have been difficult to anticipate ten years ago.

Canada's first generation biofuels industry was built from scratch. There was no existing infrastructure or market demand, and proponents faced adverse public relations campaigning from interest groups opposed to change. These obstacles were overcome by capitalizing on Canada's strengths – innovation and engineering know how; world class agriculture; and a green entrepreneurial pioneering spirit within the private sector.

The challenge now is to capitalize on these strengths and leverage future success, particularly as the advanced biofuels sector becomes an increasing commercial reality.

Major Economic, Environmental and Social Benefits

The renewable fuels industry has delivered results that are measurable and substantive:

- Job creation and economic growth
- Reductions in GHG emissions
- Agriculture benefits
- Energy security/diversity benefits
- Social benefits to Canadians

Job Creation and Economic Growth

The renewable fuels industry has quickly become a valued engine of economic growth – particularly for rural Canada where new plants have attracted jobs and economic prosperity. Demand for feedstock has created new customers and higher incomes for farm families.

These benefits include the creation of new direct employment from facility construction through to operations, as well as indirect spinoff benefits including additional employment and a broadened tax base for local governments. The first independent survey

dedicated to measuring the economic impact of Canada's biofuels sector[5] was conducted in late 2009 and early 2010 by Doyletech Corporation. It canvassed twenty-eight Canadian-based biofuels facilities that are either in production or in development and found that the advancement of this new biofuels industry has generated the following economic impacts:

- **Jobs** – Over 1,000 permanent manufacturing jobs have been created to support ongoing plant operations. Over 14,000 new direct and indirect jobs were created in construction of new production facilities.
- **Direct Investment** – $2.3 billion in total capital investment.
- **Construction Benefit** – construction of biofuels facilities has created approximately $3 billion in economic activity. The biofuels sector expanded the tax base at the local, provincial and federal levels by $1.5 billion during the construction phase.
- **Economic Activity** – the net economic benefit to the Canadian economy from the renewable fuels sector is $2.0 billion per year.

In addition to these positive economic impacts, there are parallel "clean and green" results. Renewable fuels belong to the emerging class of 'green collar' jobs that society is fostering in order to build the new green knowledge-based economy of tomorrow.

The shift to investment in clean and green technology has begun. In 2008, global investments in green energy grew to $155 billion. Many Fortune 500 companies have shifted their investment strategies towards renewable energy and clean technologies. Further research surrounding renewable fuels – particularly advanced and next generation biofuels – will create new markets for graduates in advanced technologies such as biochemical and thermo chemical sciences.

Reductions in GHG Emissions

Renewable fuels significantly reduce GHGs compared to gasoline and diesel fuel. Newly created advanced biofuels offer still greater reductions. These gains will help further reduce Canada's carbon footprint in the transportation sector, which alone accounts for 25-30% of the country's overall greenhouse gas emissions.

Independent studies confirm that first generation ethanol and biodiesel enjoys a life-cycle emissions advantage over traditional fossil fuels. Without even taking into consideration the impact of provincial mandates, the federal RFS will cut carbon emissions by 4.2 megatonnes – the equivalent of removing 1 million cars from our nation's highways.

5 Total Economic Impact Assessment of Biofuels Plants in Canada, prepared by Doyletech Corporation for CRFA, May 2010. For copy of the full report, see www.greenfuels.org/uploads/documents/01_doyletech_total.pdf.

RICHARD PHILLIPS, EXECUTIVE DIRECTOR, GRAIN GROWERS OF CANADA

"It's critical to get our biofuel industries up and running. The sooner we do, the sooner we can also move forward with the second generation. As farmers it will not only be about growing crops as raw product, but the future may also involve us using less productive croplands or growing alternative crops for cellulose or other forms of energy. There is tremendous potential, but we need to get going!"

To confirm this performance, the Canadian renewable fuels sector was recently the subject of the first comprehensive in-depth study[6] that compared its environmental performance with that of fossil fuels. The conclusion: On a life-cycle analysis, ethanol reduced GHGs at a rate of 62% compared to traditional fossil fuels, while biodiesel reduced GHGs by a remarkable 99%.

The report shows unequivocally that even at low blend levels both biodiesel and ethanol have a significant impact on GHG reductions compared to gasoline and diesel fuel. In short, the environmental benefits of renewable fuels are demonstrable and indisputable.

The estimated values for GHG reductions (known as the Social Cost of Carbon, or SCC) used around the world vary significantly. CRFA estimates of the value of GHG reductions to Canadians, using a range of possible values for SCC, are consistent with rigorous and peer-reviewed literature. The results show that Canadians will gain more than $10.7 billion worth of benefits over the next 25 years from GHG reductions (based on both federal and provincial RFS requirements for ethanol and biodiesel).

Agricultural Benefits

Renewable fuels assist the agriculture sector by:

- Increasing local 'farm gate' prices and associated revenue for farmers.
- Decreasing reliance on agricultural support and 'safety net' payments from governments.
- Providing price stability for grains and oilseeds.
- Providing forward pricing opportunities to hedge against falling grain/oilseed prices or rising crop input and fuel costs.
- Creating a valuable high protein feed market from the co-products of biofuels production.

Clearly, feedstock demand from an ethanol facility increases local prices for corn or wheat. This price increase has been estimated at 10-25 cents per bushel depending on geography and seasonal variations. With a total of more than 200 million bushels of Canadian grain going into ethanol production today, this means that more than $50 million of new revenue is going to improve the farm gate incomes of local farmers. However, while ethanol has a salutary effect on the price of corn overall, it should also be understood that ethanol production makes use of industrial grade corn, not that used for human consumption.

A similar story exists for the biodiesel sector and its use of soybeans, canola or rendered animal fats. Strong local demand created by biodiesel facilities will boost the local price of those commodities, thus providing much needed new revenue for the farmers or rendering plant.

As a consequence of these financial benefits, the federal government experiences corresponding reductions in pressure on safety net payments to farmers[7]. In Canada, reductions in payments to farmers through a variety of federal and provincial safety net programs amounted to $1.2 billion in 2008.

Improved farming techniques and crop science advances are constantly boosting corn yields. For example, corn harvests reached historic highs in both 2008 and 2009. As these advances continue to grow, new markets for corn will need to be developed to prevent a collapse in pricing. In Ontario, for example, the ethanol industry currently consumes close to 1/3 of the corn produced in the province. But with the advances being made with seed genetics, it is expected that corn production will increase well beyond existing levels of demand by 2020. The ethanol industry will remain a critical and growing component of the overall supply/demand balance for corn in Ontario. Moreover, the production of advanced biofuels will take advantage of waste agricultural biomass such as corn cobs and stover – creating new markets for Ontario's grain growers.

6 Life Cycle Asessment of Fuel Production from Canadian Biofuel Plants for 2008-2009. Final Report. Cheminfo Services Inc. November 25, 2009. Prepared for CRFA. This analysis was prepared using analytical protocols endorsed by Natural Resources Canada which are consistent with the GHGenius life cycle analysis (LCA) model. For a copy of the full report, see: www.greenfuels.org/uploads/documents/03_cheminfo_biofuel.pdf

7 In 2008, the U.S. Treasury reduced its payments to farmers by $6 billion in large part because of additional farm revenues from more than 135 ethanol plants across the country.

In western Canada, higher yield breakthroughs continue to boost wheat and canola production. Farmers have been trying to create domestic value-added markets (to complement exports) for these products. Ethanol and biodiesel provide such market opportunities, enabling growers to divert production away from traditional export markets to their own "back yards" (thereby avoiding attendant transportation and environmental costs).

The development of the biofuels industry has boosted the local basis price for grains and oilseeds, and has contributed to meaningful reductions in program spending under various government agricultural safety net programs.

> "If Canadian governments and the forest products industry heed the lessons from abroad, Canada can look forward to maintaining value-added jobs that will keep many rural communities viable and provide a renewable source of low-cost clean energy, and bio-products while enabling Canada to meet its greenhouse gas reduction targets"
>
> FOREST PRODUCTS ASSOCIATION OF CANADA, 2010

Rural Development and Forestry Benefits

About one-third of Canada's population – approximately nine million people – lives in rural communities. The "urbanization" trend has left many smaller communities with a decreasing population and shrinking tax base. Economic stagnation and loss of manufacturing jobs have emerged as significant challenges to these same communities – challenges that, in turn, further erode resources and cause an out-migration of young people. The same is true for many communities with close ties to the forestry sector.

Biofuels are one of the few industries in Canada that represent a proven source of economic renewal and growth for rural Canada.

Over the past several years, ethanol and biodiesel facilities have been built and invested primarily in rural communities because of the close proximity to feedstock such as corn, wheat or canola.

Advanced biofuels will serve to reinforce this advantage as the forestry sector responds to new demands for biomass.

Using the IGPC ethanol plant in Aylmer, Ontario as a real-life case study, a recent independent assessment showed the following local benefits are generated by a typical 150 million litre per year facility:[8]

- 1,152 jobs created in support of the construction phase.
- An additional 55 direct jobs per year created by ongoing operations, not including additional indirect job creation in the community.
- Total capitalization in excess of $100 million, including "soft costs" and design/engineering.
- Total net economic activity to the region of $276 million from the construction phase.
- Ongoing net economic activity to the region of $54 million per year from ongoing operations.

TOM COX, CHAIRMAN IGPC INC.

> "The co-operative structure of IGPC has allowed its nearly 900 members the opportunity of having a direct financial stake in the renewable energy sector. For primary agricultural producers like myself it has provided a means of vertically integrating our business as well as creating important new markets for our production. It has been a long and often challenging road to get our business and our industry established however our growth and success has made it very much a worthwhile journey."

8 The Community Economic Impact of the IGPC Renewable Fuels Plant at Aylmer, Ontario. Doyletech Corporation, November 26, 2009. Available at www.greenfuels.org/uploads/documents/02_economic_impact_study.pdf

In addition, new or expanded facilities will be developed as several next-generation technologies reach the commercialization stage. Once again, these plants require proximity to available feedstock such as forestry biomass, agricultural residues and specialty energy crops, thereby giving an additional boost to rural economies.

Energy Security/Diversity

While the importance of energy security receives far more attention in the United States than it does in Canada, it remains an important consideration for all of continental North America. Long-term energy price increases are foreseen by most economists and experts including the International Energy Agency. In addition, there remains the constant risk of significant energy price spikes caused by environmental disasters, geopolitical events or other supply disruptions. For all these reasons and others, diversification of our energy supply is a critical national imperative.

Although Canada has abundant oil reserves, supply is in the west, and major demand is in the east. As a consequence, a surprisingly significant percentage of gasoline and diesel in eastern Canada must be imported from foreign sources. This exposes much of Canada to the very same energy supply risks as the United States. Biofuels represent the potential cornerstone of a Canadian energy diversification strategy that will help to mitigate the impacts of future oil supply shocks and dependence on foreign oil – particularly in eastern Canada. As production increases, the capacity to mitigate long-term exposure similarly rises. The economic value of this effort cannot easily be calculated but there can be little question of its significance.

Social Benefits to Canadians

The most direct benefit to Canadians will be cost savings at the pumps. Ethanol and biodiesel are often priced lower than gasoline and diesel.[9] The cost advantages of ethanol could potentially save Canadian consumers $2.5 billion over the next 25 years (based on both federal and provincial RFS requirements) – provided gasoline producers pass their cost savings on to consumers.

Significant savings are also projected with respect to diesel since under reasonable assumptions, the projected cost of biodiesel for fuel producers will be less than the projected cost of diesel fuel over the next 25 years.

More broadly, cost-benefit analysis experts have estimated that the federal RFS regulations alone (once both the 5% and 2% requirements are fully implemented), will generate overall net benefits to Canadians ranging from $6 billion to $9.2 billion over the next 25 years.

When provincial mandates are taken into account, overall net benefits to Canadians from biofuels are expected to range from $13 billion to $21 billion over the next 25 years.[10]

9 For example, in 2010 wholesale ethanol prices have averaged about 30% less than gasoline. Over the past 5 years, ethanol prices have averaged 6.6% less than gasoline. And ethanol prices have been decreasing at a real average annual rate of 3.5% over the past 5 years. Wholesale gasoline prices have increased at a real average annual rate of 2.5% over the last 5 years, and 4.4% over the last 10 years. So the ethanol cost advantage over gasoline is substantial, and growing.

10 These are estimates from CRFA's cost-benefit analysis of the federal 5% and 2% requirements under the RFS regulations. The net benefit values presented are the 95% confidence interval values from Monte Carlo analysis of various ranges of cost and benefit parameter values over 25 years, and using discount rates of 3% to 8%. Scaling the results to include provincial ethanol and biodiesel mandates is based on the incremental federal requirements compared to total ethanol requirements (32.5%) and biodiesel requirements (66%) to meet both provincial and federal mandates.

Challenges and Opportunities Ahead

Challenges

Implementing the 2% Federal Mandate for Biodiesel

The ethanol industry is well positioned to meet the additional demand arising from the 5% RFS mandate starting on December 15, 2010. The biodiesel industry is equally prepared to meet its obligations and expand its efforts. However, it is critically important to establish certainty as to the prescribed date for the 2% RFS requirement for biodiesel.

The Government of Canada first published its intention to require 2% renewable content in diesel fuels and heating oil in December 2006. The framework for the regulations were published by Environment Canada on September 1, 2010 in the Canada Gazette, Part II as part of the regulations pertaining to 5% RFS. However, the 2% renewable requirement is "subject to successful demonstration of technical feasibility under the range of Canadian conditions" and no start date or first compliance period for the 2% mandate has been established. The 2% federal mandate would require approximately 500 million litres per year of renewable diesel use.

Although biodiesel is widely used throughout the world, including numerous cold weather jurisdictions similar to Canada, the CRFA, and other industry participants, participated in a suite of "technical feasibility studies" in order to fulfill the regulatory requirement. A broad range of studies were completed, including the Alberta Renewable Diesel Demonstration (ARDD) project (2007-2009) and an assortment of National Renewable Diesel Demonstration Initiative (NRDDI) projects (2008-2010) funded by Natural Resources Canada. The final NRDDI studies concluded in June 2010 and, along with the ARDD study, confirm the technical feasibility of biodiesel use in Canada.

CHRISTIAN PARADIS,
MINISTER OF NATURAL RESOURCES

"These regulations will help Canada reach our goal of becoming a clean energy leader," said Christian Paradis, Minister of Natural Resources. "Our Government supports biofuels and other alternative fuels as part of our commitment to reducing Canada's total greenhouse gas emissions by 17 percent, from 2005 levels, by 2020."

SEPTEMBER 1, 2010

The federal government has been clear in its commitment to implement the 2% renewable diesel requirement in 2011. There are no reasons or rationale for not proceeding with final regulatory approval of a start date. Any delay will have a significant negative impact on existing biodiesel production and investment decisions on planned production capacity expansion. Indeed, now that the government has completed all of its technical feasibility studies, which represented the last remaining requirement to implementing the 2% mandate, the CRFA has formally requested a start date of April 1, 2011. This would result in a first compliance period ending on December 31, 2012. This would provide regulated parties a 21-month initial compliance period including two summers and one winter as some stakeholders have sought.

The risks of delaying beyond April 2011 are severe. Further delays will almost certainly retard the build-out of additional capacity and, quite possibly, would result in some existing biodiesel capacity in Canada being lost. In addition, currently, financing for a number of biodiesel projects is being withheld by lenders due to a lack of planning certainty regarding the 2% RFS implementation schedule. The bottom line is that jobs would be lost, new investment would be at risk and valued momentum would stall.

Combating Myths

For 15 years, the renewable fuels industry worldwide has had to address numerous myths in the public domain that, despite significant evidence to the contrary, have continued to persist and influence decision makers. Some of the more popular myths include:

- **Indirect Land Use Change (ILUC)** – this mistaken assertion holds that renewable fuels in Canada divert the use of farm land at home and in the developing world from the production of needed crops. This suggestion fails to withstand scrutiny.

  The methodology required to support ILUC has been criticized and discredited by many independent experts. At minimum, it requires the use of repeated flawed assumptions. For example, Canada has more than enough current farm and fallow land to meet demand for crops, fuel and fibre. The ILUC argument assumes that the global agricultural system is operating at full capacity. This is patently untrue. Many countries are well below full utilization of their agricultural lands. In the United States for example, somewhere between 65% and 75% of the agricultural land is used to produce crops while the remaining farm land is summer fallowed, treated as temporary pasture or idle. Similar situations are found in other countries. For example, India fallows huge tracts of agricultural land each year – as much as 65% of Canada's total cropland. What's more, the potential to increase production of agricultural crops throughout the world by maximizing the capacity of existing farm land is enormous. Certainly, the world is greatly under-utilizing available crop lands.

- **Sustainability of Grain-Based Biofuels** – the argument made is that grain-based ethanol is unsustainable because it boosts its own input costs by generating crop inflation.

  This assertion relies on a flawed understanding of the economics of ethanol. There is more than ample corn feedstock supply to meet the demand that ethanol production currently generates – and meeting that supply will get easier, not harder in the years to come. Canada typically produces about 50 million tonnes of grain (wheat, barley, corn, oats, and rye) annually. Of this, about half is exported. If all Canadian gasoline contained 10% ethanol, about eight to nine million tonnes of grain would be required. Even at this level, Canada would have more than enough supply and would remain a major grain exporter. Furthermore, advancements in plant biotechnology have allowed Canadian farmers to grow more grains per arable acre. For example, with the introduction of new varieties, Canadian corn yields have increased from 112.4 bushels per acre in 1996 to 156 bushels per acre in 2008. That represents a rise of 33%. Over the next ten years, this is expected to grow to more than 300 bushels per acre.

  In the future, biomass feedstocks such as non-recyclable municipal landfill waste, low-input dedicated energy crops that can be grown on marginal lands such as switchgrass, camelina and sorghum, forestry and wood waste, and other forms of waste biomass will form an increasing percentage of our renewable fuel feedstocks. Researchers are developing biocatalysts – enzymes, yeasts and bacteria that are used to convert any organic matter into cellulosic ethanol – an attractive option since feedstocks such as agricultural by-products, grasses and wood chips are cheap and abundant. Converting these feedstocks into ethanol requires less fossil fuel in the production process and uses the whole plant, rather than just the grain.

- **Biofuels Subsidies** – the suggestion is that biofuels receive an unfair advantage from government programs and incentives.

  Governments support all areas of the energy sector, including oil and electricity. By way of comparison, renewable fuels actually receive far less support than either oil or electricity, notwithstanding such support will help Canada become a low-cost, world-class producer of this clean-burning, renewable fuel. The investment in biofuels is small compared to other government subsidization of the energy industry in Canada. This has included: more than $3-billion for Hibernia, $14-billion for the Darlington nuclear plant and in excess of $44-billion invested in the oil sands. By comparison, funding for the ethanol industry is relatively small – a payment of no more than $1.5 billion in total over nine years. Worldwide, the oil and gas sector receives an estimated annual $500 billion in taxpayer support.

- **Food vs. Fuel** – this argument charges that biofuels are diverting crops that are needed to feed the world's hungry.

This persistent myth has been demonstrated as false time and again. It came to particular prominence with food commodity price spikes in 2008. However, since then, food commodity prices have fallen steeply and global biofuels production has continued to increase significantly – indicating that the presumed causal link between biofuels demand and food crop prices was, at best, simplistic, and more to the point, invalid.[11]

In truth, there is plenty of food to feed the world's population. According to the UN FAO (Food and Agriculture Organization of the UN), the world produces at least twice the grains required to feed the planet's population. Poverty, harmful economic systems, conflict and climate change are the key underlying causes of hunger.[12] The remedies, in turn, are to be found in better public policies – in distribution, infrastructure, corruption and local politics. UN Secretary General Ban Ki-Moon and Food and Agriculture Director-General Jacques Diouf have stated emphatically that the world produces more than enough food to feed all people.[13]

Encouragingly, the world supply of grains is growing, not shrinking. In 2009 North America produced two billion more bushels than required for all uses – food, animal feed, and biofuels. Continued improvements in agricultural practices and land management, will allow us to both increase yields and minimize some of the negative effects of agriculture. Some areas that hold much promise include: better pest management, water-conserving irrigation, conservation tillage, and development of new crops through breeding or genetic modification.[14]

Finally, biofuels represent economic opportunity for the developing world. Studies from the IMF, World Bank and FAO show that biofuels production represents a source of opportunity for farmers in the developing world, heralding the arrival of electricity (from co-generation), higher employment and increased crop prices. Just as importantly, rising crop prices should ease global agricultural subsidies that hit farmers in the developing world particularly hard. In fact, the USDA reports that farm subsidies are down by $6 billion because of ethanol production. The production of renewable fuels will bring direct opportunities to developing countries because their production will create many local jobs in the value chain – from growing raw materials to their manufacture. Furthermore, the local production of biofuels in developing countries will help to preserve foreign currency reserves and decrease dependency on costly fossil fuel imports.[15]

Opportunities

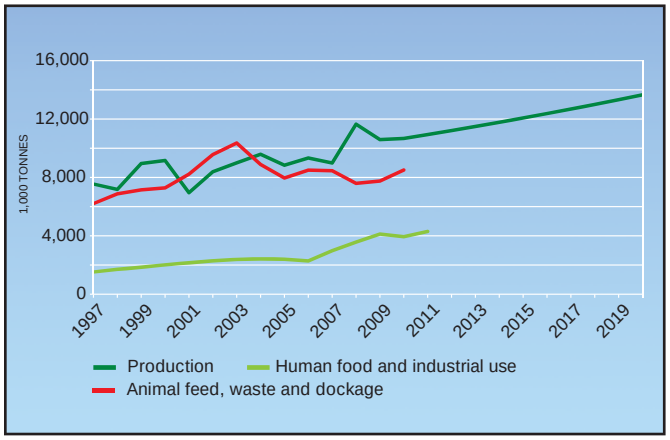
Resource Availability

The 5% and 2% targets for Canada were established to help foster a substantial, if not necessarily large, market for renewable fuels. In reality, this represents a share of the marketplace that will not prove particularly discomforting for the petroleum industry. However, these mandates will serve to demonstrate the commercial and production viability of the industry.

Once these targets are reached and the benefits of the industry established clearly, particularly with respect to the GHG emission benefit, a reassessment of the targets would be appropriate. This work needs to be done in a dynamic framework that considers not only the past performance but also the potential that could be realized in the future.

In this context, it is important to remember that by 2020 in eastern Canada the ethanol industry will actually be using less corn than expected yield improvements will generate (see figure below). By 2015, the yield increase should support an additional 550 million litres of ethanol and by 2020 the yield increase should produce 1.2 billion litres of ethanol. With demand for animal feed declining in eastern Canada, the region could soon again be in a situation where production exceeds demand and corn is subject to export.

Figure 1: Historical and Projected Corn Production



Technology Development

Canadian biofuels employ and develop an impressive range of cutting-edge technologies, and plants and practices continue to evolve. The consequence is a steadily improving environmental performance and substantial economic gains in terms of efficiency.

For example, the GHG emissions from corn ethanol have decreased by 17.7% over the past decade and are forecast to decrease by a further 13.2% in the next decade. GHG emission reductions from canola biodiesel are projected to fall by 61% over the same 20-year period.

11 The most authoritative source on the food vs. fuel mythology is "The role of demand for biofuel in the agricultural commodity price spikes of 2007/08", U.K. Department for Environment Food and Rural Affairs (DEFRA), November 26, 2009. Available at www.defra.gov.uk/foodfarm/food/pdf/ag-price-annex 5.pdf

12 Worldhunger.org – World Hunger Facts – 2009

13 2009 United Nations summit on world food security

14 University of Michigan – Global Change Program – Human Appropriate of the World's Food Supply

15 European Association for BioIndustries – EuropaBio Fact Sheet

Biofuels plants frequently utilize as well as produce renewable energy. This has the effect of further reducing their carbon footprint. Ethanol plants are also excellent candidates for applying carbon capture and storage opportunities.

Carbon capture and storage (CCS) and biomass fuel technologies are further enhancing the GHG emissions profile of current ethanol plants. Both technologies are used – or are in the process of being applied – in some of the plants currently producing ethanol. The biomass energy systems are commercially proven and the CCS systems are commercially proven for the capture stage – some plants have this installed already and under development/demonstration for the storage part of the process. Specifically, these processes allow for the capture and storage of thermal energy and CO_2 from straw and stover.

The combination of advances in technology, the substitution of biomass in the place of natural gas as the process fuel of choice, and the application of CCS for the fermenter gases, would allow ethanol production systems to become essentially GHG emission-free.

Efficient Energy Infrastructure

Canada's biofuels industry benefits in its drive to produce lower GHG emissions than its American counterpart due to the relative efficiency of our energy infrastructure. By and large, Canada's electricity sector enjoys lower carbon intensity than what is experienced in the United States. A study published by the American Petroleum Institute (API) found Canada's peculiar energy mix offered industry an advantage in terms of GHG emissions per unit of output[16] notwithstanding the fact that almost all primary and secondary manufacturing sectors in the US had a better overall energy efficiency.

In addition, a number of US ethanol plants utilize coal as an energy source which has the immediate effect or raising the carbon footprint.

Fertilizer production is another area where Canada enjoys an advantage with respect to energy efficiency. This has a positive impact on all of the biofuels pathways that utilize fertilizer in the feedstock production stage.

PIERRE LAPOINTE, PRESIDENT AND CEO, FP INNOVATIONS

"Years of intensive research and development have produced technologies that open up a world of possibility for the forest products industry in Canada. We can now rapidly convert wood fibre into a wide variety of high-value products such as bio-fuels to heat homes or power vehicles as well as bio-chemicals to make cosmetics, solvents, food additives and renewable plastics."

FEBRUARY 2010

Leading Agricultural Practices

A significant portion of the lifecycle GHG emissions for renewable fuels are related to the production of the crop or biomass. Emissions result from the manufacture of fertilizer, the use of fuel in tractors, from the application of fertilizer to the soil, and from the cultivation of the soil. While the GHG emissions from the first of these two is relatively straightforward and easily calculated by most models, the other two emission sources are more difficult to estimate.

Smart environmental practices: Canadian agricultural producers lead the world in the adoption of better environmental practices such as reduced-till and no-till agriculture. These practices offer many benefits including lower energy consumption, higher yields, the ability to build soil carbon rather than to reduce it, and better utilization of natural precipitation. No-till agriculture improves lifecycle GHG emissions performance while at the same time providing an economic benefit to the producer.

Efficient production: Canadian agricultural producers have also become some of the world's most efficient producers. A variety of factors have inspired this ongoing achievement. In particular, the need to compete internationally against countries whose farm sectors enjoy considerable public subsidy has generated a focus on production efficiency and economies. In turn, these efforts almost invariably lead to a corresponding reduction in GHG emissions.

Natural Environment: Dry conditions found in the Canadian prairies result in lower emissions of N_2O from fertilizer production than is found in other parts of the world. This has a very beneficial effect on the wheat ethanol and canola biodiesel production systems.

Evolutionary Performance

All technologies have a tendency to improve performance over time. There is strong empirical evidence that deploying new technologies leads to improvements in technical performance and cost of utilization. In short, it is an evolutionary experience. We see evidence of this process constantly in biofuels as the industry integrates key learnings, new practices and advent technology[17].

16 Canadian industries use less coal and more natural gas and the average carbon intensity of electricity in the US is 207.6 kg CO2 eq/GJ and it is 61.4 kg CO2 eq /GJ in Canada. These two factors account for Canada's competitive advantage that the API found.

17 A recent survey on ethanol energy use undertaken in the United States (Mueller, 2010) indicated that dry mills in 2008 used only 8.1 GJ of natural gas/m3 per ethanol produced, with a range from 5.2 to 11.0 GJ/m3. The large range is probably a function of the amount of co-product sold wet vs. dry. A survey undertaken by the CRFA of corn ethanol producers in Canada in 2009 found that the average energy use was 8.5 GJ of natural gas/m3 per ethanol produced, with a range of 7.8 to 10.3. These results are very similar and indicate that the Canadian industry is as efficient as the larger and more experienced US industry.

Advanced Biofuels – The Future Is Now

As jurisdictions around the world develop strategies to build a low-carbon renewable fuels industry and reduce their reliance on petroleum, Canada is uniquely positioned to become a world leader in biofuels production and the commercialization of next generation, advanced biofuels technologies.

These advanced biofuels are not only the future of the sector they are the direct consequence of the hard effort and unique partnership between government and industry in Canada over the past 15 years.

We now see a virtual rush of advanced biofuels taking shape. For example, Canada's forestry sector is poised to become a world leader in diverting biomass from wood-waste and by-products to create renewable fuels. Similarly, a variety of other technologies show promise in the production of biofuels derived from such diverse biomass feedstocks as corn cobs, switchgrass, straw, municipal waste and algae. While some of these technologies may have a longer term commercialization horizon, certain biomass-to-ethanol technologies have been – or are in the process of being – proven at demonstration scale. The fact remains that Canada has an opportunity to be a global biofuels technology leader employing new technologies and processes.

Today, the Canadian industry is poised to commercialize no fewer than four next generation technologies in ethanol, as well as several biodiesel advancements. Tomorrow's feedstock for companies like Quebec's Enerkem will be municipal solid waste. For Ottawa-based Iogen, it will be native grasses grown on the prairies, and processed there. For biodiesel pioneers like BIOX, the feedstock complex will include a range of seed oils, animal fats and perhaps even algae. Ontario's GreenField Ethanol is working with global technology companies to build a demonstration plant using its patented method to produce ethanol from corn cobs and other biomass residues.

These developments are moving Canada forward in the global advanced biofuels industry competition. And a key driver will be an on-going commitment to progressive renewable energy policies, to low carbon transportation fuels and to continued investment in this industry.

It is apparent that Canada has many options available as it looks towards the future for renewable fuels. It will be important that any plan for Canadian renewable fuels considers the full range of options against the desired policy outcomes. At the end of the day, one clear test exists to measure the efficacy of advanced biofuels: Substantial diminution of GHG emissions.

MAYOR STEPHEN MANDEL,
CITY OF EDMONTON

"Edmonton's environmental leadership has us continually looking to set the bar higher," said Edmonton Mayor, Stephen Mandel in reference to the Enerkem, Inc. waste-to-ethanol plant. "As a result of this facility, we will become the first major city in North America to see 90 per cent of residential waste diverted from landfill by 2013. This is a major achievement, and a big step towards a greener Edmonton! Thanks to all our partners whose innovation and commitment to sustainability are helping to reduce our carbon footprint."

AUGUST 31, 2010

A Path Forward

From new jobs to lower GHGs, the Canadian biofuels sector has more than delivered on its promise.

Over the past fifteen years, a number of government initiatives have been employed to expand Canadian biofuels capacity, ranging from the introduction of the initial excise tax exemption for ethanol (and the associated National Biomass Ethanol Program), to capital grants offered through the Ethanol Expansion Program and onward to the more recent operating incentives provided by the ecoEnergy for Biofuels Program. Ultimately, these programs were complemented by the introduction of the Renewable Fuels Standard.

At the outset of these initiatives, policymakers believed that Canada was uniquely positioned to establish itself as a leader in the emerging bio-economy of the 21st century – a new economy where renewable sources would be utilized to generate green energy and green jobs. That vision has been vindicated.

Indeed, today's renewable fuels industry is characterized by a range of tangible benefits that include:

- An employee base that is knowledgeable and innovative.
- A critical base of production capacity to supply the majority of domestic demand.
- A logistics infrastructure for procurement of feedstock and delivery of biofuels and related co-products to the domestic market.
- A new R&D capacity focused on both process improvements within first generation biofuels plants and, significantly, on advanced biofuels feedstock's and new technologies.
- An emerging pattern of collaboration between Canadian advanced biofuels innovators and global biofuels and bio-chemical participants.
- An established network of relationships between biofuels producers and the financial community.
- A track record of profitability.

- A strong partnership with government both at the federal and provincial levels.
- An assured level of market access provided by provincial and now federal legislation.
- A high level of product acceptance in the marketplace, as all auto and truck manufacturers now warrant ethanol and biodiesel blends.
- A widespread penetration of biofuels into the national transportation fuel system, as all Canadian oil companies now blend biofuels.

However, the job is not yet complete. The sector is confronted with new and important competitive pressures from beyond our borders. Moreover, the development of advanced biofuels is a journey far from finished and far short of secure.

The Canadian renewable fuels sector's success has come about through a proactive working relationship with federal and provincial governments across Canada. More can be achieved as industry and government work together and build upon the public policy objectives that the industry has delivered on to date. Indeed, continued partnership will be vital to leveraging the full benefit of what governments have contributed to date – as measured by new jobs, more economic growth, and increased environmental gains.

Clearly, it is in Canada's national interest to aggressively pursue the commercial development of its advanced biofuels industry for economic, environmental and energy reasons.

Recognizing this critical objective, the Canadian renewable fuels industry is calling on the federal government to establish a new Interdepartmental Working Group on Advanced Biofuels to include senior-ranking officials from the key federal government departments with Cabinet oversight. This group would serve as a focal point for policy development and coordination within the federal government, allowing for enhanced accountability and a sharper focus on policy outcomes. As part of the mandate for this working group, efforts to foster dialogue with provincial governments who have also played a significant role in the development of the renewable fuels sector must take place. This will ensure policy and program alignment between federal and provincial jurisdictions can be achieved.

The industry recognizes that policy and program instruments in the near term must be shaped with an eye to difficult fiscal realities. Given such constraints, there is a need to distinguish between near-term versus longer-term policy objectives. We have identified a number of policy issues and recommendations as set out below:

Near Term Goals

Market Access and Production Capacity for Biodiesel and Other Renewable Diesel Alternatives

- Deliver on the federal government commitment and set April 1, 2011 start date for 2% Renewable Diesel Standard with the first compliance period ending December 31, 2012.
- Re-profile existing unallocated funds within ecoENERGY for Biofuels program to ensure all remaining eligible projects receiving funding. Ensure any unspent funds remain in the program for future allocation to renewable fuels projects.
- Deliver on the government's commitment to build out canola oilseed biodiesel capacity. Since the announcement of the ecoENERGY program in 2007 not a single industrial scale biodiesel facility (>100MLY) has been built. Immediate attention must be directed towards ensuring that the Canadian biodiesel industry includes plants of industrial scale that utilize Canadian canola and other oilseeds.

SHELL / IOGEN

Shell and Iogen Energy are working towards construction of a full-scale commercial cellulosic ethanol plant in Saskatchewan Canada. The proposed project has met a number of significant milestones and feasibility and design assessment work are ongoing.

The first time an advanced biofuel has been used in the Shell V-Power race fuel used by technical partner Ferrari, in a Canadian Grand Prix.

"We are delighted that the fuel we are supplying to Scuderia Ferrari this season contains an advanced bio-component derived from Iogen cellulosic ethanol" says Dr Lisa Lilley, Shell's Technology Manager for Ferrari. "This demonstrates our commitment to the development of sustainable, low carbon fuels. At Shell, we are accelerating the research, development and demonstration of advanced biofuels and we are committed to technical innovation through our motorsport activities." FEBRUARY 23, 2010

Commercializing Targeted Next Generation Biofuels Technologies

Sustainable Development Technology Canada (SDTC) Tech Fund has supported many technology demonstration projects within the biofuels sector. Certain projects are rapidly proceeding through the commercial demonstration phase with plans for construction of 'first-of-a-kind' commercial scale plants. Unfortunately, renewal funding for the SDTC Tech Fund was not achieved this past year. The CRFA and its member companies can attest to the effectiveness of the SDTC Tech Fund, and remain hopeful that renewal of funding can be accomplished in the near term.

The SDTC NextGen Fund is designed to assist the commercialization of advanced biofuels technologies in Canada, and is of critical importance to Canadian biofuels innovators. That said, our members and other industry stakeholders have identified a number of issues and suggestions regarding the operation of the STDC NextGen Fund, and are continuing to consult with Program officials to improve the overall effectiveness of the Fund.

First of Kind Operating Incentives

The financing of biofuels projects has been a perennial challenge for Canadian developers, particularly in the last few years with economic turmoil, scarce credit, and depressed margins within the US industry. Private investment will always be necessary. But first of kind commercial advanced biofuels projects will need both capital and operating support to be viable in the near term. While the NextGen Fund provides capital assistance for such projects, there presently exists no program to deliver operating support.

In order to attract private sector capital for early stage, 'first of a kind' biofuels plants, it is critically important that such projects secure access to operating support – just as first generation projects secured funding under the federal ecoEnergy for Biofuels and other provincial operating grant programs. Certain technology innovators are intending to commence commercial scale construction in 2011. With this in mind, the CRFA intends to work collaboratively with federal and provincial authorities to design a volume-limited, transitional safety net operating incentive to ensure that the commercialization of such important technologies is not delayed.

Formal Inclusion of Advanced Biofuels within the Government's Alternative Energy Agenda

Biofuels represent the only practical alternative to conventional fossil fuels within the transportation sector and accordingly deserves equal standing alongside solar and wind technologies for the power generation sector. For policymakers, industry participants, investors and the public at large, such a mandate would send a clear signal as to the importance of renewable fuels to Canada's energy policy framework.

Coordination of Federal Government Biofuels Research

The federal government expends important research and development funding on a variety of initiatives across numerous departmental research facilities and centres in the biofuels sector. Improved coordination of these activities among the private sector, government research departments, and universities would enhance efficacy, alignment and accountability.

Longer Term Vision

Over the long term, a more robust vision is required that would revisit and/or renew a number of the key policy instruments that have supported the sector's growth over the past fifteen years.

In this respect, three broad priorities have been identified:

- **Market access** is imperative to ensure that projects enjoy access to customers once production is online. Experience has shown that without regulatory imperative, the oil industry will not blend renewable fuels.
- **Government support** must be transparent, predictable and competitive with other jurisdictions including the United States and there must be long-term certainty with any renewed or reformed investment program.
- **Technology development** must be a priority for the federal government if the industry is to realize the competitive advantages of advanced biofuels and continue to reduce our GHG footprint.

More specifically, the industry believes future policy action will, over the longer-term, be required in the following areas:

- **Expansion of the Renewable Fuels Standard** – the Canadian renewable fuels industry is committed to working with governments to expand the existing renewable fuel requirements to 10% and 5% respectively. These expanded mandates will be necessary to ensure adequate levels of market access as Canada is poised to commercialize advanced technologies and biofuels. This must, in turn, be directly linked to the capacity for Canadian renewable fuels production to expand. The nature and scope of future mandates should consider the adoption of escalating RFS 'carve-outs' for cellulosic biofuels (i.e. as presently provided under the US RFS(2) legislation). The precise time horizon for these expanded mandates should be addressed by industry and the Interdepartmental Working Group as part of its ongoing deliberations.
- **Targeted Tax Measures** – as an alternative to program funding, the industry believes government should consider revenue neutral targeted tax measures that would help incentivize expanded advanced biofuels investment and production. For example, the implementation of a refundable tax credit for domestic production of advanced biofuels (including ethanol and biodiesel) could propel commercialization efforts.
- **Monetizing Carbon Credits** – a key element of a financially sustainable advanced sector will be the ability of producers to monetize the value of the industry's carbon advantage. This will require that GHG credits created from the displacement of petroleum by renewable fuels accrue to the biofuels producers.
- **Expanding Biofuels Blend Levels** – higher content renewable fuels will be critical to the future transportation fuels mix. The Environmental Protection Agency in the United States has authorized the expansion and use of ethanol to E15 for vehicles 2007 and newer and will shortly expand this coverage to older vehicles. Already we have seen E85 blends promoted in competitor jurisdictions. Biodiesel blends from B5 to B20 and even B100 have been used in fleet demonstration trials in Canada. To encourage such development, federal policies will be required that incentivize a staged increase in ubiquity of flex-fuel vehicles and encourage refiners and marketers to increase the number of blender pumps and E85 fueling stations throughout the major transportation corridors in Canada.

Conclusion

Only a few years ago, the global renewable fuels industry was struggling to gain market access and finance new facilities. Today, the job creation and economic benefits of first generation ethanol are no longer in question. The biodiesel industry has yet to realize these benefits on a scale on par with the opportunity. Domestic utilization of canola for biodiesel production, farmer participation in the industry and implementation of the federal 2% mandate must become priorities of the government.

As the need to reduce GHGs has grown in keeping with our understanding of the threat of climate change, renewable fuels have emerged as an increasingly important and viable alternative to crude oil. These issues – combined with the prospect of rising prices for fossil fuels and new innovations in technological developments – will continue to drive energy policy and shape the future for renewable fuels.

With the commercialization of advanced biofuels becoming a reality, these benefits are becoming all the more tangible – and coveted. Competitor jurisdictions are pressing their gains. The United States, in particular, is making aggressive new advancements in biofuels development and production.

Yet, Canada has the potential to more than keep pace – provided a smart and targeted policy framework is maintained. The Canadian Renewable Fuels Association and member organizations look forward to a continuing dialogue with federal and provincial policymakers as we strive to realize our full potential in the clean energy economy of tomorrow.

Appendix A:

CRFA Guiding Principles for Sustainable Biofuels in Canada

WHEREAS the CRFA member companies are committed to the production and use of sustainable renewable fuels in Canada;

THEREFORE, BE IT RESOLVED THAT the Canadian Renewable Fuels Association approve the following Guiding Principles for Sustainable Biofuels in Canada:

All references to the biofuels industry apply to the production of feedstocks, the conversion of feedstocks to liquid biofuels and the use of biofuels in Canada, including feedstocks or biofuels imported into Canada.

Principles Addressed Through Existing Legal Requirements:

1. The biofuel industry shall comply with all applicable laws of the jurisdiction in which biofuels are produced.
2. Biofuel industry projects shall be developed and operated under appropriate transparent and participatory processes that involve all relevant stakeholders.
3. The biofuel industry shall respect natural resource rights, such as land and water rights.
4. The biofuel industry shall respect the protection of human rights and labour rights, and shall ensure safe and decent working conditions.
5. The biofuel industry shall respect environmentally sensitive lands, ecosystems, and the quality of natural resources such as soil, air, water, and biodiversity.

Advanced Principles:

6. Biofuels shall contribute to climate change mitigation by reducing life cycle greenhouse gas emissions as compared against the relevant fossil fuel baseline. Life cycle analysis of biofuels and fossil fuels shall utilize equivalent full life cycle system boundaries.
7. The biofuel industry shall provide market opportunities for regional biomass producers, thereby contributing to social and economic development.
8. The biofuel industry shall respect the goals of food security and sustainable biomass production.
9. The biofuel industry shall be dedicated to continuous improvement in the sustainability of biofuels. The biofuel industry shall strive to make advancements in the overall economic, social and environmental performance of its technologies, processes, feedstocks and fuel types.

Canadian Renewable Fuels Association

Association Canadienne Des Carburants Renouvelables

Biofuels in Canada

Biofuel Basics

Ethanol

Fuel ethanol is a high octane, oxygenated fuel component manufactured primarily through the fermentation of sugar. The sugar is usually derived from sugar producing crops, the hydrolysis of starch from grains, or through the hydrolysis of lignocellulosic materials such as straw, grass and wood. The later approach is not yet widely practiced but is the focus of much development effort.

Ethanol has been used as a motor fuel in North America since the early 1900's. Ethanol gasoline blends were used in parts of the United States prior to the Second World War but through the 1950's and 1960's there was no ethanol used in gasoline in North America. In 1979, the US Congress established the federal ethanol program to stimulate the rural economy and reduce the dependence on imported oil. The production and use of ethanol as a motor fuel in the United States and in Canada has increased continuously since that time.

There are now over seventeen billion litres of ethanol used in gasoline in the United States and Canada each year. Most of the ethanol is used in low-level blends of 5-10% ethanol in gasoline; only about 0.25% of the ethanol is used as E85.

In North America, fuel ethanol is currently produced mostly from starch containing crops such as corn, wheat and sorghum. Several plants use a waste sugar stream from other industrial plants such as sulphite pulp mills, breweries, cheese factories, potato processors and other food processing plants. The dominant feedstock is corn. There are plans to introduce new technology to convert lignocellulosic materials to ethanol. The first of these plants is expected to be built in the next several years.

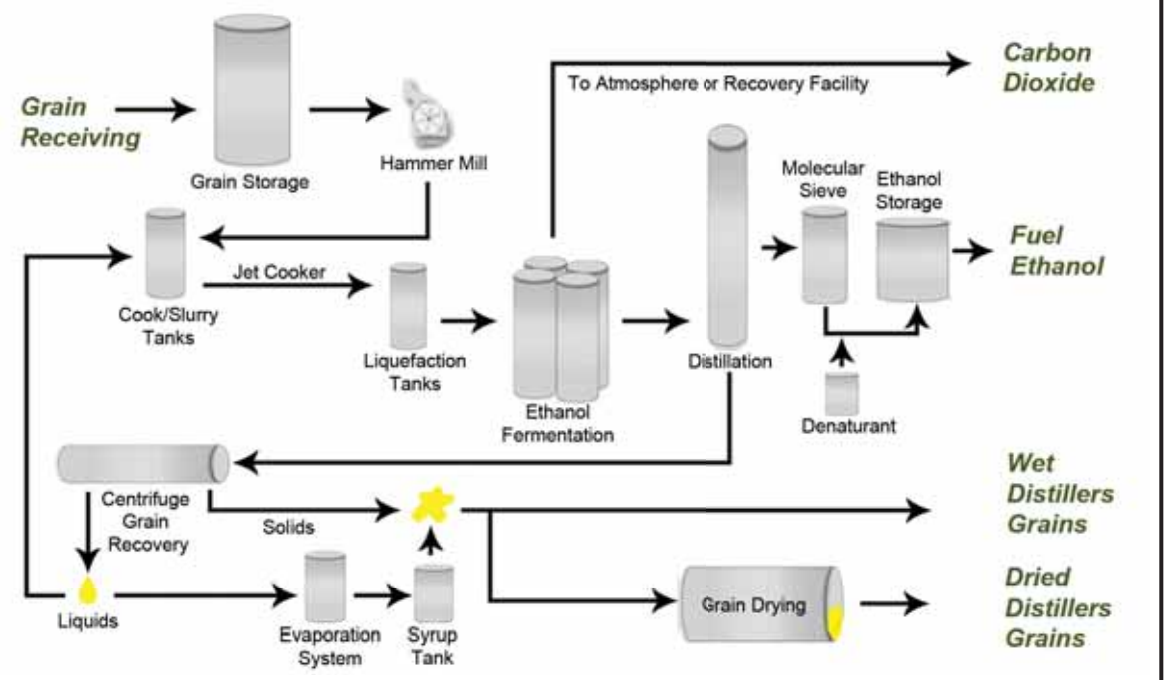
The basic process involves the enzymatic hydrolysis of starch to sugars and the fermentation of the sugars to ethanol via yeast. The weak ethanol solution known as beer is then distilled and dried to produce anhydrous ethanol, which is suitable for blending with gasoline. There are a number of process variations that are employed such as dry or wet milling, batch or continuous fermentation, etc. There are about 220 operating ethanol plants in North America.

GREENFIELD ETHANOL

GreenField Ethanol Inc. is Canada's largest ethanol company – producing 500 million litres in fuel ethanol annually from corn. In May 2008, GreenField's Centre of Excellence in Engineering, Technology, and Research and Development opened in Chatham, Ontario. The Centre contains a pilot unit of continuous hydrolysis and fermentation, as well as analytical lab space capable of supporting up to 12 continuous mashing and fermentation experiments. The Company is proceeding to construct a 5 tonne per day, continuous process, commercial demonstration facility in collaboration with Novozymes and Andritz Ltd., a global leader in equipment design and fabrication for the pulp and paper, and biofuels industries. This project will demonstrate the commercial viability of producing ethanol from agricultural biomass, using proprietary processes for biomass pretreatment and co-fermentation of purified cellulose and hemicellulose streams using advanced enzymes and next generation yeasts.

Most new ethanol plants being considered are dry mill ethanol plants. The basic process flow for one of these plants is shown in the following figure.

Figure 2: Ethanol Process Flow Schematic



Ethanol use as a blending component of gasoline began in the Province of Manitoba in 1981 with a 10% ethanol blend being marketed. In 1987, ethanol blended gasoline with 5% ethanol were offered in the four Western Canadian provinces with about 250 service stations offering the fuel. In 1992, ethanol blends were introduced into Ontario and in 1995 in Quebec.

There are no commercial programs for high-level ethanol blends in Canada. There are demonstration programs for E85 for flex fuel vehicles and some fleets have installed private refueling systems for the fuel. There are no heavy-duty applications for E85 type fuels in Canada.

Biodiesel

Biodiesel is an alternative fuel that can be made from any fat or vegetable oil. It can be used in any diesel engine with few or no modifications. It can be blended with diesel at any level (for example a 5% blend is known as B5) or used in its pure form (B100). Biodiesel is made primarily through a chemical process called transesterification whereby the glycerine is removed from the fat or vegetable oil. Biodiesel is thus an ester, if methanol is used in the production process it is a methyl ester and if ethanol is used it is an ethyl ester. Since it is made from plant or animal oils it is a renewable fuel.

Biodiesel is produced and widely used in Europe both as low level blends and as pure fuel (B100). Biodiesel production and use in North America has lagged behind the development in Europe although use of biodiesel and interest in the fuel has been expanding rapidly in recent years.

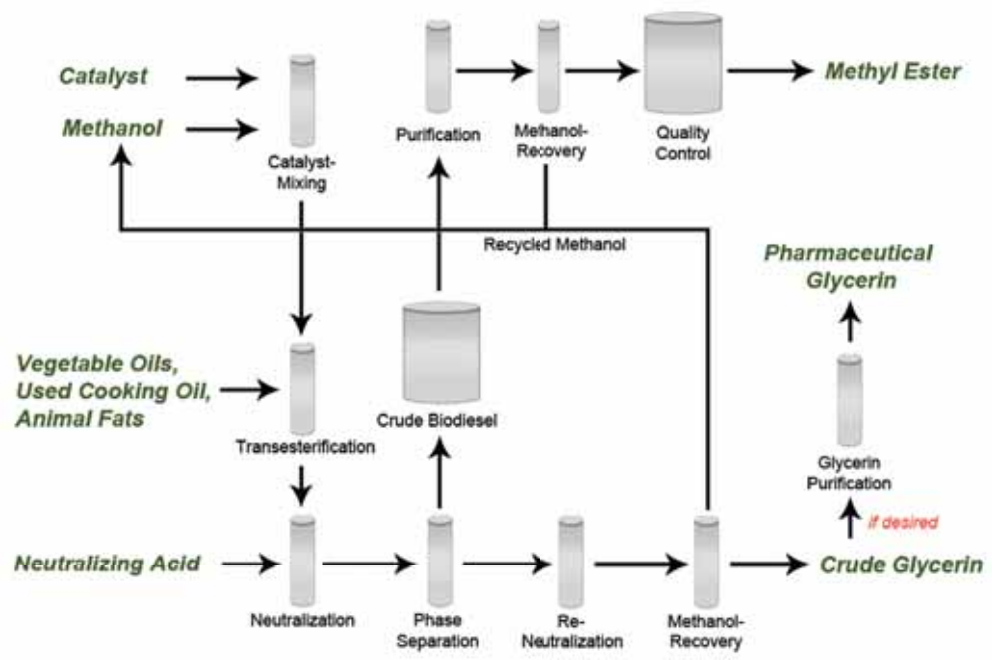
The production and use of biodiesel reduces greenhouse gas emissions due to its renewable nature. It is also a clean burning fuel and the emissions of many of the exhaust contaminants are reduced with the use of biodiesel.

Most biodiesel is produced by the same basic chemical reactions. There are variations of this process that are employed by different process developers to process different biodiesel feedstocks. Most biodiesel is also produced from methanol but other alcohols can be used and there have been ethyl esters produced and tested.

There are also some different processes that produce a diesel fuel from biomass that some developers also call biodiesel but it is chemically different from the fatty acid methyl esters that are sold commercially. In this section the basic biodiesel process, the commercial applications of the processes and some of the variants such as different alcohols and developing technologies are described.

The general biodiesel production process is shown in the following figure.

Figure 3: Biodiesel Production Process

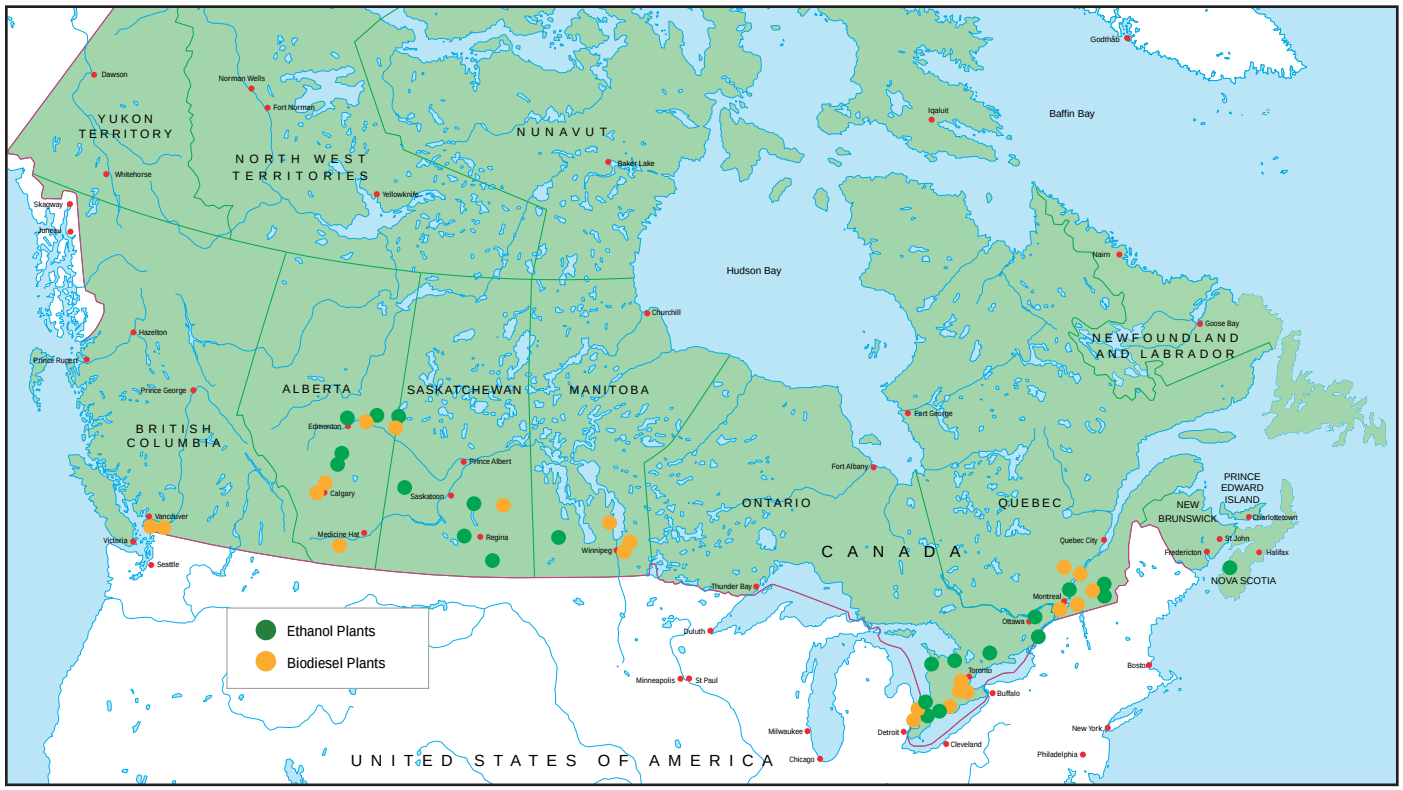


Biodiesel development in Canada has been slow compared to Europe, the United States and even Argentina. There are about 165 biodiesel plants in the United States with an annual production capacity of 10 billion litres.

The Canadian Biofuels Industry

Since 2006 the Canadian biofuels industry has expanded significantly, responding to consumer demand and to provincial and federal governments' policies and programs. Facilities have been developed in many regions of Canada as shown in the following figure.

Figure 4: Canadian Biofuel Production Facilities



The Canadian Ethanol Industry

The ethanol demand that will result from federal and provincial RFS requirements will be about 2 billion litres per year. The volume requirements of the regulation can be met with renewable fuels blended into gasoline as well as fuels blended with diesel. Imported ethanol can be used to meet this demand as well.

The production capacity of the Canadian ethanol plants in operation is over 1.7 billion litres. There are additional projects that are in development that should move to the construction phase shortly. It is thus likely that most of the demand for fuel ethanol under the new RFS requirements will be met with Canadian-produced ethanol. Canadian ethanol plants that are producing or under construction are shown in the following table.

Table 1: Canadian Ethanol Plants

Plant	City	Province	Feedstock	Capacity (Million litres/yr)	Status
Alberta Ethanol and Biodiesel GP Ltd.	Innisfail	AB	Wheat	150	Proposed plant
Amaizeingly Green Products L.P.	Collingwood	ON	Corn	58	Operational
Atlantec Bioenergy	Milford	NS	Energy beets	n/a	Demonstration facility
Enerkem Alberta Biofuels – Edmonton Waste-to-Biofuels Facility	Edmonton	AB	Municipal Solid Waste (landfill waste)	36	Under construction
Enerkem Inc. – Sherbrooke Pilot Plant	Sherbrooke	QC	Various feedstocks	0.475	Demonstration facility
Enerkem Inc. – Westbury Commercial-Demonstration Facility	Westbury	QC	Wood waste	5	Demonstration facility
GreenField Ethanol Inc. Chatham	Chatham	ON	Corn	195*	Operational
GreenField Ethanol Inc. Johnstown	Johnstown	ON	Corn	230	Operational
GreenField Ethanol Inc. Tiverton	Tiverton	ON	Corn	27*	Operational
GreenField Ethanol Inc. Varennes	Varennes	QC	Corn	155	Operational
Growing Power Hairy Hill	Hairy Hill	AB	Wheat	40	Proposed plant
Husky Energy Inc. Lloydminster	Lloydminster	SK	Wheat	130	Operational
Husky Energy Inc. Minnedosa	Minnedosa	MB	Wheat and Corn	130	Operational
IGPC Ethanol Inc.	Aylmer	ON	Corn	162	Operational
Iogen Corporation	Ottawa	ON	Wheat and barley straw	2	Demonstration facility
Kawartha Ethanol Inc.	Havelock	ON	Corn	80	Operational
NorAmera BioEnergy Corporation	Weyburn	SK	Wheat	25	Operational
North West Terminal Ltd.	Unity	SK	Wheat	25	Operational
Permolex International, L.P.	Red Deer	AB	Wheat, wheat starch, corn, barley, rye, triticale	42	Operational
Pound-Maker Agventures Ltd.	Lanigan	SK	Wheat	12	Operational
Suncor St. Clair Ethanol Plant	Sarnia	ON	Corn	400	Operational
Terra Grain Fuels Inc.	Belle Plaine	SK	Wheat	150	Operational

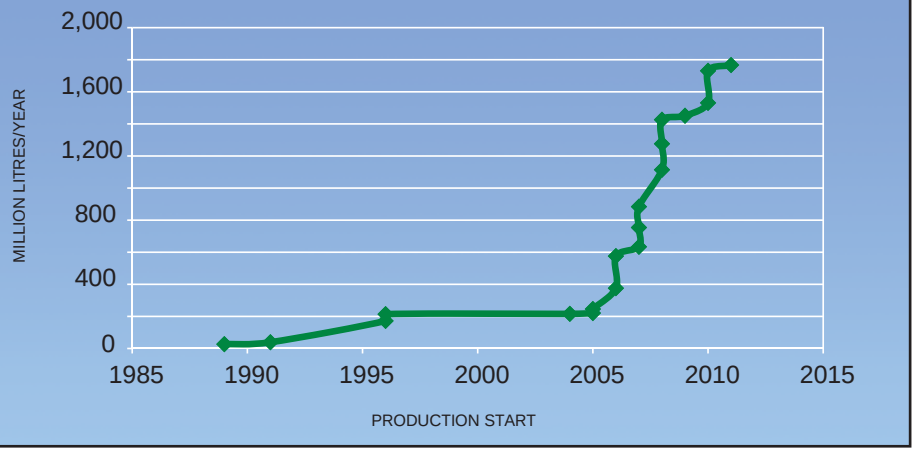
* Volumes include industrial alcohol production

The Johnstown, Aylmer, Sarnia, and Unity plants all have investments from farmers with support through the ecoABC program from Agriculture and AgriFood Canada (AAFC). Producers have contributed up to 43% of the equity investment in these projects. AAFC provided $41.3 million through repayable contributions to these four projects.

Many of these plants have the latest ethanol production technologies installed and are amongst the most efficient ethanol plants in the world. The North West Terminals plant has minimized the use of fossil energy by employing a biomass powered steam plant and as a result it will have extremely low GHG emissions.

The following figure demonstrates the growth in ethanol production capacity over the past five years. This growth has been driven by the introduction of provincial mandates and the anticipation of the federal RFS. Average annual growth in capacity from 2005 to 2010 has been 150%.

Figure 5: Ethanol Production Capacity Growth



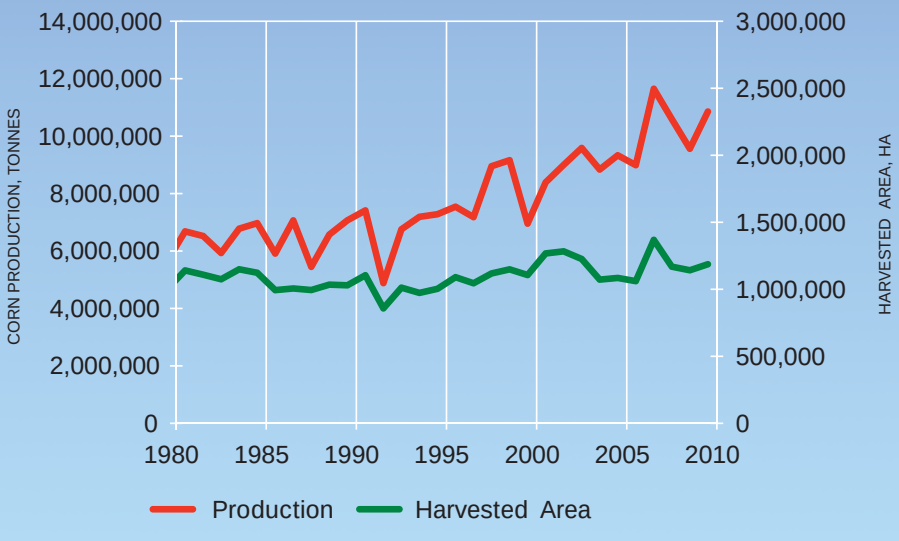
Feedstock Production

At full production capacity the ethanol facilities will create a demand for 93.0 million tonnes of corn, 1.4 million tonnes of wheat and 14,000 tonnes of cellulosic materials (the grain ethanol plants also produce distillers grains, a high protein animal feed that is also imported into Canada to supplement domestic production).

Corn Production

The harvested corn area in Canada has been relatively constant over the past 30 years but increases in agricultural productivity have lead to an almost doubling of the total quantity of corn produced during that period (as shown in the following figure).

Figure 6: Canadian Corn Production



Ethanol production is now utilizing about 27% of the Canadian corn crop. Since the corn is grown on land representing about 2.6% of the managed agricultural land in Canada, less than 0.7% of Canadian managed agricultural land is being used for corn for ethanol production.

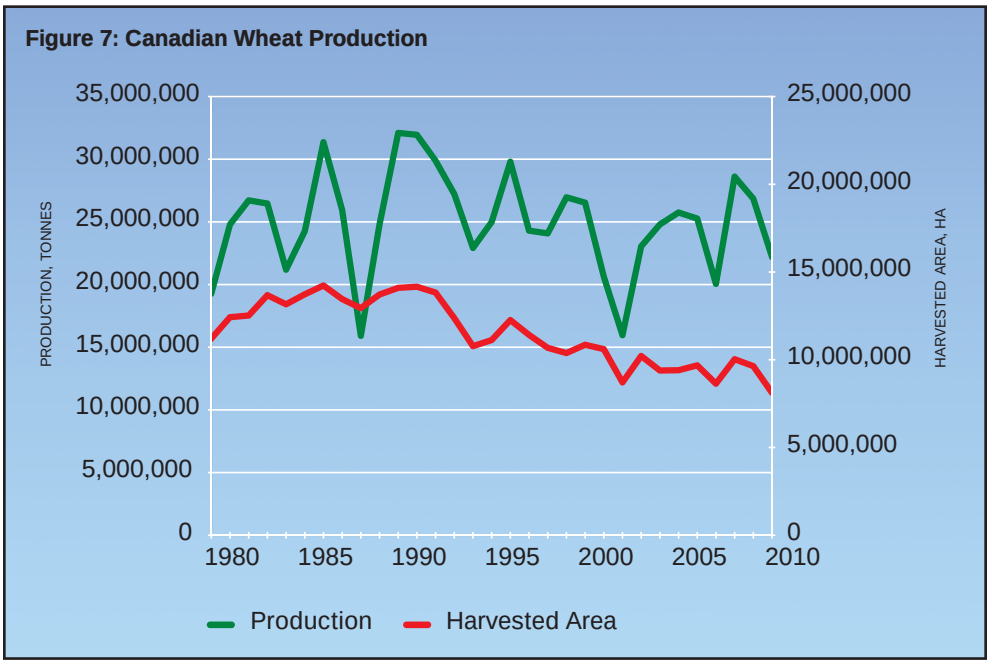
This land use amount is further reduced to about 0.4% of Canadian managed agricultural land on a net basis, by feed displacement (this is because corn and soybean meal can be displaced in animal feed rations by distillers dried grain from the ethanol plants).

Since 1980, average annual growth in corn production has been 2.0%, while average annual growth in the harvested area of corn has been 0.5%, demonstrating the yield gains in corn production.

Wheat Production

Harvested wheat area in Canada has been declining as producers adopt more sustainable crop production methods (as shown in the following figure). The wheat-fallow crop rotation has been replaced by a rotation that produces wheat every third or fourth year with canola, barley, and specialty crops such as peas now being an important part of the crop rotation.

Figure 7: Canadian Wheat Production



The quantity of wheat produced has not dropped at the same rate as the area due to increases in crop yields.

1.4 million tonnes of wheat represents about 5.7% of the average production over the past five years on a gross basis. The ethanol industry has a preference for high starch, low protein wheat and the average yield of this material has been 4.74 tonnes/ha over the past five years, 82% higher than the average yield for all wheat. Less than 300,000 ha of Canada's 45.5 million ha of managed agricultural land has been used on a gross basis and after accounting for the distillers grain co-product that is produced there has been little impact on the demand for agricultural land from the increased demand for ethanol feedstock. If the co-product is used as an energy source for livestock, the demand is about 0.4% of the managed agricultural land and if it is used as a protein source then the impact on land demand is essentially zero.

Ethanol Summary

The Canadian ethanol industry has developed rapidly over the past five years and is poised to meet the additional demand that will result from the 5% federal RFS requirement. Agricultural producers have invested in many of these plants directly with the ecoABC program. As well, other plants that were established before the ecoABC program was established also have significant producer involvement. Furthermore, the industry has enhanced rural economic development, as most of the facilities are located in rural areas.

The result of the Renewable Fuels Strategy (federal and provincial programs) has been the creation of a new domestic market for over 4 million tonnes of feedstock. This has been met through increased production on existing agricultural land (i.e. switching varieties of crops in the case of wheat, improving management practices, and the use of new varieties of corn).

GORD BROWN, MEMBER OF PARLIAMENT (LEEDS-GRENVILLE)

"Building a strong domestic renewable fuels industry means creating diverse market demand for our agricultural products and creating economic opportunities in rural communities, including Johnstown, Ontario, and its (GreenField Ethanol Inc.) ethanol plant in my riding of Leeds-Grenville. Our government is committed to delivering results for Canadian farmers and businesses and at the same time offering a new source of cleaner renewable energy to all Canadians." OCTOBER 27, 2010

The Canadian Biodiesel Industry

The Canadian biodiesel industry has not expanded as quickly as the ethanol industry, since the first provincially mandated market was only established late in 2009, about five years after the first ethanol mandates were introduced. Also, given that the federal 2% RFS requirement start date has not yet been announced, there is considerable uncertainty in the market.

Table 2: Canadian Biodiesel Plants

Plant	City	Province	Feedstock	Capacity (Million litres/yr)	Status
Bifrost Bio-Blends Ltd.	Arborg	MB	Canola	3	Operational
Biocardel Quebec Inc.	Richmond	QC	Multi-feedstock	40	Proposed plant
Bio-Lub Canada.com	St-Alexis-des-Monts	QC	Yellow Grease	10	Operational
BioStreet Canada	Vegreville	AB	Oilseed	22	Proposed plant
Bioversel Sarnia	Sarnia	ON	Multi-feedstock	170	Proposed plant
BIOX Corporation	Hamilton	ON	Multi-feedstock	66	Operational
BIOX Corporation	Hamilton Plant 2	ON	Multi-feedstock	67	Proposed plant
Canadian Bioenergy Corporation – Northern Biodiesel Limited Partnership	Lloyminster	AB	Canola	265	Proposed plant
City-Farm Biofuel Ltd.	Delta	BC	Recycled oil/tallow	10	Operational
Consolidated Biofuels Ltd	Delta	BC	Yellow Grease	10.9	Operational
Eastman Bio-Fuels Ltd.	Beausejour	MB	Canola	5	Operational
FAME Biorefinery	Airdire	AB	Canola, camelina & mustard	1	Demonstration facility
Kyoto Fuels Corporation	Lethbridge	AB	Multi-feedstock	66	Under construction
Methes Energies Canada	Mississauga	ON	Yellow Grease	5	Operational
Methes Energies Canada	Sombra	ON	Multi-feedstock	50	Under construction
Milligan Bio-Tech Inc.	Foam Lake	SK	Canola	1	Operational
Noroxel Energy Ltd.	Springfield	ON	Yellow Grease	5	Operational
QFI Biodiesel Inc.	St-Jean-d'Iberville	QC	Multi-feedstock	5	Operational
Rothsay Biodiesel, A member of Maple Leaf Foods Inc.	Sainte-Catherine	QC	Multi-feedstock	45	Operational
Speedway International Inc.	Winnipeg	MB	Canola	20	Operational
TRT-ETGO	Bécancour	QC	Vegetable Oil	100	Proposed plant
Western Biodiesel Inc.	Calgary	AB	Multi-feedstock	19	Operational

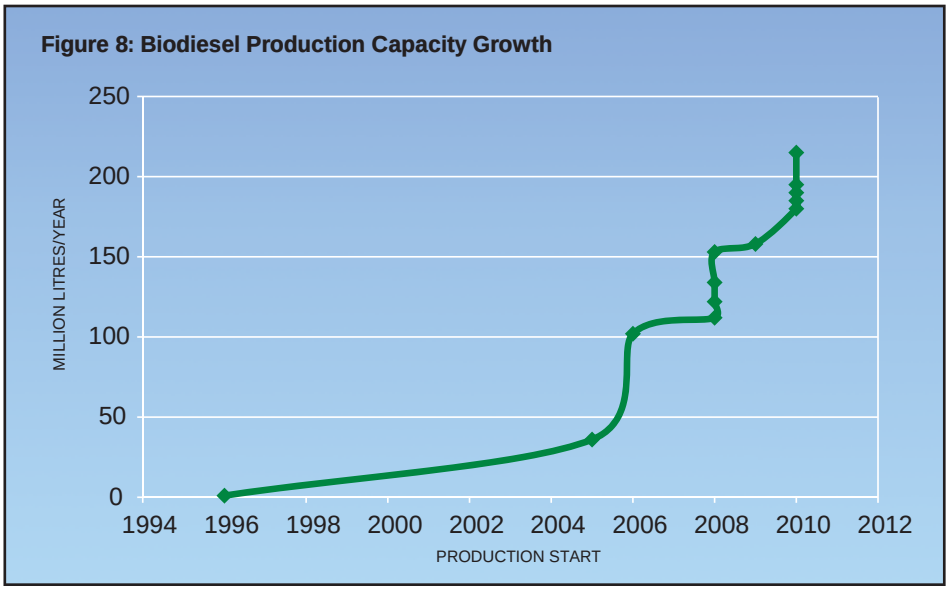
The City-Farm Biofuel plant and Western Biodiesel have received producer investments and a repayable contribution through the ecoABC program.

BIOX

BIOX, Canada's largest biodiesel company, designed, built, owns and operates a 67 million litre per annum nameplate capacity biodiesel production facility in Hamilton, Ontario. BIOX's innovative, proprietary and patented production process is significantly faster and achieves higher yields than competing methods while utilizing the widest variety of feedstocks ranging from pure seed oils to animal fats to recovered vegetable oils with no change to the production process. It is also the first public traded biodiesel company in Canada.

The following figure demonstrates the impressive growth in biodiesel production capacity over the past five years. This growth has been driven by the introduction of provincial mandates and the anticipation of the federal RFS.

Figure 8: Biodiesel Production Capacity Growth



Since 2005, average annual growth in biodiesel production capacity has been 140%. Most of the biodiesel produced to date in Canada has been produced from rendered animal fats and used cooking oils (yellow grease). Only a small quantity of biodiesel has been produced from canola oil. That said some Canadian canola oil has been shipped to the US to be transformed into biodiesel which is then shipped back to Canada to meet the demand in mandated markets.

Biodiesel Feedstocks

The production of 200 million litres of biodiesel from tallow and yellow grease requires about 190,000 tonnes of feedstock and the production of 270 million litres of biodiesel from canola oil will require about 575,000 tonnes of canola seed.

Canola Oil

Canola has become Canada's number one dollar-value crop over the past decade. The introduction of canola in western Canada and the concurrent development of markets for the oil and meal extracted from the seed have facilitated the transformation of agriculture in western Canada from the crop fallow rotation with full tillage to the continuous production system using no-till and conservation tillage systems. This transformation has dramatically improved the sustainability of agriculture in western Canada.

Canola production has reached 11 million tonnes per year in recent years. The industry has a plan to build the production to 15 million tonnes per year through both a small increase in planted area, and enhanced yields. At the same time it is working towards an increase in oil content in the seed. The projected biodiesel capacity based on canola oil will utilize about 4% of the canola crop. The industry is looking to progressively place as much as 17% of the crop into the biodiesel market worldwide, while still satisfying the market for food oils.

Tallow/Yellow Grease

Good quality data on the availability of animal fats and waste oils is difficult to obtain but it is believed that there are about 400,000 tonnes of material produced per year in Canada. It is expected that the biodiesel market in Canada may create a market for 50% of this production if the expected demand for biodiesel materializes through the establishment of mandate markets. Since historically a significant portion of this has been exported, the tallow/yellow grease industry welcomes the availability of a domestic market for this material.

Biodiesel Summary

The Canadian biodiesel industry has responded to the various government initiatives but not to the same degree as the ethanol sector. The primary reason for the slower start is the delay in introducing the market mandates. Fuel suppliers have been unwilling to commit to the use of biodiesel in advance of the 2% federal RFS requirement. Biodiesel that has been produced by existing plants in Canada has been marketed internationally, but for the industry to fully meet its potential, a domestic Canadian market must be established. The year 2010 saw the start of provincial markets in BC and Manitoba, but a significant portion of the supply for these markets is being provided by foreign producers. In at least one case, Canadian feedstock is going to the US for conversion into biodiesel and then moving back to Canada to supply the market demand.

Economic Impact of the Canadian Biofuels Industry

Ethanol Industry Impacts

There are 15 commercial ethanol plants in Canada devoted to transport fuels, either operating or under construction. (One relatively small additional commercial plant also exists, but is considered as providing alcohols for industrial purposes, rather than transport fuel, and was not included in this analysis).

There is also currently one ethanol plant in Canada (Ottawa) that is focused on doing R&D for producing ethanol from cellulosic waste. This process is not yet fully commercial, but this plant was included in this impact analysis, meaning that the analysis aggregated the economic impact of 16 ethanol plants.

Two or three more plants are believed to exist or planned to be soon under construction in Canada, as new-process pilot projects, or for R&D on new approaches to operations and processes. These plants were not included in this analysis because of the limited information presently available. Subsequent impact analyses may be able to include them.

Ethanol plants in Canada range in size from approximately 12.5 million litres per year output (12.5 MLY) to 225 million litres per year output. (In certain cases, it is feasible to build two plants close together, so as to achieve approx. 400-450 MLY output, which is being done in one Canadian location.)

In eastern Canada (Ontario and Quebec), the feedstock for ethanol plants is corn. One tonne of corn will provide enough feedstock to produce 400 litres of ethanol. This is typically grown locally, but Canada does import corn, some of which goes to provide feedstock (either directly or indirectly) for eastern Ontario and Quebec ethanol plants. Imported feedstock represents a loss to the Canadian economy, and has to be taken into account when calculating economic impact.

A major benefit of ethanol in eastern Canada is that it substitutes for gasoline that would otherwise have to be imported. This benefit can be calculated in renewable fuels' favour. (In fact, it substitutes for higher-value premium gasoline, but that benefit has been ignored here).

In western Canada (Manitoba to Alberta), the usual feedstock for ethanol is wheat. One tonne of wheat will provide enough feedstock to produce 375 litres of ethanol. Canada is a net exporter of wheat; no imports are required for wheat feedstocks.

In western Canada, ethanol production represents refined product that would otherwise require crude oil to produce. The use of ethanol allows for additional oil exports, and is a benefit offered by renewable fuels in the western part of the country.

Construction Impacts

Early in 2010, the CRFA commissioned Doyletech Corporation to undertake a detailed analysis of the economic benefits to Canada provided by the Canadian renewable fuels industry.[18]

For the 16 plants that were studied the results are presented in the following table. The plants represent 1.75 billion litres of production capacity.

Table 3: Construction Phase Impacts – Ethanol Plants

Characteristic	Result
Jobs	13,420 person-years
Capital Investment	$1,959,998,000
Net Economic Activity in Canada	$2,600,214,000
Municipal Taxes	$91,872,000
Provincial Taxes	$468,305,000
Federal Taxes	$638,714,000
Total Taxes	$1,198,891,000

The construction of these ethanol plants has resulted in significant employment in Canada in the equipment manufacturing and construction industries. The direct and indirect payments to the three levels of government have also been significant.

Some of the 16 operating plants benefited from repayable contributions from provincial and federal governments but the total value of these contributions (approximately $200 million) is much less than the benefits that the three levels of government received from the construction of these plants. The ratio of benefits to costs is approximately six to one, even in the unlikely event that none of the money was repaid.

18 For full details on the Doyletech analysis, see www.greenfuels.org/uploads/documents/01_doyletech_total.pdf

Operating Impacts

These 16 ethanol plants have created 783 direct and indirect jobs, many of which are in rural Canada. The net benefits that flow to governments total 180 million dollars per year and represent about 10 cents/litre of ethanol produced. This is above the tax revenue that the government receives on the ethanol itself when it is blended with gasoline. While one could argue that this tax revenue would have been received anyway on the gasoline, the fact that all fuel tax is done on a volume basis and not on an energy basis means that the government collects 40 to 50% more tax on ethanol than they collect on gasoline. This amounts to an additional revenue stream of about $170 to $212 million per year (or an additional 10 to 12 cents per litre of ethanol).

The results are summarized in the following table.

Table 4: Operations Phase Impacts – Ethanol Plants

Characteristic	Gross Benefit	Opportunity Cost	Net Benefit
Jobs	783	0	783
Net Economic Activity in Canada	$1,574,182,000	$544,715,000	$1,029,467,000
Municipal Taxes	$9,087,000	$0	$9,087,000
Provincial Taxes	$133,357,000	$41,510,000	$91,847,000
Federal Taxes	$107,060,000	$27,236,000	$79,824,000
Total Taxes	$249,504,000	$68,746,000	$180,758,000

Biodiesel Industry Impacts

There are 12 biodiesel plants operating or planned for being under construction in 2010, and the Doyletech analysis involved aggregating the economic impacts of these 12. Commercial biodiesel plants currently in operation in Canada range in size from approximately 1 million litres per year output to 66 million litres per year output; however, one larger plant is currently under development in western Canada with an annual capacity of 225MLY. This latter plant was included.

In eastern Canada (Ontario and Quebec), the feedstock for biodiesel plants is usually animal fats. Alternative feedstocks include used vegetable oil and tallow. While variable, one tonne of such material will provide enough feedstock to produce in the range of 1,200 litres of biodiesel. This feedstock can typically be sourced locally. However, there is a small market for such material and, to the limited extent that it could otherwise be exported or re-sold elsewhere in Canada; it could represent an opportunity cost loss to the Canadian economy. Within certain limits, this should be taken into account when calculating net economic impact.

Biodiesel provides the same major benefit that ethanol provides in eastern Canada – it substitutes for diesel fuel that would otherwise have to be imported. This benefit can be calculated in renewable fuels' favour.

In western Canada (Manitoba to Alberta), the usual feedstock for biodiesel is oil derived from canola. One ton of canola oil will provide enough feedstock to produce 1,100 litres of ethanol. Canada is a net exporter of canola and, therefore, no imports are required for canola feedstocks. However, the feedstocks for biodiesel plants do represent lost canola exports. The "opportunity costs" of lost canola exports has to be taken into account in defining the net economic benefits of biodiesel plants. Biodiesel plants benefit canola farming for a variety of technical reasons. It is not as simple as the calculation of lost wheat exports. By having the steady market for canola implied by biodiesel plants, farmers can plant canola in a useful way for crop diversity. The alternative to growing canola for biodiesel might not be canola exports but, rather, leaving ground to lie fallow. A viable biodiesel industry will provide the canola industry an important domestic market for their oilseeds, domestic markets will not be subject to the economic and political risks of international markets that can shut without warning as shown by the recent market disruptions in China, the European Union and the United States.

In western Canada, biodiesel production represents refined product that would otherwise require crude oil to produce. Additional oil exports are possible, and are a benefit that renewable fuels offer in the western part of the country.

TONY GALASSO, CHIEF OPERATING OFFICER, SANIMAX

"Sanimax is a major service provider to the food and restaurant industries in greases and cooking oils. Products collected from these industries are transformed into a high quality agricultural feed source. Our Deforest Wisconsin operation also produces a superior biodiesel from a variety of these feed sources.

Our biodiesel is capable of exceeding the industry's most stringent quality standards. We are proud of what we have created here in Deforest: superior services that have a positive impact on the environment, quality products that reduce green house gas emissions and, green jobs that employ the citizens of the USA while providing a renewal fuel to our customer base nationwide supporting a greener tomorrow."

Construction Impacts

For the 12 plants that were studied the results are presented in the following table. The plants represent 471 million litres of production capacity.

Table 5: Construction Phase Impacts – Biodiesel Plants

Characteristic	Result
Jobs	757 person years
Capital Investment	$366,990,000
Net Economic Activity in Canada	$348,952,000
Municipal Taxes	$8,363,000
Provincial Taxes	$23,830,000
Federal Taxes	$41,149,000
Total Taxes	$73,342,000

The construction of these biodiesel plants has resulted in significant employment in Canada in the equipment manufacturing and construction industries. The direct and indirect payments to the three levels of government have also been significant.

Some of the 12 operating plants benefited from repayable contributions from provincial and federal governments but the total value of these contributions (approximately $1 million) is much less than the benefits that the three levels of government received from the construction of these plants. The ratio of benefits to costs is approximately seventy five to one, even in the unlikely event that none of the money was repaid.

Operating Impacts

The 12 biodiesel plants have created 255 direct and indirect jobs, many of which are in rural Canada. The net benefits that flow to governments total 54 million dollars per year and represent about 11.5 cents/litre of biodiesel produced. This is above the tax revenue that the government receives on the biodiesel itself when it is blended with diesel.

The results are summarized in the following table.

Table 6: Operations Phase Impacts – Biodiesel Plants

Characteristic	Gross Benefit	Opportunity Cost	Net Benefit
Jobs	255	0	255
Net Economic Activity in Canada	$565,144,000	$121,430,000	$443,714,000
Municipal Taxes	$5,017,000	$0	$5,017,000
Provincial Taxes	$18,126,000	$1,127,000	$16,999,000
Federal Taxes	$38,375,000	$6,356,000	$32,019,000
Total Taxes	$61,518,000	$7,483,000	$54,035,000

Potential Cost Savings to Canadian Consumers

Over the past 5 years (2006-2010), wholesale prices of gasoline in Canada have averaged $0.624/litre (2007$). Wholesale gasoline prices have increased at a real average annual rate of 2.5% over the last 5 years, and 4.4% over the last 10 years.

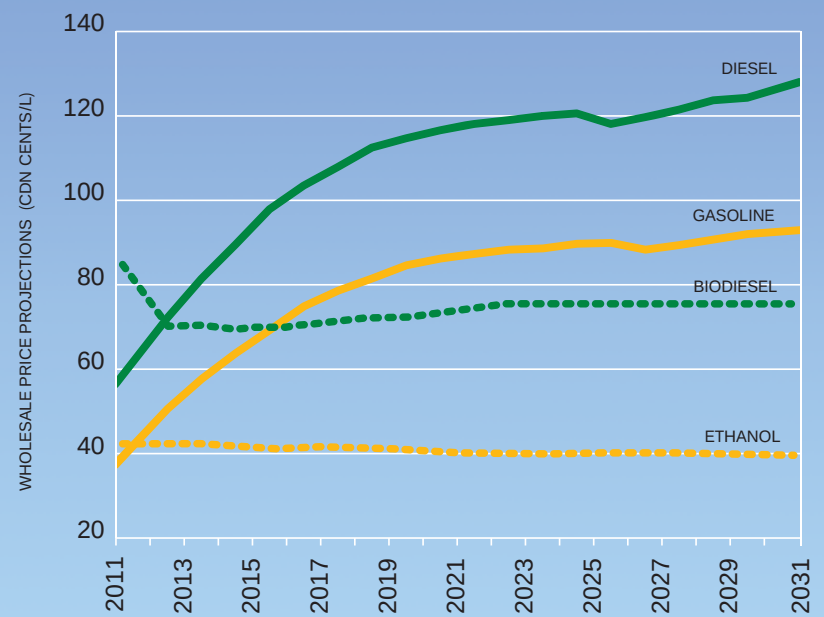
Ethanol prices have averaged $0.435/litre (2007$) in 2010, which is $0.189/litre or 31% less than gasoline. Over the past 5 years, ethanol prices have averaged 6.6% less than gasoline, or a per-litre cost advantage of $0.041 (2007$). And ethanol prices have been decreasing at a real average annual rate of 3.5% over the past 5 years.

HEATHER LAWLESS, EXECUTIVE DIRECTOR, GRENVILLE COMMUNITY FUTURES DEVELOPMENT CORPORATION

"One of the most significant impacts on the economy of Grenville County in recent years has been the opening of the GreenField Ethanol plant in Johnstown. When GreenField Ethanol commenced operations at the Johnstown plant in December 2008, close to 50 new jobs were created in the community after having up to 300 contractors on site during the construction phase. GreenField Ethanol's Johnstown facility continues to grow the local economy and the renewable energy sector in Eastern Ontario."

The figure below shows the US EPA's projected prices for gasoline, ethanol, diesel and biodiesel, showing the significant cost advantage of biofuels over the next 20 years.

Figure 9: U.S. EPA 20-Year Wholesale Price Projections



Source: Price data from the Final Regulatory Impact Analysis prepared for the Renewable Fuel Standard Program (RFS2): Final Rule, published March 26, 2010, at www.epa.gov/otaq/fuels/renewablefuels/regulations.htm.

The projected future cost advantages of ethanol and biodiesel could potentially save Canadian consumers $2.5 billion over the next 25 years (based on both federal and provincial RFS requirements) – if gasoline producers pass their cost savings on to consumers.

Also, consumers could incur significant cost savings if diesel fuel producers pass on potential cost savings that are expected to accrue to them (since under reasonable assumptions, the projected cost of biodiesel for fuel producers will be less than the projected cost of diesel fuel over the next 25 years).

ENERKEM

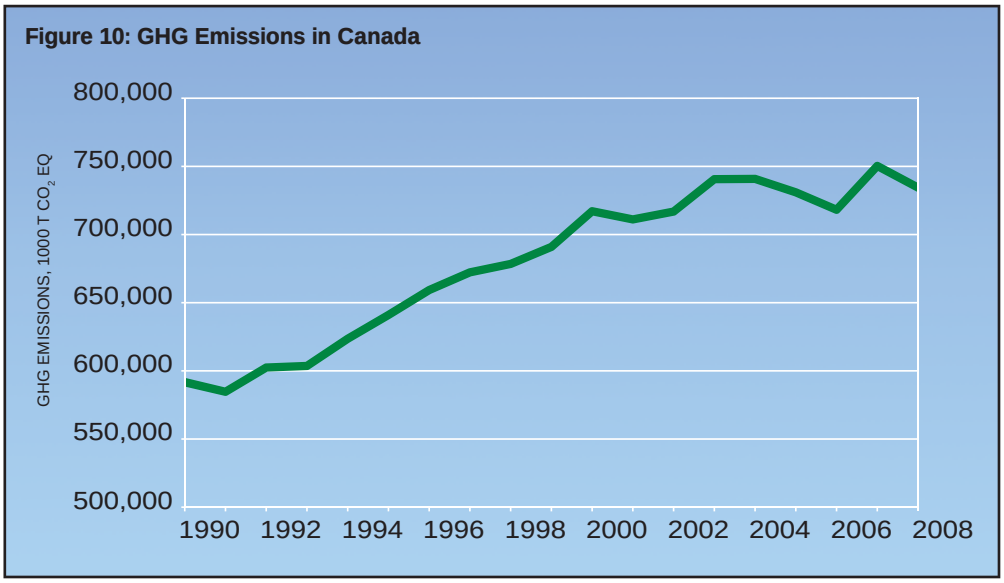
Enerkem is a world leading waste-to-biofuels and chemicals company that manufactures, owns and operates community-based advanced bio refineries founded on its proprietary thermo-chemical technology, developed in-house since 2000. Enerkem's technology converts residual materials, such as non-recyclable municipal solid waste, into clean transportation fuels and advanced chemicals and green electricity. Enerkem currently operates two plants in Sherbrooke and Westbury, Quebec. It has recently started the construction of a municipal waste-to-biofuels plant in Edmonton, Alberta and is developing a similar project in the United States. Enerkem is a private company, majority-owned by institutional, clean-technology and industrial investors. Enerkem has received financial support from governments and agencies in Canada and in the United States.

Environmental Impacts of the Canadian Biofuels Industry

Canada's GHG Emissions Performance

The federal government is tackling climate change through a broad series of initiatives (see www.climatechange.gc.ca). There are a number of actions on GHG emissions related to transport. These, and many other government, private sector and individual initiatives have finally helped Canada turn the corner on GHG emissions as shown in the following figure.

Figure 10: GHG Emissions in Canada



The transportation sector accounted for 27.0% of Canada's emissions in 2008. Emissions in the transportation sector rose by about 53 Mt, or 36.6% from 1990 to 2008. At the same time Canada's overall emissions increased by only 24.1% and emissions due to energy use rose by just 27.3%.

Of particular note in this sector is a 24.1 Mt increase – more than 116% – in the emissions from light-duty gasoline trucks, reflecting the growing popularity of sport utility vehicles. Emissions from heavy-duty diesel vehicles increased 18.7 Mt over the period, indicative of greater heavy truck transport. The information on these three sectors is summarized in the following table.

Table 7: Canada's GHG Emissions Performance

Source Categories	1990	2004	2006	2008	1990 to 2008 (Change)	
	kt CO_2 eq				Absolute	Percent
Total	592,000	741,000	718,000	734,000	142,000	24.0%
Energy	469,000	603,000	582,000	597,000	128,000	27.3%
a. Stationary Sources	281,000	349,000	324,000	335,000	54,000	19.2%
b. Transportation	145,000	188,000	191,000	198,000	53,000	36.6%

The challenge to reduce greenhouse gases by 20% from 2006 levels by 2020 is great.

In order to reduce the GHG emissions from the transport sector one can reduce fuel use through improved fuel efficiency, change the demand for fuel, or change to a fuel or fuel and engine technology that has a lower carbon footprint. There are a number of government actions underway, in all categories, directed towards the transportation sector.

In the following sections we highlight federal and provincial biofuel programs that have been implemented to address GHG emissions from the transport sector.

Federal Renewable Fuels Strategy

The federal government has developed a comprehensive Renewable Fuels Strategy for the development of renewable fuels in Canada.[19] The strategy is designed to:

1. Reduce the greenhouse gas (GHG) emissions resulting from fuel use,
2. Encourage greater production of biofuels,
3. Accelerate the commercialization of new biofuel technologies, and
4. Provide new market opportunities for agricultural producers and rural communities.

There are four primary actions that the government has put into place to achieve these objectives:

1. Increasing the retail availability of renewable fuels through regulation. The Federal Renewable Fuel Regulations (passed into law on September 1, 2010) which require 5% renewable content in gasoline will take effect starting December 15, 2010. A start date for the 2% renewable content in diesel and heating oil has not yet been set, but the government has committed to implementing this requirement by 2011.
2. Supporting the expansion of Canadian production of renewable fuels: The 2007 ecoENERGY for Biofuels Initiative will invest up to $1.5 billion over nine years to boost Canada's production of renewable fuels. This initiative provides operating incentives to producers of renewable fuels based on production levels and other factors. It makes investment in production facilities more attractive by partially offsetting the risk associated with fluctuating feedstock and fuel prices. The program has received more applications than it is capable of funding – evidence of Canadian renewable fuel producers' commitment to develop a thriving, successful industry in this country.
3. Assisting farmers to seize new opportunities in this sector. The 2007 ecoAGRICULTURE Biofuels Capital Initiative (ecoABC) is a $200 million program that provides repayable contributions of up to $25 million per project to help farmers raise the capital necessary for the construction or expansion of biofuel production facilities.
4. Accelerating the commercialization of new technologies. In 2007, $500 million was made available (over eight years) to Sustainable Development Technology Canada (SDTC) to invest with the private sector in establishing large-scale facilities for the production of next-generation renewable fuels.[20]

Provincial Renewable Fuel Policies

British Columbia

In 2008, BC set an objective to lower greenhouse gases emissions by 33% by 2020. Two blueprints spell out these objectives – BC Energy Plan (2007), and BC Bioenergy Strategy (2008).

As of January 2010, the province requires provincial annual average of 5% renewable content in gasoline sold in British Columbia. As for diesel, the provincial annual average requirement will reach 5% by 2012.

Fuel with at least 85% ethanol, natural gas and propane (effective July 1, 2010) when used in a motor vehicle are exempt of the Motor Fuel Tax Act.

Incentive programs encourage: the development and marketing of wood-to-bioenergy technologies; liquid biofuels (two projects use woody biomass to produce cellulosic ethanol); clean energy ($25 million per year).

ROGER SMITH, FLEET CHALLENGE ONTARIO

"Renewable fuels for transportation must be part of our carbon reduction plans in Canada. Biodiesel has a history of success in Canadian fleets over the past decade and fuel ethanol is part of the Canadian reality. The positive environmental and associated economic benefits that E85 (85% ethanol) has delivered in other jurisdictions such as Brazil need to be brought to Canada without undue delay."

OCTOBER 27, 2010

19 See Renewable Fuels Strategy at http://www.ecoaction.gc.ca/ecoenergy-ecoenergie/renewablefuels-carburantsrenouvelables-eng.cfm

20 Next-generation renewable fuels, produced from non-food feedstocks such as wheat straw, corn stover, wood residue and switchgrass, have the potential to generate even greater environmental benefits than traditional renewable fuels. Canada is well positioned to become a world leader in the development and commercialization of next-generation fuels.

Alberta

In 2006, the province announced a nine-point bioenergy plan, followed in 2008, by the Alberta Energy Strategy.

As of April 2011, Alberta will require 5% ethanol content in gasoline and 2% in diesel.

Certain programs which end in 2011 have supported bioenergy projects with grants totaling approximately $150 million. Another program, the $75 million Bioenergy Producer Credit Program (PCP) runs to 2016. This program focuses on the potential for second generation ethanol, which uses feedstocks like forestry, agricultural and municipal waste.

Saskatchewan

Saskatchewan's "Go Green" strategy includes developing E85 (fuel blends with 85% ethanol and 15% gasoline), developing a 1.4 billion litre biofuels industry in Saskatchewan.

Saskatchewan requires 7.5 % ethanol in gasoline.

Programs include SaskBio: An $80 million loan program that encourages investment ownership in biofuels facilities.

Manitoba

Manitoba has various incentives to promote the development of its biofuels industries.

As of 2008, Manitoba put in place a 5% ethanol requirement for the first quarter of the year and moving to 8.5 % for the remainder of 2008 and subsequent years.

Programs include direct producer grants for ethanol produced in Manitoba.

Ontario

Ontario accounts for 66% of Canada's ethanol production capacity. The province's successful ethanol strategy was comprised of two components: a renewable fuels standard and the Ontario Ethanol Growth Fund ("OEGF", announced in 2005). The OEGF program provides for both capital and operating grant support. The operating support is variable, based on prevailing commodity values for crude oil, ethanol, and corn.

As of 2007, Ontario required a minimum 5% ethanol content and biodiesel used in a licensed motor vehicle is exempt from Ontario fuel tax. By the end of 2010, ethanol demand in Ontario will surpass 1 billion litres per year.

Quebec

Quebec's focus is on the development of cellulosic ethanol. Enerkem and GreenField Ethanol have formed a consortium to construct a 'waste-to-ethanol' thermochemical plant to be integrated with GreenField's first generation grain ethanol plant at Varennes, Quebec.

Quebec currently has no mandate in place for renewable fuel content in gasoline.

Programs include a 2008 refundable tax credit for ethanol producers for use in Quebec. It began April, 2006 and expires in 2018, and a Green Technologies Demonstration Program which funds innovative greenhouse gas reduction technologies.

Atlantic Canada

Some pulp and forest product companies are exploring the integrated biorefinery approach and/or direct cellulose-to-ethanol production. Governments and the private sector are evaluating biomass availability and bioenergy technologies available to the forestry sector.

Nova Scotia is the only province to include a tax credit on biodiesel.

GERRY RITZ, MINISTER OF AGRICULTURE AND AGRI-FOODS AND MINISTER FOR THE CANADIAN WHEAT BOARD

"Support for renewable fuels is support for farmers, rural communities and our economy," said Agriculture Minister Gerry Ritz. "This is a vital step in generating new market opportunities for our farmers and maximizing Canada's high quality resources to produce food and fuel for the world."

SEPTEMBER 1, 2010

Biofuels GHG Emissions Performance

There has been considerable debate over the lifecycle GHG emissions benefits of biofuels. Most of the differences between various studies and reports can be easily explained.

Life cycle assessment (LCA) is a "cradle-to-grave" (or "well to wheels") approach for assessing industrial systems and their products. "Cradle-to-grave" begins with the gathering of raw materials from the earth to create the product and ends at the point when all materials are returned to the earth. LCA evaluates all stages of a product's life from the perspective that they are interdependent, meaning that one operation leads to the next. LCA enables the estimation of the cumulative environmental impacts resulting from all stages in the product life cycle, often including impacts not considered in more traditional analyses (e.g., raw material extraction, material transportation, ultimate product disposal, etc.). Specifically, LCA is a technique to assess the environmental aspects and potential impacts associated with a product, process, or service, by:

- Compiling an inventory of relevant energy and material inputs and environmental releases;
- Evaluating the potential environmental impacts associated with identified inputs and releases;
- Interpreting the results to help make more informed decisions.

Numerous LCAs of biofuels have been published (reviews include Fleming et al. 2006 and Larson 2006), with a wide range of results.

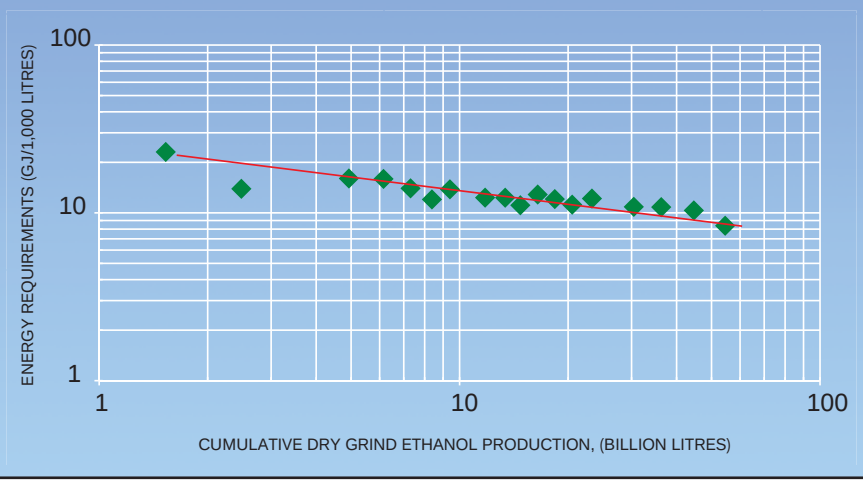
Key issues in biofuel LCAs have been differing boundaries being adopted in studies (i.e., what activities are included/excluded from the study), differences in data being collected and utilized, and disparities in the treatment of co-products. Boundaries in prior LCAs have often differed due to resource constraints. Data requirements in LCA are significant. Studies have not always used up-to-date data or data that reflect the inputs in the relevant process under study (i.e., utilization of electricity generation data for another jurisdiction rather than the one under study). There are also gaps in scientific knowledge surrounding key variables. For example, these include implications of land use change, N_2O emissions related to feedstock production, and nutrient depletion and erosion due to agricultural residue removal. Most biofuel production processes produce several products [e.g., the production of distillers dried grain from the ethanol production process]. Including co-product credits often significantly improves the environmental performance of many fuel pathways. Utilization of different co-product methods, and in some studies, ignoring co-products entirely, has had major impact on results of LCA studies (Kim and Dale 2002, Larson 2006, Farrell et al. 2006).

There is only one LCA model that uses Canadian energy data, has all of the applicable biofuels pathways of commercial interest in Canada, has current information on all of the energy sectors, and considers all sources of GHG emissions. This is the Natural Resources Canada GHGenius model. Other models that are often used to analyze biofuels emissions performance include the US GREET model. These other models have limitations in that they do not contain any Canadian data, do not consider Canadian feedstock such as canola or wheat, often utilize data that is decades old, require the user to make decisions concerning how co-products are evaluated, and don't always include all emissions sources and sinks.

Why is Canada Different?

Just as no two people are identical, it is unrealistic to think that two different analyses of the GHG emissions of biofuels that are undertaken in different regions at different times and sometimes with different technologies would produce the same results. What is important is that biofuels are *compared to* a reference scenario (rather than being analyzed on their own), the biofuel system and the reference system should *have comparable system boundaries* (same parts of the process included), and the data should be from the *same time frame*.

Figure 11: Ethanol Plant Energy Consumption



The performance demonstrated by the ethanol industry in reducing the energy costs is fully consistent with all of the experience curve knowledge gained in other industries and in fact is the expected performance given our understanding of how industries develop.

A recent survey on ethanol energy use undertaken in the United States (Mueller, 2010) indicated that dry mills in 2008 used only 8.1 GJ of natural gas/m^3 per ethanol produced, with a range from 5.2 to 11.0 GJ/m^3. The large range is probably a function of the amount of co-product sold wet vs. dry.

A survey undertaken by the CRFA of corn ethanol producers in Canada in 2009 found that the average energy use was 8.5 GJ of natural gas/m^3 per ethanol produced, with a range of 7.8 to 10.3. These results are very similar and indicate that the Canadian industry is as efficient as the larger and more experienced US industry.

Ethanol GHG Emissions

When the GHG emissions from biofuels are considered it is important that they are compared to the reference system in an appropriate way. Many studies have made the assumption that different fuels can be compared on the basis of their energy content but because no two fuels behave in the same manner in an engine this is not the best approach. Some fuels will combust with lower efficiency that gasoline and others can exhibit a slightly higher efficiency in an engine. The differences can be caused by both the fuel characteristics and the engine design and characteristics. GHGenius compares energy systems on the basis of distance driven. This approach takes into account any engine efficiency issues that are created by the different fuels.

Ethanol contains less energy that gasoline on a volumetric basis but fuel economy tests undertaken in a very controlled environment by researchers, automobile manufacturers, and governments have found that low level ethanol blends, such as E10, provide slightly better fuel economy on an energy basis. Whereas an E10 blend would be expected to provide about 3.5 to 3.7% less fuel economy than gasoline, the test results show that the actual reduction is often in the range of 1.0 to 2.5%. In GHGenius, the conservative end of the range is used for modeling (Hochhauser, et al., 1993, Ragazzi et al., 1999).

Cheminfo Services undertook an independent analysis of the GHG emissions from Canadian biofuel plants in 2009. They used GHGenius version 3.16 and data supplied by eight of the Canadian producers for the period April 2008 to March 2009. These plants used both wheat and corn as their feedstocks. Their findings are summarized in the following table.

Table 8: GHG Emissions Canadian Ethanol Producers

General fuel	Gasoline[21]	Ethanol
Fuel spec (feedstock)	30ppm S (crude oil)	E10
	g CO_2 eq/l fuel	
Vehicle operation	2,164	2,141
C in end-use fuel from CO_2 in air	0	-143
Net Vehicle Operation	2,164	1,997
Fuel production	445	474
Feedstock production	358	369
Total	2,967	2,840
Reduction compared to gasoline		127
% reduction due to ethanol		62

It can be seen from the table that corn and wheat ethanol, even though they are first generation biofuels, provide a significant reduction in GHG emissions compared to the average Canadian gasoline. The reductions would be even larger if the comparison were made to gasoline produced from oil sands.

Extrapolating these results to a 2 billion litre per industry will result in GHG reductions of 2.5 million tonnes per year, or about 2.7% of the gasoline vehicle emissions in the National Inventory.

21 Gasoline energy content has been adjusted to provide equivalent mileage to E10.

Biodiesel GHG Emissions

Cheminfo Services undertook a review of Canadian biodiesel plants in their 2009 analysis. They used GHGenius version 3.16 and data supplied by three of the Canadian producers for the period April 2008 to March 2009. These plants used animal fats and waste grease as their feedstocks. Their findings are summarized in the following table.

Table 9: GHG Emissions Canadian Biodiesel Producers

General fuel	Diesel[22]	Biodiesel
Fuel spec (feedstock)	30ppm S (crude oil)	B5
	g CO_2 eq/l fuel	
Vehicle operation	2,710	2,709
C in end-use fuel from CO_2 in air	0	-125
Net Vehicle Operation	2,710	2,584
Fuel production	351	401
Feedstock production	402	314
Total	3,463	3,299
Reduction compared to diesel		164
% reduction due to biodiesel		99

The GHG emission reductions achieved by biodiesel are quite large, ranging from 2.69 to 3.45 kg of CO_2 eq/litre of biodiesel produced and consumed. Six-hundred million litres of biodiesel can be expected to produce a 1.5 to 2.0 million tonne reduction in GHG emissions.

Value of Environmental Benefits to Canadians

The estimated values for GHG reductions (known as the Social Cost of Carbon, or SCC) used around the world vary significantly, and are fraught with problems that are the subject of much debate in the academic literature.[21] CRFA estimates of the value of GHG reductions to Canadians, using a range of possible values for SCC that is consistent with the peer-reviewed literature results in over $10.7 billion worth of benefits to Canadians over the next 25 years from GHG reductions (based on both federal and provincial RFS requirements for ethanol and biodiesel).

IOGEN

Established in the 1970s, Iogen Corporation has become a world leader in technology to produce cellulosic ethanol, a fully renewable, advanced biofuel from renewable feedstocks such as cereal straws and corn stover that can be used in today's cars. Iogen is a privately held company, based in Ottawa, Ontario with a rapidly growing work force. Since the late 1970s, more than $400 million CAD has been invested in Iogen Corporation and its activities related to cellulosic ethanol, including more than $65 million in the demonstration plant. Major investors include the Royal Dutch/Shell Group, Petro-Canada and Goldman Sachs. The company has approximately 300 permanent full-time employees.

22 These emissions are adjusted for the energy content difference between fossil diesel and biodiesel fuels.

23 A study by Richard Tol examined 211 estimates from 47 studies, and demonstrated the substantial uncertainty in SCC values. Tol found that the average SCC value from the 211 estimates is US$104.80 per tonne, but the distribution of the estimates is severely skewed so the median is considerably lower: US$29 /tonne. Overall the SCC estimates range from -US$6.60/tonne to US$2,400/tonne. The middle 50% of the estimates are found within the range of US$10 to US$90 per tonne. See Tol, R., "The Social Cost of Carbon: Trends, Outliers and Catastrophes," Economics (e-journal), Vol. 2, 2008.

In a 2008 study for the Economic and Social Research Institute, David Anthoff, Richard Tol and Gary Yohe conducted a systematic sensitivity analysis of SCC considering two parameters: the rate of pure time preference, and the rate of risk aversion. Their analysis showed that the social cost of carbon lies anywhere in between 0 and US$120,000/tC. However, when the two parameters were restricted to match observed behavior, an expected social cost of carbon of US$60/tC results. Correcting for income differences across the world, the social cost of carbon was estimated to be over US$200/tC. See "Risk Aversion, Time Preference, and the Social Cost of Carbon" at www.esri.ie/UserFiles/publications/20080904135651/WP252.pdf

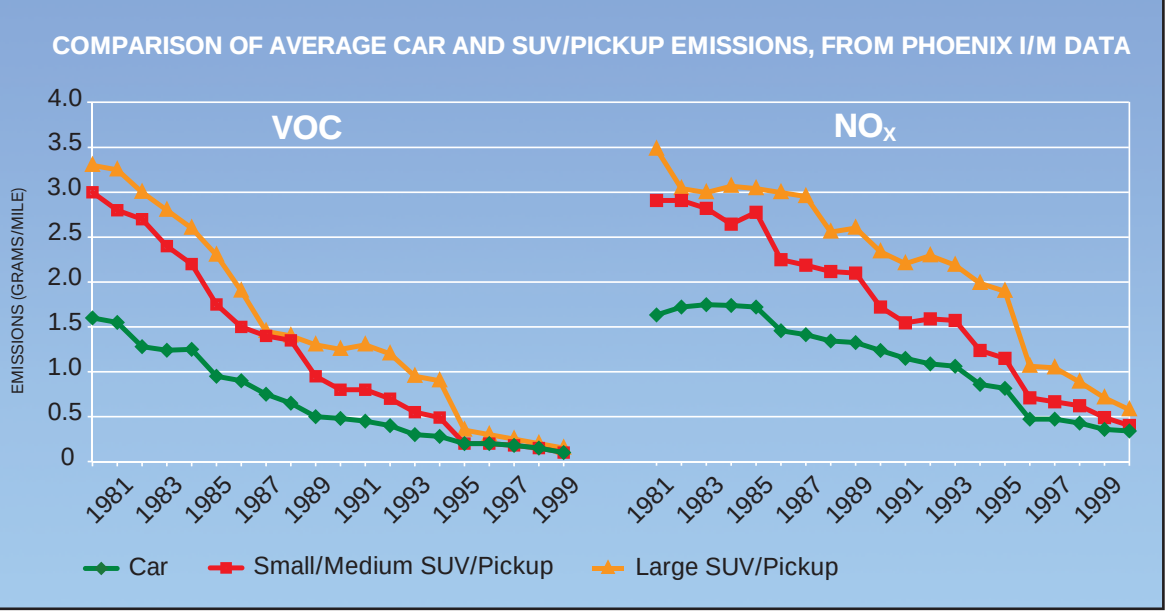
The most recent research into appropriate SCC values for Canada was prepared by the National Round Table on the Environment and the Economy (NRTEE) in its 2009 report Achieving 2050: A Carbon Pricing Policy for Canada. The NRTEE report estimated a range of SCC values from $18/tonne (short-term) to $775/tonne (long-term) that will be required to meet the Government of Canada's goals for GHG emission reductions.

In their analysis of the RFS2 regulations, the US EPA used a value of CAN$24/tonne (2007$) increasing at 3% per year (results in a value of over CAN$52 in 2034).

Other Air Emissions Benefits

The production and use of ethanol and biodiesel can provide greenhouse gas emissions reduction and air quality benefits. The exhaust emissions from vehicles are a function of the engine design and the fuel used in the engine. Great strides have been made by the automobile industry over the past 30 years in reducing the emissions from vehicles and new vehicles have reduced smog causing exhaust emissions by over 99% as shown in the following real world results. The fuel used by vehicles can also have some impact on emissions and air quality.

Figure 12: Improvement in Vehicle Emissions



Source: Based on IM147 test data collected in 2001. Data provided by Tom Wenzel, Lawrence Berkeley National Laboratory. Impact of Ethanol on Vehicle Emissions

Impact of Ethanol on Vehicle Emissions

In recent years some regions have also found some improvement in their air quality that coincided with their transition to low level blends of ethanol fuel. These regions include California, New York, Connecticut and Colorado. This benefit usually results from reduced emissions from the older vehicles on the road. Older vehicles typically contributed a larger share of the emissions related to their population share of vehicles.

Ethanol blended into gasoline can reduce the emissions from new vehicles but with the new vehicles being so clean the magnitude of the emission benefit is small. Test data from the US DOE emission evaluation of the impact of E15 on emissions from 2007 to 2009 vehicles is shown in the following table.

Table 10: Emissions Impact of E15

	CO	NOx	NMOG
	g/mile		
E0	1.19	0.051	0.053
E15	0.92	0.040	0.047
% Change	-22.7	-21.6	-11.3

Impact of Biodiesel on Vehicle Emissions

Biodiesel has passed a multi-tiered process for assessing the safety and health impacts arising from handling and combusting the fuel in the United States. The US EPA determined that biodiesel does not pose an unreasonable risk to public health. The findings of the health effects testing of biodiesel include:

- The overall ozone (smog) forming potential of the speciated hydrocarbon exhaust emissions from biodiesel is 50% less.
- The exhaust emissions of carbon monoxide (a poisonous gas and a contributing factor in the localized formation of smog and ozone) from biodiesel are 50% lower.
- The exhaust emissions of particulate matter (recognized as a contributing factor in respiratory disease) from biodiesel are 30% lower.

- The exhaust emissions of sulphur oxides and sulphates (major components of acid rain) from biodiesel are completely eliminated.
- The exhaust emissions of hydrocarbons (a contributing factor in the localized formation of smog and ozone) are 95% lower.
- The exhaust emissions of aromatic compounds known as PAH and NPAH compounds (suspected of causing cancer) are substantially reduced for biodiesel compared to diesel. Most PAH compounds were reduced by 75% to 85%. All NPAH compounds were reduced by at least 90%.

While biodiesel has been shown to increase NOx emissions in some steady state engine dynamometer testing, there is some uncertainty regarding the real world implications for two reasons. The first is that work with chassis dynamometer testing of biodiesel blends undertaken by the National Renewable Energy Laboratory (NREL) in the United States shows no clear trend in the direction of NOx emissions with varying biodiesel concentrations (Larson, 2006). Variables such as engine type, test cycle and vehicle size all appear to impact the emissions.

The other uncertainty is the impact of NOx on ozone emissions in many airsheds. NREL also found through extensive analysis of the time of day of emissions and the resulting impacts on air quality that reducing NOx emissions appears to increase the ozone levels in the atmosphere, the opposite reaction from what was expected. They concluded that reducing hydrocarbon emissions is a better strategy for improving air quality and they note that biodiesel blends clearly do decrease hydrocarbon emissions from diesel engines.

Value of Lower Air Emissions

The overall conclusion on health outcomes enunciated by the federal government in the Regulatory Impact Analysis Statement published with the RFS regulations on September 1, 2010, is that "there are no substantial differences in predicted health effects between use of conventional gasoline use and use of E10." However, the RIAS also provides, but does not elaborate on, some monetized health benefits to Canadians: "the total value of benefits associated with ozone, NO_2, $PM_{2.5}$, SO_2 and CO for all health endpoints was estimated to be less than $4 million in the East and $9.2 million in the West. The health benefit associated with E10 fuel use in 2010 compared to the conventional gasoline use for all endpoints was valued at $6.4 million for the West domain." These annual health benefits have a present value of over $340 million over a 25-year time horizon.

Lifecycle Energy Balances

Biofuels have been criticized for using more energy to produce them than exists in the fuels. While this might have been true for ethanol in the early 1980's it is certainly not true today. As shown earlier, the energy required to produce ethanol has been reduced to less than 25% of what it was when the fuel ethanol industry was first established. Similar improvements in performance have been made in feedstock production.

Lifecycle energy balances are calculated using the same models that are used to determine the GHG emission performance of fuels. The lifecycle energy balance for corn ethanol determined using the GHGenius model is shown in the following table, where it is compared to the typical; gasoline used in Ontario as well as to gasoline produced from in situ oil sands production. It can be seen that corn ethanol not only has a positive energy balance but the energy balance is better than that of gasoline produced from in situ oil sands crude oil.

Table 11: Energy Balance Corn Ethanol and Gasoline

	Ontario Average Gasoline	Ontario Gasoline SAGD Oil Sands	Corn Ethanol
	Joules consumed per joule delivered		
Fuel dispensing	0.0034	0.0034	0.0054
Fuel distribution, storage	0.0075	0.0084	0.0188
Fuel production	0.1864	0.2054	0.4877
Feedstock transmission	0.0237	0.0153	0.0461
Feedstock recovery	0.1100	0.4695	0.0821
Ag. chemical manufacture	0.0000	0.0000	0.0836
Co-product credits	-0.0009	-0.0088	-0.0670
Total	**0.3301**	**0.6933**	**0.6567**
Net Energy Ratio (J delivered/J consumed)	3.0291	1.4425	1.5229

The biodiesel energy balance can be calculated in the same manner. The results for biodiesel produced from animal fats and from canola oil are shown in the following table and compared to diesel fuels. Canola biodiesel has a better energy balance then the average diesel fuel in Ontario and much better than diesel fuel produced from in situ produced oil sands.

Table 12: Energy Balance Biodiesel and Fossil Diesel

	Ontario Average Diesel	Ontario Diesel SAGD Oil Sands	Tallow Biodiesel	Canola Biodiesel
	Joules consumed per joule delivered			
Fuel dispensing	0.0035	0.0035	0.0040	0.0040
Fuel distribution, storage	0.0077	0.0086	0.0071	0.0213
Fuel production	0.1283	0.1414	0.8543	0.1468
Feedstock transmission	0.0242	0.0157	0.0487	0.0126
Feedstock recovery	0.1124	0.4797	0.0000	0.0800
Ag. chemical manufacture	0.0000	0.0000	0.0000	0.1683
Co-product credits	-0.0009	-0.0088	-0.2723	-0.2096
Total	**0.2752**	**0.6401**	**0.6419**	**0.2235**
Net Energy Ratio (J delivered/J consumed)	3.6343	1.5623	1.5579	4.4748

Clearly, biofuels produced in Canada have a positive energy balance, very good GHG emission performance, and produce some exhaust emissions benefit when blended with fossil fuels.

The Canadian biofuels industry is on track to exceed the Government target of a 4 million tonne reduction in GHG emissions from the production and use of biofuels. Emission reductions for the biofuels are higher than originally anticipated due to the continual improvement in production technologies and process efficiencies. The target will be exceeded if the remaining portions of the RFS strategy are successfully implemented.

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