September 19, 2018

Canadian Canola:

Growing low-carbon transportation solutions

2018

Contents

This document has been prepared to provide a broad overview of Canadian canola's current position in domestic and international biofuel markets, and outline the positive outcomes that could be realized from an elegantly designed Clean Fuel Standard (CFS). This introduction is meant to provide a brief, technical overview to readers on renewable fuels regulations and carbon intensities.

Using renewable fuels in both gasoline and diesel pools helps to reduce greenhouse gas (GHG) emissions. Current use of renewables has reduced overall emissions by 4.4 megatonnes of carbon dioxide equivalents (MT CO_2e) of which renewables in diesel represents 1.8 MT CO_2e of this as compared to having no renewables in the system. This reduction has been accomplished primarily through the use of government mandates, at both the federal and provincial level.

Canada is currently developing a Clean Fuel Standard with an objective of reducing GHG emissions by 30 MT CO_2e by 2030. Renewables can play an important role in reaching this target. Using a volumetric approach, increasing the renewable fuel mandate from current levels to 10% in gasoline and 5% in diesel could result in reduced emissions of 8.7 MT of CO_2e.[1] Using a carbon intensity approach, aspiring to a 10% reduction in carbon intensity in transportation fuels, using renewables, could result in a 21.3 MT CO_2e emissions reduction.[2]

Canola's low carbon intensity makes it an ideal feedstock to help the federal government meet its emissions reduction targets. With carbon intensities at 90% less than fossil diesel, even small additions can significantly reduce emissions.

There is more than enough canola grown in Canada to meet increased demand. Canada currently produces approximately 20 million tonnes of canola each year with targets to grow production to 26 million tonnes by 2025. If canola supplied the full 5% of renewable content for a biodiesel RFS diesel, that would require 3.2 million tonnes of seed and reduce GHG by more than 4.5 MT CO_2e,[3] an amount easily accommodated through projected increased production alone.

Over 90% of canola production is exported as seed, oil (including biofuel) and meal. Our industry's crush facilities have the capacity to turn 10 million tonnes of seed into oil for use in a variety of uses, including biofuels.

Canada's domestic biodiesel production capacity currently sits at 732 million litres, annually.[4] If 5% of the diesel pool was renewable fuel, it would require 1.45 billion litres and additional refining capacity would be needed. The proposed CFS can provide a signal to an industry that is prepared to meet mandate increases, and undertake build out based on clear market direction.

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[1] Calculation derived from Doyletech, *Economic Impact Assessments of an Enhanced Renewable Fuels Standard, and a New Clean Fuel Standard*, 2018
[2] Dolytech, *supra* note 1
[3] GHGenius 4.03a, default Canada region, year of analysis 2018
[4] See Appendix I

The canola industry is ready to meet that increase, and help the federal government reduce emissions by more than 4.5 MT of CO_2e, annually.[5]

What is canola?

Canola is truly a great Canadian success story. The plant was developed in Canada to improve vegetable oil quality over traditional rapeseed. Over the past 50 years, canola has become the number one agricultural commodity in Canada.[6] Demand for canola continues to grow as the world learns more about its advantages for human health,[7] animal feed,[8] and as an input for biofuel production.[9]

The main canola products are oil for human consumption and meal for livestock feed.[10] Canola oil is refined to improve its colour, flavour, and shelf life, and is further refined into a wide range of consumer and commercial food products. Canola oil is also an excellent input, or 'feedstock', to process into value-added biofuel products because of the consistent, high-quality chemical characteristics of the oil. Other emerging industrial uses include plastics, protein isolates, adhesives, and sealants.

The Canadian canola industry

Canola was first developed by Canadian scientists in the 1970s. Using traditional plant breeding techniques, scientists were able to remove undesirable components from rapeseed, a crop highly adaptable to Canadian growing conditions, to develop a new high-quality, edible oilseed that grew well in Canada's more northerly conditions. Compared to rapeseed, canola has much lower levels of glucosinolates in the meal and erucic acid in the oil.

In just a few short decades, canola has become one of Canada's great agricultural innovation success stories.

Current status

An economic impact study released in 2017 shows Canadian-grown canola contributes $26.7 billion to the Canadian economy each year, including more than 250,000 Canadian jobs and $11.2 billion in wages.[11] Canola generates one quarter of all farm cash receipts in Canada.

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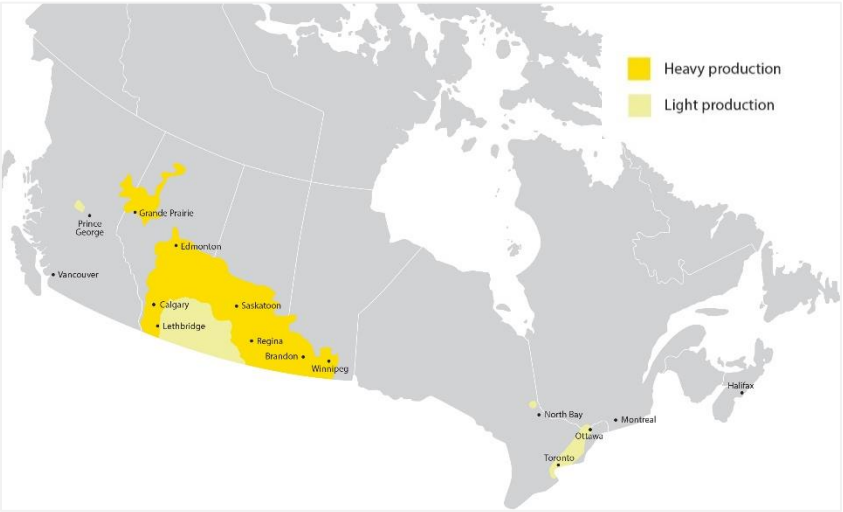
[5] GHGenius 4.03a, *supra* note 3
[6] https://canolahistory.ca/
[7] https://www.canolacouncil.org/oil-and-meal/canola-oil/health-benefits-of-canola-oil/
[8] https://www.canolacouncil.org/oil-and-meal/canola-meal/
[9] https://www.canolacouncil.org/canola-biofuels/
[10] https://www.canolacouncil.org/oil-and-meal/canola-meal/
[11] https://www.canolacouncil.org/markets-stats/industry-overview/economic-impact-of-the-canola-industry/

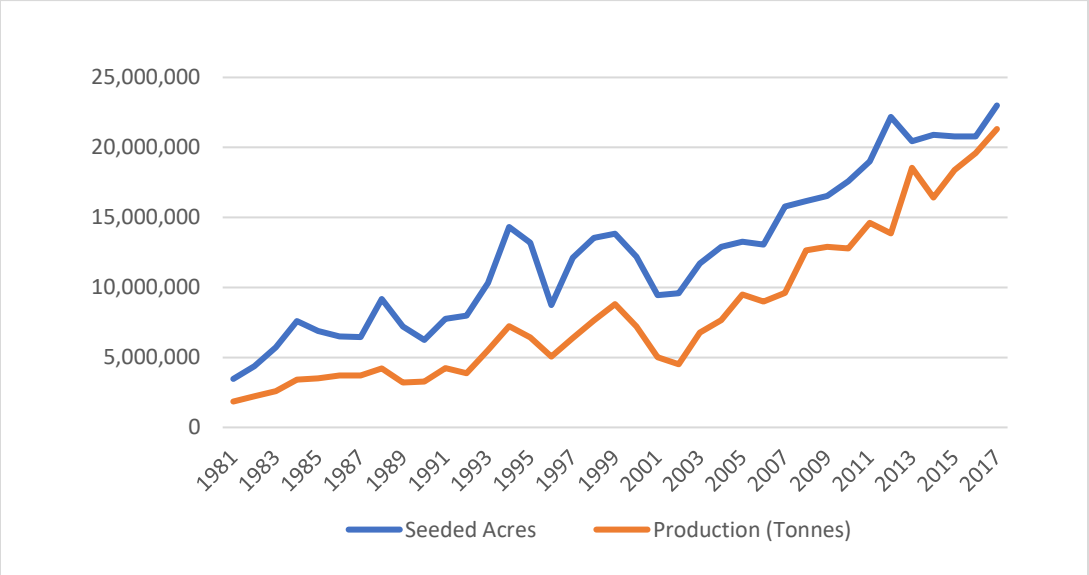
Figure 1 – Canola growing regions in Canada



In Canada, 43,000 Canadian farmers grow canola, mostly in the western provinces of Alberta, Saskatchewan, and Manitoba. Farmers in British Columbia, Ontario and Quebec also grow the crop.

Canola acreage increased over the past decade because of the profitability and resilience of the crop. Newer, herbicide-tolerant varieties produce higher yields at a lower cost and with a softer environmental footprint. New varieties are pushing the boundaries of where canola is grown in Canada.

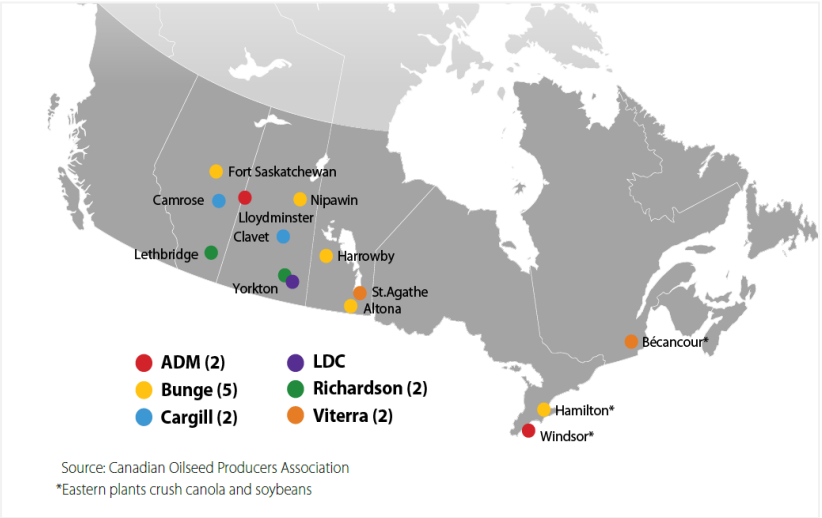
Figure 2 – Canola: seeded acres and production



Canada's canola processing (crushing) industry transforms harvested seeds into oil and meal, which are then manufactured into a wide variety of products. Canada's 14 crushing and refining facilities currently have the capacity to crush approximately 10 million tonnes of canola seed, producing approximately 4.5 million tonnes of canola oil and 5.5 million tonnes of canola meal annually.[12]

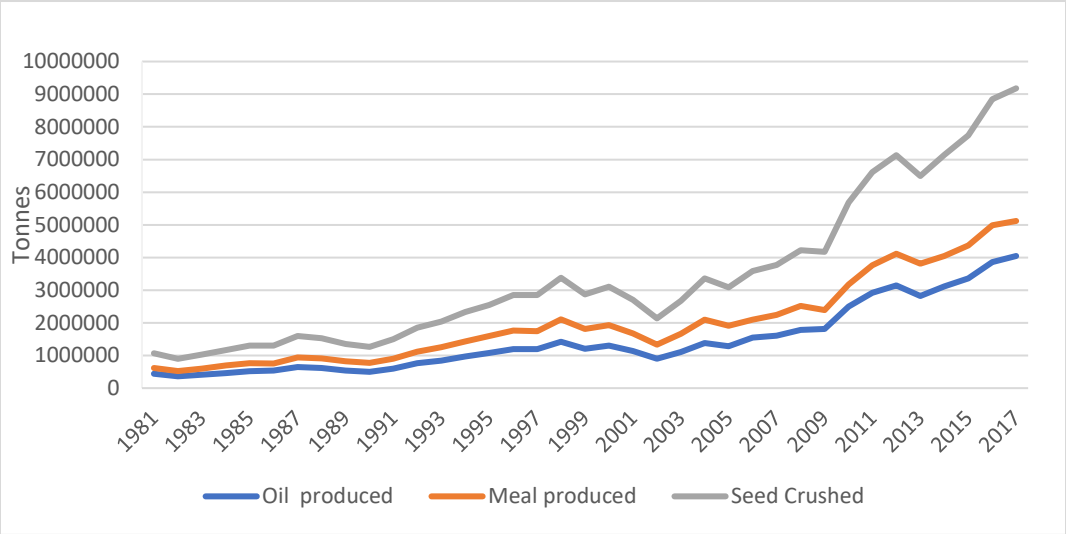
[12] https://copacanada.com/industry-profile/

Figure 3 – Location of canola processing facilities in Canada



Since 2005, Canadian crush capacity and crush volumes have nearly tripled. This has been enabled by the approximately $2 billion invested in plant construction over the last decade.

Figure 4 – Growth in Canadian canola crushing: oil and meal production



In any given year, Canada exports 90% of its canola as seed, oil or meal to over 50 markets around the world. Global biofuels market demand has expanded domestic crushing and exports of canola oil and seed.[13]

[13] Further information provided in Table 3 and discussion on page 21.

Moving into the future: Keep it Coming 2025

The Canadian canola value chain is striving towards achieving the goals set out in "Keep it Coming 2025", our industry's strategic plan which seeks to sustainably produce 26 million tonnes of canola every year by increasing yield to an average of 52 bushels per acre.[14] The plan is built on three pillars:

(1) sustainable, reliable supply,
(2) differentiated value, and
(3) stable and open trade.

In terms of sustainably increasing supply, the goal is to get more production without adding more acres of canola, which will come from achieving higher and more consistent yields on every Canadian field, which will lead to greater productivity for the industry as a whole. The industry has a track record of success:

Table 1 – Progressing towards 2025 strategic industry goals

	Results			**Target**
	2011 & 2012 avg.	2013	2017	2025
Exported seed	8.11 MMT	8.5 MMT	11.3 MMT	12 MMT
Domestic processing (crush)	6.87 MMT	7.5 MMT	9.2 MMT	14 MMT
Acres	20 million	19.8 million	22.9 million	22 million
Yield	31 bu / ac	40 bu / ac	41 bu / ac	52 bu / ac
Production	14.2 MMT	18 MMT	21.3 MMT	26 MMT

*MMT – million metric tonnes
bu/ac – bushels per acre

Transportation greenhouse gas emissions

Under the 2015 Paris Agreement,[15] Canada committed to reducing its annual greenhouse gas (GHG) emissions to 30% below 2005 levels by 2030. In the *Pan-Canadian Framework on Clean Growth and Climate Change,*[16] Canada outlined many of its actions that will contribute to meeting this goal. The approach aims to address emissions across all sectors of the economy while driving innovation and economic growth.

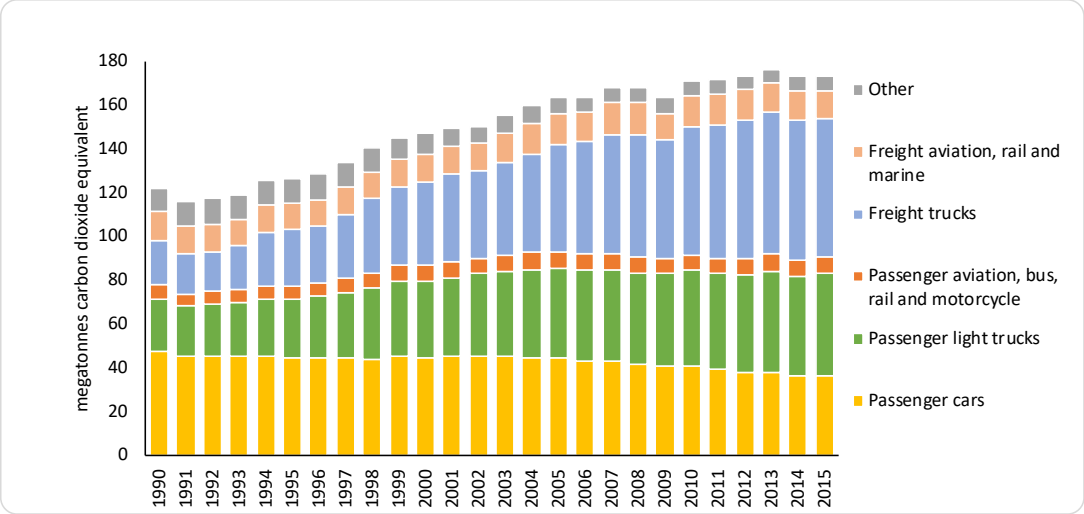
The 2030 target for annual emissions under Canada's climate commitments is 523 megatonnes of carbon dioxide equivalent (MT CO_2e). MT CO_2e is the unit by which GHG emissions—the gases that cause climate change—are measured (see *Canola and low-carbon biofuels* section). As of 2015, Canada's annual GHG emissions were 722 MT CO_2e, with more than half of the annual emissions coming from just two economic sectors: oil and gas (189 MT CO_2e) and

[14] http://keepitcoming.ca/
[15] https://unfccc.int/process/the-paris-agreement/what-is-the-paris-agreement
[16] https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework/climate-change-plan.html

transportation (173 MT CO_2e).[17] Both sectors have exhibited significant growth in emissions since 1990.

Growth in transportation emissions (43% since 1990) is due to increased demand for fossil fuels—gasoline and diesel—to power the vehicles that transport people and goods across the country. If Canada is to achieve its 2030 GHG target, specific attention must be paid to reducing the use of gasoline and diesel fuel in transportation.

Figure 5: Canada's transportation GHG emissions



Gasoline

Gasoline is the most common fuel used for light-duty passenger vehicles (e.g. cars, light trucks, vans, SUVs). In 2017, Canadians consumed over 47 billion litres of gasoline.[18] While overall transportation emissions have grown steadily since 1990, emissions from passenger vehicles have been relatively stable since around 2000, due to increased fuel efficiency and use of alternative lower carbon fuels.

Alternatives to gasoline

There are currently two prominent alternatives to gasoline for passenger vehicles: ethanol[19] and electricity.[20] Ethanol is a biofuel, commonly made from wheat or corn, that can be blended with gasoline for use in gasoline engines. On average, Canadian fuel suppliers blend about 6% ethanol into the gasoline pool.[21]

[17] https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html
[18] http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=1340004
[19] https://www.afdc.energy.gov/fuels/ethanol.html
[20] https://www.afdc.energy.gov/fuels/electricity.html
[21] http://www.naviusresearch.com/publications/biofuels-in-canada/

The electric vehicle (EV), which is powered either fully or partly by an onboard battery that is charged by plugging in to the electricity grid, can be operated entirely without the use of gasoline. When battery charging occurs in a region with clean electricity (e.g. lower GHG emissions), EVs significantly reduce emissions from passenger vehicles. Currently, there are approximately 42,000 EVs on the road in Canada,[22] of a total of approximately 22.5 million light duty motor vehicles registered.

Emerging alternatives to gasoline include ethanol made from municipal wastes, renewable gasoline made from co-processing biomass (canola oil, fats, or other bio-based oils) with crude oil in petroleum refineries,[23] and hydrogen fuel cells.[24] Renewable fuels use offsets gasoline consumption and can lower GHG emissions from passenger vehicles.

Diesel

In 2017, Canada consumed over 31 billion litres of diesel fuel.[25] Diesel fuel is used in heavy duty vehicles, such as construction equipment and semi-trailer trucks. Different grades of diesel fuel are also used to power rail locomotives, marine tankers, and airplanes. Freight emissions, from trucks, trains, planes and ships carrying goods from coast to coast across Canada, have been rapidly increasing year after year. In fact, emissions from freight trucks alone have more than tripled from 20.7 MT CO_2e in 1990 to 63.2 MT CO_2e in 2015 (see figure 5). In addition to GHG emissions, diesel fuel use contributes to air pollution[26] and has human health impacts.[27] As nearly all freight vehicles are powered by diesel engines, viable low-carbon alternatives to diesel fuel use are integral to lowering transportation emissions.

Alternatives to diesel

The most prominent alternatives to diesel fuel in heavy duty vehicles are natural gas[28] and renewable diesel fuels. There are two types of natural gas: fossil natural gas from underground reserves, and renewable natural gas (RNG) produced from organic material. Natural gas engines can either be purchased new, or some diesel engine vehicles can be converted to use natural gas. In the foreseeable future, there is no alternative motor technology that will be able to replace the diesel engine for heavy-duty commercial and industrial applications (e.g. long-haul trucking, agriculture, etc.)

[22] https://www.fleetcarma.com/electric-vehicle-sales-in-canada-q3-2017/
[23] https://www.afdc.energy.gov/fuels/emerging_hydrocarbon.html
[24] https://www.afdc.energy.gov/fuels/hydrogen.html
[25] http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=1340004
[26] http://www.who.int/sustainable-development/transport/health-risks/air-pollution/en/
[27] https://www.ccohs.ca/oshanswers/chemicals/diesel_exhaust.html
[28] https://www.afdc.energy.gov/fuels/natural_gas.html

Renewable diesel fuels, in the form of biodiesel[29] or renewable hydrocarbon diesel (RHD),[30] can be produced from oilseed crops (e.g. canola, soy), used cooking oil, or rendered animal fats. Biodiesel and RHD are currently blended with fossil diesel fuel in many parts of the world to offset diesel demand and lower the environmental impact of diesel use. Canadian fuel suppliers average just over 2% renewable content in the diesel sold in Canada.[31] Renewable diesel fuels are cost-effective and readily-available alternatives to fossil diesel that can be deployed without purchasing new, or modifying existing, heavy duty engines. When produced from Canadian oilseed crops, renewable diesel fuels offer significant GHG emissions reductions.

As immediate action is needed to address increasing levels of transportation emissions in Canada—particularly heavy-duty vehicle emissions—it is important that we utilize existing, viable alternatives to fossil fuels. Renewable diesel fuels made from canola oil are a proven and readily-available, low-carbon alternative to fossil diesel. In addition to significantly reducing GHG emissions, biodiesel use contributes to substantial reductions of other harmful tailpipe emissions. Utilizing more canola biofuels presents a great opportunity to not only grow the renewable fuels industry in Canada but also reduce the environmental impact of the transportation sector.

Canola and low-carbon biofuels

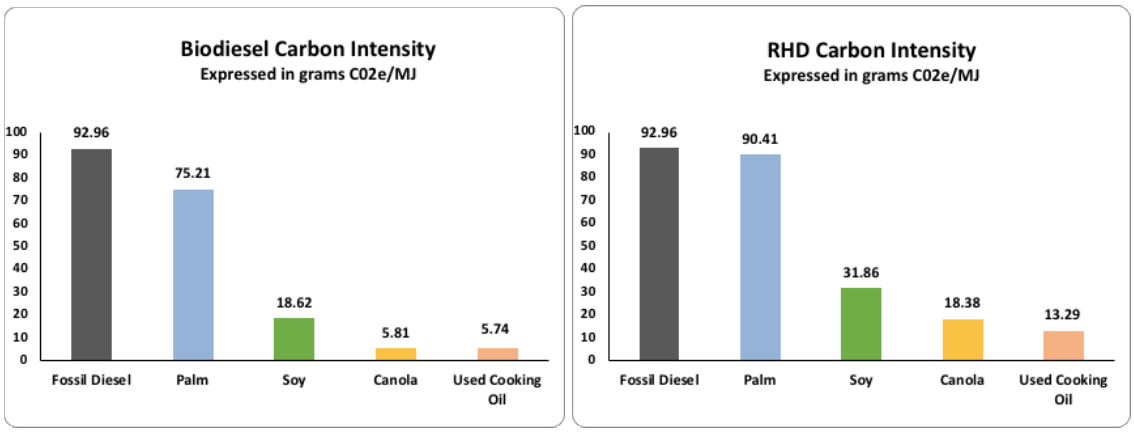
Canola oil can be used as an input, or feedstock, to make multiple types of renewable fuel (biofuel) products. The renewable or bio designation refers to fact that the fuel is made from biomass (plants). Fossil fuels, such as gasoline and diesel, are made from crude oil that comes from geologically-sequestered carbon reserves. Because the carbon emissions from biofuels are reused through plant photosynthesis, biofuel combustion is considered carbon neutral. Conversely, carbon emissions from combusting fossil fuels are increasing the levels of greenhouse gases in the earth's atmosphere.

Greenhouse gas (GHG) emissions are measured over the full life cycle of growing, harvesting, manufacturing, distributing, and using biofuels. A life cycle assessment (LCA) is performed following internationally accepted LCA guidelines to quantify the life-cycle GHG emissions from a fuel, or its carbon intensity (CI).[32] The CI of fuels is determined across a common energy unit; expressed in grams of carbon-dioxide equivalent emissions per mega-joule of energy (gCO_2e/MJ). Since there are greenhouse gases other than carbon dioxide, such as methane (CH_4) and nitrous oxide (N_2O), that are released during the life cycle of a fuel, their global warming potential is used to convert them into carbon dioxide equivalent when calculating the CI.[33]

[29] https://www.afdc.energy.gov/fuels/biodiesel.html
[30] https://www.afdc.energy.gov/fuels/emerging_green.html
[31] http://www.naviusresearch.com/publications/biofuels-in-canada/
[32] https://www.iso.org/standard/38498.html
[33] http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=CA

The GHGenius[34] LCA model was developed in Canada to calculate and compare fuel CIs.[35] Canola-based biofuels are considered low-carbon because the CI of the fuels is typically well below fossil fuel CIs.

Figure 6: Environmental (GHG) performance of select biofuels in 2018 (GHGenius) compared to fossil diesel



Renewable fuel products for diesel engines are produced globally, primarily from a range of oleochemicals (fats and oils). US biofuel producers use a variety of input feedstocks,[36] as do those in British Columbia[37] and California.[38] The following section provides a breakdown of feedstocks used for biofuel production in North American and international markets.

Canola is typically used in conventional (first-generation) renewable diesel fuels, commonly known as biodiesel and renewable hydrocarbon diesel. New technologies are emerging to convert biomass into a range of motive fuels.[39] For example, petroleum refineries are now co-processing biomass (canola oil, fats, or other bio-based oils) with crude oil into finished fuels, such as gasoline, diesel, and jet fuel. Co-processing canola oil with crude oil is a promising opportunity for petroleum refiners to reduce GHG emissions and meet regulatory compliance obligations.[40]

Co-processing

Canola oil can be co-processed with fossil fuels in a petroleum refinery to create fuels with lower carbon intensities than pure fossil fuels. Co-processing is being researched in Canada and will progress to being trialed in Canadian refineries. Co-processing offers the opportunity to

[34] https://www.ghgenius.ca/
[35] https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/renewable-low-carbon-fuels/fuel-lifecycle-assessment
[36] https://www.eia.gov/biofuels/biodiesel/production/
[37] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternative-energy/transportation/renewable-low-carbon-fuels/rlcf-007-2016.pdf
[38] https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm
[39] https://www.afdc.energy.gov/fuels/emerging_hydrocarbon.html
[40] https://www.researchgate.net/profile/Jinwen_Chen

generate emission reductions in addition to those achieved by canola-based biodiesel and renewable diesel.

The table below summarizes the current market potential for canola-based biofuels and their GHG reduction potential compared to the fossil fuels they displace:

Table 2: Canola-based low-carbon biofuels

Biofuel type	**Fuel use**	**Canola feedstock**	**Carbon intensity* gCO_{2e}/MJ (% reduction)**	**Fuel quality standards (ASTM / CGSB)**	**Market status**
Biodiesel	Diesel engines	Yes	5.81 (94%)	Yes	Global
Renewable diesel	Diesel engines	Yes	18.38 (80%)	Yes	Global
Biocrude	Petroleum refineries	Yes	t.b.d.	n/a	Development
Biojet	Jet engines	Yes	-2.58 (103%)	Yes	Development
Ethanol	Gasoline engines	No	n.a.	Yes	Global
Renewable gasoline	Gasoline engines	Yes	t.b.d.	Yes	Development

*GHGenius 4.03a default Canada region, year of analysis 2018

Canola biofuels are typically blended with diesel fuels to be used in all diesel engine platforms (e.g. cars, trucks, heavy equipment, rail, etc.). In order to assure fuels are fit for purpose, biofuels must adhere to strict quality specifications. In North America, biofuels standards are accredited by the Canadian General Standards Board (CGSB) and the American Society for Testing Materials (ASTM). When biodiesel is blended with diesel fuel the blend ratio is labeled; for example, B5 is defined as 5% biodiesel mixed with 95% diesel fuel. Quality specifications are in place in Canada for neat biodiesel (B100),[41] and blends of B5[42] or B6-B20.[43]

Canola biofuels use in North America & international markets

Biofuels use in Canada, and globally, has increased over the past 10 years as governments have adopted regulatory measures to require renewable and/or lower carbon fuel use in transportation fuel supply systems. Fuel producers, suppliers, or importers are typically the obligated parties, as they are the ones required to incorporate the renewable/low-carbon fuels into the fuels they distribute. Two types of fuel regulations are common:

[41] http://publications.gc.ca/collections/collection_2017/ongc-cgsb/P29-003-524-2017-eng.pdf
[42] http://publications.gc.ca/site/archivee-archived.html?url=http://publications.gc.ca/collections/collection_2017/ongc-cgsb/P29-003-520-2017-eng.pdf
[43] http://publications.gc.ca/site/archivee-archived.html?url=http://publications.gc.ca/collections/collection_2017/ongc-cgsb/P29-003-522-2017-eng.pdf

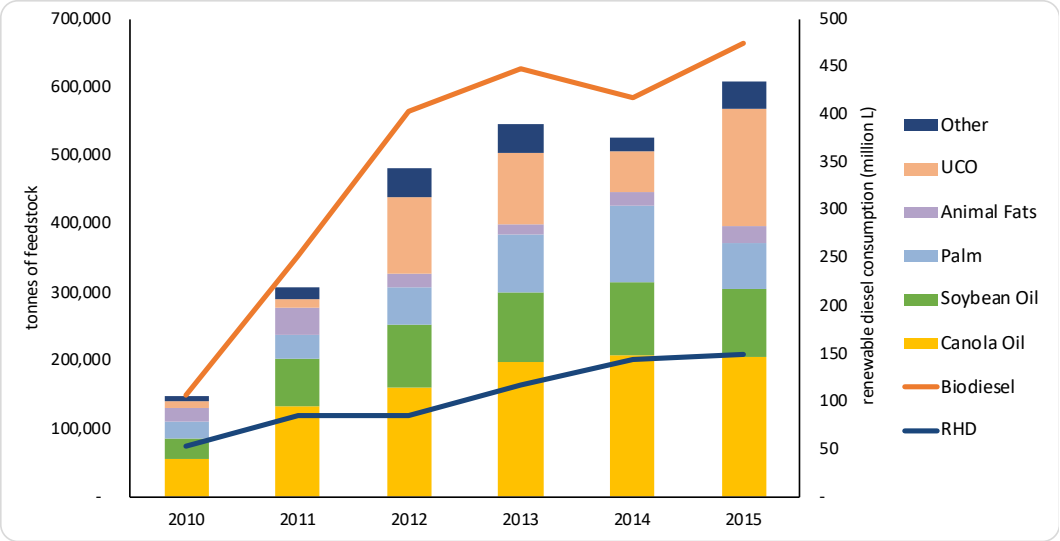
i. *Renewable Fuel Standards* (RFS) – regulations set a minimum requirement for biofuel use in a calendar year (in aggregate, not per litre). In the US RFS, biofuel products must be derived from eligible biomass and meet minimum performance standards (e.g. CI reductions, fuel quality, biomass origin). Canada's RFS is without any requirements for biomass eligibility or CI reductions.

ii. *Low Carbon Fuel Standards* (LCFS) – regulations set a minimum reduction in the carbon intensity of fuels in a calendar year (in aggregate, not per litre). Fuels (renewable, or alternative fuels such as electricity, natural gas, or hydrogen) are compared using lifecycle analysis CI and energy-equivalence ratios to baseline CIs for gasoline or diesel fuels.

Biofuels in Canada

To date, canola use in biofuels has been predominantly driven by biodiesel demand. Between 2010-2015, biodiesel and RHD use in Canada increased under RFS and LCFS measures adopted by provinces and the federal government in that period.[44] Canola oil is the most prominent feedstock for renewable diesel consumed in Canada.

Figure 7: Canadian renewable diesel consumption, feedstocks and use (2010-2015)



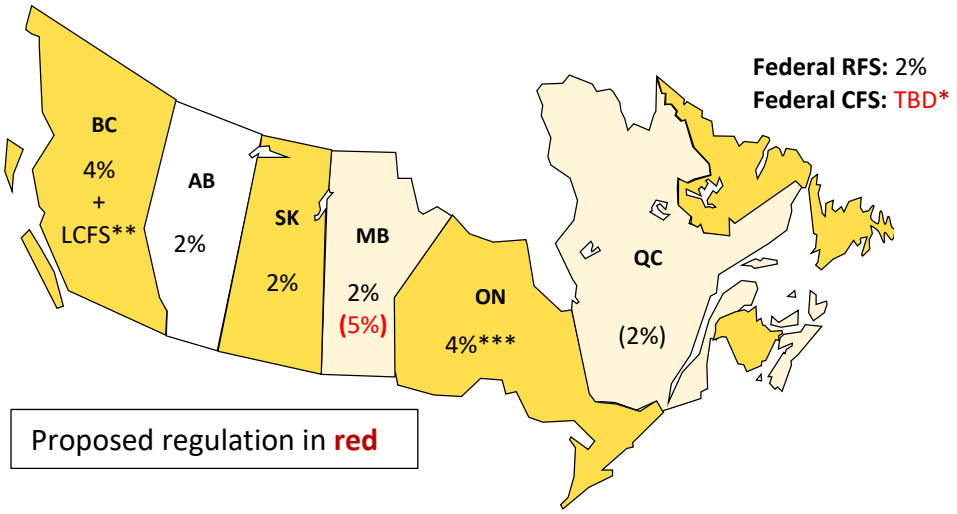
Under the *Pan-Canadian Framework on Clean Growth and Climate Change,*[45] federal and provincial governments in Canada are currently developing new or expanded fuel regulations. Regulations, such as the federal *Clean Fuel Standard* (CFS),[46] are forecast to increase low-

[44] http://www.naviusresearch.com/publications/biofuels-in-canada/
[45] https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework.html
[46] https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-standard.html

carbon fuel use to 2030.[47] However, the regulatory framework for the CFS has indicated the federal government's intention to consider eliminating the federal RFS over time; this would negatively impact demand for canola-based biofuels.[48] Renewable fuels standards provide a predictable framework for suppliers to follow, encouraging investment. Adding a carbon-intensity requirement will help the CFS achieve meaningful emissions reductions, given canola's low gCO_2e/MJ, compared to other feedstocks. Maintaining or expanding the current RFS will ensure a foundation from which those reductions can be realized.

Provincial governments are taking steps to expand the use of low-carbon biofuels and reduce GHG emissions in their respective regions. An expanded BC-LCFS[49] and new diesel RFS measures in Manitoba (5% RFS)[50] and Quebec (2% RFS)[51] will drive new demand for canola-based biofuels.

Figure 8: Canadian renewable and low-carbon fuel regulations (diesel fuels only)



* Federal Clean Fuel Standard will eliminate 30 MT of GHG annually by 2030. Consultation documents reference a carbon intensity reduction in the range of 10-15%.

** BC Low Carbon Fuel Standard (LCFS) requires carbon intensity of diesel fuel pool to decrease by 10% by 2020 through the use of lower-carbon renewable and alternative fuels.

*** Blend levels are lower if the carbon intensity of renewable fuels is more than 70% lower than fossil diesel fuel.

**** The federal and provincial regulations are noted in Appendix II.

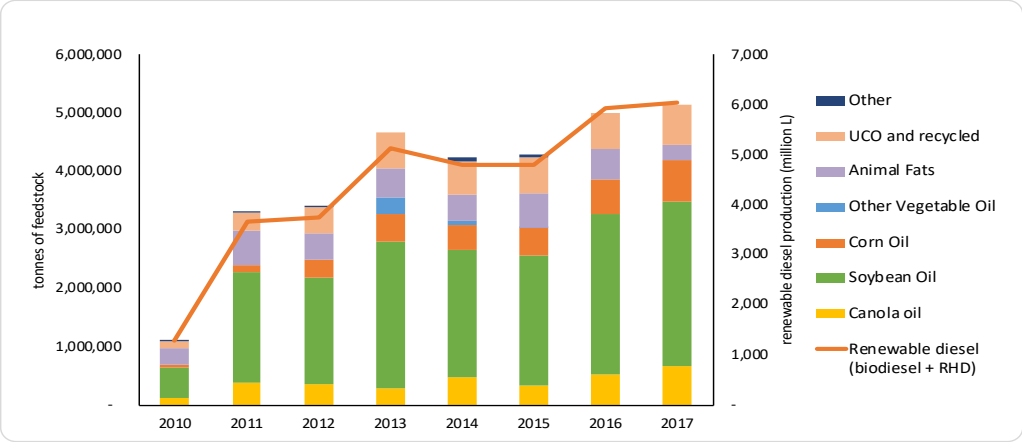
[47] http://cleanenergycanada.org/work/clean-fuel-standard-report/
[48] http://gazette.gc.ca/rp-pr/p1/2017/2017-12-23/html/notice-avis-eng.html#ne1
[49] https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/renewable-low-carbon-fuels/bc-lcfs-consultations
[50] https://www.gov.mb.ca/climateandgreenplan/index.html
[51] https://politiqueenergetique.gouv.qc.ca/wp-content/uploads/Tableau-PA-PE2030_ANG.pdf

Biofuels in the United States

The US implemented its first Renewable Fuel Standard (RFS1)[52] in 2005, requiring 4.0 billion gallons of renewable fuel to be blended into gasoline supplied in 2006. The required volumes of renewable fuels were to increase year over year to 7.5 billion gallons in 2012.[53] As this rule applied to renewable fuel in the gasoline pool only, RFS1 was essentially an ethanol mandate.

The RFS1 was amended in December 2007 under the *Energy Independence and Security Act,*[54] establishing the current standard, the RFS2.[55] The RFS2 significantly expanded the regulation to include the use of other biofuels, including biomass-based diesel, cellulosic biofuel, and advanced biofuels. The total renewable fuel requirement was extended and increased stepwise each year to reach 36 billion gallons by 2022. The biomass-based diesel requirement, which includes biodiesel and RHD, started at 0.5 billion gallons in 2009, and has since increased to 2.1 billion gallons (7.9 billion litres) for 2018.[56] Renewable Identification Numbers (RINs) are created through the use of the respective type of eligible biofuel for each regulated category, and are the key market-based compliance mechanism to mediate market actions pursuant to the regulation.[57] In essence, RINs are credits used for regulatory compliance and act as the currency of the RFS program in the United States. In its most basic form: renewable fuel producers generate RINs, market participants trade them in a market, and obligated parties obtain them and retire them for regulatory compliance.[58]

Figure 9: US Renewable Diesel Production and Feedstock Profile

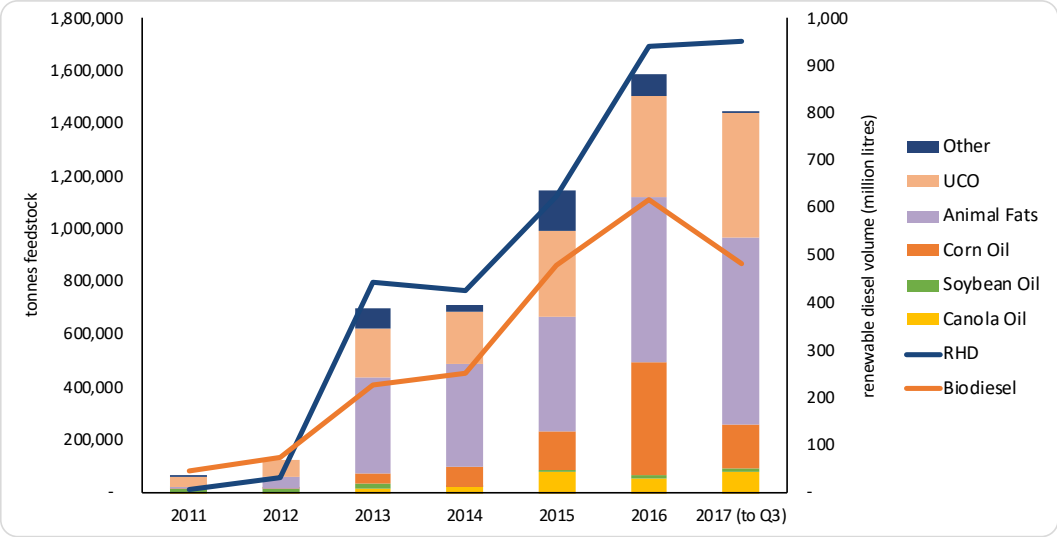


[52] https://www.epa.gov/renewable-fuel-standard-program/renewable-fuel-standard-program-rfs1-final-rule
[53] https://www.gpo.gov/fdsys/pkg/FR-2007-05-01/pdf/E7-7140.pdf
[54] https://www.congress.gov/bill/110th-congress/house-bill/6
[55] https://www.epa.gov/renewable-fuel-standard-program/renewable-fuel-standard-rfs2-final-rule
[56] https://www.epa.gov/renewable-fuel-standard-program/final-renewable-fuel-standards-2018-and-biomass-based-diesel-volume
[57] https://www.epa.gov/renewable-fuel-standard-program/renewable-identification-number-rin-data-renewable-fuel-standard
[58] https://www.epa.gov/renewable-fuel-standard-program/renewable-identification-numbers-rins-under-renewable-fuel-standard

Agricultural states in the US have also taken measures to further incent or legally require increased use of biofuels, including biodiesel. For example, Illinois exempts state taxes on biodiesel blends over 10%.[59] Minnesota legally requires 5% biodiesel blending in the winter and 10% in summer months.[60] As of May 1, 2018, their mandate has increased to 20% (from May 1 to September 31 annually).[61] These additional measures to promote the uptake of biodiesel are focused in the Midwest, which produces almost all of the US soybean crop – the primary feedstock for US biodiesel production.[62] Significant growth in soybean diesel production has been exhibited over the course of RFS2 and additional programs.

The most significant state policy is the California Low Carbon Fuel Standard (CA LCFS), which was implemented in 2011.[63] The CA LCFS requires the CI of fuels to decrease by 10% from 2010 to 2020. Further, the California Air Resources Board (CARB) is currently taking steps to implement an extension of the CA LCFS to require a 20% CI reduction by 2030.[64] Similar to the design of the federal RFS2, the CA LCFS regulation uses a market-based credit mechanism, called LCFS credits, to track compliance, establish a transparent compliance price signal, and provide flexibility to market participants.[65] Because the stringency of the regulation increases gradually over time, and because canola-based biodiesel is an effective compliance fuel, demand under the CA LCFS has increased, although modestly compared to animal fats and used cooking oil for RHD production.

Figure 10: California biomass-based diesel feedstocks and total fuel volumes

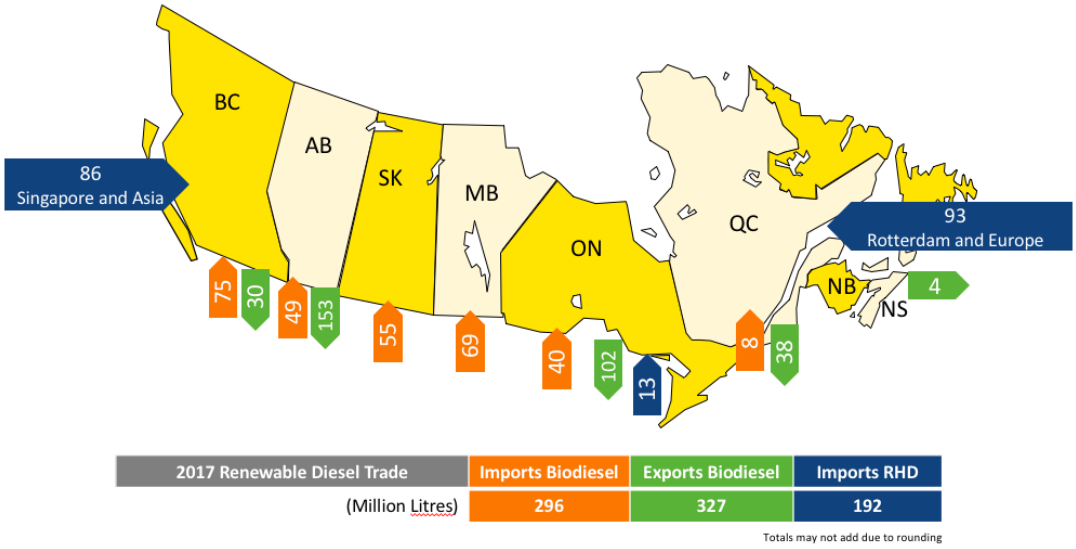


[59] https://www.afdc.energy.gov/fuels/laws/BIOD/IL
[60] https://www.afdc.energy.gov/fuels/laws/BIOD/MN
[61] http://mn.gov/commerce-stat/pdfs/b20.pdf
[62] https://www.nass.usda.gov/Charts_and_Maps/Crops_County/sb-pr.php
[63] https://www.arb.ca.gov/fuels/lcfs/lcfs.htm
[64] https://www.arb.ca.gov/regact/2018/lcfs18/lcfs18.htm
[65] https://www.arb.ca.gov/fuels/lcfs/lrtqsummaries.htm

In 2016, the State of Oregon implemented a comparable LCFS regulation, known as the *Clean Fuels Program* (OR LCFS); the OR LCFS requires the CI of fuels to decrease by 10% from 2016 to 2025.[66] The OR LCFS also tracks and reports on compliance credit activity.[67]

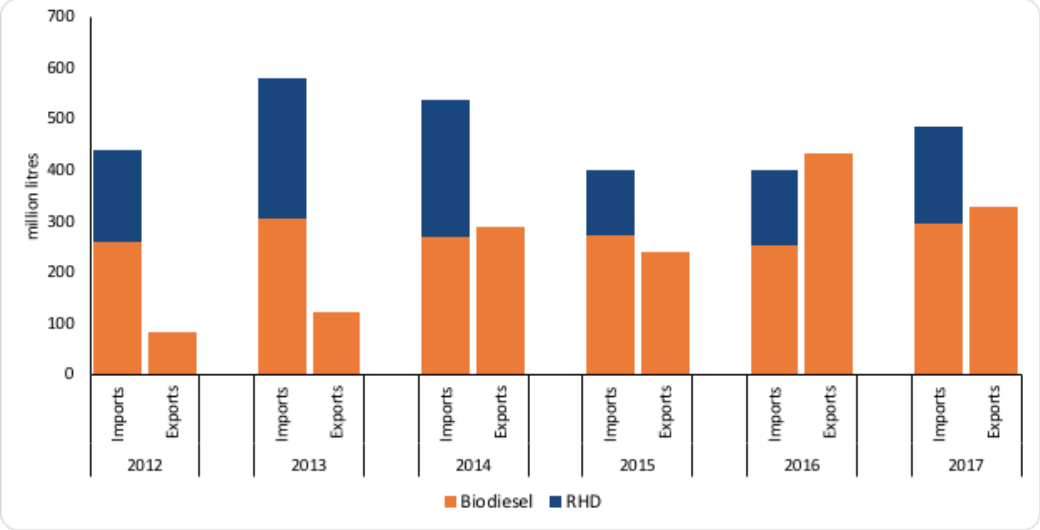
The current policy and regulatory environment in the United States has been drawing Canadian production south. The entire canola supply chain meets US EPA sustainability requirements for the biofuels market (RFS 2). The US is historically a consumer of Canadian canola to manufacture biofuels, and it is also the main consumer of Canadian-made biodiesel. Almost all biodiesel produced in Canada has been exported to the US[68] where it has benefitted from a US Blenders Tax Credit for each gallon of biodiesel blended with petroleum diesel, in addition to generating RIN and LCFS credits under the respective state regulations.[69] As a result, demand for renewable diesel fuels in Canada has largely been met by imports of US biodiesel, and RHD from Singapore and Rotterdam.

Figure 11: Import/export of renewable diesel products (2017)



[66] http://www.oregon.gov/deq/aq/programs/Pages/Clean-Fuels.aspx
[67] http://www.oregon.gov/deq/aq/programs/Pages/Clean-Fuels-Data.aspx
[68] See: Canadian International Merchandise Trade Database – Table 980-0038
[69] https://www.afdc.energy.gov/laws/395

Figure 12: Canada renewable diesel trade balance



Biofuels in Europe

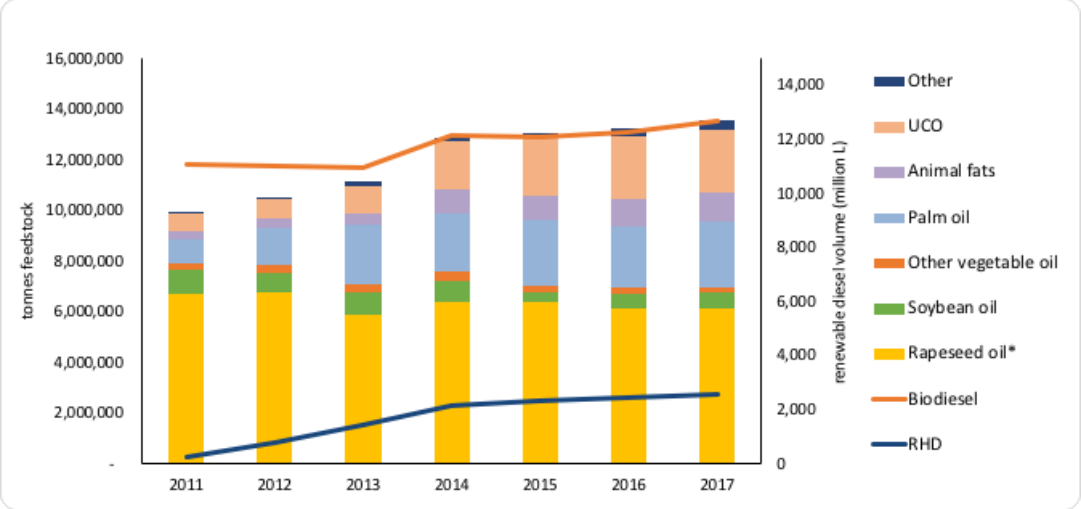
The European biofuel market is enabled via the *EU Renewable Energy Directive* (EU-RED), introduced in 2008, that sets a broad policy for the inclusion of renewable energy.[70] The EU-RED requires that at least 20% of total energy is from renewables by 2020, with at least 10% of transport fuels originating from renewable sources by the 2020 date.

In January 2018, the EU Parliament voted to approve a proposal for the next version of this policy, the EU-RED II, that would increase the target for renewables consumption to at least 27% of final energy consumption in the EU by 2030, with renewables in transport having a 12% share. The proposed EU-RED II may limit the contribution of crop-based biofuels and create a mandate (within the total renewable fuels content) for advanced fuels, including electricity in transport, waste-based biofuels, and recycled carbon fuels. The proposal includes a ban on the use of palm oil-derived biofuels beginning in 2021. The proposed EU-RED II now proceeds to negotiations with the EU Council (which represents governments of EU member states) and the EU Commission.

The European market is an export opportunity for Canadian canola biofuels. Canola is able to comply with the EU-RED's sustainability criteria and achieve the minimum GHG reduction requirements set out in the regulation: in 2018, the GHG reduction requirement increased to 50% (vs. fossil diesel) from its previous level of 35%.[71]

[70] https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive
[71] https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/sustainability-criteria

Figure 13: EU renewable diesel production and feedstocks



*Rapeseed oil includes canola seed and oil imports from Canada

In 2017, Canada shipped 678,919 tonnes of canola seed to the EU, amounting to 6% of total seed exports that year. Exports of seed, oil, and meal to the EU have averaged $180 million annually over the past five years. The vast majority of the canola Canada exported to the EU is used for biodiesel production.[72]

Key issues: Performance of canola biofuels, importance of enabling policy

Fuel operability

There are no insurmountable operability concerns that impede the continued and expanded use of canola biofuels in Canada. As of 2017, 70% of major diesel engine manufacturers operating in the United States have approved the use of biodiesel blends up to 20% (B20) in new engines.[73] The remaining 30% are approved for fuel blends of 5% (B5). Evidence included in British Columbia's LCFS consultation underway in 2018 shows that biodiesel blends of at least 2% can achieve CGSB fuel-quality specifications for any temperature experienced in Canada, with sufficient ability to blend up to 5% biodiesel without the need to include additional kerosene in the fuel blend (adding kerosene to diesel fuel allows it to be used at lower temperatures).[74] Based on experience in jurisdictions with cold climates such as Minnesota, Illinois, and the European Union, fuel suppliers can supply fuel blends as high as B11 year-round.

[72] https://www.producer.com/2018/01/eu-approves-canadian-canola-biodiesel/#post-193712
[73] http://biodiesel.org/using-biodiesel/oem-information/oem-statement-summary-chart
[74] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternative-energy/transportation/renewable-low-carbon-fuels/pathway_assessment_2017.pdf

Biofuel costs

The impact of renewable fuel regulations (RFS and LCFS) on the price of fuels is a major consideration. Wholesale fossil fuel prices in Canada are reported by the federal government; however, there is no comparable posting of market prices for renewable fuels.[75] Regardless, the US fuels market is over 10 times the size of the Canadian market and the fair market value (FMV) for fossil and the most common renewable fuels in the US are reported on public markets daily (the price of RHD is not posted on public exchanges).[76] Thus, the FMV of renewable fuels in Canada can be imputed by converting the US price to Canadian currency and adding the cost to deliver the fuel to Canadian markets.

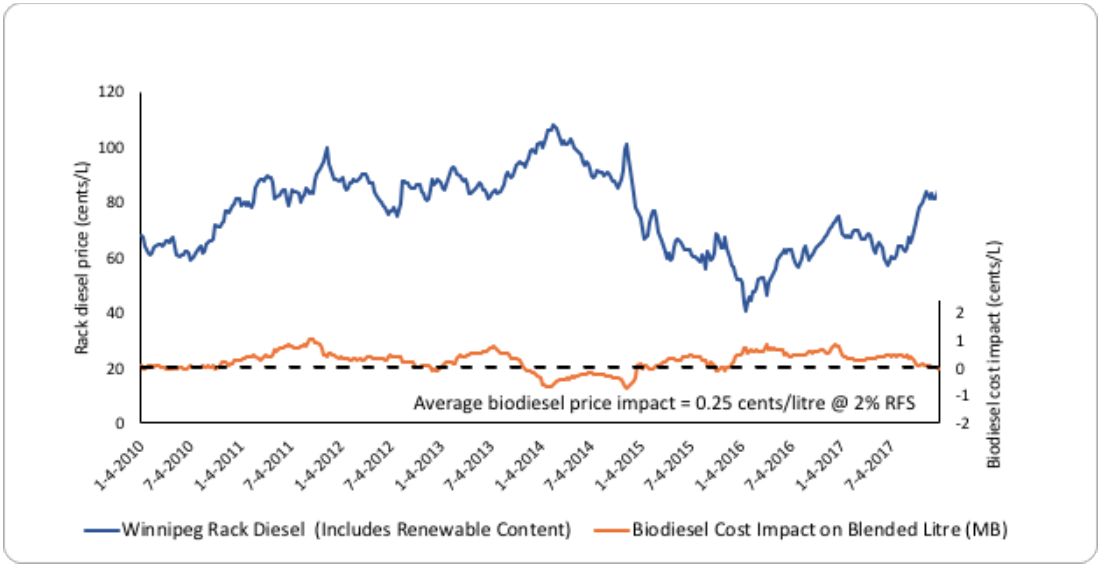
As wholesale prices of biofuels in Canada are largely dictated by prices set in the much larger US market, prices for canola biodiesel must remain competitive with the price of soybean methyl ester (SME) biodiesel imported into Canada from the US. Wholesale SME prices in western Canada (Manitoba) have averaged around $0.90/L since 2010 and have fluctuated widely between $0.37 cheaper and $1.00 more expensive than a litre of diesel fuel. Retail petroleum diesel fuel prices for the same period averaged $1.09/L.

The price of US biodiesel has historically been tempered by the Blenders Tax Credit (BTC), which lowers the effective price of US biodiesel. The BTC has, since inception in 2006, expired and been reinstated (either retroactively, or prospectively) numerous times. As of January 1, 2018, the BTC has expired again.

The direct cost of replacing 2% of diesel fuel with biodiesel (e.g. the federal RFS) can be compared to wholesale rack ultra-low-sulphur diesel fuel prices in major Canadian markets. The estimated cost premium of biodiesel use since implementation of the federal RFS is $0.0025/litre (in Winnipeg, MB – see Figure 14 below).

[75] http://www2.nrcan.gc.ca/eneene/sources/pripri/wholesale_bycity_e.cfm
[76] http://www.cmegroup.com/trading/agricultural/biofuel.html

Figure 14: Winnipeg rack diesel price and biodiesel cost impact at 2% RFS blending



Canola supply

The total supply of Canadian canola continues to trend upwards, with the strategic goal of 26 million tonnes of sustainable annual production in 2025. Canola use for biofuels in North American and European markets has grown significantly over the past decade. Canola seed for Canadian biodiesel production has grown almost ten-fold since 2005, while seed exported for biodiesel production in the US and EU has grown by more than 6 times. Even at these significant growth rates, total canola seed used for biodiesel production represented less than 10% of the total canola crop in 2015.

Table 3: Canola utilization for biofuel production

Canola seed (tonnes)	**2005**	**2010**	**2015**
Seed Crushed Domestically	3,100,000	5,700,000	7,700,000
Seed Exported	3,900,000	7,300,000	9,500,000
Seed for Canadian Biodiesel (domestic use)	50,000	130,000	470,000
Seed exported to US for use in Biodiesel	200,000	250,000	780,000
Seed for EU Biodiesel (EU use)	0.00	0.00	500,000
Total canola seed for biodiesel	**250,000**	**380,000**	**1,800,000**
Canola crop production	**9,500,000**	**12,800,000**	**18,400,000**
Percent utilization of Canadian canola crop for biodiesel	**2.6%**	**3.0%**	**9.8%**

To meet expanding demand for low-carbon fuels in Canada, biofuel producers will require commercial quantities of high quality, low-carbon, competitively priced feedstocks. Canadian canola producers and crushers are well positioned to meet this future demand.

Biofuels production

From 2010 to 2016, Canadian biofuel production increased from 1.5 billion to 2.2 billion litres per year.[77] In 2016, ethanol production was 1.7 billion litres, with corn and wheat as the primary feedstocks. Biodiesel production was estimated at 400 million litres, with used cooking oil (UCO) and canola oil as the main feedstocks.

Current total nameplate capacity for biodiesel production in Canada is approximately 700 million litres. Canadian production capacity exceeds domestic demand under existing RFS and LCFS regulations. In addition, a 19 million litre renewable fuel oil/bio-crude facility is currently operating, and several projects to produce RHD and bio-crude are under development. There is currently no RHD production capacity in Canada (See Appendix I for list of current biofuel plants in Canada). In the short-term, increased demand for biodiesel in Canada can be satisfied by the existing plants, and a stable regulatory environment could provide the investor confidence for expansion of existing or new capacity buildout.

Historically, the Canadian biodiesel industry has operated below-capacity due to volatility of US markets and conditions that have favoured use of US-made biodiesel in Canada. Low-carbon biodiesel and RHD production capacity in the US and Canada exceeds North American market demand.[78] Future demand is expected to generate investment in new plants and plant expansions over the 2020-2030 period. Primary technology platforms are expected to be biodiesel, RHD, and biomass co-processing.

Biofuels supply chains

The biofuels supply chain leverages the existing modes of transport for commodity agriculture and fossil fuel products, including truck, rail, pipelines, and vessel. As transport is a major issue for Canadian agriculture and energy sectors, increases in biofuel production and use may displace fossil fuel transport requirements.

Sustainability

Sustainability performance is an area of competitive advantage for Canadian canola. The sector has engaged extensively with sustainability via multiple projects that monitor and enhance the environmental performance of canola cultivation.[79] Specific focus is placed on ensuring that canola meets and exceeds sustainability criteria in established renewable fuel policies like the

[77] https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Ottawa_Canada_8-9-2016.pdf
[78] https://www.eia.gov/biofuels/biodiesel/production/
[79] https://www.canolacouncil.org/research/crop-production-research/sustainability-projects/

EU RED,[80] as well as being designated as an approved feedstock in the US RFS2.[81]

In the case of the EU RED, this involves ensuring that on-farm practices are in accordance with the requirements of renewable fuel regulations. This has been approached via on-farm checklists,[82] communication of best practices, and specific actions by canola processors. Select canola processors have incorporated programs[83] to supply sustainable canola under approved certification schemes like the International Sustainability and Carbon Certification Scheme (ISCC).[84] The canola sector continues to be responsive to the sustainability requirements of export jurisdictions. Canola remains a preferred biofuel feedstock under renewable fuel policies that incorporate sustainability criteria.

Indirect effects

This concept, which includes Indirect Land Use Change (ILUC), moved quickly from initial papers (2008) to quantitative inclusion in select biofuels standards (2009). The initial ILUC estimates were large, and data required for complex modelling were generally incomplete. In the decade since its introduction, significant work has addressed a number of the shortcomings of earlier modelling. Notwithstanding this progress, the state of the science remains contested.

- Unlike the measurement of direct effects (biofuels, fossil fuels) for which there is far broader (although not universal) agreement on methodology and practice, the measurement of indirect effects remains controversial and lacks consensus in academia and amongst regulators.

- While models and databases used to calculate emissions from ILUC are improving, they still have deficiencies that produce a wide range of results.[85] A recent report commissioned by the European Commission stated, "Empirical information on components for ILUC is very limited", and "most authors conclude that it is not plausible that uncertainty will be narrowed down in the near future".[86]

[80] https://www.canolacouncil.org/canola-biofuels/meeting-europe%E2%80%99s-requirements/
[81] https://www.epa.gov/renewable-fuel-standard-program/approved-pathways-renewable-fuel
[82] https://www.canolacouncil.org/canola-biofuels/meeting-europe%E2%80%99s-requirements/audit-ready-checklist-for-eu-red/
[83] https://www.adm.com/news/news-releases/adm-agri-industries-lloydminster-introduces-sustainable-grower-program
[84] https://www.iscc-system.org/
[85] https://www.sciencedirect.com/science/article/pii/S0961953414000257
[86] http://www.cener.com/en/2017/11/27/study-ec-coordinated-cener-gathers-information-iluc-ghg-emissions-associated-biofuels-production/

- The underlying hypothesis of ILUC is widely contested,[87] with historic land use changes observed that are inconsistent with predicted ILUC models, underscoring the poorly-understood modelled relationships between intensive and extensive agricultural expansion, the impact of commodity prices on land use change decisions, the underlying drivers for deforestation/grassland cultivation, and the capacity of agricultural systems to increase yields.[88]

- A recent paper highlighted shortcomings of ILUC modelling under existing US renewable-fuel regulations, and quantified new ILUC factors taking into account new modelling parameters that reflect agricultural systems evidence.[89]

- The most important development regarding ILUC has come from the International Organization for Standardization (ISO), which determined through an extensive analysis, peer review, and science-based consensus process, that science-based LCA analysis requires equivalent system boundaries.[90]

- "The system boundaries shall be treated according to the guidance in ISO/TS 14067 and shall be equivalent."[87]

- "Valid comparisons require the use of consistent methodologies, data and system boundaries. For any comparison the same lifecycle stages shall be included."[91]

- ISO is clear that including consequential emissions for one type of fuel (e.g. biofuel) while omitting it for others (e.g. fossil) is contrary to established LCA guidelines.

- Indirect Effects on fossil fuels (e.g. military emissions, indirect land use change [fracking]), refinery co-products (RFO, petcoke), and under-reported direct emissions (e.g. fugitive emissions [methane]), direct land use change, exploration impacts, and post-production impacts (abandoned wells, fossil fuel assets) can be material and are currently not included in LCA emissions quantification in regulatory systems.[92]

- International consensus has also been codified requiring comparative assessments to use principles and criteria of sustainability equally across all forms of energy.

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[87] http://www.newfuelsalliance.org/ICE_petroleumLISKA.pdf
[88] https://www.card.iastate.edu/products/publications/pdf/14sr109.pdf
[89] https://www.sciencedirect.com/science/article/pii/S0960852417321648
[90] https://www.iso.org/home.html
[91] https://www.iso.org/standard/59521.html
[92] https://circabc.europa.eu/sd/a/2378656b-c200-4661-b693-455d51e68660/indirect_emissions_final_report_ICF_2013-08-01.pdf

The concept of Indirect Effects is broader than agricultural commodities and has implications for understanding impacts from conventional fuels and emerging transportation options. Any adoption of Indirect Effects in the Clean Fuel Standard (and related regulations) will need to consider these emissions, using comparable LCA boundaries, across all fuels. ILUC is not included in Canadian renewable fuel regulations; the federal CFS under development by ECCC will not include indirect GHG emissions at present, but will review the issue at a future date.[93]

[93] https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/publications/clean-fuel-standard-regulatory-framework.html

Glossary

ASTM – American Society for Testing Materials
BC-LCFS – British Columbia – Low Carbon Fuel Standard
BTC – Blenders Tax Credit
bu / ac – bushels per acre
CARB – California Air Resources Board
CH_4 – methane
CFS – clean fuel standard
CGSB – Canadian General Standards Board
CI – carbon intensity
CO_2e – carbon dioxide equivalent
ECCC - Environment and Climate Change Canada (Federal Department)
EU RED – European Union Renewable Energy Directive
EV – electric vehicle
FMV – fair market value
gCO_2e/MJ - grams of carbon-dioxide equivalent emissions per mega-joule of energy
GHG – greenhouse gas
ILUC – indirect land use change
ISCC – International Sustainability and Carbon Certification Scheme
ISO – International Standards Organization
MJ – megajoule
MLY – million litres per year
MSW – municipal solid waste
MT – megatonne
MMT – million metric tonne
N_2O – nitrous oxide
LCA – lifecycle assessment
LCFS – low carbon fuel standard
NO2 – Nitrous Oxide
RHD – renewable hydrocarbon diesel
RIN – Renewable Identification Number
RFO – residual fuel oil
RFS – renewable fuel standard
SME – soybean methyl ester
UCO – used cooking oil

APPENDIX I: ***Biofuel plants in Canada***

Biofuel Plants in Canada

Biodiesel Plants	Capacity	Location	Feedstock	Status
Archer Daniels Midland	265	AB	Canola	Operating
Atlantic Biodiesel	170	ON	Canola/Soy	Operating
BIOX - Hamilton	60	ON	Fats/UCO	Operating
BIOX - Sombra	50	ON	Fats/UCO	Upgrading
Consolidated Biofuels	11	BC	Fats/UCO	Operating
Darling (Rothsay)	56	QC	Fats/UCO	Operating
Evoleum	19	QC	Fats/UCO	Operating
Innoltek	6	QC	Fats/UCO	Operating
Invigor Biofuels	70	AB	Mixed	Upgrading
Milligan Bio-Tech	20	SK	Canola	Operating
Noroxel Energy	5	ON	Fats/UCO	Operating
Total Capacity	**732**			
Biocrude Plants/Projects	**Capacity**	**Location**	**Feedstock**	**Status**
Canfor / Licella	10	BC	Wood biomass	Development
Cellufuel	1.5	NS	Wood biomass	Pilot
ENSYN - Renfrew	19	ON	Wood biomass	Operating
ENSYN - Cote Nord	40	ON	Wood biomass	Construction
Total Capacity	**71**			
Renewable Diesel Plants	**Capacity**	**Location**	**Feedstock**	**Status**
Forge - Edmonton	0.2	AB	Grease/UCO	Pilot
Forge - Sombra	30	ON	Grease/UCO	Development
Total Capacity	**30**			
Advanced Ethanol Plants	**Capacity**	**Location**	**Feedstock**	**Status**
Enerkem - Westbury	5	QC	MSW/wood	Pilot
Enerkem - Edmonton	38	AB	MSW	Operating
Iogen Corporation	2	ON	Cellulosic	Operating
Woodland Biofuels Inc.	2	ON	Cellulosic	Demonstration
Total Capacity	**47**			
Grain Ethanol Plants	**Capacity**	**Location**	**Feedstock**	**Status**
Greenfield Global - Chatham	195	ON	Corn	Operating
Greenfield Global - Johnstown	260	ON	Corn	Operating
Greenfield Global - Tiverton	27	ON	Corn	Operating
Greenfield Global - Varennes	175	QC	Corn	Operating
Husky Energy - Lloydminster	130	SK	Corn/Wheat	Operating
Husky Energy - Minnedosa	130	MB	Corn/Wheat	Operating
IGPC Ethanol Inc	170	ON	Corn	Operating
Kawartha Ethanol Inc	80	ON	Corn	Operating
North West Bio-Energy Ltd.	25	SK	Wheat	Operating
Permolex	45	AB	Wheat	Operating
Pound-Maker Agventures Ltd	15	SK	Wheat	Operating
Suncor	400	ON	Corn	Operating
Terra Grain Fuels Inc.	150	SK	Wheat	Operating
Total Capacity	**1,802**			
CANADIAN CAPACITY (MLY)	**2,682**			

APPENDIX II: Current federal and provincial policies and regulation

Canada - Renewable Fuel Standard

Canadian Environmental Protection Act 1999, Renewable Fuels Regulation
http://laws-lois.justice.gc.ca/eng/regulations/SOR-2010-189/FullText.html

Canada - Clean Fuel Standard (under development)

https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-standard.html

Provincial

British Columbia

The Greenhouse Gas Reduction Act, Renewable and Low Carbon Fuel Requirements Regulation
http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/394_2008

Alberta

The Climate Change and Emissions Management Act, Renewable Fuels Standard Regulation
http://www.qp.alberta.ca/documents/Regs/2010_029.pdf

Saskatchewan

The Renewable Diesel Act, The Renewable Diesel Regulations
http://www.publications.gov.sk.ca/freelaw/documents/english/Regulations/Regulations/r19-001r1.pdf

Manitoba

The Biofuels Act, Biodiesel Mandate for Diesel Fuel Regulation
http://web2.gov.mb.ca/laws/regs/current/_pdf-regs.php?reg=147/2009

Ontario

The Environmental Protection Act, Greener Diesel – Renewable Fuel Content Requirements for Petroleum Diesel Fuel
https://www.ontario.ca/laws/regulation/r14097

Quebec

Energy in Quebec: A Source of Growth – The 2030 Energy Policy
https://politiqueenergetique.gouv.qc.ca/wp-content/uploads/Energy-Policy-2030.pdf