A Report by the Biodiesel Advisory Council
to the Government of Manitoba

Biodiesel
Made in Manitoba

FEBRUARY 2005

Manitoba
Building for the Future

INDEX




Letter from the Co-chairs

Ernie Doerksen,
Canadian
Canola Growers

Bob Dolyniuk,
Manitoba Trucking
Association

Dear Ministers Wowchuk, Chomiak and Lemieux:

On behalf of all members, we would like to thank you for the opportunity to serve on the Manitoba Biodiesel Advisory Council. Over the past several months, we have learned much about biodiesel as a potential energy source. We hope the recommendations we have put forward will assist you in developing this industry for the benefit of all Manitobans.

Throughout our deliberations, the council has heard from a wide variety of stakeholders and sought to present a balanced report to government. We hope these efforts are merely a beginning to the process of developing a sustainable industry that contributes to the health of our environment and our citizens, and provides economic benefits for all stakeholders.

We would like to thank all the presenters who so generously contributed their time and expertise during our deliberations. These individuals are listed on the back cover of the report. We would also like to express our gratitude to the many provincial staff who provided assistance to us throughout our work.

Sincerely

Ernie Doerksen

Bob Dolyniuk

Manitoba Biodiesel Advisory Council's meeting in Brandon with the City of Brandon and Celtic Power and Machining Ltd. The 2004 transit test bus is fuelled by 100 per cent recycled cooking oil.

Council Members

Bob Dolyniuk, Manitoba Trucking Association

Ernie Doerksen, Canadian Canola Growers

Ajaleigh Williams, Red River Valley Clean Cities Coalition

Tom Nevakshanoff, MLA, Interlake, Manitoba

Ken Thomas, Manitoba Hydro

Harvey Stevens, Former President,
Resource Conservation, Manitoba

Dr. Barry Prentice, University of Manitoba
Transport Institute

Don Streuber, Bison Transport

Murray Froebe, Pulse Growers Association

Karen Caldwell, Association of Manitoba Municipalities

Jen Malzer, University of Manitoba, Engineering

Ian Wishart, Keystone Agricultural Producers

Barry Routledge, Manitoba Rural Adaptation Council

Paul Bobbee, Arborg Community Development
Corporation

Ed Tyrchniewicz, University of Manitoba,
Asper School of Business

Tammy Jones, Manitoba Pulse Growers Association

Ron Wardrop, Rothsay

Christine Paquette, Natural Resources Canada

Province of Manitoba /Interdepartmental Biodiesel Working Group

Garry Hastings, Assistant Deputy Minister,
Manitoba Energy, Science and Technology

Bryan Yusishen, Director, Agri-Energy,
Manitoba Energy, Science and Technology &
Manitoba Agriculture, Food and Rural Initiatives

Shaun Loney, Director, Energy Policy,
Manitoba Energy, Science and Technology

Jeff Kraynyk, Energy Policy Analyst,
Manitoba Energy, Science and Technology

Marc Arbez, Transportation Consultant,
Manitoba Energy, Science and Technology

Bob Brennand, Business Development Project Manager,
Manitoba Energy, Science and Technology

Terry Zdan, Policy Consultant,
Manitoba Transportation and Government Services

Blair Dryden, Equipment Management Engineer,
Manitoba Transportation and Government Services

Andy Chartrand, Environment and Program Analyst,
Manitoba Transportation and Government Services

Roger Brunet, Special Projects Manager,
Manitoba Agriculture, Food and Rural Initiatives

Allen Sturko, Project Manager,
Manitoba Energy, Science and Technology

Energy Lane display at Rural Forum 2004

Manitoba Biodiesel Advisory Council Sets Direction

The Manitoba Biodiesel Advisory Council was created to review the biodiesel production industry and its potential development in Manitoba. The council was asked to conduct industry and stakeholder consultations and produce a report of its findings to the Province of Manitoba.

This report reflects the knowledge the council gained through numerous stakeholder presentations and industry submissions. It addresses the technical, social, environmental and economic considerations associated with the development of a biodiesel industry in Manitoba.

The council's objectives were to:

- assess industry awareness and suggest specific actions for introducing biodiesel in the province
- examine and identify user, industry and consumer issues related to biodiesel consumption
- identify barriers that potential biodiesel producers, retailers and consumers may face and make recommendations on how to overcome them
- examine various feedstocks for opportunities to use in biodiesel production (oilseeds, animal fats, yellow grease, etc.)
- examine markets for co-products of biodiesel production and make recommendations on how to increase their use in both the Manitoba and export markets
- investigate various financial and ownership models/options for Manitoba-based biodiesel production facilities (ex: new-generation co-operatives, venture capital financing, company/community partnerships etc.)

The council was asked to consider how Manitoba might more effectively partner with the federal government, other jurisdictions, the transportation sector, the agriculture industry and other potential biodiesel industry participants, to ensure all key issues were addressed. Council members were also asked to consider the net economic impact that increased biodiesel production and consumption would have on the provincial economy.

Guiding Principles

This report has been created, based on the following key principles established by the province for the development of a biodiesel industry. These guiding principles include:

- The biodiesel industry in Manitoba will be developed in a manner which emphasizes environmental, economic and community sustainability.
- Biodiesel offers a potential to reduce harmful tailpipe and greenhouse gas emissions.
- Benefits to the rural economy will be maximized.
- A variety of development strategies, including facility size, location and ownership structure will be considered.
- All potential feedstocks will be considered.
- All positive and negative findings will be considered when making recommendations.
- Potential negative impacts on the provincial treasury will be minimized.
- Key industry stakeholders will be consulted in a clear, open and transparent manner.

Executive Summary

Biodiesel is a safe, non-toxic, renewable fuel made from a variety of sources such as vegetable oils, animal fats, tallow and used restaurant grease. Biodiesel can be used in its pure form or blended with conventional diesel fuel at various levels with little or no engine modification required.

Biodiesel's cleaner burning characteristics make it effective in reducing both tailpipe pollution and overall greenhouse gas emissions. Biodiesel in its pure form has been credited with reducing carbon monoxide by over 50 per cent, hydrocarbons by 40 per cent and harmful particulate matter by over 70 per cent.

Biodiesel has been used in some jurisdictions for years and was actually the fuel Dr. Rudolf Diesel originally designed his engines to use. The amount of biodiesel consumed around the world has increased sharply over the past number of years. Germany alone has gone from consuming roughly 40,000 tonnes of biodiesel in 1998 to over 1,080,000 tonnes in 2004. The United States has also undergone a significant expansion in the amount of biodiesel produced and consumed, with well over 100 million litres burned last year.

Little biodiesel is currently produced in Manitoba. However, the potential market is significant, with over 850 million litres of diesel fuel now being consumed in the province each year. Manitoba consumers have had limited opportunities to use biodiesel and, as a result, the fuel and its many positive characteristics are not fully understood.

An economic case for larger scale production of biodiesel is challenging without significant contributions from various levels of government. Nevertheless, there are potentially excellent opportunities in small scale production for the following reasons:

1. Niche feedstocks like wild mustard seed, low-grade canola (or other downgrade oil), low-grade animal fat and spoiled grain can be obtained in small quantities at a low cost.
2. The production cost of biodiesel (per litre) doesn't change significantly as scale increases.
3. Smaller amounts of biodiesel will be easier to market since biodiesel has had limited exposure in Canada. There may also be niche markets – buyers willing to pay more than market price for corporate image or to meet other objectives like reducing pollution or greenhouse gas emissions.

In December, 2003, the Province of Manitoba created the Manitoba Biodiesel Advisory Council. The task of the council was to learn more about biodiesel production and its potential impact on Manitoba consumers. A list of council members can be found on page two of the report.

The council heard from numerous stakeholders from a variety of sectors including industry, transportation, agriculture and the environment. In addition to the consultations, the council had the opportunity to tour North America's largest biodiesel plant located in Ralston, Iowa.

The biodiesel industry continues to evolve, with more and more jurisdictions now using biodiesel blends. Due to this rapid evolution, a significant amount of work needs to be done to ensure the industry develops in an orderly, sustainable manner. In summary, the Manitoba Biodiesel Advisory Council recommends that the provincial government:

1. encourage the development of a biodiesel industry in Manitoba – both its production and consumption – that will use primarily Manitoba-grown and produced feedstocks, creating sustainable long-term jobs and other economic benefits
2. encourage the development of a variety of production plants that will use different feedstocks and different technologies to produce biodiesel
3. encourage research into other value-added products and alternative uses of methyl esters
4. study options for support programs (incentives such as tax reductions or credits, low-interest loans to biodiesel producers) to ensure they are fair and equitable to all stakeholders
5. determine the interest of potential biodiesel producers in establishing plants in Manitoba
6. encourage local ownership through co-operatives, corporations, limited partnerships or strategic alliances that allow local individuals and or communities to have a significant ownership stake in the new biodiesel production businesses
7. develop Manitoba-based research capabilities and encourage collaboration between educational institutions and industry
8. study and communicate the environmental and health benefits of using biodiesel blends in urban bus fleets, government, special operating agencies, municipalities and other fleets
9. determine the feasibility of converting deadstock, offal and specified risk materials (SRMs) into feedstock for biodiesel; conduct a cost/benefit analysis of providing incentives to renderers to use deadstock, SRMs and other byproducts to produce biodiesel
10. require all biodiesel fuel to meet or exceed American Society for Testing and Materials (ASTM) and or Canadian General Standards Board (CGSB) standards when sold as fuel
11. take a leadership/co-ordinator role in the future development of alternative fuel initiatives

For a complete list of the Council's recommendations, see pages 52 aand 53 of the report.

Introducing Biodiesel

Biodiesel is safe, non-toxic and biodegradable – and it's not a new fuel. When Dr. Rudolf Diesel developed his diesel engine in 1912, he designed it to run on peanut oil.

What is Biodiesel?

Biodiesel is a fuel produced from renewable, biological resources for use in diesel engines. Biodiesel can be used as a pure fuel or blended with petroleum at various levels to produce a biodiesel blend (ex: B2, B20). A B2 blend would be 2 per cent biodiesel and 98 per cent petroleum diesel and so on.

Materials used to produce this fuel include animal fats, tallow and virgin and recycled vegetable oils. These materials come from crops such as canola, corn, sunflowers and soybeans as well as tall oil, derived from wood pulp waste. These materials, and others used in the production of biodiesel fuel, are referred to as feedstock.

Biodiesel Production

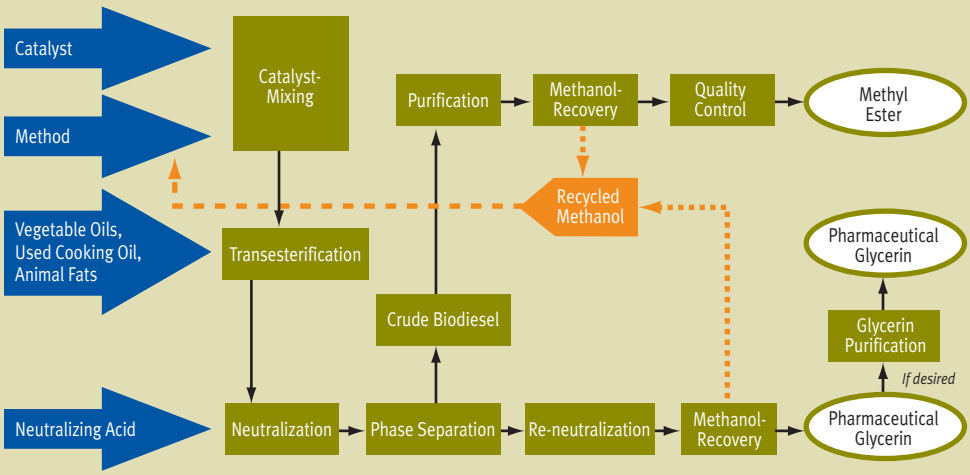
The most common way to produce biodiesel is through a process called transesterification. In this process, oil – gathered from oilseed crops or animal fats – is combined with a catalyst and alcohol to produce two main products.

The products are:

- biodiesel or methyl ester
- glycerine

The added methanol alcohol is usually recycled back through the system. The co-products, glycerine and feed quality fats can be sold to generate added income.

Biodiesel Production Process



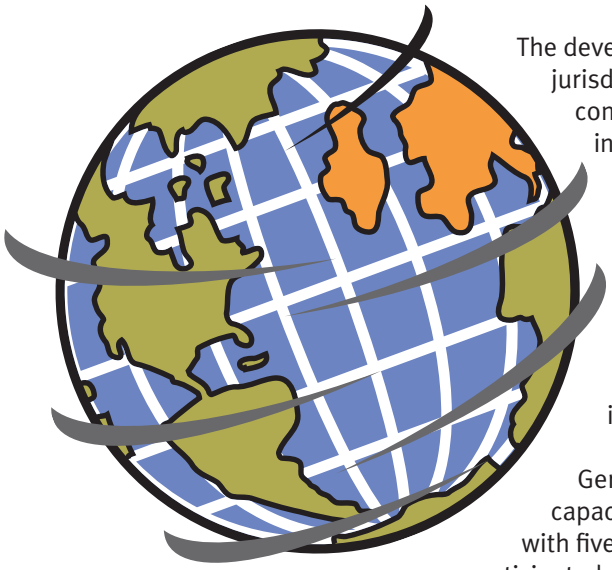
CASE STUDY ST. JOHNS SCHOOL BUSES ROLLING 1 MILLION MILES ON BIODIESEL

St. Johns Public Schools was the first Michigan school district to switch its entire bus fleet over to B20 (20 per cent soy biodiesel fuel and 80 per cent petroleum diesel) in 2002.

Wayne Hettler, the district's garage foreman and head mechanic, said their 31 school buses (including 13 powered by Cummins, two powered by Mercedes and 16 powered by International – and nine support vehicles – including pickup trucks, foodservice truck, service truck, New Holland tractor and Toro Diesel 3-wing mower) have come a long way in the past two years on biodiesel, "and all with no challenges and no modifications," Hettler added.

NOTE: In this report, feedstock is defined as the source materials for the production of biodiesel.

Global Perspective



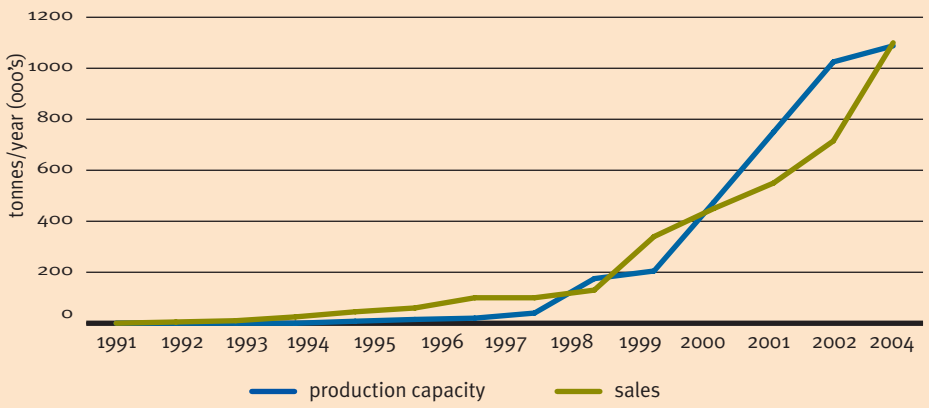
The development of the biodiesel industry varies significantly from jurisdiction to jurisdiction. In many European countries, biodiesel has been widely produced and consumed for several years. In North America, although developing rapidly, the industry is far less advanced.

Europe

The biodiesel industry has been flourishing in Europe in recent years. Combinations of agriculture, tax, energy and environmental policies have combined to make biodiesel production and use a profitable business. New energy policies being developed by the European Union (EU) should see the industry continue to grow over the next 10 years.

Germany is the largest producer and consumer of biodiesel in the world. The capacity of Germany's 19 biodiesel plants is now 936,000 tonnes per year, and, with five more plants under construction, an additional 173,000 tonnes annually is anticipated. Over 1,700 independent filling stations now sell biodiesel, typically in pure form (B100), (S&T² Consultants).

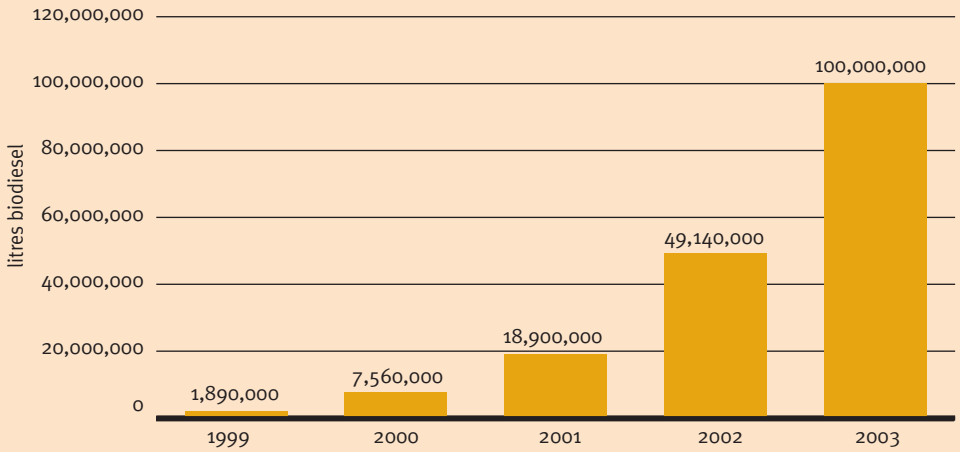
Germany – Plant Utilization



U.S.

Biodiesel is produced and used in the U.S. in limited quantities. In 1997, the U.S. Congress approved biodiesel as an alternative mechanism to comply with the *Energy Policy Act* (EPAct). EPAct requires government fleet operators to use a certain percentage of alternative fuel vehicles. Because biodiesel generally costs more than petroleum-based diesel fuel, many users are opting for biodiesel either for environmental reasons or to comply with the requirements of EPAct.

U.S. Biodiesel Production



Minnesota has adopted a more aggressive program to encourage biodiesel production by legislating the use of B2 (2 per cent biodiesel and 98 per cent petroleum-based diesel) in the state's diesel fuel by 2005. This requirement is contingent on the state developing, by that time, an annual biodiesel production capacity of at least 30 million litres. As a result, two new plants are currently under construction in the state.

A 2002 Minnesota report on the impact of B2 (2 per cent biodiesel and 98 per cent diesel) and B5 soy-diesel noted statewide benefits of expanded soy production and processing that included:

- a 3 to 7 per cent annual increase in demand for Minnesota soybean crop, plus a 9 to 21 per cent increase in processing capacity
- an additional 1,128 to 2,798 jobs that will generate $212 to $527 million (U.S.) in statewide economic benefits in agriculture and many other sectors

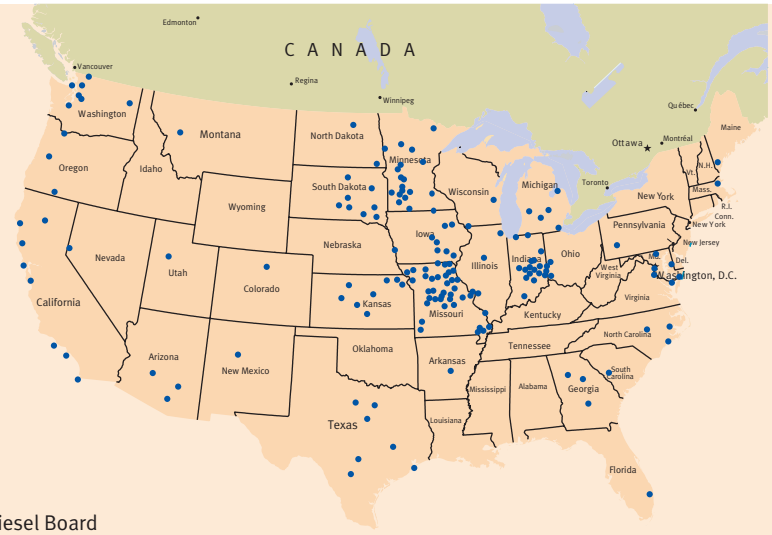
CASE STUDY LAS VEGAS SERVED UP BIODIESEL FOR LOCAL SCHOOLS

The Clark County School District in Las Vegas currently operates virtually all its buses on B20 (a blend of 20 per cent biodiesel and 80 per cent petroleum diesel fuel).

"Our responsibility is to deliver children to and from school safely and efficiently," said vehicle maintenance co-ordinator Frank Giordano. "It was our obligation to explore alternatives that would help clean up the exhaust from our diesel engines."

The retail station locations that have registered with the National Biodiesel Board are shown in the following figure.

U.S. Biodiesel Retail Locations



Source: National Biodiesel Board

Canada

In December 2003, the Biodiesel Association of Canada (BAC) was formed by a core group of stakeholders who identified a need to have national representation, education and awareness of biodiesel fuel in Canada.

The founding members of the association are Canadian Canola Growers (Manitoba Canola Growers Association, Saskatchewan Canola Development Commission and Saskatchewan Canola Growers Association); Canadian Oilseed Processors (Archer Daniels Midland Company, CanAmera Foods – Bunge and Cargill); Renderers Association (Rothsay, West Coast Reduction and Sanimal Inc.); and Ontario Soybean Growers. These members currently represent the board of directors along with the newest member, BIOX Corporation.

An incorporated, not-for-profit organization, the BAC sees its role as the authoritative centre of information on biodiesel in Canada.

To date, there has been limited production and use of biodiesel in Canada with primary producers being Rothsay, a rendering company in Montreal, Quebec and Milligan Bio-Tech, an oilseed fuel-additive producer in Foam Lake, Saskatchewan. This biodiesel has been used, for the most part, by fleet operators in various regions across Canada and by individuals seeking added lubricity for their fuel. Ocean Nutrition, a Nova Scotia company, also produces approximately five million litres of biodiesel annually for home heating fuel.

Some fleet managers have expressed the need to address the industry's ability to meet the growing demand for biodiesel. At the first meeting of the newly formed Canadian Association of Municipal Fleet Managers (CAMFM), the difficulties in securing supplies of biodiesel were discussed. The issues focused mainly on availability of supplies and industry standards. "Some municipalities have imported biodiesel from the U.S," said Yvan Lupien, chief operating officer for City of Winnipeg, Fleet Management Agency. Lupien added that the lack of an agreed-upon standard for the bio part of the fuel was also extensively discussed.

Biodiesel Incentives

Biodiesel in Germany is 100 per cent tax exempt when sold as B100 (in its pure form) and does not receive any subsidy if blended. This tax incentive equals approximately 70 cents per litre (Cdn). In addition to the exemption, German producers have the option of producing rapeseed on set-aside land. This has resulted in more than 1,700 gas stations selling B100 at about 15 cents (Cdn) per litre less than petroleum-based diesel.

Large fleets wordwide have been the initial consumer of biodiesel. Agriculture, transit, mining, hydro, shipping and forest industries have been the first to take advantage of the benefits of biodiesel.

Previously, the U.S. government had not offered any significant, financial incentives for biodiesel use. Certain states, such as Hawaii, Idaho and Illinois, have offered specific incentive packages to help stimulate production – typically in the form of excise tax exemptions. However, at the federal level, *The Energy Bill*, passed recently in the Senate, contains a one cent (U.S.) per U.S. gallon reduction of the diesel excise tax per percentage of biodiesel produced from agricultural products like vegetable oils, and a half cent (U.S.) per per cent for recycled oils. This incentive is aimed at the blender level and passed on to the consumer.

In Canada, little support is provided to biodiesel producers. At the federal level, the four-cent excise tax has been removed on biodiesel. Provincially, Ontario was the first jurisdiction to create an incentive for biodiesel production by removing its road tax of 14.3 cents (Cdn) per litre. However, on July 1, 2004, British Columbia also eliminated the road tax on biodiesel, which can range from 15 to 21 cents (Cdn) per litre, depending on location.

MANITOBA BIODIESEL PRODUCERS

Recently, in Manitoba, several people have begun producing biodiesel in small quantities to be used primarily by the agricultural sector and smaller fleet operators. Nationally, much more needs to be done to support a biodiesel industry that is on the verge of rapid development in Canada.

Paul Bobbee of Bifrost Enviro-Blends

Bifrost Enviro-Blends has begun producing up to 300 litres of biodiesel per week. Waste or down-graded oil seeds, such as green or heated canola and other oil seed crops will be used as a portion of the feedstock. Bobbee's company hopes to market his product among local retailers and agriculture producers in the area. "There is a lot of demand in rural Manitoba for this fuel", said the Arborg producer. "Farmers are eager to support their own industry."

City of Brandon

Recently, the City of Brandon began operating one of its buses on 100 per cent recycled waste cooking oil and animal fats. "We haven't had any problems with the operation of the bus," said a representative from Celtic Power, the company that manufactures the recycled fuel. "The motor is running well and passengers love the idea of riding on a bus that is burning used restaurant product and producing far fewer harmful emissions."

Brandon's biofuel bus at Energy Lane – Rural Forum 2004

Manitoba Has the Natural Advantages to Develop a Successful Biodiesel Industry

- Manitoba's $3 billion agriculture industry has the potential to double in the next 10 years.
- One in every nine Manitobans is employed in the agriculture industry.
- Manitoba's oilseed and pork industries are among the largest in Canada.

Strong Agrarian Economy

Manitoba's thriving agricultural sector makes the province a natural location for biodiesel production. These are just some of the advantages:

- abundant, renewable supply of feedstocks
  - crops – canola, sunflowers, soybeans
  - animal fats
  - recycled grease and oils
- opportunity to use lower quality, lower value feedstocks
- stable feedstock costs
- agriculture is a major consumer of diesel fuel

Manitoba's agriculture industry is critical to the production of biodiesel however, it is also a significant potential consumer. Nearly 300 million litres of diesel fuel are consumed by Manitoba agricultural producers each year. In many other jurisdictions that have developed a biodiesel industry, it is often the agriculture industry that first adopts biodiesel. Given the positive impact of biodiesel fuel on the agricultural sector, this can be expected to occur in Manitoba as well.

Business Climate – Competitive, Diverse, Dynamic

The costs of operating a biodiesel production facility in this province would be relatively low due to Manitoba's many competitive advantages:

- The Province of Manitoba passed *The Biofuels Act* in December 2003 to support the production and use of cleaner fuels, such as ethanol and biodiesel. In addition, companies investing in a new processing plant and/or equipment within the province are eligible to receive a 10 per cent manufacturing investment tax credit.
- Manitoba has competitively priced natural gas and the lowest published electricity costs in North America, with one of the most reliable delivery systems on the continent.
- Abundant, clean, water supplies are available from Manitoba's rivers, lakes and large regional aquifers.
- Manitoba has a qualified labour pool for high-tech manufacturing facilities. In general, Manitoba's labour pool is characterized by a strong work ethic and one of the lowest average manufacturing wage rates in Canada.
- Manitoba remains competitive by offering affordable business and land costs.
- Manitoba provides a good quality of life supported by one of the lowest costs of living on the continent.
- *The Manitoba Ethanol Advisory Panel Report* recommended that the province explore the development of other biofuels such as biodiesel.

CASE STUDY ROTHSAY

Ron Wardrop – Rothsay

Rothsay is one of Canada's largest renderers. In Montreal, Rothsay has a 3.5 million litre biodiesel plant, which recycles fats and oils into biodiesel that's sold mainly to fleets. For a one- year period, 155 buses of Montreal Transit ran on biodiesel in downtown Montreal. The Montreal bus demonstration indicated increased fuel efficiency under stop-and-go city conditions.

Biodiesel council visits Rothsay plant in Winnipeg

Market Opportunities

Manitoba is not only the ideal location for biodiesel production, it also provides an immediate local market for the biodiesel and it's co-products.

Internal Market

- Manitoba's agriculture industry will not only be a supplier of raw products, it will also be a major user of biodiesel. The meal co-product will be used in Manitoba's significant feed industry. In other jurisdictions, agriculture has led the initial uptake and use of biodiesel.
- The province's large trucking industry provides another major market. Thirteen major inter-provincial and international trucking companies have head offices in Manitoba.
- Manitoba's thriving transportation sector, including trains, buses and fleet vehicles, provides markets for biodiesel.
- Mining, forestry and construction industries are also potential users.

Export Market

- Ontario and B.C. already have a tax incentive program in support of biodiesel use. Given Northwestern Ontario's petroleum-based diesel fuel is currently supplied through Winnipeg terminals, Manitoba would be the natural choice to supply biodiesel to neighbouring provinces.
- Europe is now the largest biodiesel market in the world. Future targets for biodiesel use by the European community could mean increased imports, which Manitoba would be able to supply through the Port of Churchill.

The council recommends that the provincial government:

- **encourage the development of a biodiesel industry (both its production and consumption) in Manitoba that will use primarily Manitoba-grown and produced feedstocks, creating sustainable long-term jobs and other economic benefits**
- **develop Manitoba-based research capabilities and encourage collaboration between educational institutions and industry**
- **encourage the accreditation of local testing laboratories for fuel quality**

Opportunities and Challenges

The Manitoba Biodiesel Advisory Council has spent many months reviewing the potential of a biodiesel industry in this province. During that time, the council was able to study biodiesel production in other jurisdictions to learn how best to develop the industry in Manitoba.

The council identified specific opportunities and challenges for Manitoba's proposed biodiesel industry.

Feedstock

- Biodiesel is not necessarily affected by oil quality. It does not need the same oil quality required for food processing. Therefore, biodiesel production provides a market for lower quality, lower value feedstock including off-grades, green canola, screenings, spoiled and heated crops, and low quality tallow fats, oils and greases.
- More research needs to be done on production efficiencies and new, high-yielding, high-quantity oil and non-food-grade industrial crops.

Trade

- Western Canada's dominance in the production of canola may provide a marketing advantage. Canola produces a superior quality biodiesel fuel that meets the European standard, while U.S. soy biodiesel does not. Manitoba is also Canada's third largest producer of oilseed crops.
- Co-products of biodiesel require further development, as do markets for these products.

Adoption

- Early adoption of biodiesel fuel in Manitoba is expected to occur in fleets, agriculture, mining, government, crown corporations and forestry.
- A successful demonstration of the efficient use of biodiesel in larger national trucking firms located in Manitoba is needed to penetrate additional markets. Lubricity and other biodiesel benefits also need to be demonstrated and documented for the province.

Environment

- Pure biodiesel (B100), when compared to regular diesel, can reduce lifecycle greenhouse gas (GHG) emissions by over 91 per cent, sulfur oxide by 100 per cent, unburned hydrocarbons by 40 per cent, particulate matter by 70 per cent, methane by over 50 per cent, carbon monoxide by 50 per cent and poly aromatic hydrocarbons, (which can cause cancer and emphysema), by up to 80 per cent. More work is needed to address the 10 per cent increase in nitrogen oxide.

West Central Soy in Ralston, Iowa, produces 45 million litres of biodiesel per year and 540,000 million kilograms of glycerine.

It is very important that biodiesel sold as fuel meets or exceeds industry standards. Whether the ASTM, European standard or soon-to-be-released CGSB standard is used, consumers must know that the fuel they are using is of high quality. Programs such as BQ 9000, which assists biodiesel producers to meet these standards are critical to the continued development of biodiesel in North America."

Christine Paquette, Executive Director of the Biodiesel Association of Canada.

Fuel Quality

- As biodiesel use continues to expand in North America, it is important that the quality of the fuel is assured.
- The current American Society for Testing and Materials standards tests biodiesel in its pure form while the upcoming Canadian General Standards Board standard will test biodiesel as a blend from 1 per cent to 5 per cent.

Cold Weather

- Biodiesel must be able to function in Canadian climates. Feedstocks such as yellow grease have high, free fatty acids, high saturated fat and high cetane, but reduced cold flow qualities. Canola, on the other hand, has superior cold flow qualities.
- As in all high quality fuels, seasonal blends, cold flow additives and quality standards for biodiesel will be important. Low level blends such as B5 or less significantly reduce or eliminate cold flow concerns.

Economics

- Although the cost of producing biodiesel has steadily declined over the past several years, it remains more expensive than refining petroleum-based diesel fuel. Many jurisdictions offer some form of incentive for producers, which help offset the additional cost.

New Engine Technology

- The world of diesel engine technology is changing rapidly. The U.S. Environmental Protection Agency (EPA) has mandated changes to diesel engines aimed at decreasing harmful NOx and particulate emissions. Environment Canada requires a reduction in the amount of sulfur in petroleum-based diesel fuel from 500 ppm to 50 ppm and eventually to 15 ppm, by 2005 for on-road vehicles.
- The impact of using ultra-low sulfur diesel by itself, or as a blend with biodiesel, is not known. However, the added lubricity of biodiesel may help offset the loss of lubricity that occurs when sulfur is removed.

Infrastructure

- Given the current limited use of biodiesel in Manitoba, any expansion of the industry will likely require infrastructure upgrades. These changes may include blending facilities at the terminal level and/or added tanks and pumps at retail filling stations.
- Cost effective and timely quality testing for biodiesel is required but is not yet available in Manitoba.

Transportation

- Manitoba has a large trucking sector, with 13 major trucking firms headquartered in Winnipeg.
- Including the diesel fuel used in agriculture production, fleet and rail, Manitoba consumes close to 850 million litres of diesel fuel annually.

Building Knowledge

- The biodiesel industry is showing rapid growth globally and Manitoba is learning from world leaders in biodiesel, such as Germany.
- In Canada, biodiesel is at the early stages of a developing market. Government, industry, academic and consumer awareness, along with research and adoption actions, are required as biodiesel expands across North America.




Feedstock

Biodiesel can be made from a number of raw materials (referred to as feedstocks) including canola, soy, flax, mustard, palm, hemp, fish, algae, animal tallow and fats and yellow and brown grease/used cooking oils. In Manitoba, feedstocks that show the most potential for producing biodiesel are:

- oilseed crops
- animal fats
- recycled oils and grease

Biodiesel samples at the Biomass Energy Conversion Centre, Iowa

The largest oilseed crop in Manitoba is canola. However, there are lesser amounts of flax seed and mustard that could also be used to produce biodiesel. Vegetable oils make excellent feedstocks due to the low, free-fatty acid content.

All biodiesels have cetane values higher than that of the diesel fuel currently sold in Manitoba. This is a definite advantage for biodiesel.

Of all the vegetable oils, canola is probably the best suited for biodiesel production because of its low level of saturated fats. It has the best cold weather properties of all the biodiesel feedstocks. Unfortunately, this low level of saturated fat also gives canola biodiesel the lowest cetane level. Nevertheless, biodiesel cetane levels will still be higher than that of conventional diesel fuel.

Animal fats, on the other hand, have a higher level of cetane, which can increase engine life and time span between maintenance. However, they also have higher free fatty acids and saturated fats that may require pre-treatment. Cold weather properties pose more of a challenge for biodiesel produced from animal fats. This will be discussed further in the Fuel Quality section of the report.

In biodiesel production, feedstocks represent 65 to 85 per cent of the total production costs. These total costs are highly influenced by the kind of feedstock used and the plant size. For example, the use of two to five per cent biodiesel in all Manitoba's diesel fuel could be supplied by the tallow feedstocks available in the province. Because tallow and recycled cooking oil feedstocks are generally lower priced than vegetable oils, the result would be a lower cost biodiesel.

CASE STUDY MILLIGAN BIO-TECH DIESEL FUEL CONDITIONER

Milligan Bio-Tech (MBTI), a Foam Lake, Saskatchewan company formed in 1995, has been researching and developing a number of industrial canola oil products. Its first product, a diesel fuel conditioner, was released in April 2001. President Helgi Helgason said that since then, the market has increased and the future looks promising for this rural, community-based company.

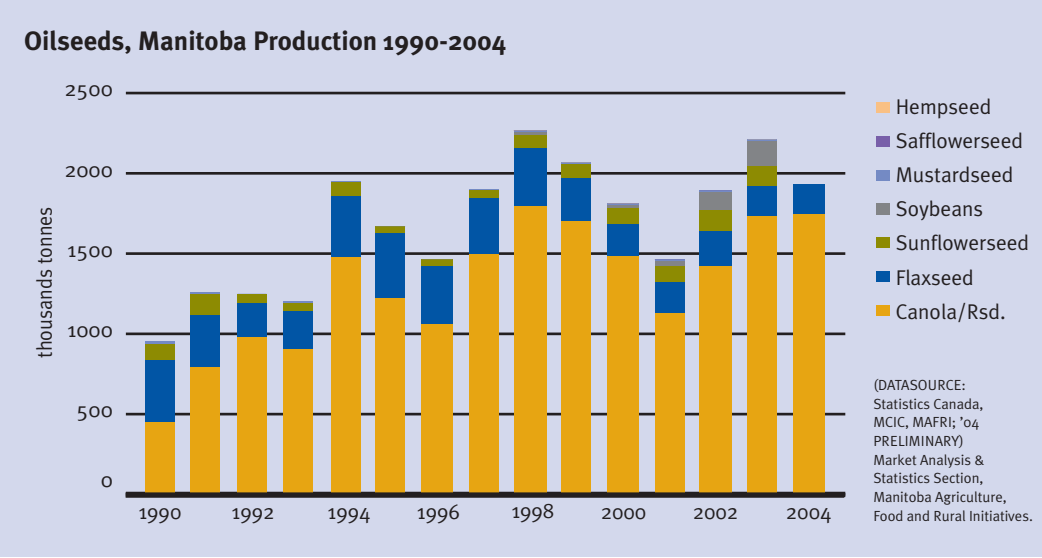
Milligan Bio-Tech Diesel Fuel Conditioner is a proprietary blend of canola-based products that combines the excellent cleaning properties of biodiesel with the outstanding lubricity properties of biodiesel and canola derivatives. The result is an environmentally responsible fuel additive with superior lubricity that offers improved engine performance, quieter operation, increased fuel economy and extended engine life.

More information on Milligan Bio-Tech is available at http://www.milliganbiotech.com/index.html.

The following table illustrates the approximate amount of oil (either animal or oilseed derived), in litres, that would be required to satisfy various blend levels in Manitoba assuming 100 per cent market penetration:

Blend	B2	B5	B20	B100
Litres	17 million	43 million	170 million	850 million

Oilseed Crops



Canola

- Canola is the largest oilseed crop in Manitoba.
- Manitoba produced over 1.12 million tonnes of canola in 2001, or 22.8 per cent of the total Canadian canola crop.
- Canola occupied 16.3 per cent of the Manitoba agricultural area planted in 2001.
- The oil content of canola ranges from 40 to 45 per cent, making it an excellent feedstock for biodiesel. Due to the low saturated-fat level of canola oil, it has the best cold weather properties of all biodiesel feedstocks.

While there are large volumes of oil produced in Manitoba, and a premium biodiesel can be produced, some stakeholders believe that given the higher price for the normal (high) quality canola oil, it would be a challenge to make it economically feasible in the short term.

Both Europe and the U.S. have supported their industries with incentives and, in some instances, mandates. Meanwhile, Milligan Bio-Tech in Saskatchewan produces and markets a higher value, high-quality fuel additive and lubricity product from canola oil.

Flax

- Manitoba, one of three provinces that produce flaxseed, has been growing the crop since the late 1800s.
- In 2001, Manitoba produced 200,000 tonnes of flaxseed, down from 560,000 tonnes in 1985.

- Manitoba contributed 28 per cent of the Canadian flaxseed crop in 2001, down from 62.4 per cent in 1992, when Manitoba was the largest producing province in Canada.
- The total oil content of the Manitoba flaxseed crop is about 90,000 tonnes but very little of it is extracted in the province. Flaxseed is processed into a variety of products from breads to linseed oil for use in products from paints to linoleum.

Soybeans

- Soybeans are the major feedstock used by the U.S. biodiesel industry.
- Soybean acreage in Manitoba has seen rapid growth over the past five years. In 2002, the Manitoba harvest reached 108,900 tonnes (Manitoba Agriculture, 2003). With an oil content of 18 to 20 per cent, the total provincial soybean oil production will be about 22,000 tonnes per year.
- In 2003, a new soybean crushing plant (Jordan Mills) began operations near Carman. It is processing 7,600 litres per day on a projected 270-day per year operation, generating 4,900 tonnes of soy oil annually.

Mustard

- Mustard seed prices in Manitoba vary from 44 cents to 66 cents per kilogram (Manitoba Agriculture, 2003).
- The oil content of yellow mustard seed is approximately 27 per cent, while brown mustard seed, which is ground into flour and used to produce hot mustard for European products, is about 36 per cent.
- Over the past five years, mustard seed production in Manitoba has ranged from 2.27 million to 10 million kilograms per year. With an oil content of 30 per cent, the crop would produce up to 3,175 tonnes of oil or 3.5 million litres of biodiesel, if 100 per cent of the crop were used.

Oilseed Production Summary:

	Canola	Flaxseed	Mustard	Soybeans
Total production	1.1 to 1.6 million tonnes	240,000 to 350,000 tonnes	2,300 to 9,000 tonnes	109,000 tonnes
Oil content	40-45%	45%	30%	20%
Oil production	0.45 to 0.7 million tonnes	90,000 to 150,000 tonnes	690 to 2,700 tonnes	22,000 tonnes
Extracted MB	270,000 tonnes	Minimal	Minimal	4,900 tonnes

CASE STUDY JOHN DEERE - Factory fills Tractors with B2

Jefferson City, MO. – John Deere recently announced that it plans to use B2, a blend of two per cent biodiesel fuel, as the preferred factory-fill in its diesel propelled machines made in the United States. John Deere representatives shared the announcement with more than 850 biodiesel enthusiasts from across the country gathered for the 2005 National Biodiesel Conference & Expo, which took place January 30 to February 2, 2005 at the Broward County Convention Center in Ft. Lauderdale, Fla.

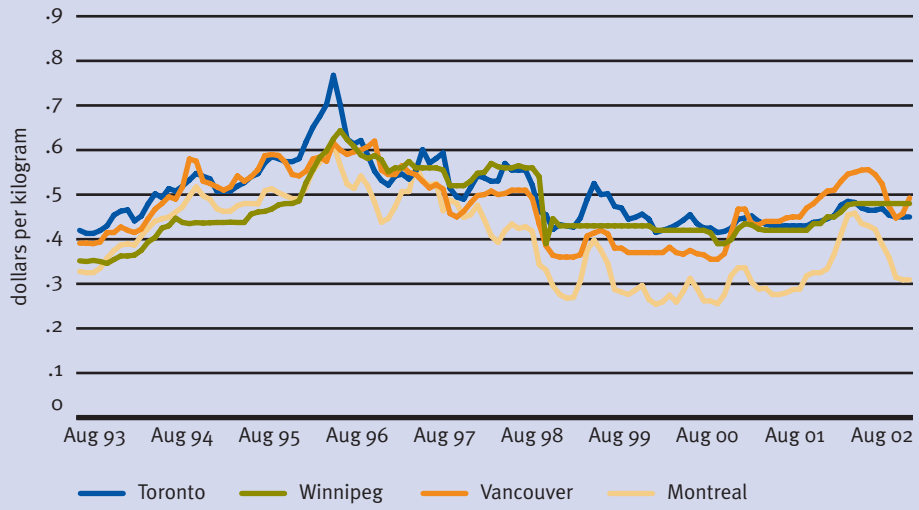
"This is a big step forward in confirming our commitment for the use of biodiesel fuel," said Don Borgman, manager market planning and customer integration, John Deere Ag Marketing Center. "Our manufacturing plants in the U.S. will use B2 biodiesel for fueling tractors, combines, self-propelled sprayers, and other diesel powered machines."

Animal Fats

- The rendering process recycles animal and poultry by-products, including bones, trim, fat, offal, feathers and waste cooking oils into a broad range of commercial tallow (animal/vegetable fat) and protein products (meat and bone, poultry, feather, blood, fish and porcine meals).
- In Manitoba, the most significant animal feedstock for the rendering industry is waste product from hog processing.
- In 2001, over four million hogs were slaughtered in the province (Manitoba Agriculture 2003). Future volumes are expected to continue increasing and may reach an annual slaughter of six million to seven million hogs by 2006 or 2007.
- There is an estimated 22 million litres of inedible pork product in the province. Most is blended with yellow grease for the feed industry.
- At the end of September 2003, prices for hog lard, or tallow, from Rothsay's Winnipeg plant, were $480 (Cdn)/tonne or 48 cents (Cdn)/kilogram.

No ruminant animals are rendered in Manitoba. Biodiesel production may provide a future alternative for livestock producers who can no longer render ruminant animals. This current material volume could be used to produce up to 5 million litres/year of biodiesel.

Animal Fat Prices



Recycled Oils and Grease

- The most common, recycled cooking oil is called yellow grease and has high, free-fatty acids. It is generated from a wide variety of small cooking operations in restaurants and food processing businesses across the province. It also comes from a few large operations, such as potato processing plants that produce a pre-cooked product (ex: pre-fried french fries).
- Manitoba generates roughly 4.25 million litres of processed yellow grease annually. Volume growth for this grease is expected to be two to five per cent per year.

- Other recycled oils in Manitoba (ex: trap grease), sometimes called brown grease, are estimated at 2.2 million litres annually. However, further research is required to determine what volume is being captured and if it is technically and economically feasible to use brown grease as a feedstock for biodiesel.
- If all Manitoba's animal fat and yellow grease were diverted to the biodiesel market, there would be enough feedstock for nearly 32 million litres of biodiesel. This scenario is unlikely and, in practice, up to 20 million litres could be produced from this resource.

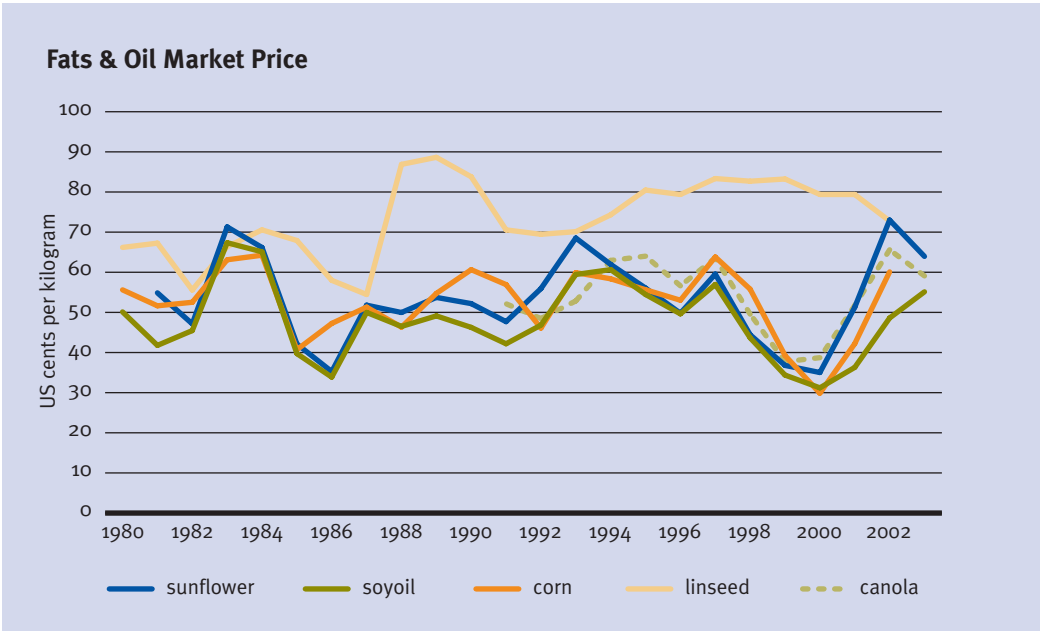
Animal Fat and Yellow Grease Summary

Manitoba	Total Volume	Market Price Cdn	Free Fatty Acid Content
Tallow	27.5 million litres	$0.48/kg	7% max.
Yellow Grease	4.25 million litres	$0.47/kg	15% max.
Total	31.75 million litres		

* Note that lower free fatty acid content improves overall cold flow characteristics

Future Feedstocks

- The biodiesel industry will continue to grow rapidly while addressing economic factors arising from the high cost of feedstock and production potential.
- New technologies and feedstocks are expected to reduce inputs and cost. Research is focusing on the development of high fat, high oil, high yielding and non-food-grade industrial crops, particularly in canola, mustard and flax. High oil crops, such as solin and mustard, are expected to benefit the biodiesel industry in two to four years.
- New technologies to capture and process recyclable fats, oils and greases are being developed as new plants continue to be built in Canada and the U.S.



Bovine Spongiform Encephalopathy (BSE)

Bovine Spongiform Encephalopathy is a progressive, fatal disease of the nervous system in cattle. It is a transmissible spongiform encephalopathy (TSE). Other TSEs include chronic wasting disease in deer and elk, and Creutzfeldt-Jakob disease (CJD) in humans. The exact cause of BSE is unknown, but we do know it is associated with the presence of an abnormal protein called a prion. There is no treatment or vaccine currently available for the disease.

There have only been a few cases of BSE ever diagnosed in this country. The first case was found in 1993 in a beef cow. The animal carcass and the herd it came from were destroyed. The second case of BSE was reported May 20, 2003. The animal was destroyed and no meat from the carcass entered the food system.

In 1997, Canada adopted a mammalian-to-ruminant feed ban which prohibits the feeding of proteins from mammalian species to ruminant animals such as cattle. However, proteins derived exclusively from porcine (hogs) or equine (horses) animals and milk and blood proteins from all mammals, including ruminants, may be fed to all species including ruminants.

In December 2000, the Canadian Food Inspection Agency suspended the importation of rendered animal material from any country that Canada did not recognize as free of BSE.

CFIA is currently in discussion with industry partners about potential actions that would be included within a national strategy aimed at repositioning the Canadian cattle industry. Included in this discussion is the potential to eliminate specified risk material (SRMs), or that material that can carry BSE including the brain and central nervous system from the feed and pet food industry. Eliminating all SRM's from the process chain, will have a significant impact on the source and composition of the material that Canadian renderers can process.

Scientists and technical reports from Europe and North America indicate that:

Biodiesel poses negliable BSE-related health risk to humans for several reasons.

1. The biodiesel production process purifies the methyl esters to eliminate insoluble products and other impurities.

2. During rendering, BSE prions tend to associate themselves with the protein materials rather than the tallow.

3. The infectivity risk to humans associated with potential airborne exposure to the combustion products when using raw tallow as a combustion fuel in diesel engines is negligible.

Removal of Deadstock

Proper removal of fatalities in livestock operations is important. Currently in Manitoba the majority of ruminant deadstock is disposed of on-farm or landfilled. However, if the deadstock could be captured and processed, it would represent both a source for biodiesel production as well as a solution to a growing environmental concern.

In September 2004 the Manitoba Agriculture Food and Rural Initiative's Minister Rosann Wowchuk released recommendations from the provincial BSE Ruminant Task Force and committed the province to continue laying the groundwork necessary to ensure a future for the province's beef and ruminant industries in a post-BSE era.

Biodiesel may provide part of the solution to this significant challenge.

The Manitoba Biodiesel Advisory Council recommends that:

- **the government research and determine the feasibility of using specified risk materials (SRMs) and other byproducts (ex: offal) from ruminant slaughtering plants to create a new dedicated feedstock stream for biodiesel plants**

Co-products from Biodiesel Production

Biodiesel can be produced using three basic technologies:

- base catalyzed transesterification of the oil with alcohol
- direct acid catalyzed esterification of the oil with methanol
- conversion of the oil to fatty acids and then to alkyl esters with acid catalysis

Using the most common transesterification technology, the vegetable oil (or animal fat) is first filtered and then pre-processed with alkali to remove free fatty acids. From there, it is mixed with alcohol (usually methanol) and a catalyst (usually sodium or potassium hydroxide), which causes the oil's triglycerides to form esters and glycerol. These fractions are separated and purified into glycerine and biodiesel fuel, and the methanol from the biodiesel stream is recovered and reused.

The main products of the transesterification process are biodiesel and glycerol. The co-product (glycerol) can be refined into glycerine, which is used for a variety of products from cosmetics to pharmaceuticals.

When vegetable oils are used for the feedstock, the seed-crushing process creates vegetable meal, which is used by the livestock industry as high-protein animal feed.

Glycerine Markets

Glycerine is a clear, odourless, gel-like substance commonly used in a number of industry sectors including food and beverage, pharmaceutical, textile, cosmetic, and pulp and paper. Although glycerol is used in the production of literally thousands of products, those uses can change with pricing and new technology development. Glycerol can be produced synthetically as well as naturally, as a co-product of fatty acid, fatty alcohol or biodiesel production.

The demand, supply and pricing of glycerine is determined by national and international market forces, which are both complex and unpredictable. Because it's a co-product, the demand for glycerine will be largely influenced by the demand for the primary products, such as biodiesel. As biodiesel production capacity grows to meet the rising demand, the amount of glycerine available for sale will also increase. The increased supply will likely reduce the price of glycerine.

Biodiesel council members examine biodiesel co-products at West Central Soy, Ralston, Iowa.

West Central Soy markets numerous co-products of biodiesel including glycerine, cutting oils, penetrating oil, lubricant, hydraulic oil, fifth wheel grease, chain bar oil, solvent, graffitti oil stain remover, asphalt release and diseal fuel additive. These products can command a premium sale price as some consumers prefer the biodegradable oil lubricant benefits.

Biodiesel – More Than a Fuel

One way to address the cost of producing biodiesel as a fuel is to investigate opportunities for higher value uses for biodiesel, or methyl esters. Identifying additional or alternative market opportunities will allow manufacturers to distribute the total costs of methyl ester production between the fuel and non-fuel markets.

Multi renewable fueling station

The potential market for non-fuel, biodiesel esters in the U.S. is estimated to be as high as $53 billion.

The rising demand for environmentally friendly chemicals is one of the driving forces behind market opportunities for methyl esters. They can be used as a platform chemical with a number of industrial products. The market segments are outlined below.

- plastics and plasticizers – 5.1 billion kilogram
- agrochemicals – 5.4 billion kilogram
- solvents and paint strippers – 2.7 billion kilogram
- industrial chemicals – 2.2 billion kilogram
- adhesives – 3.4 billion kilogram
- lubricants – 1.6 billion kilogram
- surfactants – 2.7 billion kilogram

Lubricating Oils

Lubricant products, including chainsaw oil, gear oil, hydraulic fluid and transmission fluid, can be made with both canola methyl ester and unmodified canola oil. The majority of lubricants sold in Canada are petroleum-based. However, because of environmental concerns and health problems associated with using petroleum lubricants for some applications, more environmentally friendly lubricants have been developed.

Although vegetable oil lubricants currently cost approximately twice as much as conventional petroleum lubricants, Canadian companies seem to be willing to pay higher prices for these vegetable oil lubricants in environmentally sensitive areas. Currently, there are several companies distributing vegetable oil lubricants in Canada. Typical customers include logging companies, municipalities, parks and golf courses.

Solvents

Solvent is a generic term, referring to a liquid substance capable of dissolving other substances. Methylene chloride is a solvent being phased out in the U.S. and Canada due to environmental and health regulations. It is a primary component in paint remover, plastics, adhesives and urethane foams. Biodiesel represents a significant opportunity to replace methylene chloride as a more environmentally friendly solvent.

Metal Working Oil

Metal working/cutting oils are used to reduce heat when cutting or forming metal. As well, they lubricate the cutting area, remove contaminants and prevent corrosion. There are two broad categories of conventional metal working oils: neat and water-based. Neat oils, used for heavy-duty operations, can be derived from animal, petroleum, vegetable or synthetic sources, although most are petroleum-based. Water-based or aqueous metal working oils contain water or must be mixed with water after purchase. There are three types of aqueous oils: soluble, semi-synthetic and synthetic.

Because vegetable oil cutting fluids are more environmentally friendly, less of a health hazard, and superior in performance, vegetable oil is increasingly becoming the oil of choice.

The Manitoba Biodiesel Advisory Council recommends that the provincial government:

- **research value-added opportunities for co-products**

CASE STUDY RED RIVER VALLEY CLEAN CITIES COALITION WINNIPEG CHAPTER INC.

Founded in 1998, the Red River Valley Clean Cities Coalition (RRVCCC) Winnipeg Chapter Inc. is a voluntary partnership between government, business, non-profit organizations and post-secondary institutions with a mission to expand transportation energy choices, strengthen the economy and maintain a healthy environment in Manitoba.

The RRVCCC Winnipeg Chapter works throughout Manitoba to:

- advance the use of cleaner burning transportation fuels, such as ethanol, biodiesel, hydrogen, natural gas and propane
- develop markets for advanced vehicle technologies, including gas-electric hybrids, hydrogen fuel cells and E85 vehicles (85 per cent ethanol blend)
- promote idle reduction activities and technologies
- educate the public and private fleet operators about the economic and environmental benefits of alternative fuels and alternative fuel vehicles

City of Winnipeg Biodiesel Study:

The City of Winnipeg in conjunction with RRVCCC will be conducting an extensive study on biodiesel use in heavy equipment vehicles. Biodiesel at the B5 and B20 levels will be tested in heavy equipment vehicles for a one-year period to capture year-round seasonal performance. The biodiesel tested will be a Canadian-made, canola-based fuel. The study is unique in that it will be using ultra-low sulphur diesel as the conventional diesel source to be blended with biodiesel. Project partners are Milligan Bio-Tech, Canadian Canola Growers Association, Manitoba Hydro and the Province of Manitoba. The project is scheduled to begin in April 2005.

Fleet Management Agency employees line up in front of a City of Winnipeg welding truck and industrial tractor-loader operating on biodiesel from Milligan Biotech. It's part of an alternative fuel vehicle demonstration at RRVCCC Winnipeg Chapter's Alternative Fuel Odyssey Event in April 2004.

City of Winnipeg's Fleet Management Agency

Biodiesel as a Fuel – Quality and Engine Performance

Biodiesel can be used in its pure form (100 per cent) as a substitute for diesel fuel. Alternatively, it can be blended at any level with petroleum to create a biodiesel blend. In the U.S., the most common blend is B20 (20 per cent biodiesel, 80 per cent petroleum) but there are also areas where a B2 (2 per cent biodiesel, 98 per cent petroleum) fuel is being marketed.

"Biodiesel is proven operationally across more than 60 million road miles and is currently used in over 200 public and private fleets across Canada and the U.S."

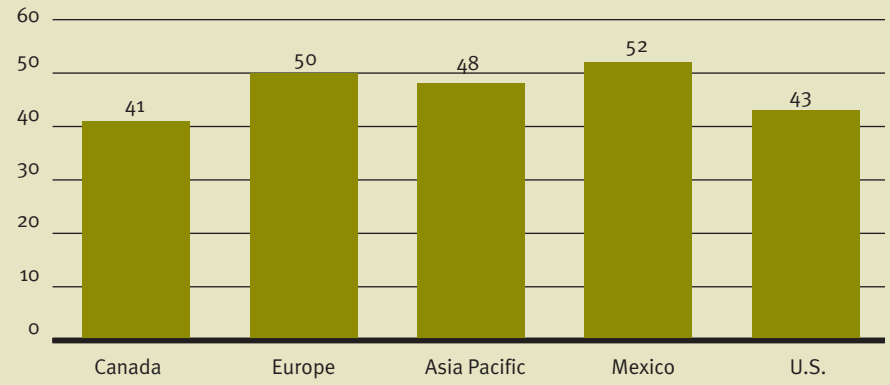
Canadian Renewable Fuels Association

Quality of Canadian Diesel Fuel

The cetane number is a measure of the ignition quality of diesel fuel and influences combustion characteristics. Higher cetane-number fuels are known to give better performance in aspects like emissions, noise and cold white smoke generation. As a rule, all forms of biodiesel have higher cetane values than those of conventional, petroleum-based diesel.

In Canada, no federal regulated requirements exist for cetane number or cetane index. However, the Canadian General Standards Board (CGSB) specification for both regular and low-sulphur diesel fuel is, at minimum, a cetane number of 40. The specification for diesel fuel used in locomotives can be lower.

Cetane Levels in Diesel Fuel



CASE STUDY TORONTO HYDRO CORPORATION – BIODIESEL PILOT PROJECT

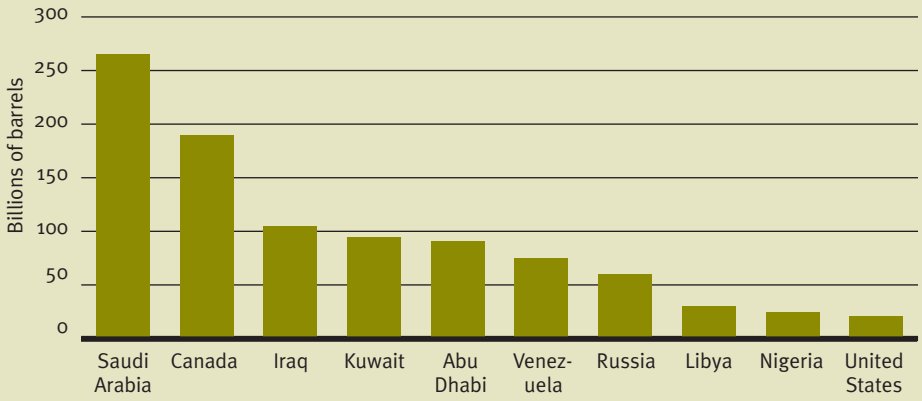
In September 2001, Toronto Hydro Corporation began a large-scale pilot project using biodiesel in about 80 fleet vehicles. By July 2002, the project had expanded to include the entire diesel fleet of 400. As a result, Toronto Hydro-Electric System received the Award of Excellence during National Transportation Week 2002.

Based on worldwide annual fuel surveys, U.S. and Canadian diesel fuels have a significantly lower cetane number than most diesel fuels. It's also important to note that currently, in Canada, on-road diesel fuel is regulated, but off-road diesel fuel is not.

Low-sulfur diesel's current Sulphur in Diesel Fuel Regulations require that the concentration of sulphur in diesel fuel produced, or imported for use in on-road vehicles, does not exceed 500 ppm before May 31, 2006, and 15 ppm after May 31, 2006. Diesel fuel sold in the northern supply area should not exceed 15 ppm after August 31, 2006.

It was recently announced that the oil reserves from the Alberta tar sands marks Canada as having one of the largest oil reserves worldwide. In recent years, it has become technologically viable to extract oil from the tar sands, ranking Canada as the second largest holder of oil reserves in the world, directly under Saudi Arabia and above Iraq.

Global Crude Oil Reserves



Source: Red River Valley Clean Cities Coalition

* As crude oil reserves continue to decline, renewable fuels are expected to continue to demand more market share

Lubricity

Since the introduction of low-sulphur diesel fuel in the 1990's, considerable efforts have been made by the automotive industry, end users and the petroleum industry, to address the lubricity requirements of diesel fuel. The processes used to reduce the sulphur content in diesel fuel also remove other elements like nitrogen compounds, that provide some fuel lubricity. The sulphur content of diesel fuel will be declining again in 2006 and there is some concern the lubricity problems may increase.

Fuel lubricity can be increased by adding conventional additives to the fuel. The cost of additives to provide acceptable lubricity in ultra-low sulphur diesel fuel is estimated at five to 10 cents (Cdn) per litre. At the same time, the addition of biodiesel, which has excellent lubricity properties, is being promoted as a means to address potential problems.

Cold Flow and Cloud Points

User experience with cold weather varies. B20 blends are used in some very cold climates, such as northern Minnesota and Wyoming, where temperatures can fall below -40 °C in the winter.

Other user examples:

- B20 was used in an airport shuttle fleet in Boston for four years without any problems.
- Some users have reported using B100 in extremely cold climates like Yellowstone National Park. The vehicles were equipped with winterization packages but no other precautions were noted.
- The Montreal bus demonstration project only experienced cold weather issues when blending an animal fat biodiesel with petroleum-based diesel, when the diesel fuel was colder than -10 °C. Once the fuel was blended, there were no operating problems. The buses operated in temperatures as low as -30 °C, although they were kept in a heated garage when not in use.

Pour point, the temperature point above which the fuel will pour, is important because it directly affects the use of the fuel in colder climates. The high-pour points of many biodiesels significantly limit their use in pure form in cold weather. Even though the blends show much better pour-point temperatures at lower concentrations, handling the pure biodiesel, before mixing, will require insulation and heated tanks to ensure the liquid can be moved prior to mixing.

Biodiesel can be splash blended on top of petroleum diesel, or if bottom loading is used, the biodiesel should be added first, then adding the diesel fuel will provide the required agitation. In many cases, bioiesel is splash blended either on-farm or at the distributor level. Some larger fleets blend the bio portion at their own distribution terminals.

Biodiesel can be blended with no problems if the diesel fuel temperature is 10 °C or higher. If biodiesel is blended with cold diesel fuel (fuel temperature is less than 8 °C to 10 °C), the biodiesel should be warmer (up to 30 °C). Otherwise, saturated compounds in the biodiesel can crystallize and plug fuel filters and fuel lines.

The pour-point results from a number of feedstocks are shown in the following table including both high free fatty acid (HFFA) and low free fatty acid (LFFA) grease. At the 20 per cent biodiesel level, there is a 9 °C difference between canola and soy biodiesels and the animal fat biodiesels.

CASE STUDY JEEP LIBERTY CRD DIESEL SUVs TO RUN ON B5

Daimler Chrysler recently announced that each new 2005 Jeep Liberty common-rail diesel (CRD) sport utility vehicle (SUV) rolling off the assembly line will be fueled with B5, a blend of 5 per cent biodiesel and 95 per cent standard petroleum diesel.

"This is an important first step in encouraging wider use of these clean, renewable, environmentally friendly fuels in the United States," said Chrysler Group President and CEO Dieter Zetsche.

Pour Point Results °C

Biodiesel Concentration	Soy	Canola	Lard	Edible Tallow	Inedible Tallow	LFFA Yellow Grease	HFFA Yellow Grease
0%	-27	-27	-27	-27	-27	-27	-27
0.25%	-27	-21	-24	-24	-24	-24	-24
0.50%	-27	-24	-24	-24	-24	-24	-24
1%	-24	-24	-24	-21	-24	-24	-24
3%	-24	-24	-21	-21	-21	-21	-21
5%	-21	-21	-18	-18	-15	-18	-18
10%	-18	-21	-15	-12	-12	-18	-18
20%	-18	-18	-9	-9	-9	-9	-12
35%	-15	-18	0	-6	-2	-6	-6
50%	-9	-15	3	3	3	0	-3
100%	-1	-4	11	13	8	12	8

Source S&T² Consultants

The cloud point of diesel fuel is an important measure because it's the temperature at which components of the fuel begin to crystallize, forming a visible clouding of the liquid. When circulating in the fuel system, the components that produce the clouding can be captured in filters, or cause components to wear, due to the solidification of the lubricants. The cloud point exhibits a larger increase at low concentrations of biodiesel, but to a lesser extent than the pour-point tests. The cloud point results are shown in the following table.

Cloud Point Results °C

Biodiesel Concentration	Soy	Canola	Lard	Edible Tallow	Inedible Tallow	LFFA Yellow Grease	HFFA Yellow Grease
0%	-18	-18	-18	-18	-18	-18	-18
0.25%	-20	-18	-18	-16	-16	-15	-18
0.50%	-17	-18	-17	-16	-17	-14	-15
1%	-16	-18	-17	-15	-17	-16	-15
3%	-16	-17	-16	-13	-14	-16	-15
5%	-16	-17	-15	-12	-13	-16	-14
10%	-15	-17	-14	-9	-10	-13	-13
20%	-12	-15	-3	-2	-6	-6	-8
35%	-9	-12	-3	0	0	5	-6
50%	-9	-10	-2	3	4	13	-3
100%	2	-3	14	20	23	42	8

Source S&T² Consultants

Fuel Efficiency

Engine power and torque are very similar with biodiesel and petroleum diesel, especially in the lower blends. The performance of 100 per cent biodiesel may be slightly lower than the petroleum diesel due to the lower energy content.

Because biodiesel contains oxygen, it has about an 8 per cent lower energy content than petroleum diesel by weight. However, the specific gravity of biodiesel is about 4 per cent higher than petroleum diesel, which compensates for some of the lower energy content.

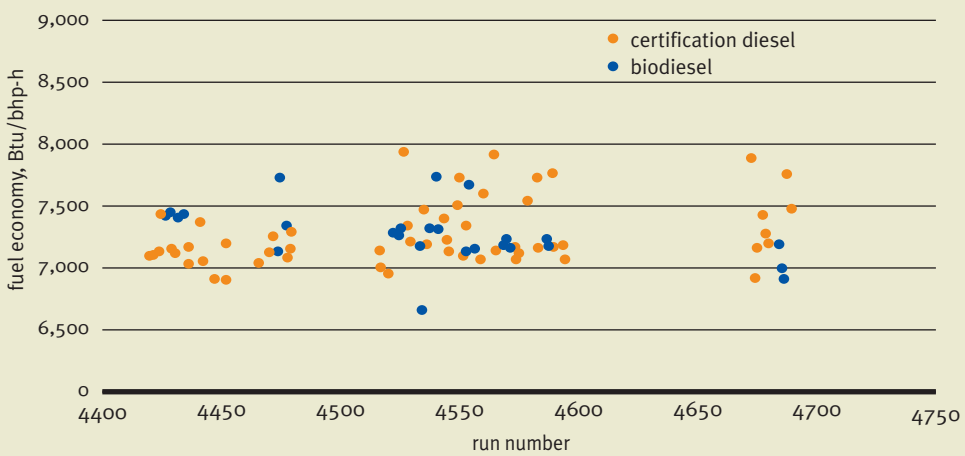
The volumetric fuel economy is about 4 per cent less for B100. With a B20 blend, the difference in mileage will be less than 1 per cent and probably not noticeable. The biodiesel demonstrations in Montreal and Minnesota have confirmed that the on-road fuel economy is not statistically different from petroleum diesel fuel. Other studies have shown an overall decrease in fuel efficiency of 1 per cent to 2 per cent using a B20 blend.

Some researchers have reported fuel efficiency gains using biodiesel blends.
A report by Dr. Barry Hertz (June 2003, University of Saskatchewan) concludes that using low-level biodiesel blends (up to 5 per cent) results in fuel efficiency gains of 2 per cent to 13 per cent. As well, the application of canola-based fuel additives can decrease light-duty engine wear by up to one-half. (Biodiesel Fuel Lubricity Additives for Increasing Engine Life and Efficiency, 2004).

Some local users have also indicated small increases in fuel economy at low level blends in medium-duty vehicles. John Shack, owner of Northern Air Biodiesel in Beausejour, recycles used canola oil to produce biodiesel used as B2 in the agriculture and pulp and paper industries. Shack said that a 2000 Volvo tractor trailer hauling pulp wood in Eastern Manitoba used his biodiesel as a B2 blend. The operator reported an increase in horsepower and 10 per cent better fuel economy.

The fuel usage on an energy content basis is the same as diesel fuel. The researcher Graboski, tested many different biodiesels on the same engine and his test results are shown in the following figure. There is no difference in energy efficiency apparent from this data.

Biodiesel Energy Efficiency



S&T² Consultants, 2003

Ultra-Low Sulphur Diesel/New Engine Technology

There are pending changes in Canadian diesel fuel regulations that are important to potential biodiesel manufacturers. With the exception of a northern supply area, the Canadian Sulphur in Diesel Fuel Regulation specifies that the concentration of sulphur in diesel fuel produced, or imported for use in on-road vehicles, should not exceed 500 mg/kg up to May 31, 2006 and 15 mg/kg after this date. A three-month transition period gives manufacturers until August 31, 2006 to comply with the regulation.

At present, the Canadian General Standards Board (CGSB) only specifies a voluntary limit for sulphur in diesel fuel for off-road vehicles and engines (of 5000 ppm). Environment Canada, however, has stated plans to recommend a regulatory limit for off-road diesel fuel within the same time frame planned by the U.S. Environment Protection Agency (EPA).

The EPA has recently called for changes to diesel engines. These changes will include mandated reductions in both nitrogen oxide and particulate emissions.

Compatibility with Engines

Biodiesel can be operated in any diesel engine with little or no modification to the engine or the fuel system. It has a solvent effect that may release deposits accumulated on tank walls and pipes from previous petroleum diesel fuel storage. The release of these deposits may clog filters initially, so precautions should be taken. One such precaution may require the changing of oil filters, since biodiesel acts as a solvent and tends to clean out fuel lines and deposit residue in the fuel filter.

Both the European Union and the United States' American Society of Testing and Materials (ASTM) have standards in place to ensure the quality of biodiesel in those jurisdictions. The Canadian General Standards Board (CGSB) has recently drafted a standard for biodesel blends of up to 5 per cent. The Canadian standard is expected to be passed in 2005.

In 2004, the National Biodiesel Board announced the BQ 9000 program, which combines the ASTM standard with a quality systems program that includes storage, sampling, testing, blending, shipping, distribution and fuel management. Accreditation under the BQ 9000 program is open to all companies that actively, or intend to produce, distribute or market biodiesel.

CASE STUDY BRAMPTON FIRST CANADIAN MUNICIPALITY TO USE BIODIESEL FUEL

In July 2002, Brampton, Ontario became Canada's first municipality to commit to the ongoing use of biodiesel fuel for its fleet.

"As of July 2, we are using biodiesel fuel in 200 City of Brampton vehicles, ranging from large graders to the litter-busting Madvacs used, in city parks and on boulevards," said Alex MacMillan, the city's commissioner of works and transportation. "Pilot tests conducted in the past two months on 16 city vehicles were successful, showing a 24 per cent reduction in emissions."

Warranties – Industry Statements

In 2002, the Engine Manufacturers Association (EMA) issued a new position paper on the use of biodiesel, replacing an earlier one published in 1995. The EMA is an international organization representing the interests of the manufacturers of internal combustion engines. Its position on the use of biodiesel is:

> *Based on current understanding of biodiesel fuels and blending with petroleum based diesel fuel, EMA members expect that blends up to a maximum of B5 should not cause engine or fuel system problems, provided the B100 used in the blend meets the requirements of ASTM D 6751, DIN 51606, or EN 14214. If blends exceeding B5 are desired, vehicle owners and operators should consult their engine manufacturers about the implications of using such fuel.*

The EMA makes the following statement about warranties:

> *Engine manufacturers are legally required to provide an emissions warranty on their products (which are certified to EPA's diesel fuel specification) and, typically, also provide commercial warranties. Individual engine manufacturers determine what implications, if any, the use of biodiesel fuel has on the manufacturers' commercial warranties. It is unclear what implications the use of biodiesel fuel has on emissions warranty, in-use liability, anti-tampering provisions, and the like… more information is needed on the impacts of long-term use of biodiesel on engine operations.*
>
> *Many major engine companies have stated formally that the use of blends up to B20 will not void their parts and workmanship warranties. This refers to blends below 20 per cent biodiesel, such as the 2 per cent biodiesel blends that are becoming common in some parts of the U.S.*

Warranty information regarding biodiesel continues to be updated as more knowledge is gained on the effects of biodiesel on modern diesel engines.

Statements on Warranty Positions on Biodiesel Use

Caterpillar	Caterpillar neither approves nor prohibits the use of biodiesel fuels. Caterpillar is not in a position to evaluate the many variations of biodiesel fuels, and the long-term effects on performance, durability or emissions compliance of caterpillar products. The use of biodiesel fuel does not affect Caterpillar's materials and workmanship warranty. Failures resulting from the use of the fuel are not Caterpillar factory defects and therefore the cost of repair would not be covered by the caterpillar warranty. Some Caterpillar engines are limited to 5 per cent biodiesel blends.
Cummins	Cummins neither approves or disapproves of the use of biodiesel fuel. Cummins is not in a position to evaluate the many variations of biodiesel fuels or additives, and their long-term effects on performance, durability or emissions compliance of Cummins products. The use of biodiesel fuel does not affect Cummins Material and Workmanship warranty. Failures caused by the use of biodiesel fuels or other fuel additives are not defects of workmanship and/or material as supplied by Cummins, Inc and can not be compensated under Cummins warranty.
Detroit Diesel	Biodiesel fuels are alkyl esters of long chain fatty acids derived from renewable resources. Biodiesel fuels must meet ASTM Specification D 6751. Biodiesel meeting the D 6751 specifications can be blended up to 20 per cent maximum by volume in diesel fuel. Failures attributed to the use of biodiesel will not be covered by Detroit Diesel product warranty.
International	International Engine Corporation neither approves nor disapproves any product not manufactured or sold by International. The use of products such as biodiesel is at the discretion of the end-user. Any engine performance problem or failure attributed to biodiesel would not be recognized as the responsibility of International Engine Corporation. International's engine warranty covers defects caused by material or workmanship. The International engine warranty, workmanship and material is not affected simply by the use of biodiesel regardless of the product's origin. Fuel is not warranted by International under any condition.
John Deere	John Deere has approved the use of up to 5 per cent concentration soy-based biodiesel fuel in its PowerTech® diesel engines. Biodiesel fuels may be used in John Deere diesel engines only if the fuel meets the provisional ASTM PS121 (U.S.) or DIN 51606 (German) specifications. NOTE: Raw pressed vegetable oils are NOT acceptable for use for fuel in any concentration. These oils do not burn completely, and will cause engine failure by leaving deposits on injectors and in the combustion chamber.

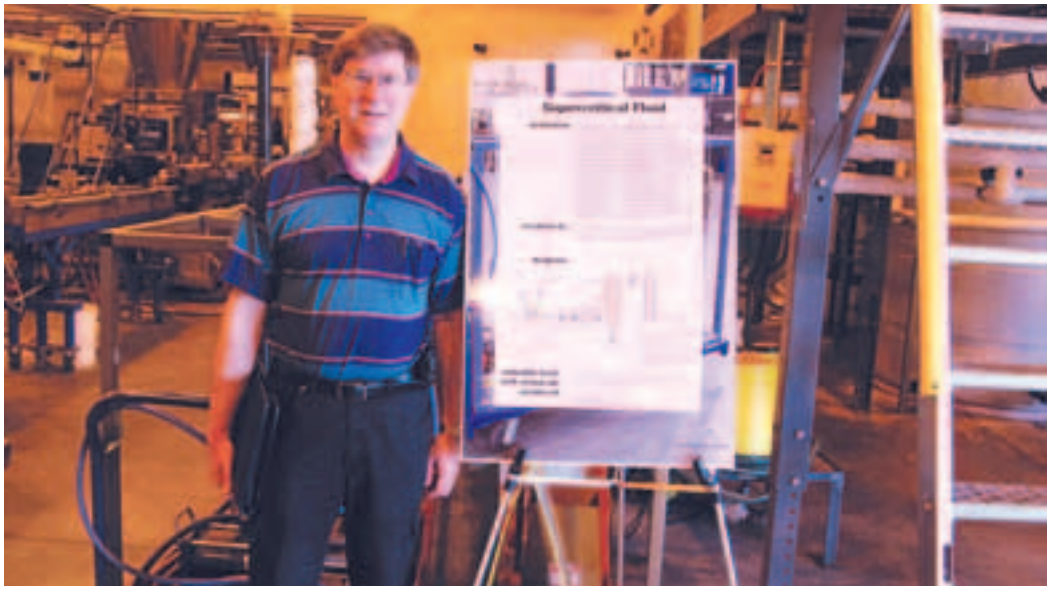
Note that engine manufacturers typically do not warranty engine problems caused by the fuel, regardless of the origin.

Biodiesel – Worth the Cost?

An Overview of the Economics of Biodiesel

Biodiesel represents significant economic opportunities for Manitoba farmers. A study by the U.S. Department of Agriculture shared the following findings:

- An average annual increase of the equivalent of 200 million gallons of soy-based biodiesel demand would boost total crop cash receipts by $5.2 billion (U.S.) cumulatively by 2010. This would result in an average net farm increase of $300 million (U.S.) per year.
- The price for a bushel of soybeans would increase by an average of 17 cents (U.S.) annually during the 10-year period.



Council member Ken Thomas of Manitoba Hydro at Iowa's Biomass Research Center

Making the Case

However, before farmers can begin to benefit from this industry, there must be an economic case to produce and sell biodiesel. There are four main factors to determine the economic viability of biodiesel:

- feedstock costs
- capital costs
- production costs
- selling price of biodiesel

Feedstock Costs

The primary costs of producing biodiesel are feedstock costs, which make up over two-thirds of the overall cost of production. The conversion of feedstock triglycerides to methyl ester is typically one to one on both a weight and a volume basis. So one kilogram of feedstock would make 1.13 litres of biodiesel (this includes the methanol used in the process).

In Manitoba, there are two potential sources of feedstock that would support larger scale biodiesel production:

- animal fats (tallow)
- canola oil

Animal fats in Winnipeg have ranged from 40 to 50 cents (Cdn) per kilogram over the past four years. The 10-year range has been 35 to 65 cents (Cdn) per kilogram. If it is possible to segregate yellow grease, it may be feasible to reduce the feedstock costs by about five cents per kilogram.

Canola oil prices have ranged from 40 cents to over $1 (Cdn) per kilogram over the past 20 years. Prices have been almost that volatile just in the past three years, with a low of 40 cents (Cdn) per kilogram in early 2001 and a high of nearly 95 cents (Cdn) per kilogram in November 2002. The long-term trend line is up, with a current value at approximately 68 cents (Cdn) per kilogram. This is about 50 per cent higher than the price for animal fats. However, some canola oil sells for significantly less due to its quality and the reduced price it would fetch in the food market.

Capital Costs

The capital costs for a biodiesel plant are relatively modest compared to an ethanol plant, but the feedstock is generally more expensive. As production processes vary, depending on the feedstock used, the capital costs fluctuate accordingly.

A number of plant cost estimates have been published in the past several years for different plant sizes (Shumaker, 2003; Agri-Industry Modeling & Analysis Group, 2002). Results from the Shumaker study are shown in the following table. (The estimates were based on a greenfield site in the U. S. and were made to a +/- 25 per cent accuracy.)

Capital Cost Estimates for Biodiesel Plants

Plant Size	Capital Costs (Canadian $)
1.9 million litres/year	$1.33 million
11.3 million litres/year	$4.75 million
56.7 million litres/year	$13.5 million
113 million litres/year	$21 million

Other cost estimates found in various literature are summarized in the following table:

Other Capital Cost Estimates

Source	Feedstock	Size million litres	Capital Cost (Canadian $)
Agri-Industry Modeling Group	Soy oil	50	26.3 million
Lurgi	Vegetable oil	60	19 million
Lurgi	Vegetable oil	120	28 million
BIOX	Animal Fat	60	15 million

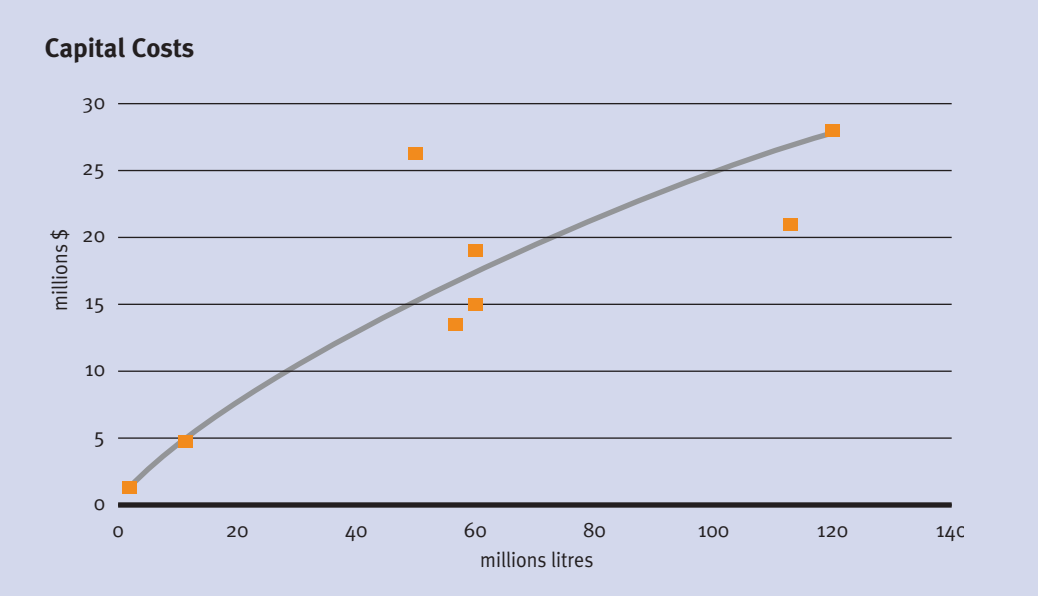
CASE STUDY WEST CENTRAL SOY

West Central Soy, located in Ralston, Iowa, is the largest commercial biodiesel production facility in North America, producing about 45.4 million litres (12 million U.S. gallons) of biodiesel annually. The plant, which also produces and markets over 545,000 kilograms (1.2 million pounds) of glycerine per year, uses soy oil as its feedstock.

A number of council members had an opportunity to tour the facility and were impressed at the size and scope of the plant. The council also learned that this modern plant does not produce any wastewater – rather, all process wastewater is recycled back into the facility. West Central Soy also markets a number of non-biodiesel products such as solvents, lubricants and various cleaning products.

Council members tour West Central Soy, Ralston, Iowa

The capital cost data presented in the tables is plotted in the following figure with a trend line added.



Operating Costs

The operating costs (excluding feedstock costs) consist primarily of labour, energy, methanol, catalyst and other chemical costs. Chemical costs will vary depending on the feedstock used.

In general, as the physical size of the plant increases, feedstock costs (per litre of production) increase, while all other operating costs (per litre of production) decrease. Some recent Manitoba estimates using food-grade canola as feedstock, show that biodiesel can be produced for between 50 and 60 cents (Cdn) per litre – and potentially much lower, if waste or degraded feedstock streams can be found.

Glycerin produced from plant by-products typically are of higher value than those produced from animal fats, as a result, the co-product value for plants with primarily animal fats as feedstocks, are expected to command a price 25 per cent lower than that of glycerine from vegetable oil plants.

Several jurisdictions now use biodiesel in their emergency vehicles

Biodiesel Selling Price

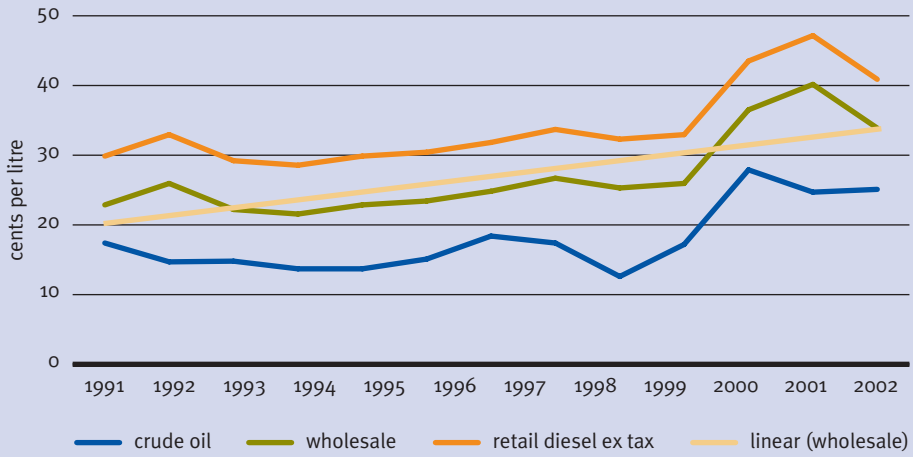
Biodiesel selling prices will have to be higher than production costs to generate an adequate return for the equity participants and to attract financing to the projects. The selling price of biodiesel will be closely linked to the price of diesel fuel and influenced by any tax incentives, along with positive and negative attributes of the biodiesel.

The positive attributes of biodiesel include its cetane properties and lubricity. Most diesel fuels in Western Canada contain a cetane-enhancing additive. Recent studies show that the cetane value of a vegetable oil biodiesel will add about 4 cents (Cdn) per litre to the biodiesel value – for an animal fat biodiesel with its higher cetane, the extra value will be about 1.2 cents (Cdn) per litre. In fact, the overall value of biodiesel could increase over time as knowledge about its positive attributes grow.

The following figure shows the retail price of diesel fuel in Winnipeg over the past 12 years excluding tax. To arrive at the wholesale price, it has been assumed that the average retail margin has been 7 cents (Cdn) per litre. The figure also shows the price of crude oil in Edmonton. In the U.S., current estimates reveal that for every percentage point of biodiesel added, the price increases by approximately one cent (U.S.) per gallon.

In many European countries, the price of biodiesel is actually less than regular diesel fuel. This is due, however, to the significant incentives provided to biodiesel producers. Diesel fuel in North America sells for much less than in Europe due, in part, to tax and incentive policies that can favour fossil fuels. The 2000 *Commissioner of the Environment and Sustainable Development Report* (an office of the Canadian Auditor General) documented that Canada spent $40 billion between 1971 and 1999 supporting the oil and gas industry.

Diesel Fuel Price – Winnipeg



This graph shows that diesel fuel prices have been rising over the past 12 years. The average price has been over 35 cents (Cdn) per litre for the past three years.

The following table is an example of a hypothetical 10 million litre plant in Manitoba. Actual costs of production could vary significantly.

	Total $	$ Per Litre
Annual Production - millions of litres	**10**	
Expenses - Operating		
Feedstock	3,968,274	0.397
Methanol	372,000	0.037
Processing supplies	300,000	0.030
Direct labour	416,000	0.042
Direct labour - benefits	83,200	0.008
Maintenance and operating supplies	115,000	0.012
Natural gas	98,000	0.010
Electricity	12,500	0.001
Sub Total	5,364,974	0.536
Expenses - Overhead		
General sales and administrative costs	124,800	0.012
Insurance and taxes	53,475	0.005
Sub Total	178,275	0.018
Depreciation	287,500	0.029
Interest on long-term debt	287,644	0.029
Sub Total	753,419	0.075
Revenues		
Glycerine	802,646	0.080
Total Costs	5,315,747	0.532

S&T² Consultants, 2003

The chart above assumes average market price for feedstock (a mixture of canola and animal fats). The feedstock costs would be significantly reduced by targeting lower quality canola and animal fats which would not affect the quality of the biodiesel. Assuming a producer can cut feedstock costs by just one-third, using lower value feedstocks, biodiesel would be produced for approximately 40 cents (Cdn) per litre.

Since feedstock costs represent up to 80 per cent of overall cost of production, a reduction of feedstock costs can have a significant impact on the cost of producing biodiesel.

Biodiesel production unit at Iowa's Biomass Energy Research Center

Manitoba Looks Ahead – Economic Opportunities

Larger scale production of biodiesel in Manitoba may be more economically viable in the intermediate or long term. With this in mind, there are many factors that could benefit the future of biodiesel in Manitoba:

1. Federal regulations are reducing the sulphur content of diesel in 2006. Because reduced sulphur diesel will require enhanced lubricants, biodiesel could be more in demand for its lubricating properties.
2. As shown earlier, animal fats currently command a relatively high market price. Much of these animal-based oils are added to livestock feed. Many experts in the livestock feed industry predict that this market for animal fat may wane due to federal regulations. This move could reduce the cost of producing biodiesel.
3. Fossil fuels are is increasingly being targeted as a significant contributor to climate change and smog. It's possible that in the years and decades to come, the price of diesel could increase to capture more of its environmental costs. Should this occur, biodiesel, as a fuel extender, would become more valuable.

Rate of Fuel Tax on Biodiesel

	Canada	BC	AB (3)	SK (4)	MB	ON	QC	NB	PE	NS	NL	YK	NT	NU
¢ per litre	Exempt [1]	Exempt [2]	9.0	15.0	11.5	Exempt [3]	16.2	16.9	16.5	15.4	16.5	7.2	9.1	9.1

[1] Federal Excise Tax – Effective February 19, 2003 the 4¢ (Cdn) per litre federal excise tax on diesel fuel was removed on the biodiesel portion:

[2] British Columbia – Blends of diesel fuel that contain at least 85 per cent ethanol or methanol are exempt from tax.

[3] Ontario - Effective June 18, 2002 the 14.3¢ (Cdn) per litre fuel tax on diesel fuel was removed from biodiesel, and from the percentage by volume of biodiesel in a blend of diesel and biodiesel.

The council recommends that the provincial government:

- **Solicit indications of interest from biodiesel producers for establishing plants in Manitoba. The government may consider providing additional resources during the early stages of industry development.**
- **Encourage local ownership through co-operatives, corporations, limited partnerships or strategic alliances that allow local individuals and/or communities to have a significant ownership stake in the new biodiesel production businesses.**

Biodiesel: A Renewable Resource

HOW IT AFFECTS CLIMATE CHANGE, HEALTH AND THE ENVIRONMENT

"B20 reduces net greenhouse gas emissions by approximately 16 per cent as compared to petroleum diesel. The U.S. Department of Energy reports that biodiesel B100 decreases accumulation of greenhouse gases in the atmosphere by upwards of 78 per cent, making it the **single most effective greenhouse gas reduction technology that exists diesel engines."**

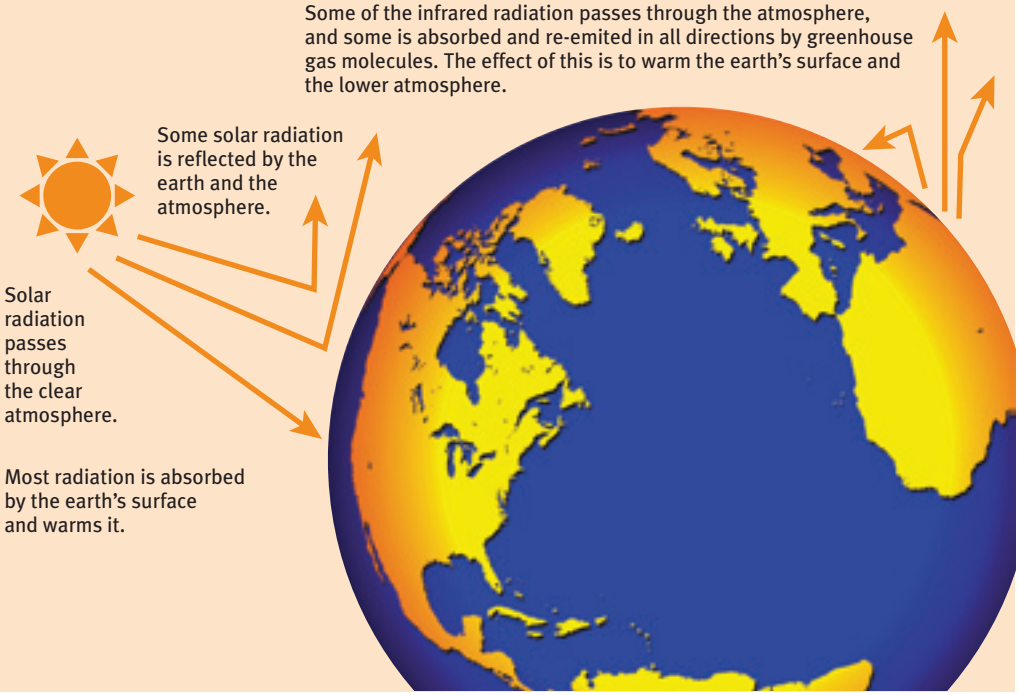
Canadian Renewable Fuels Association

Climate change

Climate change has the potential to seriously influence the future of Canada's agriculture sector. Shifting temperature and precipitation patterns, changing frequencies of extreme events like droughts or floods, insect and disease infestations, changing productivity of farm lands at local levels – these are all effects of climate change that have important implications for agricultural production and economic values.

Carbon dioxide, methane and nitrous oxide are naturally occurring greenhouse gases (GHGs). When the concentration of these main gases increases, more heat energy is trapped and the earth's temperature increases. Human activities, like the burning of fossil fuels (ex: petroleum-based gasoline and diesel fuel), have added greater amounts of greenhouse gases into the atmosphere, causing the earth's rise in temperature.

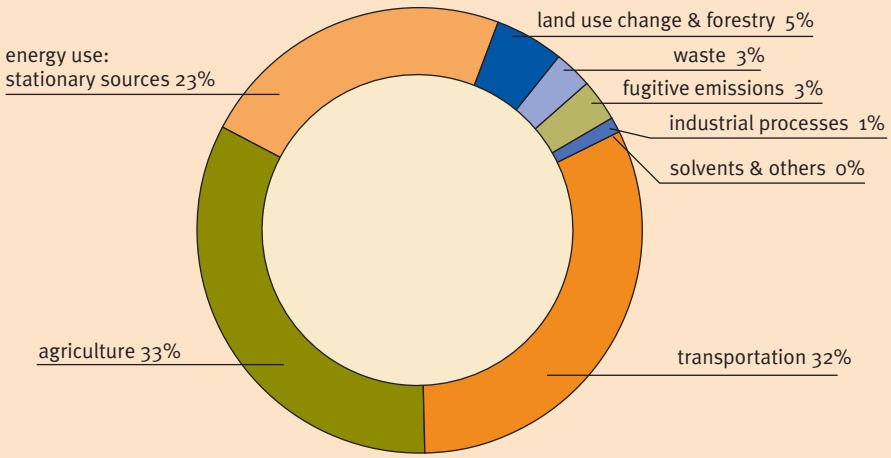
The Greenhouse Effect



Source: http://www.climatechange.gc.ca/english/climate_change/earth.asp

In Manitoba, the transportation and agriculture sectors produce the highest GHG emissions, each contributing about one-third of the province's total emissions. It should also be noted that transportation includes farm machinery and passenger vehicles. Heavy trucks represent 21 per cent of transportation emissions and 7 per cent of Manitoba's total GHG emissions.

Manitoba Greenhouse Gas Emissions 2002



Source: Environment Canada Gas Division, 2004

CASE STUDY YELLOWSTONE NATIONAL PARK 'TRUCK-IN-THE-PARK' PROJECT

The Truck-in-the-Park project is a jointly funded research project that demonstrates the benefits of using biodiesel in a tourism-related industry. The National Park Service (NPS) has operated a truck in Yellowstone National Park (YNP) for 149,408 kilometres on 100 per cent biodiesel fuel, produced by the University of Idaho. The main focus of the project was to demonstrate the reliability, benefits and costs of using biodiesel to NPS, tourism operators and potential fuel producers.

The truck was emissions-tested at the Los Angeles Metropolitan Transit Authority Emissions Testing Facility at the beginning and end of the project. Results from these tests indicated hydro carbons (HC) and carbon monoxide (CO) decreased as the percentage of biodiesel was increased. Interestingly, nitrous oxide (NOx) generally decreased as the percentage of biodiesel was increased.

Manitoba and Climate Change

In 2001, the Manitoba Climate Change Task Force, chaired by Federal Member of Parliament Lloyd Axworthy, was established to investigate Manitoba's climate change challenges and opportunities. The task force made over 30 recommendations in the report, *Manitoba and Climate Change: Investing in Our Future* (www.gov.mb.ca/est/climatechange/pdfs), which was then submitted to Premier Gary Doer in September 2001. The recommendations included increasing the use of renewable fuels in Manitoba.

As part of this recommendation, the province undertook the Manitoba ethanol initiative. This included mandating ethanol-blended gasoline in Manitoba, which will succeed in reducing GHG emissions by 135,000 tonnes – the equivalent of removing 10,000 vehicles from Manitoba roads. The *Manitoba Ethanol Advisory Panel Report* also recommended that the government examine the potential for biodiesel in the province.

Producing and consuming biodiesel in Manitoba is a good GHG-emission-reduction measure for both the agriculture and transportation sectors. For more information on climate change and what the Manitoba government is doing about it, see http://www.gov.mb.ca/est/climatechange.

Biodiesel – Good for the Environment, Good for our Health

Compared to regular diesel, biodiesel has a number of significant environmental benefits. The U.S. EPA (2002) recently published a fact sheet on biodiesel. It noted that the actual emission impact of using biodiesel varies between engines.

The following table is a summary of the emissions impact, relative to conventional diesel fuel, for B20 and B100, in an engine that takes full advantage of the fuel's clean-burning properties.

	B20	**B100**
Carbon Monoxide	-11%	-50%
Particulate Matter	-10.1%	-70%
Total Hydrocarbons	-21.1%	-40%
Sulfur Oxide	-20%	-100%
Nitrogen Oxides	+2%	+9%
Poly Aromatic Hydrocarbons	N/A	-80%
Methane	N/A	-51%

Biodiesel has passed Tier 1 and Tier II Health Effects testing under *The Clean Air Act* and significantly reduces EPA-targets emissions such as *carbon monoxide, unburned hydrocarbons* and *particulate matter.*

"Research commissioned by the U.S. National Renewable Energy Laboratory demonstrates that the **biodiesel B100 can reduce cancer risk caused by diesel vehicle emissions by as much as 94 per cent,** while B20 reduces the risk by 27 per cent."

Canadian Renewable Fuels Association

As shown below, while biodiesel significantly reduces overall emissions, most research shows biodiesel consumption increasing nitrogen oxide levels. California Clean Diesel Technologies Inc. claims to have discovered a fuel blend that reduces nitrogen oxide levels by 5 per cent.

An overall summary of biodiesel lifecycle GHG emission reductions is shown below:

	Canola Biodiesel % GHG reduction vs. petrol-diesel	Soy Biodiesel % GHG reduction vs. petrol-diesel	Animal Fat Biodiesel % GHG reduction vs. petrol-diesel
B2	-1.2	-1.2	-1.8
B20	-12.4	-12.3	-17.8
B100	-63.7	-63.1	-91.7

Source: Report prepared for Natural Resources Canada by Levelton Engineering Ltd in association with (S&T)^2 Consultants Inc., September 30th, 2002.

Biodiesel has an overall energy balance of 3.2 units of energy produced from each unit consumed. (If recycled oils or animal fats are used, the overall energy balance is even greater.)

The U.S.–based National Biodiesel Board reports that compared to diesel fuel, a 20 per cent biodiesel blend will reduce carcinogens by anywhere from 13 to 50 per cent.

The United States Environmental Protection Agency lists more than 40 components of diesel exhaust that are hazardous air pollutants. At least 21 of these are listed by the State of California as known carcinogens or reproductive toxicants. (Extrapolated from Schwatz, Dockery and Neas, Journal of the Air and Waste Management Association, 1996)

According to the American-based organization, Environmental Defense, 80 per cent of the total cancer risk from all hazardous air pollutants is associated with inhaling diesel exhaust. Therefore, displacing regular diesel fuel may also represent an opportunity to offset certain health costs.

The council recommends that the provincial government:

- **study and communicate the environmental and health benefits of using biodiesel blends in urban bus fleets, government, special operating agencies, municipalities and other fleets**

CASE STUDY BIODIESEL USE AT THE FARGO LANDFILL

In May 2001, the City of Fargo's Division of Solid Waste conducted a pilot project to test the use of biodiesel fuel in its landfill equipment and vehicles for one year. Potential benefits included reduced emissions, enhanced engine performance and market support for a locally grown renewable resource.

ENGINE MANUFACTURERS ASSOCIATION TECHNICAL STATEMENT ON THE USE OF BIODIESEL

Source: Engine Manufacturers Association

Introduction

The Engine Manufacturers Association (EMA) is an international membership organization representing the interests of manufacturers of internal combustion engines. In 1995, EMA published a "*Statement on the Use of Biodiesel Fuels for Mobile Applications*." Since that time, increased worldwide interest in reducing reliance on petroleum-based fuels and improving air quality has led many stakeholders, including engine manufacturers, to continue to investigate the use of alternative, renewable fuels, including biodiesel fuels, as a substitute for conventional diesel fuel. In addition, recent government proposals in the United States and Europe have called for incentives or mandates to increase the production and use of such renewable fuels. This statement, which takes into consideration additional laboratory and field research conducted since the publication of the 1995 statement, sets forth EMA's position on the use of biodiesel fuels with current engine technologies. It should be noted, however, that only limited data is available regarding the use of biodiesel with those technologies that have been, or are about to be, introduced to meet the (U.S.) Environmental Protection Agency's (EPA's) 2004 heavy-duty on-highway emission standards. Moreover, because of the absence of available data, the statement does not address the potential use of biodiesel fuels with advanced emission control technologies, including after treatment systems designed for future ultra-low emission engines.

Biodiesel

Biodiesel fuels are methyl or ethyl esters derived from a broad variety of renewable sources such as vegetable oil, animal fat and cooking oil. Esters are oxygenated organic compounds that can be used in compression ignition engines because some of their key properties are comparable to those of diesel fuel. Soy methyl ester diesel (SME or SOME), derived from soybean oil, is the most common biodiesel in the United States. Rape methyl ester diesel (RME), derived from rapeseed oil, is the most common biodiesel fuel available in Europe. Collectively, these fuels are sometimes referred to as fatty acid methyl esters (FAME).

Biodiesel fuels are produced by a process called transesterification, in which various oils (triglycerides) are converted into methyl esters through a chemical reaction with methanol in the presence of a catalyst, such as sodium or potassium hydroxide. The byproducts of this chemical reaction are glycerols and water, both of which are undesirable and need to be removed from the fuel along with traces of the methanol, unreacted triglycerides and catalyst. Biodiesel fuels naturally contain oxygen, which must be stabilized to avoid storage problems. Although biodiesel feedstock does not inherently contain sulfur, sulfur may be present in biodiesel fuel because of contamination during the transesterification process and in storage.

ENGINE MANUFACTURERS ASSOCIATION TECHNICAL STATEMENT ON THE USE OF BIODIESEL

Biodiesel Specifications

Biodiesel is produced in a pure form (100 per cent biodiesel fuel referred to as B100 or neat biodiesel) and may be blended with petroleum-based diesel fuel. Such biodiesel blends are designated as BXX, where XX represents the percentage of pure biodiesel contained in the blend (ex:, B5, B20). Several standard-setting organizations worldwide have recently adopted biodiesel specifications. Specifically, ASTM International recently approved a specification for biodiesel referenced as D 6751. In addition, German authorities have issued a provisional specification for FAME under DIN 51606. And, Europe's Committee for Standardization (CEN) is in the final stages of setting a technical standard for biofuels to be referred to as EN 14214. The European specifications include more stringent limits for sulfur and water, as well as a test for oxidation stability, which is absent from the current ASTM specification.

Depending on the biomass feedstock and the process used to produce the fuel, B100 fuels should meet the requirements of either ASTM D 6751 or an approved European specification, such as DIN 51606 or EN 14214 (once adopted). In addition, it should be noted that the National Biodiesel Board has created the National Biodiesel Accreditation Commission to develop and implement a voluntary program for the accreditation of producers and marketers of biodiesel. The Commission has developed a standard entitled, "BQ-9000, Quality Management System Requirements for the Biodiesel Industry," for use in the accreditation process.

Biodiesel Blends

Public and private bodies recently have taken positions regarding the use of biodiesel blends. For example, the (United States) Energy Policy Act of 1992 (EPAct) was amended in 1998 to allow covered fleets to use biodiesel to fulfill up to fifty per cent (50%) of their annual alternative fuel vehicle (AFV) acquisition requirements. Under EPAct's Biodiesel Fuel Use Credits provisions, covered fleets are allocated one biodiesel fuel use credit (the equivalent of a full vehicle credit) for each 450 gallons of B100 purchased and consumed. Such credits are awarded only if the blended fuel contains at least twenty percent biodiesel (B20) and is used in new or existing vehicles weighing at least 8,500 pounds. No credits are awarded for biodiesel used in a vehicle already counted as an AFV.

During the same time period, however, a consortium of diesel fuel injection equipment manufacturers (FIE Manufacturers) issued a position statement concluding that blends greater than B5 can cause reduced product service life and injection equipment failures. According to the FIE Manufacturers' Position Statement, even if the B100 used in a blend meets one or more specifications, "the enhanced care and attention required to maintain the fuels in vehicle tanks may make for a high risk of noncompliance to the standard during use." As a result, the FIE manufacturers disclaim responsibility for any failures attributable to operating their products with fuels for which the products were not designed.

Based on current understanding of biodiesel fuels and blending with petroleumbased diesel fuel, EMA members expect that blends up to a maximum of B5 should not cause engine or fuel system problems, provided the B100 used in the blend meets the requirements of ASTM D 6751, DIN 51606, or EN 14214. If blends exceeding B5 are desired, vehicle owners and operators should consult their engine manufacturer regarding the implications of using such fuel.

ENGINE MANUFACTURERS ASSOCIATION TECHNICAL STATEMENT ON THE USE OF BIODIESEL

Engine Operation, Performance and Durability

The energy content of neat biodiesel fuel is about eleven per cent (11%) lower than that of petroleum-based diesel fuel (on a per gallon basis), which results in a power loss in engine operation. The viscosity range of biodiesel fuel, however, is higher than that of petroleum-based diesel fuel (1.9 – 6.0 centistokes versus 1.3 – 5.8 centistokes), which tends to reduce barrel/plunger leakage and thereby slightly improve injector efficiency. The net effect of using B100, then, is a loss of approximately five to seven per cent (5-7%) in maximum power output. The actual percentage power loss will vary depending on the percentage of biodiesel blended in the fuel. Any adjustment to the engine in service to compensate for such power loss may result in a violation of EPA's anti-tampering provisions. To avoid such illegal tampering, as well as potential engine problems that may occur if the engine is later operated with petroleum-based diesel fuel, EMA recommends that users not make such adjustments. Neat biodiesel and higher percentage biodiesel blends can cause a variety of engine performance problems, including filter plugging, injector coking, piston ring sticking and breaking, elastomer seal swelling and hardening/cracking, and severe engine lubricant degradation. At low ambient temperatures, biodiesel is thicker than conventional diesel fuel, which would limit its use in certain geographic areas. In addition, elastomer compatibility with biodiesel remains unclear; therefore, when biodiesel fuels are used, the condition of seals, hoses, gaskets, and wire coatings should be monitored regularly. There is limited information on the effect of neat biodiesel and biodiesel blends on engine durability during various environmental conditions. More information is needed to assess the viability of using these fuels over the mileage and operating periods typical of heavy-duty engines.

Emission Characteristics

In October 2002, U.S. EPA released a draft report entitled, *A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions*. The draft technical report can be found on the EPA Web site at: http://www.epa.gov/otaq/models/biodsl.htm.

Use of neat biodiesel and biodiesel blends in place of petroleum-based diesel fuel may reduce visible smoke and particulate emissions, which are of special concern in older diesel engines in non-attainment areas. In addition, B100 and biodiesel blends can achieve some reduction in reactive hydrocarbons (HC) and carbon monoxide (CO) emissions when used in an unmodified diesel engine. Those reductions are attributed to the presence of oxygen in the fuel. Oxygen and other Biodiesel characteristics, however, also increase oxides of nitrogen (NOx) in an unmodified engine. As a result, B100 and biodiesel blends produce higher NOx emissions than petroleum-based diesel fuel. As such, EMA does not recommend the use of either B100 or biodiesel blends as a means to improve air quality in ozone non-attainment areas.

Storage and Handling

Biodiesel fuels have shown poor oxidation stability, which can result in long-term storage problems. When biodiesel fuels are used at low ambient temperatures, filters may plug, and the fuel in the tank may thicken to the point where it will not flow sufficiently for proper engine operation. Therefore, it may be prudent to store Biodiesel fuel in a heated building or storage tank, as well as heat the fuel systems' fuel lines, filters, and tanks. Additives also may be needed to improve storage conditions and allow for the use of biodiesel fuel in a

ENGINE MANUFACTURERS ASSOCIATION TECHNICAL STATEMENT ON THE USE OF BIODIESEL

wider range of ambient temperatures. To demonstrate their stability under normal storage and use conditions, biodiesel fuels, tested using ASTM D 6468, should have a minimum of 80 per cent reflectance after aging for 180 minutes at a temperature of 150°C. The test is intended to predict the resistance of fuel to degradation at normal engine operating temperatures and provide an indication of overall fuel stability. Biodiesel fuel is an excellent medium for microbial growth. Inasmuch as water accelerates microbial growth and is naturally more prevalent in biodiesel fuels than in petroleum-based diesel fuels, care must be taken to remove water from fuel tanks. The effectiveness of using conventional anti-microbial additives in biodiesel is unknown. The presence of microbes may cause operational problems, fuel system corrosion, premature filter plugging, and sediment build-up in fuel systems.

Health & Safety

Pure biodiesel fuels have been tested and found to be nontoxic in animal studies. Emissions from engines using biodiesel fuel have undergone health effects testing in accordance with EPA Tier II requirements for fuel and fuel additive registration. Tier II test results indicate no biologically significant short term effects on the animals studied other than minor effects on lung tissue at high exposure levels.

Biodiesel fuels are biodegradable, which may promote their use in applications where biodegradability is desired (ex:, marine or farm applications). Biodiesel is as safe in handling and storage as petroleum-based diesel fuel.

Warranties

Engine manufacturers are legally required to provide an emissions warranty on their products (which are certified to EPA's diesel fuel specification) and, typically, also provide commercial warranties. Individual engine manufacturers determine what implications, if any, the use of biodiesel fuel has on the manufacturers' commercial warranties. It is unclear what implications the use of biodiesel fuel has on emissions warranty, in-use liability, anti-tampering provisions, and the like. As noted above, however, more information is needed on the impacts of long-term use of biodiesel on engine operations.

Economics

The cost of biodiesel fuels varies depending on the basestock, geographic area, variability in crop production from season to season, and other factors. Although the cost may be reduced if relatively inexpensive feedstock, such as waste oils or rendered animal fat, is used instead of soybean, corn or other plant oil, the average cost of biodiesel fuel nevertheless exceeds that of petroleum-based diesel fuel. That said, users considering conversion to an alternative fuel should recognize that the relative cost of converting an existing fleet to biodiesel blends is much lower than the cost of converting to any other alternative fuel because no major engine, vehicle, or dispensing system changes are required.

ENGINE MANUFACTURERS ASSOCIATION TECHNICAL STATEMENT ON THE USE OF BIODIESEL

Conclusions

- Depending on the biomass feedstock and the process used to produce the fuel, B100 fuels should meet the requirements of either ASTM D 6751 or an approved European specification.
- Biodiesel blends up to a maximum of B5 should not cause engine or fuel system problems, provided the B100 used in the blend meets the requirements of ASTM D 6751, DIN 51606, or EN 14214. Engine manufacturers should be consulted if higher percentage blends are desired.
- Biodiesel blends may require additives to improve storage stability and allow use in a wide range of temperatures. In addition, the conditions of seals, hoses, gaskets, and wire coatings should be monitored regularly when biodiesel fuels are used.
- Although the actual loss will vary depending on the percentage of biodiesel blended in the fuel, the net effect of using B100 fuel is a loss of approximately five to seven per cent in maximum power output.
- Neat biodiesel and biodiesel blends reduce particulate, HC and CO emissions and increase NOx emissions compared with petroleum-based diesel fuel used in an unmodified diesel engine. Neither B100 nor biodiesel blends should be used as a means to improve air quality in ozone non-attainment areas.
- Biodiesel fuels have generally been found to be nontoxic and are biodegradable, which may promote their use in applications where biodegradability is desired.
- Individual engine manufacturers determine what implications, if any, the use of biodiesel fuel has on the manufacturers' commercial warranties.
- Although several factors affect the cost of biodiesel fuel, its average cost exceeds that of petroleum-based diesel fuel. The relative cost of converting an existing fleet to biodiesel blends, however, is much lower than the cost of converting to other alternative fuel.

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List of Presenters

- Don O'Connor, S&T² Consultants
- Randy Baldwin, Kelwin Management Consultants
- Ron Wardrop, Rothsay
- Ernie Doerken, Manitoba Canola Growers Association
- Paul Bobbee, BBB Seeds
- Al Sturko, Manitoba Energy, Science and Technology
- Mark Stumborg, Agriculture and Agri-food Canada
- Chuck Peterson, University of Idaho
- Roger Gault, U.S. Engine Manufacturers Association
- Ken Dack, City of Brampton
- Ed Tyrchniewicz, University of Manitoba, Transport Institute
- Ajaleigh Williams, Red River Valley Clean Cities Coalition
- Ken Mitchell, Shell Canada
- Jim Rollefson, National Research Council
- Don Irmen, West Central Soy
- Scott Lewis, BIOX Corp.
- Brian and Gavin Reynolds, Bob McDonald, Brandon Biobus Project
- Bruce Polatinick, Capital Technologies
- Diane Roberts, Manitoba Agriculture, Food and Rural Initiatives
- John Braha, Lubrizol Corporation
- Chris Zgerlicke, Energy and Environment Research Centre
- Deborah Johnson, North Dakota Soy Bean Producers
- Ralph Groschen, Minnesota Department of Agriculture
- Norm Olson, Iowa Biomass Research Centre
- Steve Lawrence, City of Brooklyn Park
- Carol Gunvaldson, Manitoba Agriculture Food and Rural Initiatives

Information Resources

Natural Resources Canada Office of Energy Efficiency
http://oee.nrcan.gc.ca/vehiclefuels/biodiesel/biodiesel.cfm?PrintView=N&Text=N

Biodiesel Association of Canada
http://www.biodiesel-canada.org

Canadian Renewable Fuels Association
http://www.greenfuels.org/index.html

National Biodiesel Board
http://www.biodiesel.org/

Alternative Fuels Data Center (U.S. Department of Energy)
http://www.afdc.doe.gov/

Montreal Biobus Project
http://www.stm.info/English/info/a-biobus.htm

City of Saskatoon Biobus Project
http://www.city.saskatoon.sk.ca/org/transit/biobus.asp

Magazines/Publications

(excellent up- to-date information on biodiesel)

Biodiesel Magazine (ordered through BBI at http://www.bbibiofuels.com/biodieselmagazine/)

- all biodiesel related
- international context

Altfuels advisor (ordered through alternative fuel vehicle group at http://www.altfuels.com/afa.php)

- updates on alt fuel industry
- Canada and U.S. content

Summary of Recommendations

The Manitoba Opportunities

The council recommends that the provincial government:

- Encourage the development of a biodiesel industry in Manitoba - both its production and consumption - that will use primarily Manitoba-grown and produced feedstocks, creating sustainable long-term jobs and other economic, environmental and social benefits.
- Develop both “push” (production oriented) and “pull” (demand for biodiesel) strategies to promote Manitoba biodiesel production and consumption.
- Develop a communications strategy to convey the benefits and costs of developing a biodiesel industry and of any support required or offered.
- Develop Manitoba-based technical and research capabilities and encourage collaborations between educational institutions and industry.
- Co-ordinate and harmonize its efforts and programs with national initiatives such as the Biodiesel Association of Canada, the federal Climate Change Initiatives and programs designed to achieve Kyoto Agreement targets, and Sustainable Transportation.
- Encourage the accreditation of local testing laboratories for fuel quality.
- Take a leadership/co-ordinator role in the future development of alternative fuel initiatives.

Feedstocks

The council recommends that the provincial government:

- Research Manitoba-based production and distribution costs of biodiesel using a range of available feedstocks and plant sizes.
- Research and determine the feasibility of using specified risk materials (SRMs) and other byproducts (ie: offal) from slaughtering plants to create a new feedstock stream for biodiesel plants.
- Based on the results of the research conducted, encourage the development of a variety of production plants that would use different feedstocks and different technologies to produce biodiesel.
- Research alternate high-oil yielding and plant-based feedstocks.

Co-Products

The council recommends that the provincial government:

- Encourage research into other value-added products and alternative uses of methyl esters.
- Research opportunities for developing new biodiesel co-products.
- Examine opportunities to expand the production and market potential for glycerin and meal derived from the production of biodiesel.

Supporting Biodiesel Development in Manitoba

The council recommends that the provincial government:

- Study options for production and consumption based support programs to ensure they are fair and equitable to all stakeholders. Incentives should encourage both the private sector and public sectors.

- Research the options for supporting biodiesel and ensure that any strategies for supporting the development of a biodiesel industry do not negatively impact the funding of transportation infrastructure
- Study the long-term impact of biodiesel use considering several factors including:
  - the older, higher-emission engines used in agriculture, trucking and off-road applications including rail
  - the expected introduction of lower emission engines in 2007 and 2010 and ultra-low sulfur diesel fuel in 2006
  - the economic and environmental benefits of a new biodiesel industry with the objective of minimizing any potential costs to the provincial treasury.
- Solicit indications of interest from potential biodiesel producers in establishing production in Manitoba.
- Encourage the development of a structure to obtain credits for the GHG emission reductions that will occur from increased use of biodiesel. These credits should remain in Manitoba.
- Encourage local ownership through co-operatives, corporations, limited partnerships or strategic alliances that allow local individuals and/or communities to have a significant ownership stake in new biodiesel production businesses.
- Encourage, where feasible, location of biodiesel production plants in rural areas to create maximum benefits for Manitoba's rural economy.

The Environment

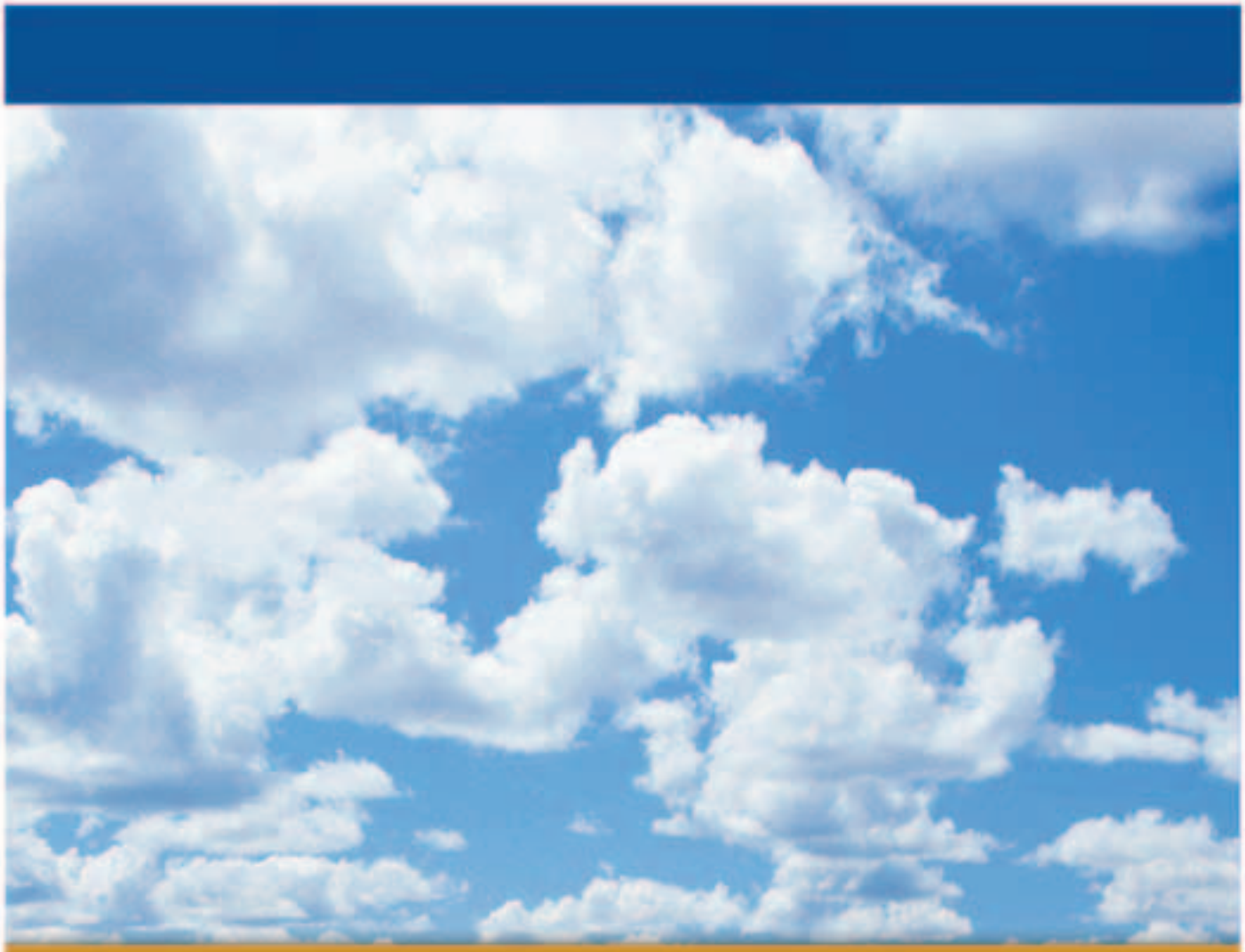
The council recommends that the provincial government:

- Study and communicate the environmental and health benefits of using biodiesel blends.
- Research the life-cycle (environmental, health, and cost/benefit) of biodiesel blends in comparison to current conventional diesel (both on-road and off-road), the potential benefits from 2007 and 2010 diesel engine technology improvements, ultra-low sulfur diesel (ULSD), and older stationary/off-road engines (including railways).
- Determine the feasibility of converting deadstock, offal and specified risk material (SRMs) into feedstock for biodiesel; conduct a cost/benefit analysis of providing incentives to renderers to use deadstock, SRMs and other byproducts to produce biodiesel feedstocks.

Legislation and Regulations

The Council recommends that provincial government:

- Continue to monitor the feasibility of a mandate in the future.
- Strongly encourage crown corporations, provincial government departments, special operating agencies, bus fleets, municipalities and other appropriate fleets (where centralized fuelling and purchasing makes this feasible) to use biodiesel blends.
  - This aforementioned recommendation reaffirms the premier's stated support of alternative fuel development. It could also play a role in developing the first biodiesel plant under the call for solicitations of interest, by creating an initial small market to allow experience to be gained from the first Manitoba-based plant using primarily Manitoba feedstock.
- Require all biodiesel to meet or exceed ASTM and CGSB standards when sold as fuel.



For more information contact:
Manitoba Energy Development Initiative
1200-155 Carlton Street
Winnipeg, Manitoba R3C 3H8
(204) 945-1764 in Winnipeg
1-800-282-8069 Toll-Free
Web site: www.manitobaenergy.com