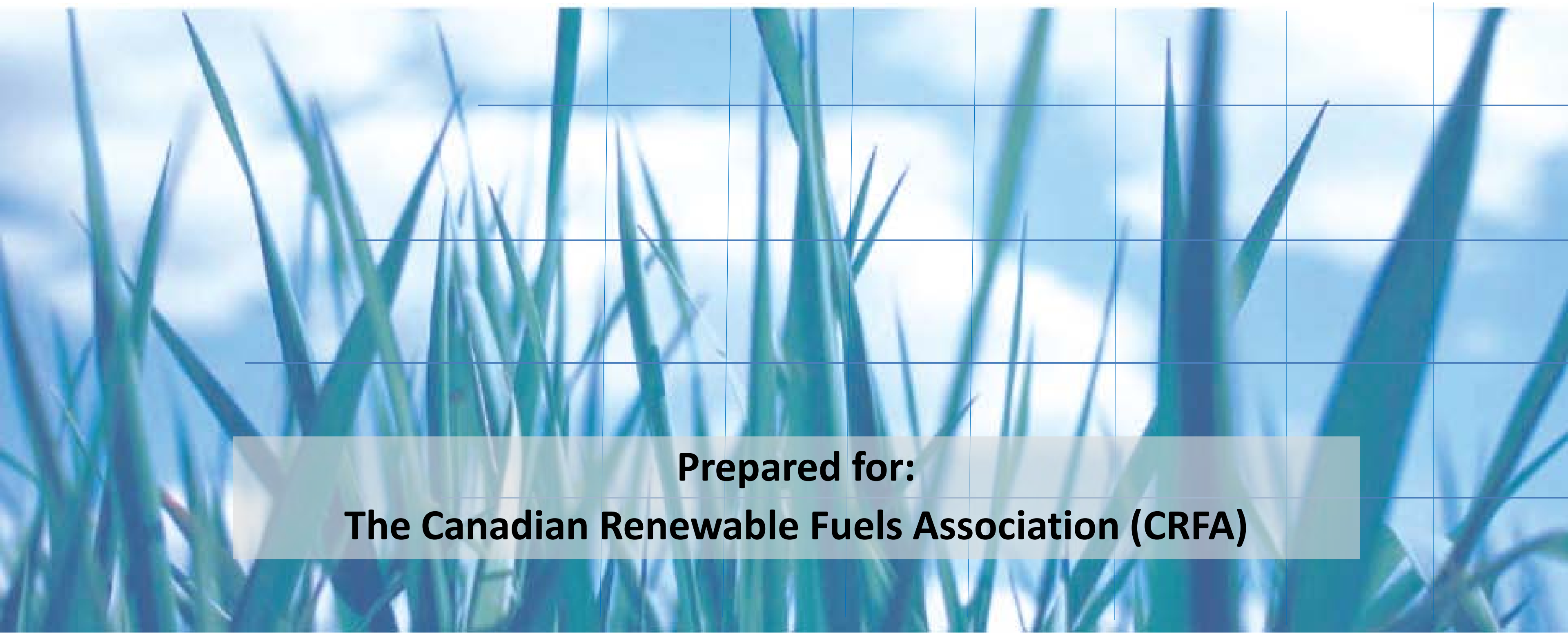
Total Economic Impact Assessment of Biofuels Plants in Canada



Prepared for:

The Canadian Renewable Fuels Association (CRFA)

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- Doyletech Corporation was contracted by the Canadian Renewable Fuels Association (CRFA) to develop a total economic impact assessment of renewable fuels investments in Canada.
- Doyletech employed its EconWin econometric model to develop total impact assessments for each of the 28 renewable fuels plants in Canada that are commercially operating or under construction in 2010, including one R&D facility, for which information was available.
- The model was run for both the Construction and Operating Phases for each plant. These results were in turn aggregated into the total economic impact of renewable fuels across Canada. The implications for Canada's trade in oil and refined products were included in the analysis.
- The Construction Phase total impact results are presented as "net" results. These take into account the so-called "opportunity costs" of construction investment.
- The Operating Phase total impact results are presented in both "gross" and "net" terms. The gross results are typical of economic impact analysis generally. However, the net results take into account the opportunity costs of alternate possibilities for feedstock sales.

Executive Summary: Total Economic Impact of Renewable Fuels Plants in Canada

- A key element in Doyletech's methodology is that all Construction phase benefits were calculated in terms of "net" gains. These Construction Phase results take into account the so-called "opportunity costs" of alternate investment opportunities.
- Accordingly, the Construction phase benefits calculated here should be interpreted as representing incremental benefits to the Canadian economy, above and beyond what would have happened anyway if the industry had not come into being.
- However, the Operating phase total impact results are presented in both "gross" and "net" terms. There are important differences between these two levels.
- The gross results include all the feedstock inputs to the 28 plants as a benefit of the renewable fuels industry. This is frequently how an economic impact analysis would be presented. Accordingly, for comparative purposes with other analyses, it is judged that the **gross** benefits may well be the more appropriate benchmarks.
- In contrast, the **net** results take into account the opportunity costs of alternate possibilities for feedstock sales. This is probably more realistic, but understandably is commonly overlooked in economic total impact assessments.
- As well, for the Operations Phase, we have calculated a hypothetical Net Present Value (NPV) of Operations for both gross and net benefits, based on 30 years of operations discounted at 8% annually. This is in accordance with federal government benchmarks.

Executive Summary: Total Economic Impact of Renewable Fuels Plants in Canada

- A key finding emerging from the research undertaken for this project was that Canadian industry is now able to supply the majority part of the capital plant and equipment required for renewable fuels plants; in turn this means that renewable fuels represent a highly-significant capability to enhance regional economies in Canada, and specifically rural areas can be re-vitalized.
- Renewable fuels represent a valuable off-set to the increasing Canadian imports of refined oil products in Eastern Canada, and they also allow expanded Canadian exports of crude oil from Western Canada.
- The positive results from these calculations suggest that Canadian investment in renewable fuels continues to represent an important strategic industrial development option for Canada.

Executive Summary: Total Economic Impact of Renewable Fuels Plants in Canada – Construction Phase

- The construction of **28** renewable fuels plants in Canada, at 2010 replacement cost prices, has involved a total direct investment of **$2.326 billion**.
- The total **net** economic activity derived from this renewable fuels investment, across Canada, was **$2.949 billion**, including $100.2 million to municipal governments, $492.1 million to provincial governments, and $679.9 million to the federal government.
- This construction activity created **14,177** direct and indirect jobs during the respective construction periods.
- All these numbers reflect net benefits after making allowances for the "opportunity costs" of the investments, i.e., they are the incremental benefits to the Canadian economy from the construction of renewable fuels' production facilities, that would otherwise have been lost in totality had no such renewable fuels industry developed in Canada.

Executive Summary: Total Economic Impact of Renewable Fuels Plants in Canada – Operations Phase, Gross Benefits

- Operating these 28 renewable fuels plants provides a total of 2.25 billion litres of renewable fuels annually.
- They generate **gross** annual economic benefits of **$2.139 billion** to the Canadian economy across Canada, including $14.1 million to municipal governments, $151.5 million to provincial governments, and $145.4 million to the federal government.
- These operations are creating **1,038** direct and indirect jobs annually.
- These are all gross benefits; they include the total value of feedstock sales to the plants as a benefit. This is debateable. However, for comparison purposes with other total economic impact analyses, gross benefits are likely the better benchmark for comparative assessments.
- As well, there are further annual oil exports from western Canada thanks to biofuels' contribution to transport fuels supply that would otherwise have to be met by refining western Canada crude oil. These exports are calculated at 6.75 million barrels of oil equivalent (approx. 19,300 barrels of oil per day).
- At an illustrative value of CDN $80/barrel, this would represent an annual benefit of **$540 million** in additional oil exports that are possible because of western Canada biofuels production.
- The grand total of the annual **gross** economic impact of renewable fuels is accordingly **$2.679 billion**.

Executive Summary: Total Economic Impact of Renewable Fuels Plants in Canada – Operations Phase, Net Benefits

- In contrast the **net** benefits make allowances for the opportunity costs of alternate sales for the feedstocks. This approach is frequently overlooked in total economic impact assessments.
- Accordingly, they represent the true incremental benefits to the Canadian economy from renewable fuels that would be lost in totality if there were no such renewable fuels industry in Canada. In practice, this means that our model reduces the additional spending within the Canadian economy as a result of the alternate value of the feedstocks. The plants' operations and their jobs, of course, continue.
- Under these parameters, the 28 renewable fuels plants generate net annual economic benefits of **$1.473 billion** to the Canadian economy across Canada, including $14.1 million to municipal governments, $108.8 million to provincial governments, and $111.8 million to the federal government.
- The operations continue to create net **1,038** direct and indirect jobs annually.
- Expanded oil exports would continue as an annual benefit of **$540 million.**
- Accordingly, the grand total of the annual **net** economic impact of renewable fuels is **$2.013 billion**.

Executive Summary: Total Economic Impact of Renewable Fuels Plants in Canada – Operations Phase, 30-Year Benefits at Net Present Value (NPV)

- The project team developed a Net Present Value (NPV) assessment of both gross and net benefits. In each case, we used a 30-year time horizon for operations, and discounted future benefits by 8% annually. We understand these conditions are harmonious with federal government guidelines for such analyses.
- The NPV of 30 years of **gross** benefits at 8% discount works out to **$30.385 billion**. This figure assumes that the entire value of feedstocks is a benefit to renewable fuels plants. This is usually the basis for developing NPV results.
- The NPV of 30 years of **net** benefits at 8% discount works out to **$22.888 billion**. This reduces the benefits, by taking into account the alternate sales potential of feedstocks, i.e., they could be sold anyway.
- Over 30 years, there would be **31,140 person-years** of Full-Time Equivalent (FTE) employment created by renewable fuels plants.

Part I:
Objectives and Methodology

Objectives of this Project

To do a **total economic impact assessment across Canada** of all renewable fuels plants currently built and operating in Canada, or scheduled to be operating or under construction by year-end 2010.

- This assessment includes both ethanol and biodiesel plants producing transport fuels.
- The economic impacts are calculated and expressed for two phases for each plant – the economic impact of constructing such plants, which involves a fixed time-period; and, the economic impact of the operations from such plants, which are on-going and which are calculated and expressed on an annual basis.
- The overall analysis is designed to capture not only the current economic impact of renewable fuels plants' construction and operations, but also to project how renewable fuels can enhance and revitalize rural economic regions of Canada, and to calculate how increasing use of renewable fuels allows further advantageous expansion of Canadian oil exports.

Technical Characteristics of Ethanol and Biodiesel

- Ethanol is an alcohol-derived fuel processed from biomass sources such as corn or wheat.
- Ethanol is usually blended with gasoline in relatively low, but significant, proportions of 5-10% ("E5" – "E10"). As a generalization, conventional gasoline engines can absorb blends in this range without modification. Virtually all current automobile manufacturers accept blends of up to 10% (E10) without affecting service intervals, warranty commitments, or driving habits/procedures.
- Ethanol has a lower calorific (heat) value than gasoline. Accordingly, 1 litre of ethanol cannot substitute for 1 litre of gasoline. For purposes of this assessment, we have used the commonly-referenced figure of 0.82 as the ethanol calorific value as compared to gasoline, i.e., it takes 1.22 litres of ethanol to substitute for 1 litre of gasoline.

Technical Characteristics of Ethanol and Biodiesel

(Continued)

- Ethanol has a higher anti-knock or octane value than gasoline. Ethanol's blending octane rating would be 115, as contrasted to the current consumer gasoline levels ranging from 87 to 91. This means ethanol can substitute for high-octane premium gasoline rather than lower-value regular gas.
- Similarly, biodiesel is not precisely equivalent in calories per given volume to conventional transport diesel. Biodiesel is usually used in still-lower proportion blends, typically 2% ("B2"). At this level, the commonly-referenced factor is that biodiesel has .95 ratio of calorific value, i.e., 1.05 litres of biodiesel substitute for 1 litre of diesel, although some fleets have found a volumetric fuel consumption benefit.
- These differences should be taken into account when quantifying the economic impact of ethanol renewable fuels plants.

Significant Economic Differences Between Refining Petroleum and Growing Biofuels in order to Produce Transport Fuels (I)

- Assuming competitive markets, and within the blending limits expressed above, the economic impact of 1.22 litres of ethanol and 1.05 litres of biodiesel should be the same as 1 litre of gasoline and 1 litre of diesel fuel respectively. The two biofuel commodities should be able to substitute perfectly for their respective fossil fuel counterparts with indifference from the consumers. Market competitiveness is the benchmark for economic impact.
- In reality of course the analysis is much more complex.
- In particular, from a public policy perspective, the relative "mix" of *factors of production* that go into the process of providing transport fuels will be important.
- Fossil fuels are typically refined in capital-intensive plants under conditions of high sensitivity to economies of scale. Hence, refinery complexes tend to offer few direct jobs and are heavily concentrated geographically.
- In Canada, there are now only three main refinery centres: Edmonton (Alberta), Sarnia (Ontario), and Montreal East (Quebec).

Significant Economic Differences Between Refining Petroleum and Growing Biofuels in order to Produce Transport Fuels (Continued II)

- In Canada, a typical competitive refinery will have a processing capacity of 150,000 barrels of oil per day. This would be equivalent to processing 8.4 billion litres annually.
- Trends in the oil refinery industry continue to emphasize economies of scale: in the USA, it is estimated that a competitive refinery would have an even larger capacity of around 250,000 barrels of oil per day. This would be 14 billion litres annually.
- If for any reason threshold economies of scale cannot be met, the logical alternative for petroleum product firms is to shut down the refinery and import the required product. But this means value-added and jobs are lost to the domestic economy.
- There is some evidence that this structural change is happening in Canada today, most notably in eastern Canada where the Montreal East refinery complex is diminishing.
- Canada is becoming closer to being a net importer of refined product (as opposed to continuing or expanding as a net exporter of crude oil).

Significant Economic Differences Between Refining Petroleum and Growing Biofuels in order to Produce Transport Fuels (Continued III)

- Moreover, the quality of the crude oil resource affects the output. For example, while synthetic crude oil from oil sand bitumen is technically good for gasoline refined product, the quality of diesel fuel is relatively poorer. As the proportion of crude oil in Canada that comes from the oil sands increases, the relative availability of high quality fossil-fuel-derived diesel will decline.
- Biodiesel will likely be a useful new source of fuel for diesel engines that might otherwise have to be replaced by gasoline ones – the latter are not as energy efficient.
- In contrast, renewable fuels are much less sensitive to economies of scale and are less capital intensive. A large biofuels processing plant has a capacity of 225 million litres annually – much smaller than an oil refinery.
- Accordingly, from a scale perspective, renewable fuels plants offer the prospect of being economically more viable across Canada. In turn, this should enhance regional economies, and offer proportionally more jobs. From this perspective, public policy to mandate their use may well be cost/effective.
- As well, biofuels represent an option for re-balancing the effective mix of transport fuels between gasoline and diesel engines.

Description of Ethanol Plants (I)

- There are 15 commercial ethanol plants in Canada devoted to transport fuels, either operating or under construction in 2010. (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 addition, there is 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.
- Accordingly, our 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 owing to the limited information presently available. Subsequent impact analyses may be able to include them.
- Ethanol plants in Canada range is size from approximately 12.5 million litres per year output (12.5 MLY) to 225 million litres per year (225 MLY) 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.)

Description of Ethanol Plants (Continued II)

- 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 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.
- However, 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. Accordingly, no imports are required for wheat feedstocks.
- However, the feedstocks for western ethanol plants could represent lost wheat exports. The "opportunity costs" of lost wheat exports also has to be taken into account in assessing *net* benefits. (Technically, ethanol plants prefer higher-yielding wheat grades than those that are typically exported, but that is ignored here as an offset to the value of premium gasoline mentioned above).
- Nevertheless, in western Canada, ethanol production represents refined product that would otherwise require crude oil to produce. Accordingly, the use of ethanol allows additional oil exports, and are a benefit that renewable fuels offer in the western part of the country.

List of Canadian Ethanol Plants and Their Capacity

Canadian Ethanol Plants, 2010	Capacity (ML per Year)
Aylmer, Ontario	162
Chatham, Ontario	162
Collingwood, Ontario	50
Havelock, Ontario	80
Johnstown, Ontario	225
Ottawa, Ontario (R&D facility)	4
St. Clair, (Sarnia) Ontario	225
St. Clair, Ontario (expansion)	225
Varennes, Quebec	132
Minnedosa, Manitoba	130
Belle Plaine, Saskatchewan	150
Lanigan, Saskatchewan	12.5
Lloydminister, Saskatchewan	130
Unity, Saskatchewan	25
Weyburn, Saskatchewan	25
Red Deer, Alberta	40

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Description of Biodiesel Plants (I)

- There are 12 biodiesel plants operating or planned for being under construction in 2010, and our 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 (1 MLY) to 66 million litres per year (66 MLY) output; however, one large one is currently under construction in western Canada with 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 recovered 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.
- However, there is the same major benefit of biodiesel as ethanol in eastern Canada - it substitutes for diesel fuel that would otherwise have to be imported. This benefit can be calculated in renewable fuels' favour.

Description of Biodiesel Plants (Continued II)

- 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. Accordingly, 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 also has to be taken into account in defining the net economic benefits of biodiesel plants.
- However, canola farming is strongly benefited by biodiesel plants for a variety of technical reasons. It is not as simple as the calculation of lost wheat exports. To illustrate, 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.
- Moreover in western Canada, biodiesel production represents refined product that would otherwise require crude oil to produce. Accordingly, as for ethanol, additional oil exports are possible, and are a benefit that renewable fuels offer in the western part of the country.

List of Canadian Biodiesel Plants and Their Capacity

Canadian Biodiesel Plants, 2010	Capacity (ML per Year)
Hamilton, Ontario	66
Mississauga, Ontario	6
St. Alexis-des-Monts, Quebec	12
Montreal, Quebec	35
Arborg, Manitoba	3
Beausejour, Manitoba	12
Winnipeg, Manitoba	20
Foam Lake, Saskatchewan	1
Calgary, Alberta	20
Lethbridge, Alberta	66
(West) Lloydminster, Alberta	225
Delta, British Columbia	5

Our Methodology – the EconWin Model (I)

- This model has been specifically designed for assessing the economic impact of a new capital investment within communities of less than approximately 100,000 people. This is typical of the Canadian communities in which the majority of ethanol and biodiesel plants currently operate.
- However, the model can be run for larger economic units perfectly well. Some of the renewable fuels plants are now located in larger urban areas, such as Calgary, Hamilton, and Ottawa. To run the model for larger units, it is necessary to ensure that there is a consistent approach to defining the relevant “local”, “regional”, and “import” areas, and for comparison purposes, that the investigative scenarios have similar characteristics, which the runs for this project do.
- EconWin is an econometric model that is able to isolate individual investments (such as an investment in renewable fuels infrastructure) and then calculate, under a variety of scenario conditions, what the returns would be to the community as a whole in terms of increased economic activity. We have used this model extensively in the past for numerous investment analyses across Canada, and it seems fair to say that it has facilitated many positive investment decisions.
- The model works on what is known as the “economic base” principle, i.e., it differentiates between an investment that serves purely local needs, as opposed to an investment that effectively brings in revenues from outside the locality.
- The model integrates key exogenous inputs (such as the value of construction and operating labour and materials) and projects forward, using various endogenous economic multipliers, the value of eventual total outputs (such as number of jobs created, value of extra local spending, and new municipal taxes generated).
- A key value of the model is its ability to calculate “indirect” economic effects, taking into account the “downstream” multiplier effects from the original investment.

Our Methodology – the EconWin Model (Continued II)

- A key element in the model is its differentiation between the "local" economy and the surrounding "regional" economy. The model takes the latter as being related to the local economy, but the benefits of a new investment are diluted by the model to reflect the distance involved. The third category of "imports" represent a loss to the Canadian economy, and all "import" spending is taken as flowing out from Canada and lost.
- The total economic impact was derived by aggregating the economic effects of each of the relevant 28 plants within its local and regional economy. We usually treated the "local" economy as being the general supply area that the plants drew on, with the regional economy being effectively the rest of Canada. For assessing the impact on a pan-Canadian basis, this is a reasonable approach with the model.
- For each plant, it was necessary to run the model for two separate Phases:
  - First, for a "Construction Phase", in which jobs and spending are generated, but with a fixed period of time only, after which the plant became operational and no further construction spending or jobs are created; and
  - Second, for an "Operating Phase" in which jobs and spending are generated on an annual basis.
- The total construction investments and operating revenues have to be apportioned into the appropriate EconWin format of local, regional, and imports, for running the model.

Our Methodology – Specific Inputs to EconWin for Construction Phase (I)

- For purposes of running the model, it was necessary to develop specific characteristics for every renewable fuels plant (a total of 28 plants included in this analysis).
- For the impacts related to the Construction Phase, these characteristics included: total capital cost to construct; how financed; source of such financing, such as Canadian equity, Canadian debt, or sourced off-shore; total annual capacity; and an accurate apportionment of the total construction costs between the "local economy", the "regional economy", and "imports". A further requirement for running the model was to obtain data within the "local economy" supply component on the number of direct construction jobs and their respective costs.
- It was not physically possible to interview every plant proponent for developing these construction input numbers. Accordingly, the project team relied on previous work, or a sampling process as follows:
  - First, two large ethanol plants had already been the objects of a detailed economic impact assessment using EconWin. Accordingly, detailed input numbers for these plants were readily available.
  - Second, construction details of many of the other ethanol plants were well-known to the project team as a result of previous work on provincial and federal contribution programs, which required successful proponents to provide details of their construction costs and how spent. In particular, this covered some of the smaller ethanol plants.
  - Third, a series of interviews were carried out to develop representative data for large and small biodiesel plants, and any missing representative ethanol plants, for example in particular, wheat-based large and small ethanol plants.
  - Fourth, some proponents consented to providing the necessary breakdowns themselves from their records, understanding that the data was to be held completely confidential.

Our Methodology – Specific Inputs to EconWin for Construction Phase (Continued II)

- A key issue with assessing the economic impact of a given investment, such as construction of a renewable fuels plant, is how the investment is financed.
- It can be argued that any investment in Canada that was financed by Canadian savings or debt represents an investment that prevents those funds from being put to productive use elsewhere. (In technical economic terms, what are the "Opportunity Costs" of the investment).
- A key feature of the EconWin model is the "export ratio" function. This function asks the question "what proportion of the investment or output of the facility is derived from external sources"? The higher the "export ratio", the greater the contribution to the "economic base", and the better the economic impact in terms of jobs and spending.
- We used the "export ratio" function to capture the "Opportunity Costs" of each plant's construction. To do this, we had to develop an assessment of what might have happened if the investment had been structured differently, or had not gone to a renewable fuels plant.
- The greater the financing from off-shore sources, the greater the "export ratio". (In effect, Canadian construction jobs and spending would be being paid for by foreigners). This is positive for benefits. However, note that this carries implications for the subsequent Operations Phase: if financed from off-shore, then a corresponding component of the returns to the investment have to be calculated and assigned to the "imports" category, which segment represents a loss in economic benefits.
- A parallel financing question is whether the investment, had it not gone to a Canadian renewable fuels plant, could itself have gone off-shore; i.e., could the Canadian investment funds have been lost to the Canadian economy, because the proponent decided to invest in a US ethanol or biodiesel plant, or invest in a completely different off-shore prospect, such as a manufacturing facility in (say) China or wherever?

Our Methodology – Specific Inputs to EconWin for Construction Phase (Continued III)

- Information on financing is not easy to obtain. In some cases, full details of the proponent's financing were known to the project team. From these numbers, the implied "export ratio" was calculated directly. For example, it was known that one plant was financed to a significant degree by off-shore bank loans. This contributed to a beneficial, high, "export ratio". (Although it also meant that the Operations Phase has to pay back the loans to foreigners).
- However, almost all the renewable fuels plants in Canada are owned by privately-held corporations, and investment financing information is highly confidential.
- During our research interviews, the project team deliberately asked proponents to indicate what might have been their alternate investments, had they not invested in the renewable fuels facility. Illustrations of hypothetical alternate investments in Canada or off-shore were expressly given, to encourage deliberations. In every case the answers were the same - consideration of what might have happened was pure speculation. It was not possible to provide an answer.
- Accordingly, the project team, in order to accommodate potential "Opportunity Costs", in the cases of plants for which there was virtually no information, used an "export ratio" of 0.5, i.e., it was taken that, had the investment been structured differently, or had gone in another direction, there was precisely a 50-50 percentage probability that it would either have come from external sources or would have gone outside Canada. This can fairly be described as the "least worst" approach.
- Accordingly, the numbers generated by the model for the Construction Phase are offered as being **net** benefits: they are after consideration of the Opportunity Costs. This is an important point to bear in mind when reading the results.

Our Methodology – Specific Inputs to EconWin for Construction Phase (Continued IV)

- An important change that has taken place over the last several years is the increasing proportion of capital equipment that Canadian industry is able to supply for ethanol and biodiesel plants. This is a major benefit to the Canadian economy.
- As a broad generalization, the greater the role of economies of scale in an industry, the greater the propensity for that industry to concentrate its suppliers in specific locations, and the greater the propensity to standardize on long-production-run equipment. All this works against local equipment suppliers from competing for such business.
- However, for biofuels, there is much greater opportunity for local suppliers to compete. Economies of scale are much less vital for the economics of such plants. Moreover, Canadian engineering firms are now undertaking the design, engineering, and prime contracting of biofuels plants.
- For our EconWin model runs specifically, this means that our research illuminated that most of the plants' capital equipment came from Canadian sources, i.e., the systems and components were manufactured and assembled in Canada. In turn this meant that economic loss to the "imports" category was not substantial, and helped improve total benefits in the construction phase. This is an important factor in why the benefits are as positive as they are.

Our Methodology – Specific Inputs to EconWin for Construction Phase (Continued IV)

- This finding goes to the prospect of rural re-vitalization in Canada.
- Commodity production, such as biofuels, usually involves putting production facilities in close proximity to the resource, e.g., near the farms growing corn, wheat or canola. This is the most practical strategy. Thus, such a high proportion of the Canadian renewable fuels plants are in small communities with only a few thousand people.
- There may be very limited options for developing the economic base in such communities. Biofuels represent a local value-add capability in rural areas.
- The evolving Canadian industrial capability in respect of renewable fuels plants was striking from interviews. Proponents across Canada frequently volunteered that capital equipment came from regional sources, and it was Canadian construction firms that have built the plants.
- The project team's research indicated that relevant capital equipment and/or construction capability exists in Quebec, Ontario, Manitoba, Saskatchewan, Alberta, and BC. Other provinces may also have capabilities, but no information was readily available.

Our Methodology – Specific Inputs to EconWin for Operations Phase (I)

- For the impacts related to the Operations phase, specific characteristics for each plant were required. They included: total annual capacity and price for the output; where the output was sold; source and costs of feedstocks; type and source of other necessary inputs (ranging from electricity to enzymes); and an accurate apportionment of the total operating revenue between the "local economy", the "regional economy", and "imports".
- Once again, a further requirement for running the model was to obtain data, within the "local economy" operating costs component, on the number of direct plant operating jobs and their respective "fully-burdened" costs.
- Similar to the Construction Phase, it was not physically possible to interview every plant proponent for developing these operating revenue apportionments. Accordingly, the project team relied on previous work or the same sampling process as described above for the Construction Phase. These included existing detailed knowledge of some plants, interviews with proponents directly, and again some proponents consented to providing their numbers, distributed in our required format, from their own accounting.

Our Methodology – Specific Inputs to EconWin for Operations Phase (II)

- Commodity prices fluctuate through fairly significant ranges within even one year. Accordingly, the project team used values based on direct research as much as possible, and developed the concept of “representative prices” as of May 2010.
- To illustrate, we took ethanol prices as being between $0.65 and $0.80 per litre, depending upon province and available incentive*.
- Similarly, biodiesel was valued between $0.80 and $0.94 per litre, depending on province and incentives.
- Corn was taken in the range of $155-$186/ton depending upon the location of the plant. This range reflected both direct information from some proponents, and a review of prevailing corn prices in international exchanges.
- Wheat was taken at $130/ton and canola oil was valued $910/ton.
- Animal fats were taken as having a value of $585/ton.

* It should be noted that the ‘representative’ ethanol prices used in this report ($0.65/litre to $0.80/litre) include the federal producer incentives and the provincial incentives. In Ontario, incentives total more than $0.20/litre, in Manitoba, $0.30/litre, in Saskatchewan up to $0.25/litre, in Alberta $0.25/litre. Actual wholesale prices of ethanol have averaged $0.604 in 2010.

Our Methodology – Specific Inputs to EconWin for Operations Phase (Continued III)

- A key issue with assessing the economic impact of a given operation, such as a renewable fuels plant, is where the output is sold.
- As described above, a key feature of the EconWin model is the “export ratio” function. This function asks the question “what proportion of the output of the facility is exported outside of Canada?” It will be recalled that the higher the “export ratio”, the greater the contribution to the “economic base”, and the better the economic impact in terms of Canadian jobs and spending.
- Ethanol plants have two (2) main outputs: ethanol as a transportation fuel; and Dried Distillers Grains (DDGs), a by-product emerging from the corn or wheat feedstocks that can be re-sold as animal feed. The project team took DDGs output tonnage as being equivalent to 32% of the corn or wheat feedstock inputs.
- However, virtually all the output of the transport fuels component of Canadian renewable fuels plants is sold within Canada. (There may be small quantities of ethanol or biodiesel exports from some locations.) This would suggest a low “export ratio”, and implies that the model would calculate less economic benefit as compared with exported output.

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Our Methodology – Specific Inputs to EconWin for Operations Phase (Continued IV)

- But this is not a reasonable accounting. Renewable fuels outputs (ethanol, biodiesel) are substitutes for high-value premium gasoline and diesel fuel. Canada imports both these fossil fuel commodities. In the absence of these renewable fuels facilities, given Canadian refinery limitations, Canada would have no other recourse but to further import the equivalent gasoline and diesel.
- For example, Canada annually (2009) imports 5.3 billion litres of motor gasoline, and 2.1 billion litres of diesel fuel (Source: Statistics Canada 45-004-X). The Canadian production of ethanol and biodiesel, in fossil fuel calorie equivalents at the factors of 0.82 and 0.95 respectively as described above, would be 1.5 billion litres and 0.4 billion litres, fossil fuel equivalent respectively. Canadian production of biofuels is less than Canadian imports of the respective refined oil products, i.e., despite Canadian biofuels production, Canada still has to import refined products.
- These numbers suggest that the Canadian production of renewable fuels is a useful import substitution for imported refined products.
- In sum, renewable fuels plant outputs in respect of transport fuels are effectively a Canadian export by virtue of their import substitution characteristics.

Our Methodology – Specific Inputs to EconWin for Operations Phase (Continued V)

- Moreover, the DDGs output component from ethanol plants may well be directly exported out of Canada. Based on previous projects, interviews, and current trends, the project team assumed that 20% of DDG production from eastern Canada was exported, and 50% of the western DDGs production. In both cases, these exports could likely be taken as going for animal feed for nearby or regional US livestock populations.
- Accordingly, the export ratio for ethanol plants calculated by the project team was developed as a composite from the import substitution value of transport fuels and the relevant proportion of exported DDGs. It usually varied between 0.84 and 0.90.
- Biodiesel plants do not have the same set of by-products as ethanol ones; however, the biodiesel was taken as representing import substitution production. This allowed an export ratio of 1.00. This is positive for economic benefits of renewable fuel plants.

Our Methodology – Specific Inputs to EconWin for Operations Phase (Continued VI)

- However, for *net* benefits, a question of "Opportunity Costs" for the operations of renewable fuels plants can also be asked, in parallel to same for the Construction Phase.
- For the Operations Phase, such question relates primarily to the purchase of feedstocks, as these are the single most important cost in operating the biofuels plants. A major economic benefit from renewable fuels plants is the purchase of feedstocks from Canadian farmers (or in the case of biodiesel, other respective suppliers). These purchases can be legitimately described as a benefit of renewable fuels plants, and for developing the *gross* benefits of the plants in this analysis, they were so taken.
- This is debatable. Couldn't these feedstocks have been sold anyway ?
- It can be argued that any feedstock purchases from Canadian sources, that could have been sold at an equivalent price to other customers, are not truly an economic benefit of renewable fuels. The relevant economic gains would have occurred regardless.

Our Methodology – Specific Inputs to EconWin for Operations Phase (Continued VII)

- In order to calculate the "Opportunity Costs" of feedstock production that could have anyway been sold, regardless of the presence of renewable fuels plants, it was necessary to run the model twice for each of the 28 renewable fuels plants in Canada.
- The first run accepted Canadian-origin feedstocks as a benefit of renewable fuels plants. This gave a **gross** value of the economic impacts.
- The second run developed the value of feedstocks that the project team calculated would have been sold anyway. The model allows itself to be run "backwards", simulating a shut-down or other loss, and this was how the second run was conducted. The results from the second run were accordingly deducted from the first to derive **net** benefits for each plant.
- In practice, this meant that the model reduced the total spending benefits of all plants whose feedstocks were believed to offer an opportunity cost.
- As the plants themselves were considered as continuing to operate, there were no meaningful reductions in jobs related to the plants coming out of the net benefit runs.

DOYLETECH CORPORATION

Our Methodology – Specific Inputs to EconWin for Operations Phase (Continued VIII)

- Not all the value of feedstocks were incorporated into the second run of the model. For example, the presence of a renewable fuels plant may well allow for lower transaction costs, and lower trading or transport costs, for local area farmers or other feedstock providers. Nevertheless, in a location such as southwestern Ontario (corn), or western Canada (wheat), the project team assumed 90% of the value of the renewable fuels plants corn or wheat feedstocks could have been sold anyway, and this number formed the basis for valuing the necessary opportunity costs model runs.
- On the other hand, corn in eastern Ontario and Quebec was calculated to have lower opportunity costs. This was calculated thanks to previous detailed experience with a regional ethanol plant. Direct research showed that local corn farmers in the region typically obtain a 20% price premium for their corn, thanks to the demand from the ethanol plant. Taking again a factor of 10% benefit for lower transaction costs, in these cases, the opportunity costs of feedstocks were taken as only 70% of the total value of domestic corn purchases by the plant.
- Moreover, it should be noted that for both gross and net benefit calculations, in eastern Ontario and Quebec a proportion (according to project team direct research, 40%) of the corn feedstocks for ethanol plants actually have to be imported from the U.S. The model automatically eliminates any benefit of these, as they represent a loss to the Canadian economy.

Our Methodology – Specific Inputs to EconWin for Operations Phase (Continued IX)

- For some other feedstocks, such as biodiesel feedstocks, the opportunity costs were calculated separately on a case-by-case basis.
- Some biodiesel plants have a multi-feedstock capability. For these plants the opportunity costs were taken as effectively zero, and there was no need to conduct the second model run in respect of those plants. This is because a multi-feed capability would always allow for the lowest-cost feasible feedstock to be used, and likely its market value would be low anyway.
- Similarly, for biodiesel plants with essentially waste material as feedstocks, such as used vegetable oil, or waste animal fats, second runs were ignored. The hypothetical opportunity costs would be very low.
- However, for the biodiesel plants using canola oil as feedstock, the project team did allow for an opportunity cost in canola sales, but less than the opportunity costs for corn or wheat feedstocks for ethanol plants. Based on existing experience and knowledge of western Canada biodiesel plants, and consideration of the use and sales of canola in Canada, the project team took 50% of the value of canola feedstocks purchases as representing the opportunity costs, i.e., without the biodiesel plants, half of the annual canola feedstock purchases' value would have occurred anyway.

Our Methodology – Specific Inputs to EconWin for Operations Phase (Continued X)

- For purposes of calculating the impacts of the Operations Phase, the project team also used the concept of Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA), to formulate how differences in financing affected the net benefits of biofuels plants.
- It will be recalled that the project team, in the absence of better factual data, used the factor of 0.5 for the investment financing “export ratio”, i.e., it was assumed that there was precisely a 50% probability that the investment funds came from overseas, or that the Canadian investment funds would otherwise have left Canada, or some equivalent trade-off between these two.
- There are implications for the Operations Phase in this assumption. If the construction investment was indeed from off-shore, or would have otherwise left Canada, then an equivalent return to a hypothetical off-shore investor or investment has to be allowed in the apportionment of revenues during operations.

Our Methodology – Specific Inputs to EconWin for Operations Phase (Continued XI)

- In the course of previous research for the Government of Ontario in developing the Ontario Ethanol Growth Fund (OEGF), the project team became extensively familiar with financing requirements in the biofuels industry. These usually necessitated relatively fast payback of any debt investment, and a build-up of cash reserves before lenders would allow any distribution to shareholders.
- Accordingly, if we did not have specific information on a plant's financing, we usually assessed EBITDA at 30%. This is likely higher than normal for Canadian industry. However, we believe that it is realistic for commodities production, such as biofuels.
- It should be noted that for some smaller plants, the EBITDA could go as low as 5% in our calculations for apportioning revenues into the EconWin format. This means that the economics of that particular plant were not as good as the others. However, this was not normal.
- Out of these amounts, and depending upon specifics of a given plant and its revenues/costs implications, we built an income sub-model that typically directed 25-33% of the EBITDA apportionments from revenues to "imports", and hence was revenue lost to the Canadian economy. We apportioned most of the balance to the local economy, but we also took into account the proportion of capital plant that was in the "import" category. Such capital imports costs had to be returned off-shore through the D&A component of the EBITDA.
- Again depending upon specifics of the plant and its revenues and costs implications, we also allowed for a build up-of cash reserves, typically around 5-10% of revenues. These sums had to be apportioned in accordance with the EconWin model format, and we believed that these sums would be held in local financial institutions, and hence represented a benefit to the local economy.

Our Methodology - Key Parameters of The Respective Communities and their Local and Regional Economies (I)

- Each of the communities in which a renewable fuels plant has been constructed and operates had to be defined in terms of geographic area, population, employment and unemployment, housing, family/household size, prevailing local wage rates, average property taxes, and welfare recipients. These variables affect the outputs of the model.
- These community characteristics had to be carried over consistently for all three model runs for each plant – construction, operations gross benefits, and operations opportunity costs.
- In each case, the project team conceived of the local community as representing a hypothetical area within which the plant could draw for supplies and services in both construction and operations phases. For example, in respect of a plant on the border between two provinces, the “local economy” was taken as a hypothetical “corridor” cutting across both provinces and within which it was known that the plant had in fact drawn logistical supplies and services.

Our Methodology - Key Parameters of The Respective Communities and their Local and Regional Economies (II)

- The regional economy was conceived of being anything else in Canada. For example, natural gas for running the plant would likely come from Alberta or Saskatchewan. Certainly in eastern Canada, this could not be counted as part of the "local economy" supply base. However, natural gas is nevertheless a Canadian resource. Its use should be counted as a benefit to Canada. This was taken as an example of a "regional economy" benefit.
- Imports were anything brought in from off-shore, i.e., often engineering design services were from the US, and certain categories of equipment such as centrifuges and dryers tended to be sourced this way. These imports represent a loss to the Canadian economy.

Part II:
Bottom-Up Results

Results – Construction Phase

- After each plant's analysis with the EconWin model was completed, the results were tabulated into an aggregated result.
- The construction of **28 renewable fuels** plants in Canada, at 2010 replacement cost prices, was calculated to have involved a total direct investment of **$2.33 billion**.
- In turn, the total net economic activity derived from this renewable fuels investment, across Canada, was **$2.95 billion**.
- This construction activity created **14,177** direct and indirect jobs during the respective construction periods.
- All these numbers reflect **net** benefits, after making allowances for potential "opportunity costs" of the investments.

Results – Operations Phase, Gross Benefits

- Operating these 28 renewable fuels plants provides a total of 2.25 billion litres of renewable fuels annually.
- They generate **gross** annual economic benefits of **$2.139 billion** to the Canadian economy across Canada.
- These operations are creating **1,038** direct and indirect jobs annually.
- These are all **gross** benefits; they include the total value of feedstock sales to the plants as a benefit. (The value of net benefits from the Operations Phase are given in the next slide).
- Frequently total economic impact analyses based on gross benefits are used to present the results. Accordingly, gross benefits may be the best benchmark for comparative assessments.

Results – Operations Phase, Net Benefits

- Operating these 28 renewable fuels plants provides a total of 2.25 billion litres of renewable fuels annually.
- They generate net annual economic benefits of **$1.473 billion** to the Canadian economy across Canada.
- These operations are creating net **1,038** direct and indirect jobs annually.
- Again, all these numbers reflect **net** benefits, after making allowances for the opportunity costs of alternative uses and sales for the feedstocks, i.e., they are incremental benefits to the Canadian economy from renewable fuels that would be lost in totality if there were no such renewable fuels industry in Canada.

Results – Operations Phase, Net Present Value (NPV) over 30 Years, Gross and Net Benefits

- The project team developed a Net Present Value (NPV) assessment of both gross and net benefits. In each case, we used a 30-year time horizon for operations, and discounted future benefits by 8% annually. We understand these conditions are harmonious with federal government guidelines for such analyses.
- The NPV of 30 years of **gross** benefits at 8% discount works out to **$30.385 billion**. This figure assumes that the entire value of feedstocks is a benefit to renewable fuels plants. This is usually the basis for developing NPV results.
- The NPV of 30 years of **net** benefits at 8% discount works out to **$22.888 billion**. This reduces the benefits, by taking into account the alternate sales potential of feedstocks, i.e., they could be sold anyway.
- Over 30 years, there would be **31,140 person-years** of Full-Time Equivalent (FTE) employment created by renewable fuels plants.

Results – Municipal Government Revenues

- Municipal governments have benefited from both the Construction and Operations Phases.
- During all the respective Construction Phase time periods, **$100.2 million** in revenues were generated for municipal governments.
- During the Operations Phase, the total revenues generated each year for municipal governments under both gross and net parameters are **$14.1 million**.
- These latter Operations Phase benefits are annual ones, and will continue as long as the plants keep functioning.

Results – Provincial Government Revenues

- Provincial governments have also benefited from both the Construction and Operations Phases.
- During all the respective Construction Phase time periods, **$492.1 million** in revenues were generated for respective provincial governments. These are net benefits.
- During the Operations Phase, the total revenues generated for provincial governments each year under the **gross** benefit parameters would be **$151.5 million**.
- Under the **net** benefit parameters, the total annual revenues generated for provincial governments are **$108.8 million**.
- These latter Operations Phase benefits are annual ones, and will continue as long as the plants keep functioning.

Results – Federal Government Revenues

- Finally, the Federal government has benefited strongly from both the Construction and Operations Phases.
- During all the respective Construction Phase time periods, **$679.9 million** in revenues were generated for the Federal government.
- During the Operations Phase, the total revenues generated for the federal government each year under the **gross** benefit parameters would be **$145.4 million**.
- Under the **net** benefit parameters, the total annual revenues generated for the Federal government are **$111.8 million**.
- These latter Operations Phase benefits are annual ones, and will continue as long as the plants keep functioning.

Part III:
Oil Trade Impact Analysis

Additional Oil Exports (I)

- Western Canada is the source of virtually all Canadian crude oil or synthetic crude oil exports.
- It can be claimed that the use of biofuels produced in western Canada also allows expanded crude oil exports. Ethanol and biodiesel output represents transport fuels that would otherwise have to be produced from refining crude oil. Thanks to biofuels production, the equivalent volume of crude oil can now be exported.
- Canadian biofuels production in the western part of the country (Manitoba to BC inclusive) amount to 512.5 million litres of ethanol annually, and 352 million litres of biodiesel annually.
- However, these volumes have to be converted to the equivalent values for gasoline and diesel fuel oil. As described earlier, we take a factor of 0.82 for ethanol equivalency to gasoline, and a factor of 0.95 for biodiesel equivalency to diesel fuel oil. Accordingly, the volumes of biofuels have to be reduced by these respective factors in order to calculate the relevant oil volumes.
- Using these factors, the refined oil product equivalents are 420.3 million litres annually for gasoline, and 334.4 million litres annually for diesel fuel oil.

Additional Oil Exports (II)

- A common unit of measurement for crude oil is the “barrel”. A barrel of oil is equivalent to 160 litres in volume.
- However, it is not reasonable to convert the refined product volumes into barrels by dividing directly by 160.
- This is because there are refinery limitations on the categories of refined product possible from crude oil. A barrel of crude oil typically only converts about 43% of its volume into gasoline, and another 27% into diesel fuel for a total of about 70% useable transport fuels. Accordingly, to calculate crude oil replacement by biofuels, the gasoline and diesel fuel equivalents coming from biofuels have to be scaled up to allow for these refinery limitations.
- After allowing for both refinery limitations and calorific losses with biofuels, we calculate that, expressed in barrels, the potential oil exports, representing crude oil released by biofuels effectively substituting domestically, are 6.75 million barrels annually (approx. 19,300 barrels of oil per day).

Additional Oil Exports (III)

- At an illustrative value of CDN $80/barrel (in May 2010 approximately US $77/barrel), this would represent an annual benefit of **$540 million** in additional oil exports that are possible because of western Canada biofuels production.
- If the price of oil rises in the future, these benefits will increase.
- To illustrate, at an oil price of CDN $120/barrel (approx. US $115 at May 2010 exchange rates), the total annual benefits from increased oil exports thanks to biofuels production would rise to CDN $810 million.
- If the oil price were to return to its historic peak of CDN $160/barrel (US $147/barrel), the annual benefits to Canada would be CDN $1.08 billion.

Part IV:
Conclusions

Conclusions – Total Economic Impact of Renewable Fuels Plants in Canada

- Even making allowance for the opportunity costs of alternate investments, and the opportunity costs of alternate feedstock sales, renewable fuels plants in Canada represent a positive net economic benefit.
- This net economic benefit extends through the Construction Phase to current annual Operations Phase.
- The major benefits of renewable fuels plants are not merely the provision of transport fuels, but also they provide vehicles for rural re-vitalization, increased oil exports from western Canada, industrial development, and valuable options for re-balancing fuel “mix”.
- All levels of government gain from renewable fuels plants. In light of the net benefits to governments at the provincial and federal levels being in the hundreds of millions of dollars, and many millions at the municipal level, it would seem that incentive programs to encourage biofuels production and use in Canada have been a wise investment.

Taxation Issue – Calories or Volumes? (I)

- It is possible to consider that one litre of biofuels should substitute for one litre of refined oil product: both for gasoline/ethanol, and diesel oil/biodiesel the respective fuels are stored in the appropriate tank of the vehicle, and combusted in the same engine.
- In this report we have tried to indicate why the relationship between biofuels and refined oil products is not equivalent by volume, as follows:
  - On volume, biofuels are less energy-intensive than refined oil products: 0.82 for ethanol; 0.95 for biodiesel
  - Biofuels are high-value products, because they substitute for premium gasoline or relatively scarce diesel, but this is an economic phenomenon, not a volume one. The additional value of biofuels is not equivalent to off-setting the volume energy intensity
- Total Canadian annual production of biofuels is: ethanol, 1,777.5 million litres per year; biodiesel, 471 million litres per year. This is a total volume of 2,248.5 million litres per year.

Taxation Issue – Calories or Volumes? (II)

- Converting to refined oil product calorific equivalents, these represent 1,905.0 million litres of refined oil product. This is a difference of 343.5 million litres.
- Imagine a hypothetical tax, from either or both the provincial and federal levels of government, of $0.20 per litre of volume on all transport fuels.
- The tax on the **volume** of biofuels would be $449.7 million; the same tax on **calories** would be $381 million.
- This would mean that the extra burden a volume tax would place on biofuels over a calorific approach would be annually **$68.7 million**.