Analysis of the Implications of Canada's Proposed Clean Fuel Standard for Canadian Biofuels and Biofuel Feedstocks

Prepared by:
John Kruse, PhD
Principal & Director of Quantitative Analysis, WAEES
Email: jkruse@waees-llc.com
Phone: 573-228-9842

World Agricultural Economic and Environmental Services

Website: www.waees-llc.com

November 20, 2020

Introduction

The objective of this analysis was to determine the implications of Canada's proposed Clean Fuel Standard (CFS) for Canadian biofuels and biofuel feedstocks. Rather than using a blend requirement, Canada is considering a system that sets a target for carbon emission reduction and allows renewable fuels produced from different feedstock pathways, each with different carbon intensities, to compete in meeting the required reductions.

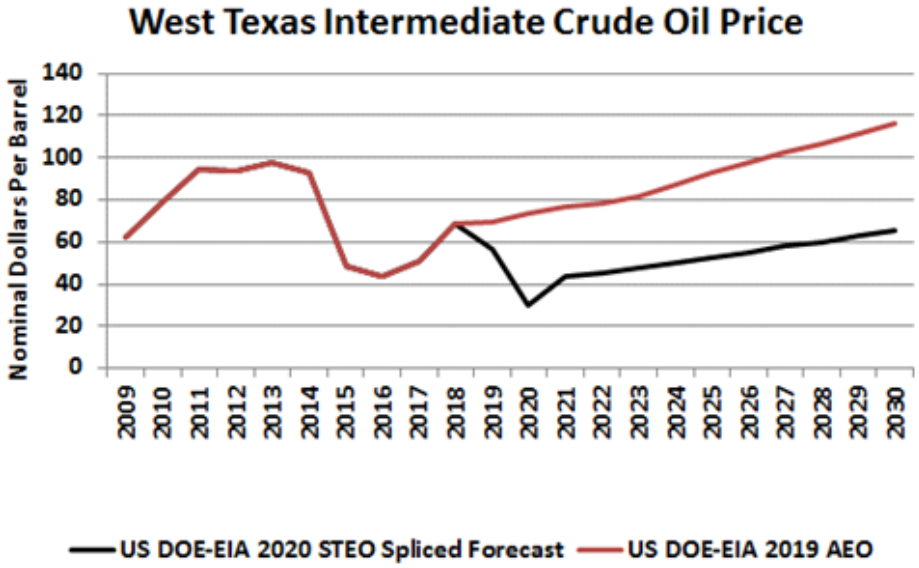
Environment and Climate Change Canada (ECCC) released a revised E3MC model in May 2019. WAEES followed the carbon calculations laid out in this model to build an endogenous model of the Canadian CFS within the larger WAEES global agricultural and biofuels modeling system. In order to project feedstock demands within the simultaneous system, carbon intensity scores for each biofuel feedstock pathway were needed. WAEES used the carbon intensity scores provided by Advanced Biofuels Canada from the GHG Genius 5.0 model for pathways not explicitly reported in the E3MC model.

The Canadian CFS policy is a new addition to the WAEES global agricultural and biofuels partial equilibrium model which encompasses 48 countries and geographic regions and over 30 agricultural commodities as well as the primary biofuels (e.g. ethanol, biodiesel, and renewable diesel) in the key global markets (see Appendix A for additional details).

Scenario Context

These scenarios were run using baseline projections generated in April/May 2020 for the National Biodiesel Board from the WAEES global agricultural and biofuels econometric model. Some important developments since the 2019 analysis are significantly lower crude oil prices (illustrated below) and, at the time of these projections, generally low commodity prices which translate into lower feedstock prices for biofuels. COVID-19 impacts on global transportation fuel demand were also included.

The California Low Carbon Fuel Standard was included, but fairly conservative growth in renewable diesel production was assumed relative to various company announcements. The WAEES model was aligned to the low demand/low electric vehicle scenario assumptions in the California Air Resources Board 2018 illustrative compliance scenarios. WAEES also included the cap on compliance credit prices in the LCFS policy which was binding in the baseline.



Gasoline Transportation Fuel Consumption Changes Due to COVID-19

	2020	2021
	percent	
United States		
Gasoline	-11.20%	-4.50%
Diesel	-9.10%	-3.65%
Brazil	-5.66%	-0.93%
Other South America	-0.55%	1.10%
Europe	-7.32%	-1.68%
China	-8.19%	-1.35%
Japan	-9.92%	-6.15%
Other Asia	-4.89%	-0.59%

Source: US Data - US DOE-EIA Feb 2020 STEO and May 2020 STEO
Int'l Data - US DOE-EIA Feb 2020 STEO and Apr 2020 STEO

The international historical data used in this study was updated to USDA's production, supply, and disposition estimates database (PSD) as of April 2020. International biofuels historical data, excluding Canada, draws upon the reported estimates by USDA's Foreign Agricultural Service.

Argentina's monthly historical biodiesel production, consumption, and trade data is based on Argentina's Instituto Nacional de Estadistica y Censos (indec). The EU-28 monthly trade data in biofuels is updated based on the European Commission's Market Access Database.

Modeling Approach to the Canadian CFS

Development of the Canadian Clean Fuel Standard (CFS) in the WAEES model is based on the May 2019 Reduction Opportunities Model (ROM), and information released by ECCC in the target and trajectory webinar on June 19, 2020. The major difference to ECCC's ROM is that the WAEES model solves for the quantities of biofuels supplied by feedstock pathway. In each feedstock pathway the overall compliance credit price is translated into the value per liter based on the carbon intensity assigned to the feedstock pathway. The value for each feedstock pathway is what incentivizes potential biomass-based fuel suppliers to produce more. Some feedstock pathways have significantly higher values from the compliance credit price due to their low carbon intensity scores. However, the WAEES model also tracks the available supplies and other demands for agriculturally based feedstocks. Even though a particular feedstock pathway may have a high value from the compliance credit price, how much of the feedstock that can be used depends on its supply and demand situation. The extra value from the compliance credit price will be eroded as the feedstock price increases and the supply of the feedstock limits how much can be used. For example, animal fats and used cooking oils often have low carbon intensity scores but it is difficult to increase the supply of these products since they are low valued by-products of other processes (i.e. tied to livestock demand for meat consumption).

The WAEES model uses econometric equations to solve for the biofuels that will be used to meet the requirements of the Canadian CFS. Each scenario has fixed assumptions regarding compliance credit use from non-biofuel pathway credit generating actions (e.g. upstream emission reduction credits, fuel switching to electric vehicles, etc.). The obligated parties are expected to meet CFS requirements, in part, by incentivizing the production of biofuels through the compliance credit price. If the obligated parties cannot get enough compliance credits from all sources to meet their obligation in a period, they bid up the compliance credit price until they do or they could ultimately hit the price cap that is in the Canadian CFS policy. As more biofuels are produced, the demand for biofuel feedstocks also rises, increasing feedstock prices.

The combination of fuel type and feedstock pathway form a unique pathway and carbon intensity score. The amount of carbon intensity reduction (from the fossil fuel reference) can then be calculated for each pathway and the subsequent value of that pathway given a compliance credit price. Each pathway has a different compliance credit value based on its carbon intensity score. Pathways that have a higher compliance credit value per liter

incentivize more biofuel production in that pathway. In order to simulate this, the model looks at the margin for each pathway which includes the biofuel price plus the carbon intensity value less the cost of the feedstock. If the compliance credit price is zero then no incentive is added to the margin equation. Both domestic and international biofuel producers see the carbon intensity value incentives.

It is important to emphasize that this is not an optimization model that solves for the least cost pathways resulting in corner solutions subject to constraints. Instead, this model emulates how each pathway responds to additional economic incentives. While the model will result in solutions that are directionally similar to an optimization model, the resulting change in the magnitude for each pathway will be different; this is because the current infrastructure is allowed to respond to the incentives it will experience, based the carbon intensity values of its respective pathway.

Since there has been no Canadian CFS policy before, there is no historical data to help guide the exact calibration of the model. The model solves for the compliance credit price by simulating how much Canadian domestic producers and international producers respond to the carbon intensity value incentive. Therefore, the level of the compliance credit price depends on the responsiveness of supply equations for each pathway. The more responsive the pathways in increasing production, the lower the compliance credit price. International supply and demand conditions for feedstocks and biofuels can influence their availability and prices in Canada and ultimately the level of the compliance credit price.

Another important difference from the Reduction Opportunities Model is that the overall level of electric vehicle use has a direct impact on the amount of energy demanded from gasoline and diesel vehicles. As the quantity of energy supplied by electric vehicles rises, the quantity of energy that needs to be supplied by gasoline and diesel vehicles directly declines. For the scenarios considered in this analysis, different levels of compliance credits were generated by electric vehicles across the scenarios. We assume an even split of the electric vehicle credits in displacing gasoline and diesel. Using the ZEV credit equation for the energy effectiveness ratios (EERs) provided by ECCC, we can back into the reduction in terajoules of energy needed. Using the energy density of gasoline and diesel, we can derive the reduction in liquid fuels needed.

Finally, compliance credit stocks are assumed to be modestly responsive to compliance credit prices in this model which does allow credit pools to be drawn down to low levels, but not depleted. This has the effect of keeping carbon credit prices higher because credit pool stocks are not fully utilized to meet CFS compliance requirements.

Scenario Implementation

In order to facilitate explaining how the scenarios were implemented, it may be helpful to identify the categories of compliance credits that are assumptions (exogenous) and those that are determined through solution of the model (endogenous). The simple description is that those credits that are not generated by biofuels are exogenous to the model and all biofuels credits are endogenous. There is one important exception and that is the compliance fund. Unless specifically defined in the scenario, credits from the compliance fund are endogenously generated by the model. These credits occur if the compliance credit price is bid up to the compliance fund price ceiling set in the CFS policy. When the price ceiling is reached, the remaining credits are supplied through the compliance fund up to the 10 percent limit based on the obligated party's total debits.

CFS compliance credits fall into roughly three categories:

Compliance Category 1 (CC1)

- Carbon Capture and Storage
- Upstream Improvements
- Reductions in Refineries
- Incremental Methane Reductions – Conventional Oil

Compliance Category 2 (CC2)

- Ethanol
- Biodiesel
- Renewable Diesel (also called 'hydrogenation-derived renewable diesel' or HDRD in Canada), inclusive of co-processing of biofuel feedstocks in a petroleum refinery
- Pyrolysis Oil (Biocrude)
- Biojet

Compliance Category 3 and Other (CC3)

- Diesel Displaced by Propane
- Diesel Displaced by Natural Gas
- Gasoline Displaced by Electric Vehicles
- Diesel Displaced by Electric Vehicles
- Cross Stream Credits
- Emerging Tech Credits
- Compliance Fund

Based on the scenario assumptions set in the model regarding CC1 and CC3, the model solves for the compliance credit price need to incentivize enough supply of biofuels to meet the remaining credits needed to comply with the CFS.

The Canadian demand for transportation energy as measured in terajoules is held constant across scenarios. However, there are shifts between electric and liquid fuel vehicles depending on the assumed credit delivered by electric vehicles.

Scenario Definitions

Four scenarios were evaluated to determine the impact of alternative assumptions on biofuel and feedstock demands. These scenarios were formulated based on the assumptions made regarding the CC1 and CC3 categories.

The four scenarios shared some common assumptions including:

- Maximum use of cross stream trading credits was assumed, based on 10% of fossil fuel debits each year.
- Biojet volume was assumed to be 1% of aviation turbo fuel.
- Pyrolysis oil was assumed to be 10% of heavy fuel oil.
- Minimum credits in the compliance credit bank were set at 2,000,000, although this is not a binding constraint in these scenarios.
- In 2022, credits were allowed to be accumulated over the full year while carbon debits generated by fossil fuels were only accumulated over the July to December period.

The table below provides a quick summary of the assumption changes across the four scenarios by the year 2030.

FF-CC1

In the FF-CC1 (Fossil Fuel – Compliance Category 1) scenario, the credits from CC1 are assumed to reach 14 million metric tons (mmt) by 2030 and electric vehicle credits reach 3 mmt. Including cross stream credits of 3 mmt, over 20 mmt or nearly two thirds of the required credits are supplied by non-biofuel sources. This scenario represents highest credit generation from upstream fossil fuel emissions reductions.

ECCC-TT

In the ECCC-TT (Environment and Climate Change Canada – Target and Trajectory) scenario, the compliance fund is imposed at 3 mmt rather than endogenously solving in the model. Although the credits supply by CC1 are 6 mmt lower than the FF-CC1 scenario, the additional 2 mmt of credits from emerging tech brings the total to 19 mmt of credits supplied by non-biofuel

sources. In other scenarios, ECCC's emerging tech credit pool is not included, as credits are specifically allocated to each category type. This scenario mirrors ECCC's modelling in the target and trajectory credit generation tables (June 19, 2020).

EV-CC3

In the EV-CC3 (Electric Vehicle – Compliance Category 3) scenario, the credits from electric vehicles are increased to 9 mmt from 3 mmt in the FF-CC1 and ECCC-TT scenarios, but CC1 credits are reduced by 2 mmt and emerging tech credit generation is set at 0 mmt. Including cross stream credits, 18 mmt of credits are supplied by non-biofuel sources. This scenario represents the highest credit generation from electric vehicle use.

RF-CC2

In the RF-CC2 (Renewable Fuel – Compliance Category 2) scenario, the credits from CC1 are reduced to 6 mmt and the credits from electric vehicles are set at 6 mmt. With cross stream credits of 3 mmt, a total 15 million credits are supplied by non-biofuel sources. This scenario represents the highest credit generation from biofuels use.

Credit Generation Assumption Comparisons Across Scenarios in 2030

	Scenarios			
	FF-CC1	ECCC-TT	EV-CC3	RF-CC2
million metric tons				
Compliance Category 1	14	8	6	6
Electric Vehicles	3	3	9	6
Emerging Tech	0	2	0	0
Cross Stream Credits	3	3	3	3
Compliance Fund	model	3	model	model

Scenario Results

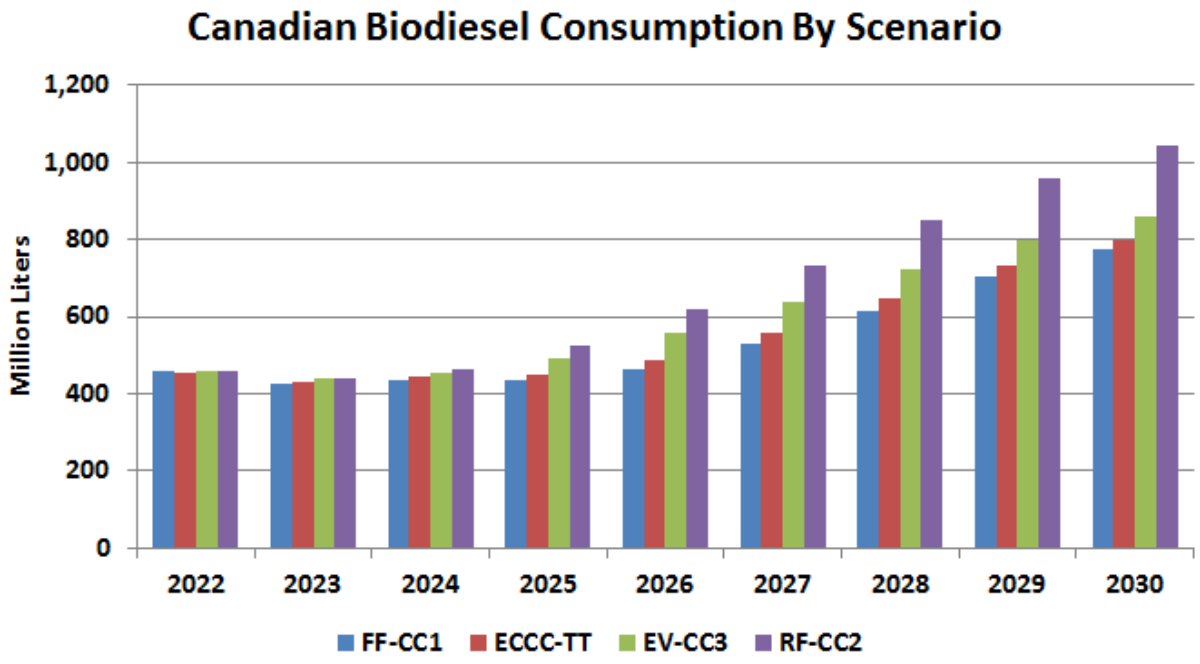
Summary tables of the scenario results are presented in Appendix B. Although the results are available for each year, the summary tables omit some years to allow the tables to conform to the page size. It should be noted that the biofuels tables are presented in a calendar year format while the grain and oilseed tables are presented in a marketing year format.

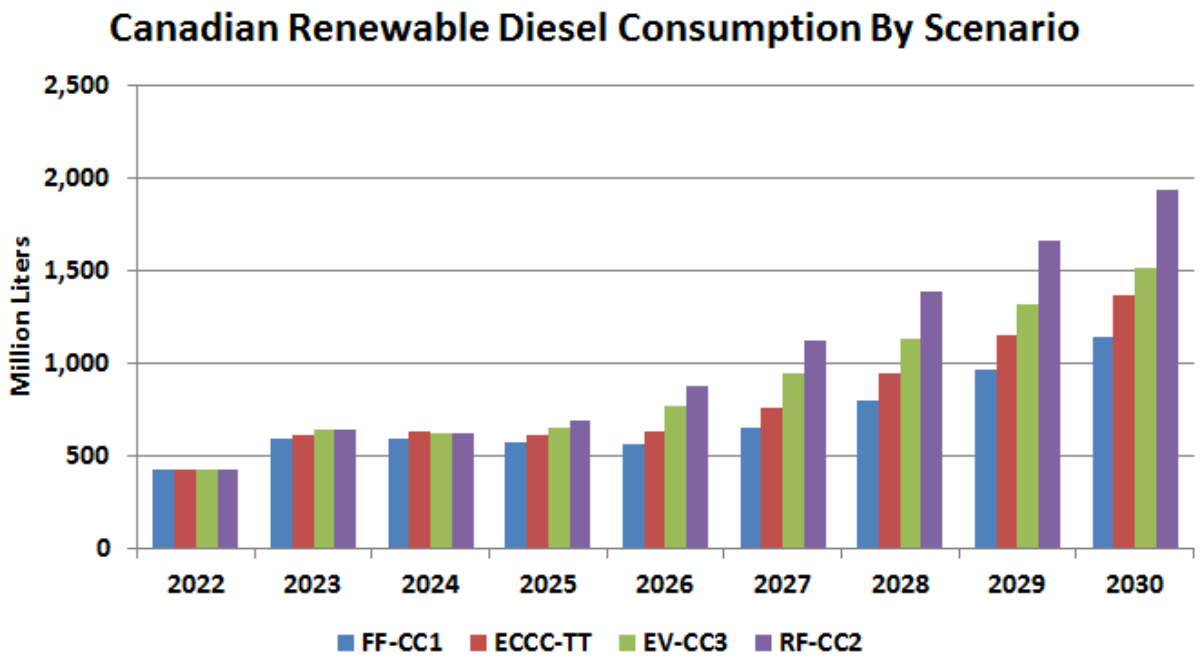
The simplest way to understand the scenario result is to consider the quantity of compliance credits supplied by non-biofuel sources. As you would expect, the larger the quantity of carbon credits supplied by non-biofuels sources, the lower the quantity of biofuels needed to reach compliance with the CFS. Since the FF-CC1 scenario has the highest number of compliance credits supplied by non-biofuel sources, it requires the lowest quantity of biofuels to reach

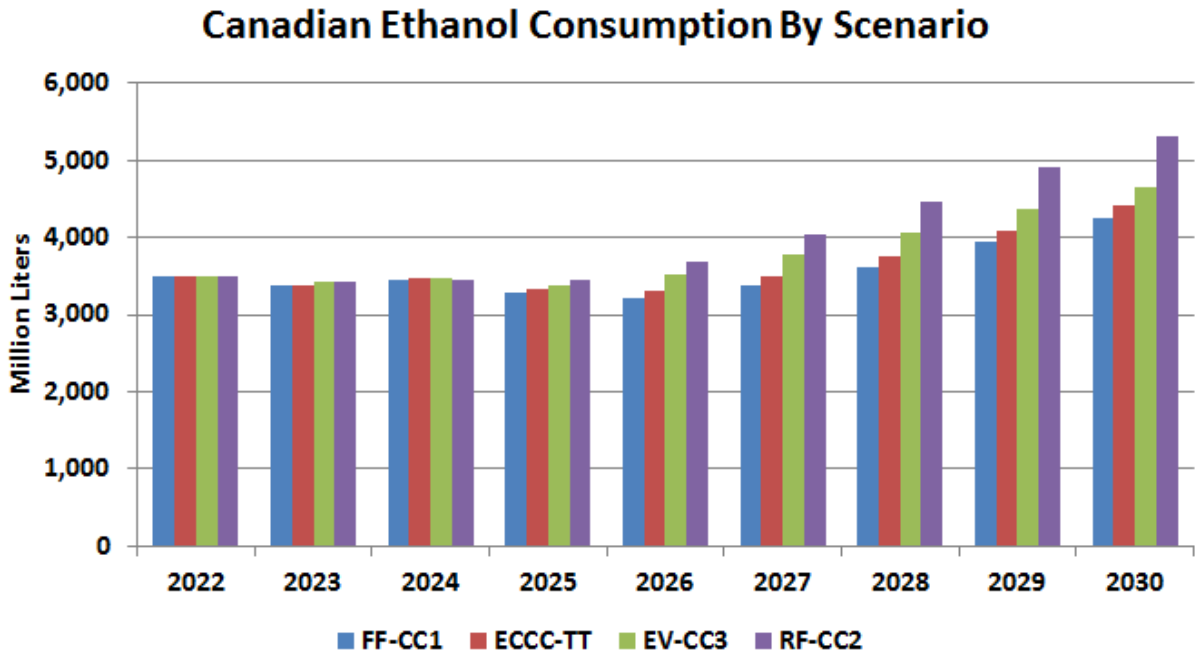
compliance. The RF-CC2 has the lowest number of compliance credits supplied by non-biofuel sources, and subsequently requires the highest quantity of biofuels to reach compliance.

Biofuels Consumption

Biodiesel, renewable diesel, and ethanol all see increases in the quantity demanded across the four scenarios. While there is currently nearly zero renewable diesel production in Canada, we do allow renewable diesel capacity to be built and come online in 2023 if the economics provide enough incentives. While renewable diesel is modelled as a stand-alone fuel type, it can







also be a proxy for lower carbon intensity fossil fuels from co-processing fats, oils, or biocrude feedstocks at a petroleum refinery (e.g. Parkland Refinery); the WAEES model does not currently incorporate co-processing as a pathway.

An important question is how the model sorts out how much of the CFS is met by ethanol, renewable diesel, and biodiesel. Within the model the expected net returns for each biofuel by feedstock pathway are calculated. Each biofuel feedstock pathway generates a different amount of carbon reduction based on its carbon intensity score and subsequently produces a specific value of that carbon reduction based on the compliance credit price. For example, biodiesel produced from canola oil would get the value of the biodiesel price plus the value of carbon reduction specific to the canola oil pathway. The values of these compliance credits for each feedstock pathway in each scenario are presented in Appendix B. In the case of the RF-CC2 scenario, the value of the compliance credit for biodiesel made from canola oil is $0.40 per liter by 2030. Importantly, the net returns also include the cost of the feedstocks. This means that even as gross returns increase with the value of the compliance credit, the cost of the feedstock increases as more of that feedstock is demanded offsetting some of the increase in gross returns.

The responsiveness of the supply of biodiesel, renewable diesel, and ethanol to changes in net returns is what determines how much of each biofuel is consumed. The responsiveness is determined by past responsiveness of the sector to increases in returns, differences in returns across sectors including the value of the compliance credits generated by the particular fuel pathways. In the case of renewable diesel, expert judgement has been used on how responsive

the industry, which doesn't currently exist in Canada, would be to expanded production incentives from the regulation based on the experience in other countries. Ethanol consumption peaks out just above a 14 percent blend and biomass-based diesel (biodiesel and renewable diesel) consumption peaks at 9 percent blend in 2030.

Canadian imports of renewable diesel from Neste's Singapore plant are based on the additional incentives from the compliance credit price specific to the feedstock pathway. Imports of renewable diesel under the RF-CC2 scenario increase the most because the compliance credit values are the highest in that scenario. Renewable diesel imports increased by over 80 million liters in the RF-CC2 scenario. It is possible that imports of renewable diesel could be higher depending on the size of the renewable diesel expansion in the United States that is currently underway, but this will also be tied to US state and federal biofuels policy. Renewable diesel imports could be lower, should the Canadian market be more responsive to building capacity to meet the domestic and global demand.

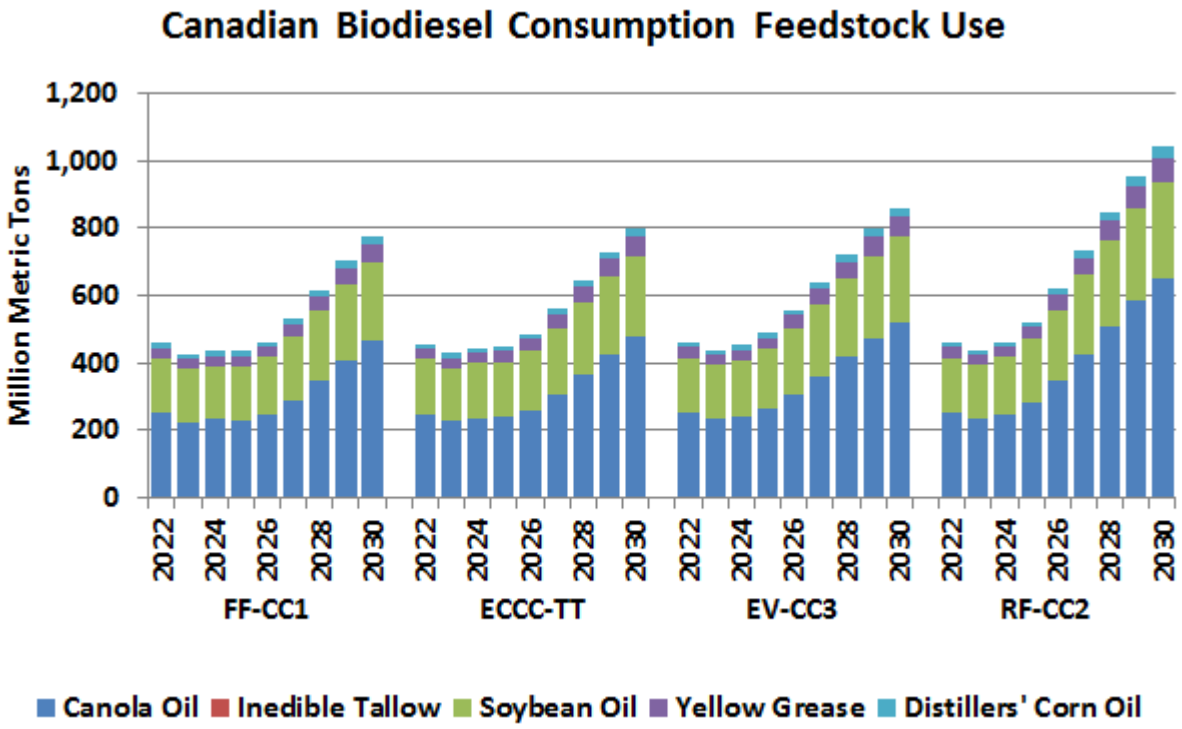
Biodiesel imports increase more significantly under the RF-CC2 scenario growing from nearly 300 million liters to 639 million liters by 2030. This production capacity could also be built in Canada, which would lower biodiesel imports.

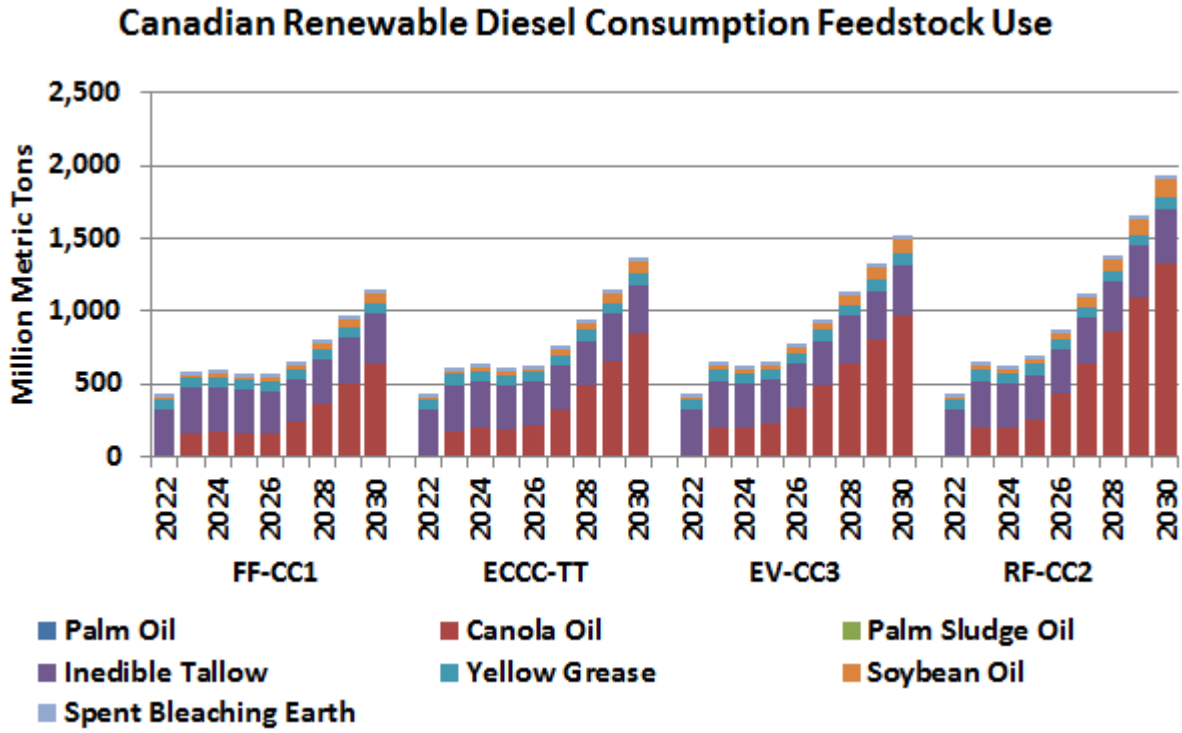
The scenarios illustrate the impact of the credit generation assumptions from non-biofuel sources. With higher credit generation assumptions from other sources, the need for credits from biofuels is reduced. The FF-CC1, ECCC-TT, and the EV-CC3 scenarios have lower biofuel demands due to higher non-biofuel credit generation assumptions, (20, 19, and 18 mmt respectively). In the RF-CC2 scenario, only 15 mmt of credit generation is assumed to occur from non-biofuel sources strengthening the demand for biofuels.

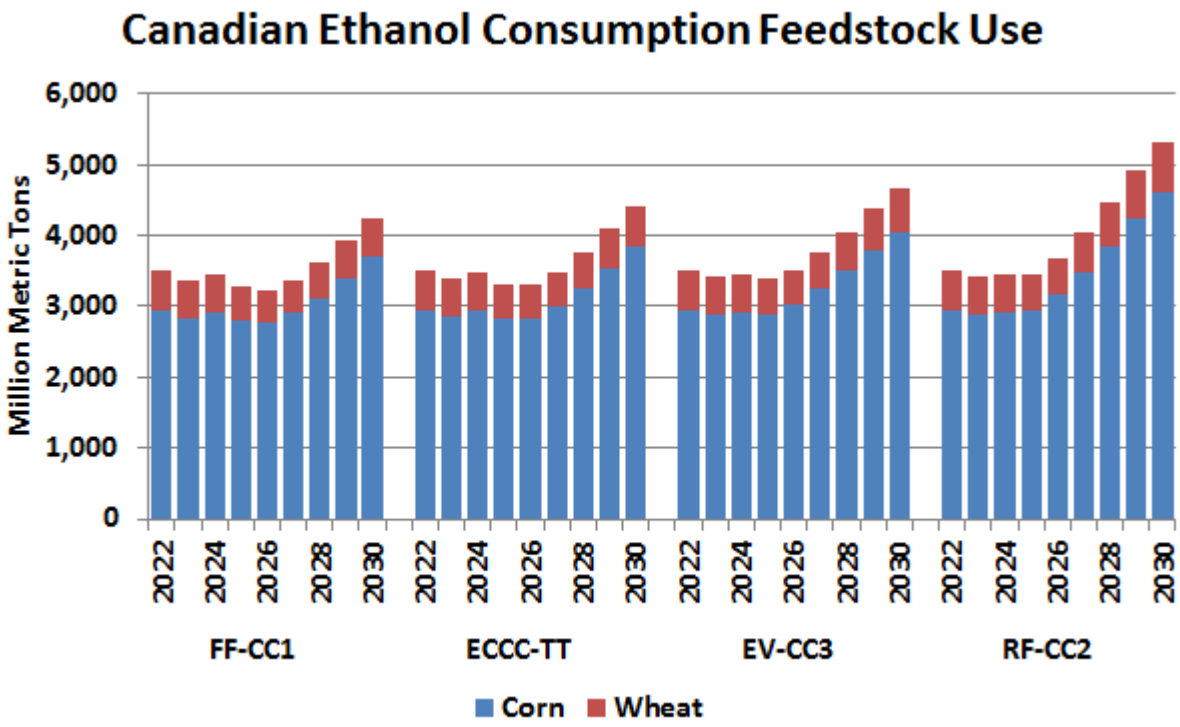
Feedstock Use

Feedstock use is determined by the expected net returns for each feedstock pathway, feedstock prices, and the available supply of feedstocks. Canola oil and soybean oil serve as the primary feedstocks due to their ample availability and comparable compliance credit values.

For biodiesel production, inedible tallow, white grease, and yellow grease have the lowest carbon intensity scores. However, there are only limited supplies of these feedstocks and we only allow them to reach about half of the available supply. Canola oil has the next lowest







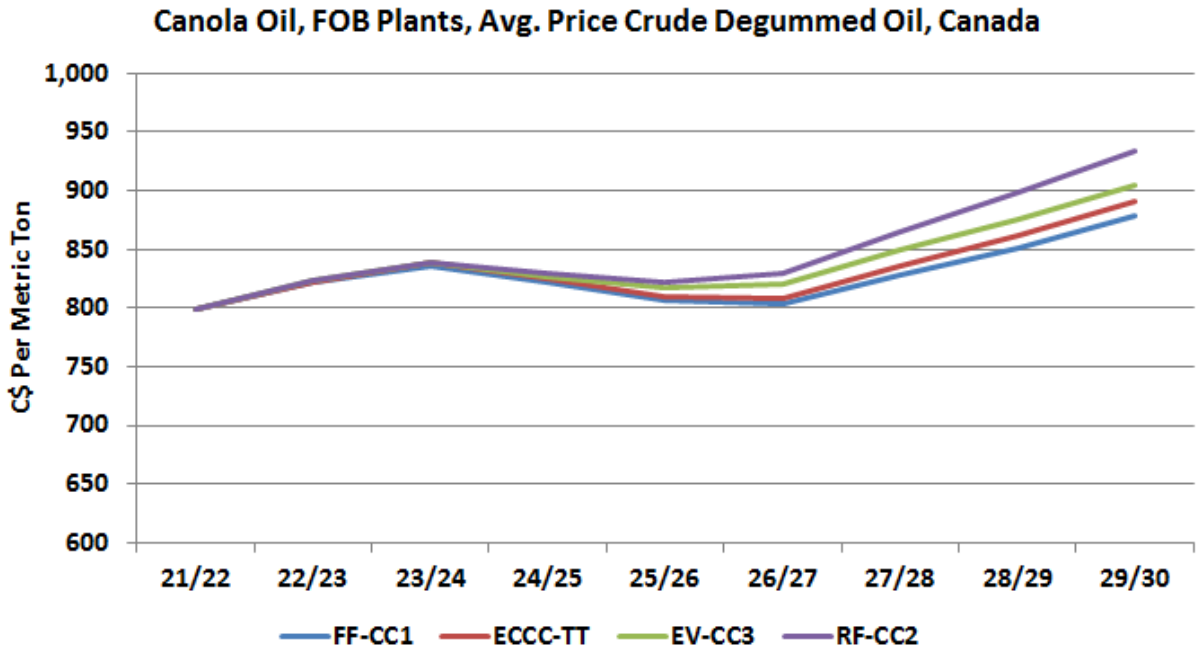
carbon intensity score subsequently resulting in it being the dominant source of feedstock to meet additional production. Corn and wheat remain the primary feedstocks for ethanol production.

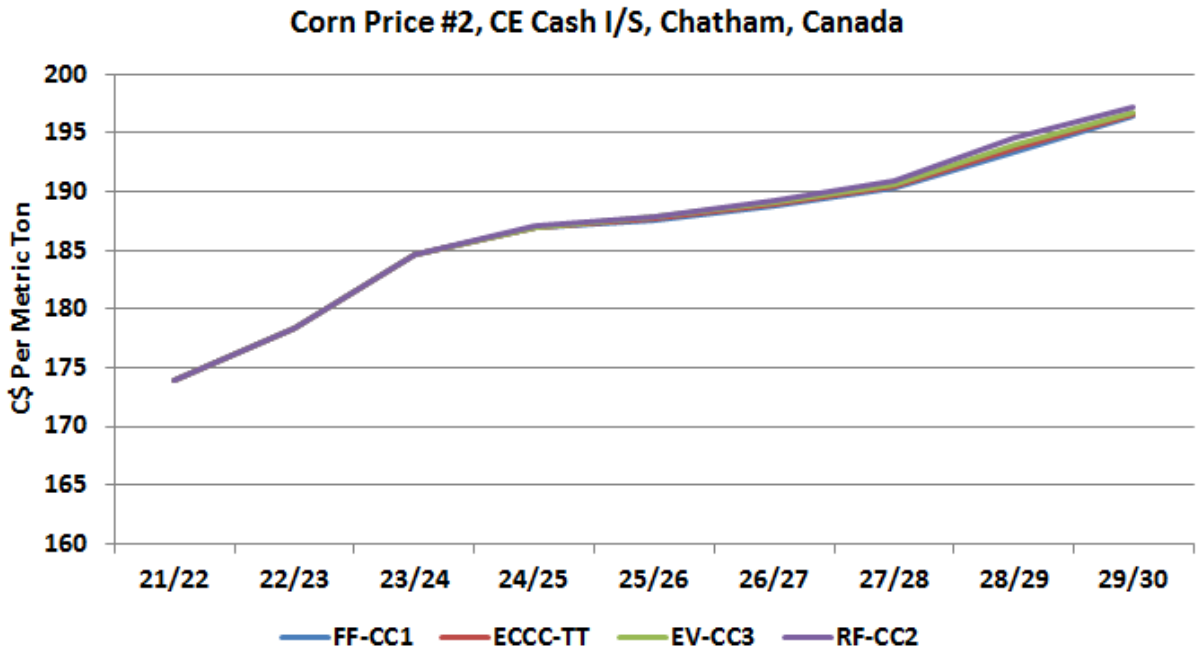
Feedstock Costs

The graphs below show modest impact on feedstock costs. Canola oil prices are higher as more canola oil is used for the production of both biodiesel and renewable diesel. All prices in the WAEES tables are reported in nominal terms (i.e. not adjusted for inflation) although all equations include price adjusted for inflation in the WAEES econometric model.

In the RF-CC2 scenario with the highest biofuel demand, nominal canola oil prices increase 15 percent over the 2022 to 2030 period. In the FF-CC1 scenario with the lowest biofuel demand, canola oil prices increase 8 percent over the 2022 to 2030 period. Comparing the RF-CC2 scenario with the FF-CC1 scenario, canola oil prices are 6.3% higher by (crop year) 2030. This stems from the additional feedstock demand, which under the RF-CC2 scenario, increases canola oil use by 1.7 million metric tons over the 2022 to 2030 period.

Although more corn and wheat are used to produce ethanol for the Canadian CFS, in a global context, the increase in demand is a relatively small amount resulting in very little impact on corn prices across the scenarios.

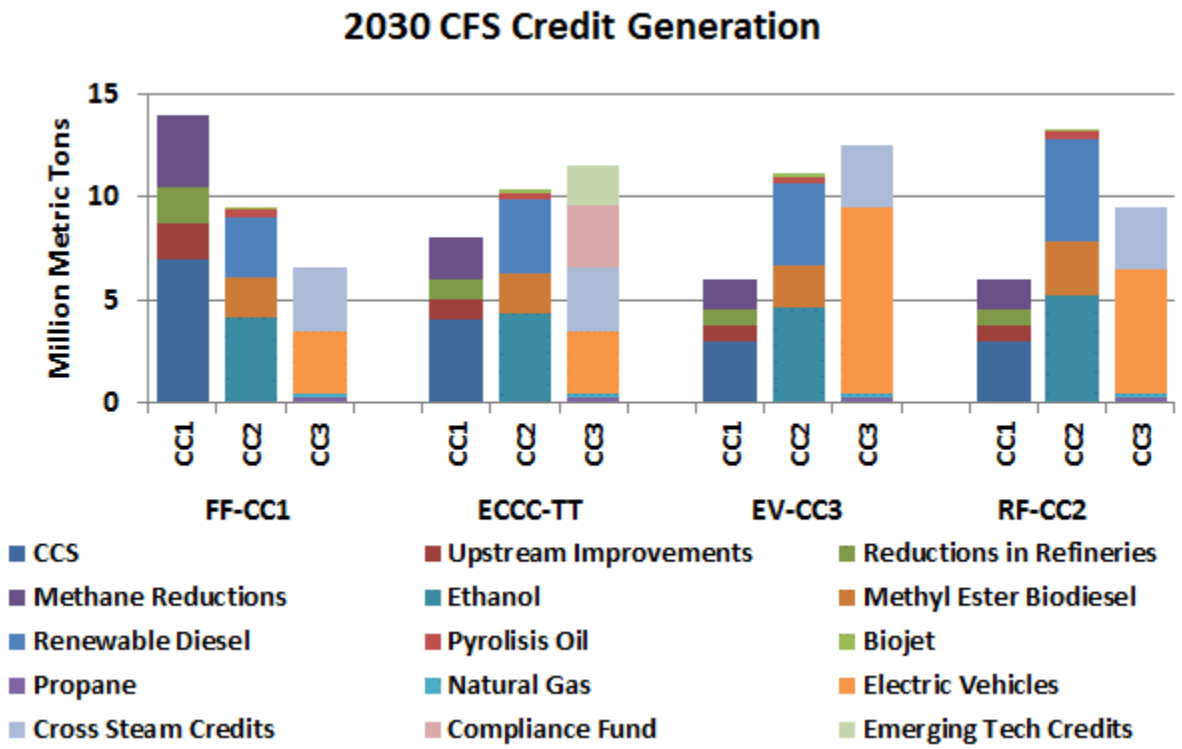


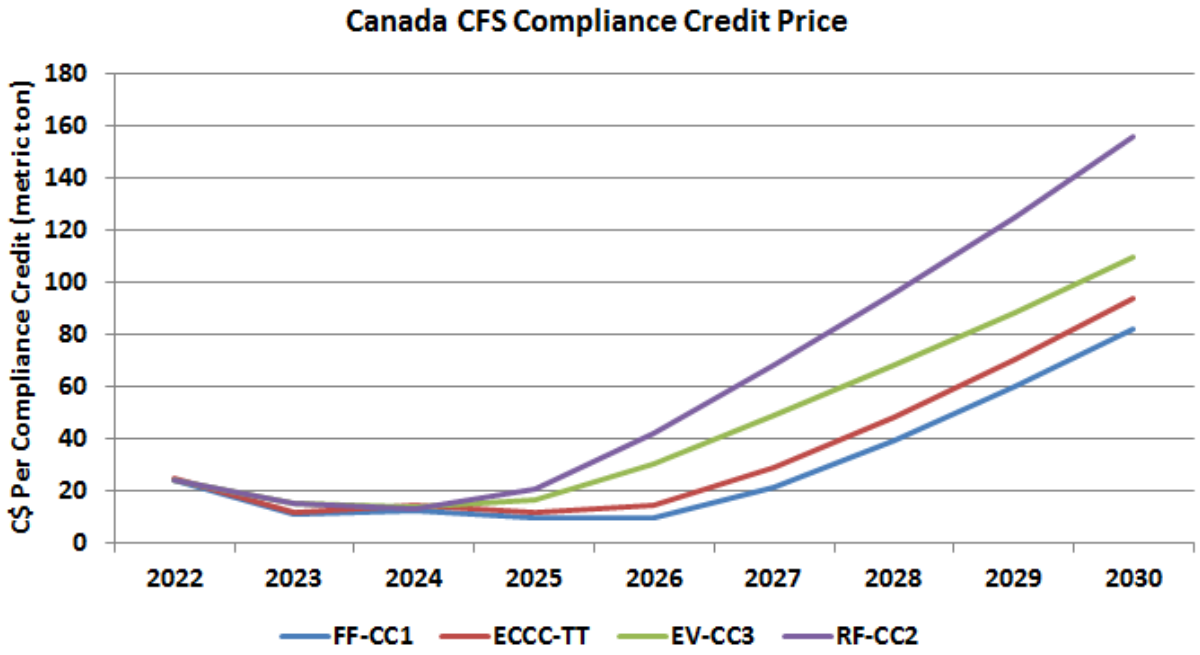


Compliance Credits

The graph below illustrates the CFS credits in 2030 generated from each compliance category for each scenario. Compliance category 2 (CC2) is primarily made up of credits from biofuels. In the FF-CC1 scenario, the majority of the credits come from compliance category 1 (CC1) and when combined with compliance category 3 (CC3), leaves less than 10 mmt of credits that need to come from CC2 (biofuels). In the ECCC-TT scenario, most of the credits are shifted from CC1 to CC3 leaving slightly over 10 mmt of credits to be supplied by CC2. The EV-CC3 scenario is similar to the ECCC-TT scenario except that most of the credits are generated by electric vehicles instead of the imposed compliance fund credits and emerging tech credits.

The CFS Credit Generation graph below illustrates how the price of compliance credits change as more biofuels are needed to meet the CFS standard. As modelled, the compliance credit prices are driven by the quantity of credits that need to come from biofuels. The higher the volume of biofuels required, the higher the compliance credit price. This does not reflect any incentives needed to increase the process improvement credits or electric vehicle use.





Summary & Conclusions

The analysis evaluates the impact of introducing the Clean Fuel Standard as a national policy in Canada directed at reducing carbon emissions. The analysis is focused on the biofuels sector and provides results for alternative scenarios regarding the assumed level of compliance credits from other sources.

The analysis evaluated four scenarios with alternative assumptions regarding compliance credits generated from non-biofuel sources. The Canadian CFS increases growth in domestic production of ethanol, biodiesel, and allows for the development of renewable diesel production. Biomass-based diesel consumption expands by significantly more over the projection period than ethanol consumption. This reflects the lower carbon intensity scores assigned to biodiesel and renewable diesel feedstock pathways which results in carbon credit values that are more than double the ethanol pathways. Due to limited supplies of inedible tallow, yellow grease, and white grease, much of the feedstock demand increases fall to canola oil which is in surplus supply in Canada. In the RF-CC2 scenario with the highest biofuel demand, canola oil prices increase 15 percent over the 2022 to 2030 period. In the FF-CC1 scenario with the lowest biofuel demand, canola oil prices increase 8 percent over the 2022 to 2030 period. Feedstock prices for ethanol increase very slightly because the demand increase is not significant in a global context.

The table below captures the impact on Canadian biofuel production and imports. As more compliance credits are filled by biofuels, the production and imports expand to meet the CFS requirements.

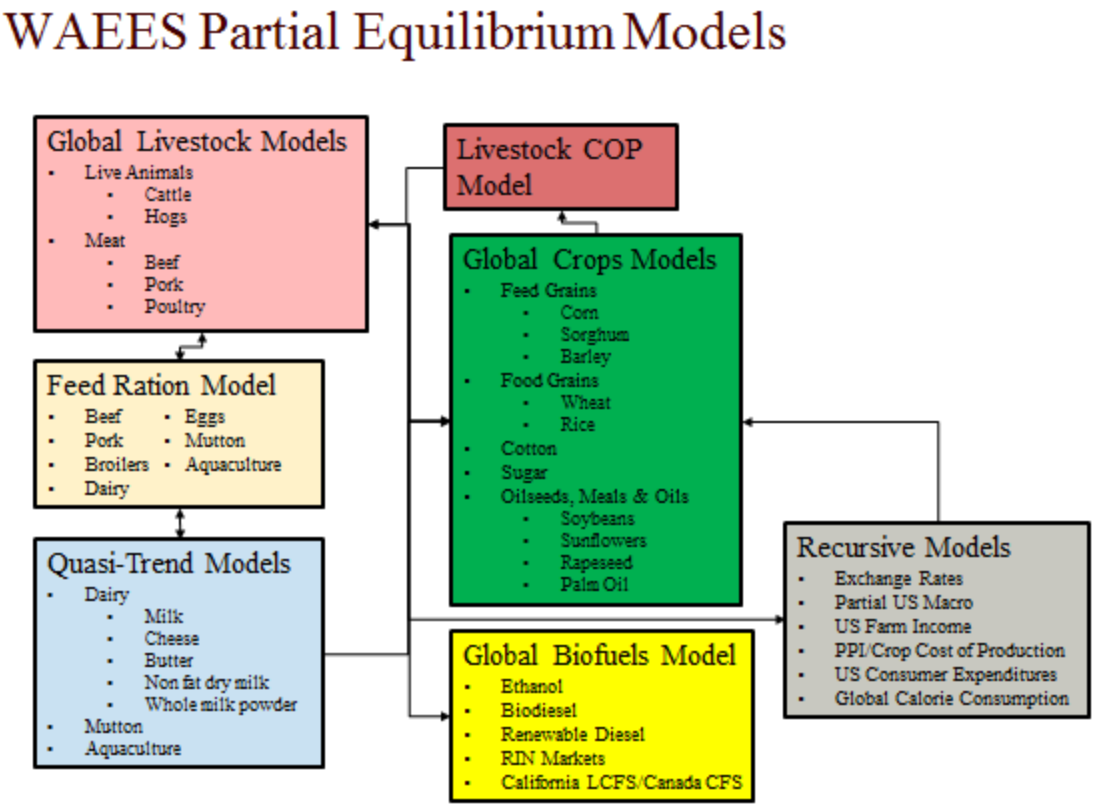
Biofuel Impacts by Scenario

	Scenarios			
	FF-CC1	ECCC-TT	EV-CC3	RF-CC2
	million metric tons in the year 2030			
Non-Biofuel Compliance Credits	20	19	18	15
	growth from 2022 to 2030 in million liters			
Biodiesel				
Domestic Production	162	170	202	292
% change	39%	41%	49%	71%
Imports	156	175	199	293
% change	46%	51%	58%	85%
Renewable Diesel				
Domestic Production	690	904	1,039	1,428
Imports	30	39	54	85
% change	7%	9%	13%	20%
Ethanol				
Domestic Production	694	844	1,057	1,667
% change	30%	36%	46%	72%
Imports	54	69	99	151
% change	4%	6%	8%	13%
	volumetric percent blend rates in the year 2030			
Ethanol Blend Rate	11.3%	11.7%	12.4%	14.1%
Biomass Based Diesel Blend Rate	5.7%	6.4%	7.1%	8.9%
Biodiesel Blend Rate	2.3%	2.4%	2.6%	3.1%
Renewable Diesel Blend Rate	3.4%	4.1%	4.6%	5.8%

The analysis results are dependent on the global context in terms of the supply, demand, and prices of biofuels and feedstocks and the policy assumptions for other countries. International supply and demand conditions for feedstocks and biofuels can influence their availability and prices in Canada and ultimately the level of the compliance credit price.

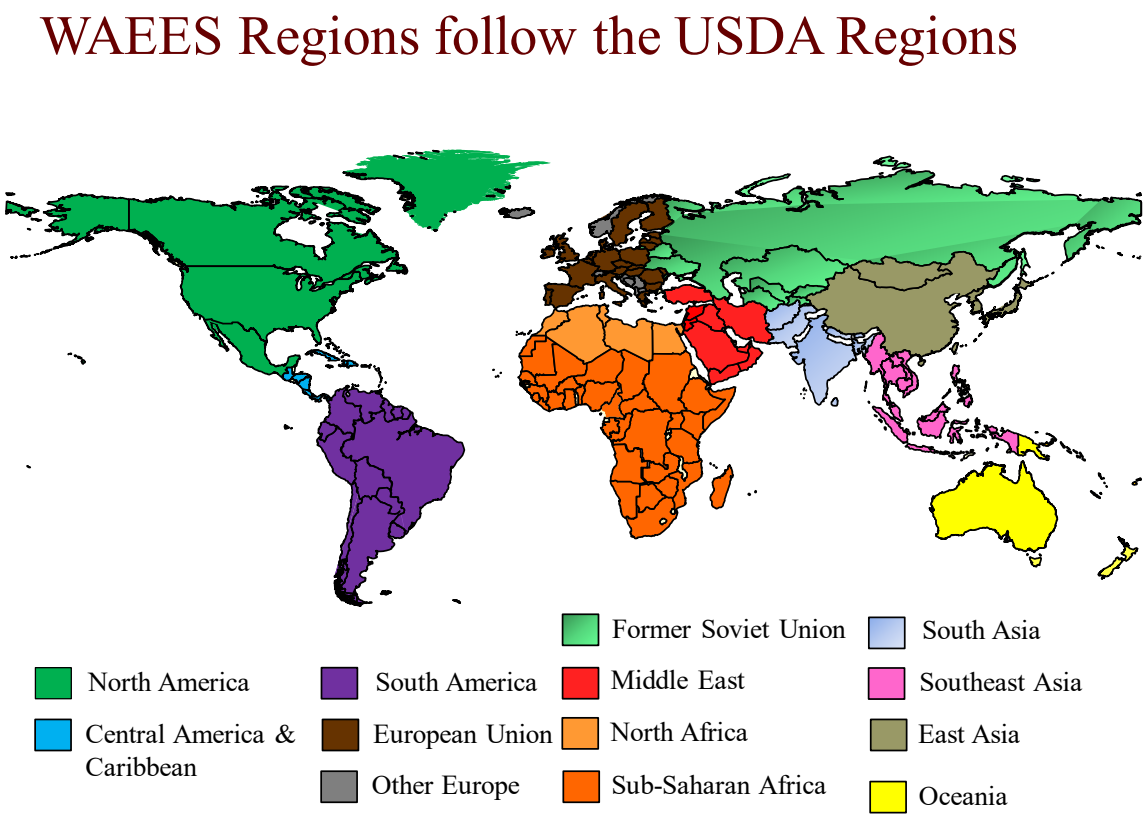
Appendix A – Overview of the WAEES Global Agricultural and Biofuels Econometric Model

The WAEES partial equilibrium modeling system is made up of a set of global econometric models emulating the behavior of the global agricultural sector. The partial equilibrium models can be broken down into crops, livestock and biofuels components encompassing feed grains, food grains, cotton, sugar, oilseeds, beef, pork, poultry, ethanol, biodiesel, and renewable diesel.



The WAEES models cover 48 countries/regions with an additional 12 regional aggregates including the world total. WAEES follows USDA's reported data coverage which may mean that a zero is reported for a particular commodity which USDA does not cover or has discontinued covering. USDA currently covers at least 90 percent of global production; therefore, the countries which are omitted represent a small portion of total global production. Specifically the WAEES model includes Canada, Mexico, the United States, Caribbean and Central America, Argentina, Brazil, Bolivia, Chile, Colombia, Paraguay, Uruguay, Other South America, the

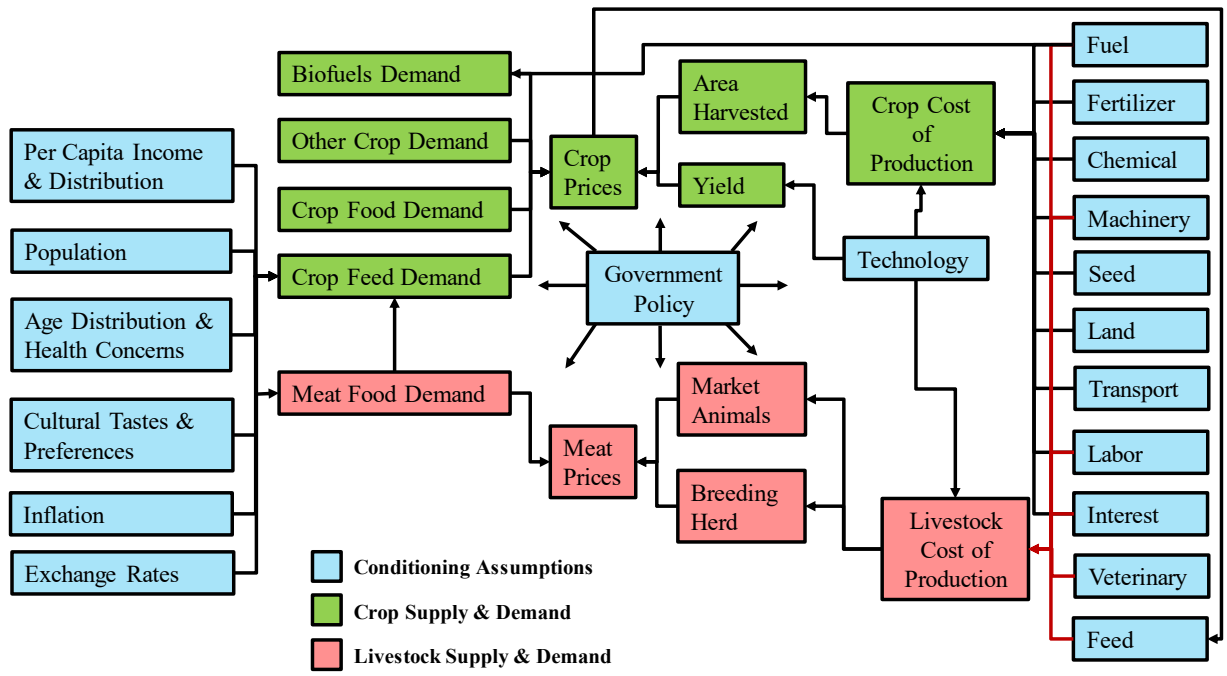
European Union 28, Other Europe, Kazakhstan, Russia, Ukraine, Uzbekistan, Other Former Soviet Union, Iran, Saudi Arabia, Turkey, Other Middle East, China, Japan, South Korea, Taiwan, Other East Asia, Bangladesh, India, Pakistan, Other South Asia, Indonesia, Malaysia, Myanmar, Philippines, Thailand, Vietnam, Other Southeast Asia, Australia, Other Oceania, Egypt, Morocco, Other North Africa, Kenya, Nigeria, South Africa, and Other Sub-Saharan Africa. WAEES also reports projections on crop area, yield, and production for each of the EU-28 countries.



Partial Equilibrium Models

Each partial equilibrium module is broken down into commodities with a system of structural equations capturing the supply and demand components for each of them. The drivers of these equations are theoretically derived based upon the behavioral postulates from economic theory of profit maximization by the market participants and utility maximization by consumers subject to various domestic and international trade policies. The diagram below illustrates the inter-linkages of the crops and livestock model. In the diagram, the blue boxes represent the key drivers (conditioning assumptions) of the agricultural sector including income, population, culture, inflation, exchange rates, domestic and trade policy, technology and input costs. The

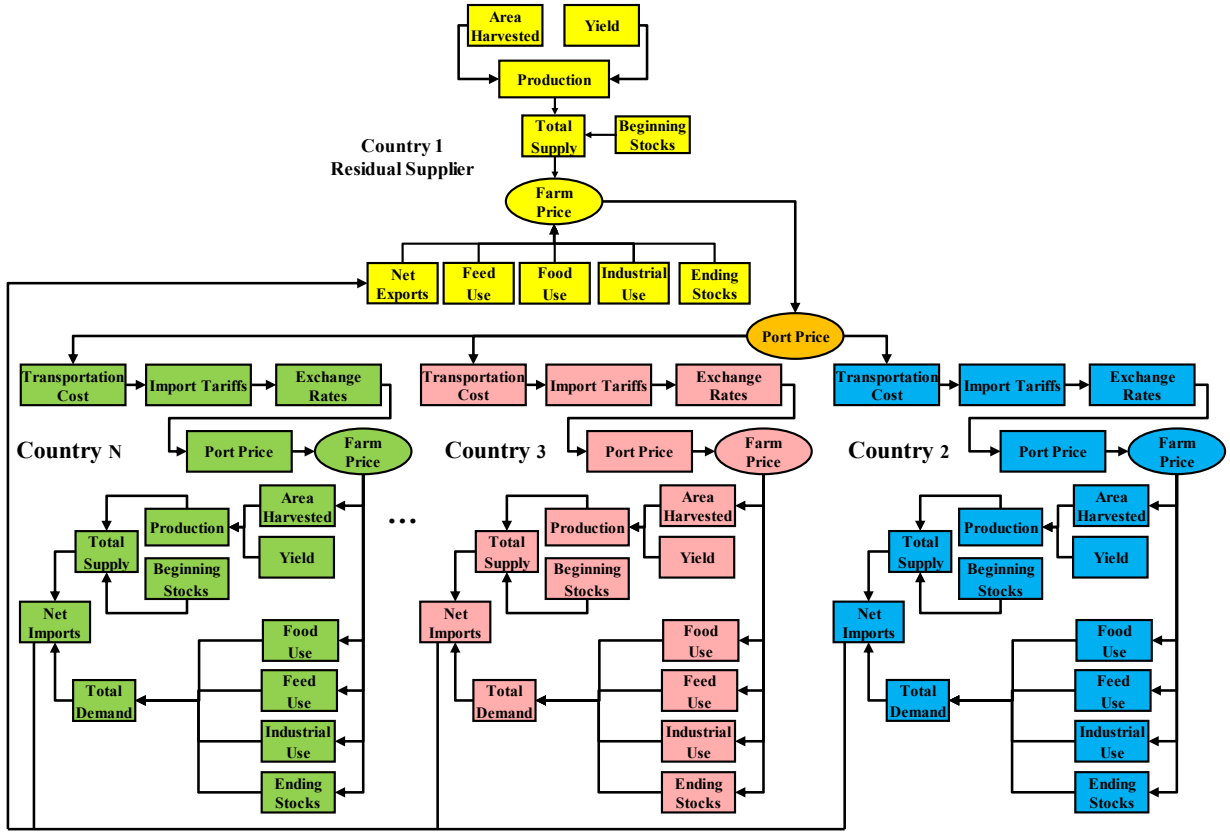
green boxes are an aggregate approximation of the crops sector. As relevant, each box represents an equation for each commodity covered. For example, there are specific feed demand equations for corn, sorghum, barley, soybean meal, sunflower meal, etc. The pink boxes are an aggregate approximation (within the diagram) of the detailed livestock sector model encompassing beef, pork and broilers. The diagram illustrates how income, population, and other factors drive food demand for crops and meats. Crude oil prices (and policies) drive the demand for biofuels. As demand increases, crop prices increase providing an incentive for production expansion. Technology growth (based on historical yield improvement trends) drives yield expansion providing much of the needed production. Crop area may also grow to meet demand needs although in developed countries this often amounts to tradeoffs among crops and fallow land. Ultimately supply and demand are balanced via commodity prices. If demand is stronger than supply, commodity prices increase until demand growth is slowed and supply growth is increases enough for supply and demand to balance.



The WAEES partial equilibrium models solve iteratively to find equilibrium by balancing global supply and demand. This occurs at the individual country level for each commodity. Most countries are at least somewhat open to trade albeit with tariffs. The trade diagram below

illustrates conceptually how global supply and demands are balanced within a "global" price equilibrium solution. Typically, a large exporting country is chosen as the residual supplier for the world. The choice of this country does not affect the solution. The commodity price in the residual supplying country is solved for by assuming an initial level of exports. This price is then transferred to other countries through trade barriers, transportation costs, and exchange rates. Based on a given price level, each country determines how much it is willing to supply or demand at that price and subsequently how much it wants to import or export. While not depicted in the diagram below, occasionally a country has tariffs high enough that no trade will occur or only a fixed amount of trade will occur at the lower tariff level. Note that in those countries internal prices may not reflect the world level of prices because supply and demand must be balanced from domestic sources. After the supply and demand in each country is determined and the implied trade position, these trade positions are summed to find the new level of exports for the residual supplying country replacing the initial assumption. The process then repeats itself until prices adjust to balance global supply and demand. For example, if the sum of trade across all other countries is lower than the initial starting assumption for the residual supplying country, the price level in the residual supplying country will fall to balance supply and demand. This lower price level will then get transferred to all other countries affecting their supply and demand and ultimately net trade positions and of course replace the exports again in the residual supplying country. This process continues until global supply and demand balance.

WAEES Structural Partial Equilibrium Models

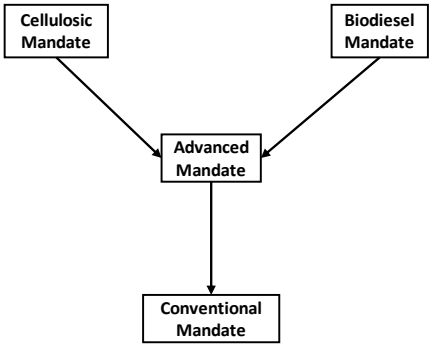


An Example of the US Partial Equilibrium Model for the Biofuels Sector

Within the WAEES model, the US ethanol, biodiesel and renewable diesel sectors are set up as partial equilibrium models with supply and demand equations and an endogenous ethanol, biodiesel and renewable diesel price. The structure of the model has its roots in the ethanol specifications documented by John Kruse, Patrick Westhoff, Seth Meyer, and Wyatt Thompson in a 2007 journal article in AgBioForum entitled, "Economic impacts of not extending biofuel subsidies." With the second Renewable Fuel Standard, these original specifications have been updated to reflect the hierarchical system of mandates. The biofuels mandates require compliance with each specific mandate type including biodiesel, cellulosic, advanced and the overall renewable fuel mandate. The rationale for different mandates in the legislation was to encourage biofuel producers to move towards feedstocks that provided the greatest level of greenhouse gas (GHG) reductions compared with conventional petroleum. The term "advanced biofuels" was used to describe biofuels that reduced GHG emissions by at least 50 percent compared with a 20 percent reduction requirement for conventional feedstocks. Cellulosic derived biofuels must reduce GHG emissions by 60 percent. Compliance with the mandates by the obligated parties is enforced by the EPA through as system of Renewal

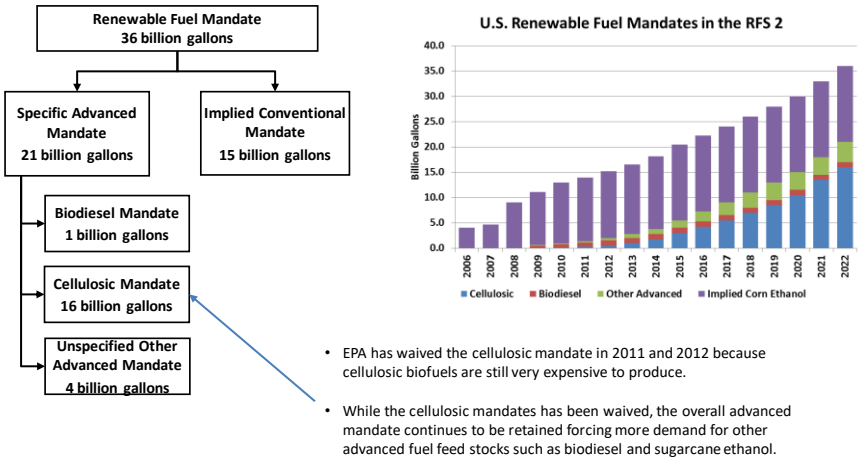
Identification Numbers (RINS) assigned to each type of biofuel produced. Obligated parties must demonstrate that they have met their assigned obligations through the number of RINS they have for each type of fuel. Theoretically there could be a specific RIN value for each type of mandate – cellulosic, biodiesel, advanced, and conventional, if each mandate was binding. Mandates are binding when the market is forced by policy to produce more than what normal economic conditions would suggest.

Hierarchical RINS Modeling



- Theoretically there can be 4 different RIN prices specific to each mandate if all the mandates are binding.
- Mandates are binding when the market is forced by policy to produce more than what normal economic conditions would suggest.
- Given the hierarchy of the mandates, it must be the case that RIN values for biodiesel are greater than or equal to advanced RIN values and advanced RIN values must be greater than or equal to conventional RINS. This is because biodiesel RINS can be used as advanced RINS and advanced RINS can be used as conventional RINS. (This process is referred to as demotion.)
- Biodiesel RINS can have the same value as advanced RINS if the biodiesel mandate is less binding than the advanced mandate.

US Biofuels Mandates in 2022



A diagram of the US biofuels models is presented below. The US biofuels sector is made up of ethanol, biodiesel, and renewable diesel. Although there are many state mandates, the diagram illustrates the national Renewable Fuel Standard (RFS) and the California Low Carbon Fuel Standard (LCFS). The RFS is enforced through the supply and demand of RINs with RIN values reflected in the plant or wholesale prices of the various biofuels. RIN values increase if more biofuel production needs to be incentivized to meet the annual volume obligations set by the Environmental Protection Agency. Simultaneously, the California LCFS requires specific reductions in carbon emissions from transportation fuel use. The program works through a system of carbon debits and credits. Fossil fuels generate debits which must be offset by credits which are generated by a variety of sources including biofuels. For biofuels, carbon credits are calculated based on the carbon intensity of each feedstock pathway. Biofuel producers are incentivized by the carbon price which creates a different incentive for each feedstock pathway based on the carbon intensity of that pathway. The LCFS allows other non-biofuel renewable fuel sources such as electric cars to generate carbon credits. The WAEES models include specific assumptions about the other sources of carbon credit generation based on the California Air Resources Board's Illustrative Compliance Scenarios model released in 2018.

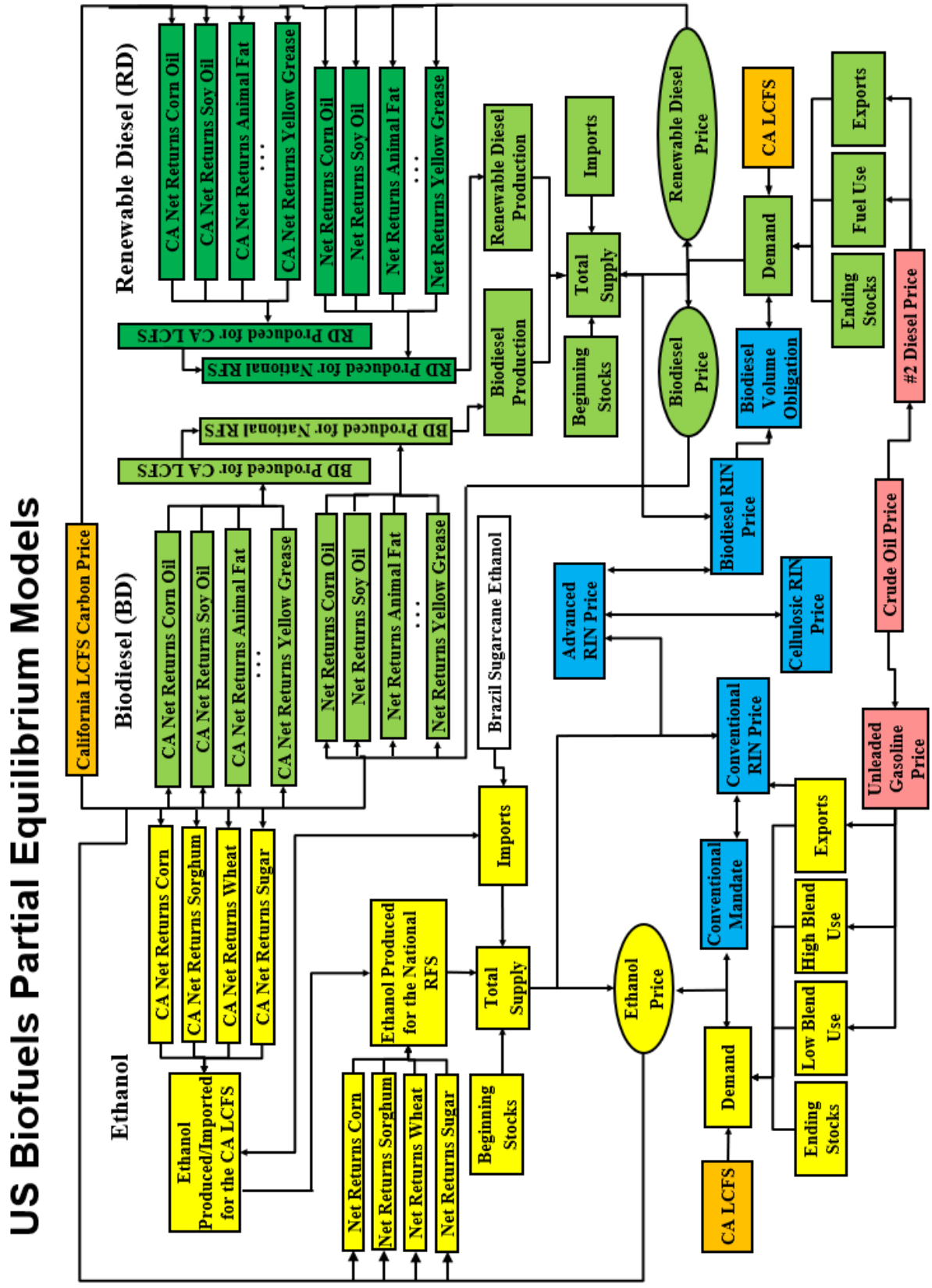
Although neither of these policies are detailed in the diagram below, the influence of the RFS and California LCFS can be seen in the diagram. Each of the biofuels includes the incentive (net returns) provided by each feedstock pathway for biofuels produced for California use or biofuels produced to meet the national RFS. Biofuels produced for the California LCFS get the

extra boost of the LCFS carbon price translated into a per gallon value based on the carbon intensity of the feedstock pathway. Biofuels produced for the national RFS but not used for the California LCFS do not realize the incentives from the LCFS carbon price. Since there are stronger incentives in the California LCFS, feedstocks compete to fill the California LCFS requirements first. Biofuels produced for the California LCFS also count towards the volume obligation requirements under the RFS.

RIN values are the primary method to incentivize biofuel production outside the California system. There is an interaction between RIN values and the California LCFS Carbon price in the model. The presence of the LCFS carbon price tends to reduce RIN values because it creates incentives to expand biofuels supply. If the LCFS carbon price weakens, RIN values tend to increase to the extent needed for the national RFS compliance. The LCFS carbon price is influence by the carbon debits created by fossil fuel use as well as credits generation by non-biofuel and biofuel sources. For example, stronger adoption of electric cars results if fewer carbon credits demanded from biofuels and lower LCFS carbon prices.

Biodiesel and renewable diesel are separated on the supply side because they each experience different incentives based on the biodiesel and renewable diesel price as well as the feedstock pathway. In both cases the LCFS carbon price provides an extra return to biofuel producers (producing for the California LCFS) specific to the carbon intensity of the feedstock pathway. However, renewable diesel also enjoys an addition price premium due to its full fungibility with petroleum. Generally, this results in stronger incentives to expand renewable diesel production than biodiesel production. Each feedstock pathway then has an associated supply curve captured by the model driven by the net returns of the pathway. Note that feedstock prices will increase as more feedstock are demanded reducing the profitability of the affected pathway. The supply and demand of each biofuel feedstock as well as substitution across feedstocks determine the feedstock price.

The total supply of each biofuel is determined by the underlying supply curves for each feedstock pathway. The demand for ethanol, biodiesel, and renewable diesel is determined by the RFS and LCFS credits required from biofuels. Higher blend ethanol uses also compete on price and fuel economy. Large adoption of higher ethanol blends is generally not incentivized under the current national RFS policy, but the CA LFCS does provide enough incentive that is likely that E15 blends can be attained in California. Based on the U.S. Department of Energy, Energy Information Administration projections of falling motor gasoline consumption, the 15-billion-gallon volume obligation for conventional biofuels would seem to push ethanol through the 10 percent blend wall. However, this will depend on the extent to which renewable diesel production growth is incentivized by the LCFS possibly resulting in Diesel RINs being used to fill the convention RIN volume obligation.


US Biofuels Partial Equilibrium Models
California LCFS Carbon Price
Ethanol
Biodiesel (BD)
Renewable Diesel (RD)
CA Net Returns Corn
CA Net Returns Sorghum
CA Net Returns Wheat
CA Net Returns Sugar
Ethanol Produced/Imported for the CA LCFS
Net Returns Corn
Net Returns Sorghum
Net Returns Wheat
Net Returns Sugar
Ethanol Produced for the National RFS
Beginning Stocks
Imports
Total Supply
Ethanol Price
Demand
CA LCFS
Ending Stocks
Low Blend Use
High Blend Use
Exports
Conventional Mandate
Conventional RIN Price
Brazil Sugarcane Ethanol
CA Net Returns Corn Oil
CA Net Returns Soy Oil
CA Net Returns Animal Fat
CA Net Returns Yellow Grease
Net Returns Corn Oil
Net Returns Soy Oil
Net Returns Animal Fat
Net Returns Yellow Grease
BD Produced for CA LCFS
BD Produced for National RFS
Biodiesel Production
Beginning Stocks
Total Supply
Imports
Biodiesel Price
Biodiesel RIN Price
Biodiesel Volume Obligation
Advanced RIN Price
Cellulosic RIN Price
RD Produced for CA LCFS
RD Produced for National RFS
Renewable Diesel Production
Renewable Diesel Price
Demand
CA LCFS
Ending Stocks
Fuel Use
Exports
Crude Oil Price
#2 Diesel Price
Unleaded Gasoline Price

The WAEES Global Modeling Process

Forecast Assumptions

WAEES begins each semi-annual forecast by developing a set of conditioning assumptions that will be used for the forecast. These assumptions include the critical domestic and trade policies affecting agriculture and biofuels in each country; macroeconomic conditions such as per capita income growth, population growth, inflation rates, and exchange rates; technology assumptions such as crop yield growth; and key cost of production drivers such as interest rates, petroleum prices, wage rates, and other trends in tastes and preferences. Infrastructure constraints and land area expansion assumptions are also outlined in this process. These assumptions are direct inputs into the WAEES global agricultural partial equilibrium models.

Historical Data

The second step in the process is updating all historical data to the latest numbers. A large portion of the historical supply and demand data is drawn from USDA's Production, Supply, and Disposition (PSD) database. Historical data on crop area, yield, and production for each of the EU-28 countries is taken from Eurostat and supplemented with data from each of the country Ministries of Agriculture as needed. Some historical data such as sugarcane and sugar beet area harvested is taken from FAOSTAT, but the data is reviewed for consistency prior to being used in the models. Historical data on commodity prices are taken from a variety of sources including the respective Ministries of Agriculture (or equivalent) in each country, USDA, FAO, etc. Historical government policy information is gathered from USDA Gain Reports, the WTO, OECD, FAO, and the respective Ministries of Agriculture (or their equivalent) in each country. In Canada, the *Biofuels in Canada (2020)* data was utilized to inform historic fuel use to 2019e.

The timing of historical data releases determines when the WAEES forecasts are completed. The critical updates for PSD's global livestock data occur in April and October. The global crops data is updated more frequently throughout the year. Since the size of the southern hemisphere crops are generally available in April/May and the size of plantings in the northern hemisphere crops are generally known, WAEES conducts the first of the semiannual forecasts over the month of May targeting the beginning of June for release of the forecast numbers. The second forecast is typically done over the month of November targeting the beginning of December for a release of the forecast numbers. At this time of the year, the northern hemisphere crop sizes and the southern hemisphere plantings are generally known.

Model Development and Equation Updates

The WAEES global partial equilibrium models are in a constant state of review to ensure that the equations are performing adequately, the model structure is adapted to changes in the marketplace, changes in data sources are captured, and new coverage is added as necessary. While WAEES does not keep an exact count on the number of equations in the system, it now exceeds 20,000 equations. The performance of the behavioral equations within the system are continuously monitored within the system based on their percent root mean square errors, consistency with market behavior, and their recent pattern of historical errors. Prior to each forecast, the equations are reviewed and replaced as needed.

Model Calibration and Adjustment

After the historical data has been updated, each equation is recalibrated to the updated historical data. After reviewing the equation performance as per the description above, the model adjustment factors are set for the first forecast year. These adjustments are set based on a weighted average of the equation's errors over the previous 3-5 years in the model. In most of the equations this adjustment factor is held constant over the forecast horizon of 2016 through 2030. There are a few equations, particularly in the livestock sector, where adjustments are used to generate the livestock cycles.

Generating the forecast

After capturing the forecast assumptions, updating the historical data, reviewing the model equations, and calibrating the model, the model is then solved to generate a global forecast of commodity prices that balances supply and demand within each country and around the world. Since the commodities are highly interrelated within the model sometimes the forecast assumptions generate unexpected results and/or push the model into a region outside the experience based on historical data. The global solution is carefully reviewed and the equation results are evaluated based on direction and magnitude of response, and if necessary, the model equations are adjusted and the model is re-solved for a new global solution. These corrections are usually small or not needed, but some scenarios can push the model into untested ranges.

Reporting the Forecast Results

Each model within the WAEES global modelling system includes a master data block capturing the historical and forecast data. These data blocks are combined from the various models and used to generate a standard set of world tables and country supply and demand tables for each commodity. These tables are reported in one Excel file with and index including hyperlinks that facilitate location of the different table types. WAEES also generates an Access database of the

forecast data with a user interface for making queries so that no knowledge of Access is needed to make queries. Finally, a written report is generated documenting the key assumptions, results, and key sensitivities for the forecast.

Appendix B – Scenario Summary Tables

Results for Scenario FF-CC1

Canada Ethanol Supply and Demand: Scenario FF-CC1

Calendar Year	Units	2022	2024	2026	2028	2030
Supply & Demand						
Beginning Stocks	Million Liters	0	0	0	0	0
Production	Million Liters	2,315	2,172	1,978	2,402	3,009
Imports	Million Liters	1,203	1,287	1,256	1,237	1,256
Total Supply	Million Liters	3,517	3,459	3,233	3,638	4,265
Domestic Use	Million Liters	3,503	3,444	3,219	3,624	4,251
Exports	Million Liters	14	14	14	14	14
Ending Stocks	Million Liters	0	0	0	0	0
Total Demand	Million Liters	3,517	3,459	3,233	3,638	4,265
Feedstocks						
Corn	1000 Metric Tons	4,161	3,943	3,697	4,483	5,642
Wheat	1000 Metric Tons	1,475	1,342	1,109	1,355	1,669
Feedstock Yield						
Corn	1000 Liters/MT	0.42	0.42	0.42	0.42	0.42
Wheat	1000 Liters/MT	0.39	0.39	0.39	0.39	0.39
Distillers' Grains Production						
Corn	1000 Metric Tons	1,263	1,197	1,122	1,361	1,713
Wheat	1000 Metric Tons	448	408	337	411	507
Wholesale Ethanol Price (excludes CFS Credit Value)	CAD/Liter	0.59	0.61	0.61	0.62	0.64

Canada Biomass Based Diesel Supply and Demand: Scenario FF-CC1

Calendar Year	Units	2022	2024	2026	2028	2030
Biodiesel Supply & Use						
Beginning Stocks	Million Liters	0	0	0	0	0
Production	Million Liters	416	394	393	472	578
Imports	Million Liters	338	336	365	440	494
Total Supply	Million Liters	755	730	757	911	1,072
Domestic Use	Million Liters	459	435	463	616	775
Exports	Million Liters	296	295	294	296	297
Ending Stocks	Million Liters	0	0	0	0	0
Total Demand	Million Liters	755	730	757	911	1,072
Renewable Diesel Supply & Use						
Beginning Stocks	Million Liters	0	0	0	0	0
Production	Million Liters	0	171	154	382	690
Imports	Million Liters	426	422	412	419	455
Total Supply	Million Liters	426	593	566	801	1,146
Domestic Use	Million Liters	426	593	566	801	1,146
Exports	Million Liters	0	0	0	0	0
Ending Stocks	Million Liters	0	0	0	0	0
Total Demand	Million Liters	426	593	566	801	1,146
Domestic Feedstocks						
Canola Oil (Biodiesel Plants)	1000 Metric Tons	265	246	246	296	363
Canola Oil (Renewable Diesel Plants)	1000 Metric Tons	0	157	141	351	633
Inedible Tallow	1000 Metric Tons	0	0	0	1	6
Soybean Oil	1000 Metric Tons	71	70	70	83	97
Yellow Grease	1000 Metric Tons	26	26	26	30	36
Choice White Grease	1000 Metric Tons	0	0	0	0	0
Domestic Feedstock Yield						
Canola Oil	1000 Liters/MT	1.11	1.11	1.11	1.11	1.11
Inedible Tallow	1000 Liters/MT	1.04	1.04	1.04	1.04	1.04
Soybean Oil	1000 Liters/MT	1.11	1.11	1.11	1.11	1.11
Yellow Grease	1000 Liters/MT	1.04	1.04	1.04	1.04	1.04
Choice White Grease	1000 Liters/MT	0.00	0.00	0.00	0.00	0.00
Biomass-based Diesel Prices						
BC/AB Canada B99 Rack Price	CAD/Liter	0.71	0.74	0.74	0.79	0.85
Canada HDRD Wholesale Price	CAD/Liter	1.40	1.42	1.42	1.48	1.54

Canada CFS Program Parameters: Scenario FF-CC1

Calendar Year	Units	2022	2026	2028	2030
Program Goals					
2016 Stream Carbon Intensity	tCO2e/TJ	91.6	91.6	91.6	91.6
Credit Stream Carbon Intensity Reference	tCO2e/TJ	88.4	85.0	82.9	80.8
Obligated Fossil Fuel Carbon Intensity Reduction	tCO2e/TJ	2.4	7.2	9.6	12.0
Obligated Jet Fuel Carbon Intensity Reduction	tCO2e/TJ	2.4	7.2	9.6	12.0
Energy Economy Ratios					
Hydrogen (Gasoline)	Ratio	2.1	2.1	2.1	2.1
Hydrogen (Diesel)	Ratio	1.9	1.9	1.9	1.9
CNG (Diesel)	Ratio	1	1	1	1
EV (Gasoline)	Ratio	4.1	4.1	4.1	4.1
EV (Diesel)	Ratio	5	5	5	5
Energy Density of Fuels					
Gasoline	MJ/Liter	34.69	34.69	34.69	34.69
Diesel	MJ/Liter	38.65	38.65	38.65	38.65
Aviation Fuel	MJ/Liter	35.46	35.46	35.46	35.46
Ethanol	MJ/Liter	23.58	23.58	23.58	23.58
Biodiesel	MJ/Liter	35.40	35.40	35.40	35.40
Renewable Diesel (HDRD)	MJ/Liter	36.51	36.51	36.51	36.51
Biojet	MJ/Liter	34.81	34.81	34.81	34.81
Electricity	MJ/kWh	3.60	3.60	3.60	3.60
LFO	MJ/Liter	38.80	38.80	38.80	38.80
Kerosene	MJ/Liter	37.68	37.68	37.68	37.68
Pyrolisis Oil (Biocrude)	MJ/Liter	21.35	21.35	21.35	21.35
HFO	MJ/Liter	41.10	41.10	41.10	41.10

Canada CFS Carbon Intensity Average Scores: Scenario FF-CC1

Calendar Year	Units	2022	2026	2028	2030
Motor gasoline	tCO2e/TJ	91.9	91.9	91.9	91.9
Ethanol	tCO2e/TJ				
Ethanol from corn	tCO2e/TJ	44.1	41.9	40.9	39.8
Ethanol from wheat	tCO2e/TJ	38.6	37.0	36.2	35.3
Diesel fuel oil	tCO2e/TJ	97.1	97.1	97.1	97.1
Biodiesel	tCO2e/TJ				
Biodiesel from canola oil	tCO2e/TJ	9.6	9.1	8.8	8.6
Biodiesel from inedible tallow	tCO2e/TJ	-1.2	-1.7	-1.9	-2.1
Biodiesel from soybean oil	tCO2e/TJ	16.8	16.1	15.8	15.5
Biodiesel from yellow grease	tCO2e/TJ	4.2	3.9	3.8	3.7
Biodiesel from distillers corn oil	tCO2e/TJ	16.7	15.9	15.4	15.0
Biodiesel from unknown	tCO2e/TJ	3.8	3.8	3.8	3.8
Renewable diesel (HDRD) (weighted avg)	tCO2e/TJ				
Renewable diesel from palm oil	tCO2e/TJ	71.7	70.3	69.6	68.9
Renewable diesel from canola oil	tCO2e/TJ	9.6	9.1	8.8	8.6
Renewable diesel from palm sludge oil	tCO2e/TJ	11.2	11.0	10.9	10.9
Renewable diesel from tallow	tCO2e/TJ	7.2	6.9	6.7	6.5
Renewable diesel from yellow grease	tCO2e/TJ	12.7	12.4	12.3	12.2
Renewable diesel from soybean oil	tCO2e/TJ	30.8	30.0	29.6	29.2
Renewable diesel from spent bleaching earth	tCO2e/TJ	18.6	18.0	17.8	17.5
Light fuel oil	tCO2e/TJ	87.0	87.0	87.0	87.0
Kerosene & stove oil	tCO2e/TJ	82.0	82.0	82.0	82.0
Heavy fuel oil	tCO2e/TJ	91.0	91.0	91.0	91.0
Pyrolisis Oil (Biocrude)	tCO2e/TJ	25.0	21.0	19.0	17.0
Aviation gasoline	tCO2e/TJ	94.0	94.0	94.0	94.0
Aviation turbo fuel	tCO2e/TJ	90.1	90.1	90.1	90.1
Biojet	tCO2e/TJ	30.0	30.0	30.0	30.0
Propane Vehicle	tCO2e/TJ	68.0	68.0	68.0	68.0
Natural Gas Vehicle	tCO2e/TJ	62.9	62.9	62.9	62.9
EV (Gasoline)	tCO2e/TJ	21.7	21.7	21.7	21.7

Canada Fuel Consumption Volumes: Scenario FF-CC1

Calendar Year	Units	2022	2026	2028	2030
Blended Gasoline (volumetric total)	million liters	41,689	38,941	38,086	37,579
Motor gasoline	million liters	38,186	35,722	34,462	33,329
Ethanol	million liters	3,503	3,219	3,624	4,251
Ethanol from corn	million liters	2,945	2,769	3,123	3,690
Ethanol from wheat	million liters	558	450	501	561
Blended Diesel (volumetric total)	million liters	32,176	32,118	32,052	32,066
Diesel fuel oil	million liters	31,336	31,139	30,704	30,236
Biomass Based Diesel	million liters	840	979	1,348	1,830
Biodiesel	million liters	435	439	583	735
Biodiesel from canola oil	million liters	240	234	330	440
Biodiesel from inedible tallow	million liters	0	0	0	0
Biodiesel from soybean oil	million liters	152	161	195	221
Biodiesel from yellow grease	million liters	30	31	41	51
Biodiesel from distillers corn oil	million liters	13	13	18	22
Biodiesel made from unknown	million liters	0	0	0	0
Renewable Diesel (HDRD)	million liters	404	540	765	1,096
Renewable diesel made from palm oil	million liters	11	11	11	11
Renewable diesel made from canola oil	million liters	0	135	335	606
Renewable diesel made from palm sludge oil	million liters	0	0	0	0
Renewable diesel made from tallow	million liters	293	285	290	318
Renewable diesel made from yellow grease	million liters	68	66	67	72
Renewable diesel made from soybean oil	million liters	7	19	37	61
Renewable diesel made from spent bleaching earth	million liters	26	25	25	27
Blended Light Fuel Oil		2,057	1,903	1,833	1,762
Light diesel fuel oil	million liters	2,012	1,852	1,764	1,671
Biomass Based Diesel	million liters	45	51	69	90
Biodiesel	million liters	23	24	32	40
Biodiesel from canola oil	million liters	13	13	18	24
Biodiesel from inedible tallow	million liters	0	0	0	0
Biodiesel from soybean oil	million liters	8	9	11	12
Biodiesel from yellow grease	million liters	2	2	2	3
Biodiesel from distillers corn oil	million liters	1	1	1	1
Biodiesel from unknown	million liters	0	0	0	0
Renewable Diesel (HDRD)	million liters	21	26	36	50
Renewable diesel made from palm oil	million liters	1	1	1	1
Renewable diesel made from canola oil	million liters	0	7	16	28
Renewable diesel made from palm sludge oil	million liters	0	0	0	0
Renewable diesel made from tallow	million liters	15	14	14	15
Renewable diesel made from yellow grease	million liters	4	3	3	3
Renewable diesel made from soybean oil	million liters	0	1	2	3
Renewable diesel made from spent bleaching earth	million liters	1	1	1	1
Blended Heavy Fuel Oil		2,672	2,628	2,617	2,616
Heavy fuel oil	million liters	2,429	2,389	2,379	2,378
Pyrolisis Oil (Biocrude)	million liters	243	239	238	238
Blended Jet Fuel		8,577	8,817	9,018	9,254
Aviation turbo fuel	million liters	8,492	8,729	8,929	9,162
Biojet	million liters	85	87	89	92
Kerosene & stove oil	million liters	443	409	395	383

Canada Fuel Consumption Volumes in Terajoules: Scenario FF-CC1

Calendar Year	Units	2022	2026	2028	2030
Blended Gasoline	terajoules	1,407,269	1,315,108	1,280,934	1,256,407
Motor Gasoline	terajoules	1,324,668	1,239,208	1,195,479	1,156,176
Ethanol	terajoules	82,601	75,900	85,455	100,231
Ethanol from corn	terajoules	69,434	65,284	73,632	87,012
Ethanol from wheat	terajoules	13,167	10,616	11,823	13,219
Blended Diesel	terajoules	1,241,308	1,238,776	1,235,292	1,234,628
Diesel fuel oil	terajoules	1,211,133	1,203,527	1,186,726	1,168,622
Biodiesel	terajoules	15,409	15,538	20,652	26,008
Biodiesel from canola oil	terajoules	8,495	8,268	11,665	15,578
Biodiesel from inedible tallow	terajoules	0	0	0	0
Biodiesel from soybean oil	terajoules	5,370	5,713	6,919	7,825
Biodiesel from yellow grease	terajoules	1,075	1,084	1,441	1,815
Biodiesel from distillers corn oil	terajoules	468	472	628	791
Biodiesel from unknown	terajoules	0	0	0	0
Renewable Diesel (HDRD)	terajoules	14,766	19,712	27,914	39,998
Renewable diesel made from palm oil	terajoules	405	390	390	403
Renewable diesel made from canola oil	terajoules	0	4,916	12,218	22,111
Renewable diesel made from palm sludge oil	terajoules	0	0	0	0
Renewable diesel made from tallow	terajoules	10,710	10,403	10,597	11,616
Renewable diesel made from yellow grease	terajoules	2,473	2,410	2,446	2,639
Renewable diesel made from soybean oil	terajoules	243	686	1,344	2,234
Renewable diesel made from spent bleaching earth	terajoules	935	907	920	996
Blended Light Fuel Oil	terajoules	79,665	73,678	70,918	68,097
Light fuel oil	terajoules	78,065	71,849	68,448	64,848
Biodiesel	terajoules	830	863	1,146	1,424
Biodiesel from canola oil	terajoules	457	459	647	853
Biodiesel from inedible tallow	terajoules	0	0	0	0
Biodiesel from soybean oil	terajoules	289	317	384	429
Biodiesel from yellow grease	terajoules	58	60	80	99
Biodiesel from distillers corn oil	terajoules	25	26	35	43
Biodiesel from unknown	terajoules	0	0	0	0
Renewable Diesel (HDRD)	terajoules	771	966	1,324	1,825
Renewable diesel made from palm oil	terajoules	21	19	18	18
Renewable diesel made from canola oil	terajoules	0	241	579	1,009
Renewable diesel made from palm sludge oil	terajoules	0	0	0	0
Renewable diesel made from tallow	terajoules	559	510	503	530
Renewable diesel made from yellow grease	terajoules	129	118	116	120
Renewable diesel made from soybean oil	terajoules	13	34	64	102
Renewable diesel made from spent bleaching earth	terajoules	49	44	44	45
Blended Heavy Fuel Oil	terajoules	105,011	103,270	102,863	102,825
Heavy fuel oil	terajoules	99,825	98,170	97,783	97,747
Pyrolisis Oil (Biocrude)	terajoules	5,186	5,100	5,080	5,078
Blended Jet Fuel	terajoules	304,091	312,578	319,725	328,089
Aviation turbo fuel	terajoules	301,135	309,540	316,617	324,899
Biojet	terajoules	2,956	3,039	3,108	3,189
Kerosene & stove oil	terajoules	16,688	15,420	14,886	14,418
Propane Vehicle	terajoules	7,585	12,292	14,646	17,000
Natural Gas Vehicle	terajoules	6,246	10,123	12,062	14,000
Electric Vehicles (Gasoline) Assumption	terajoules	3,476	4,095	4,487	4,904
Electric Vehicles (Diesel) Assumption	terajoules	2,655	3,116	3,406	3,713

Canada Fuel Blend Rates: Scenario FF-CC1

Calendar Year	Units	2022	2026	2028	2030
Ethanol in gasoline	% by Volume	8.4%	8.3%	9.5%	11.3%
Biomass based diesel in diesel	% by Volume	2.6%	3.0%	4.2%	5.7%
Biodiesel in diesel	% by Volume	1.4%	1.4%	1.8%	2.3%
Renewable Diesel (HDRD) in diesel	% by Volume	1.3%	1.7%	2.4%	3.4%
Biomass based diesel in LFO	% by Volume	2.2%	2.7%	3.7%	5.1%
Biodiesel in LFO	% by Volume	1.1%	1.3%	1.8%	2.3%
Renewable Diesel (HDRD) in LFO	% by Volume	1.0%	1.4%	2.0%	2.8%
Pyrolisis oil (Biocrude) in HFO	% by Volume	9.1%	9.1%	9.1%	9.1%
Biojet in aviation turbo fuel	% by Volume	1.0%	1.0%	1.0%	1.0%
Ethanol in gasoline	% by Energy	5.9%	5.8%	6.7%	8.0%
Biomass based diesel in diesel	% by Energy	2.4%	2.8%	3.9%	5.3%
Biodiesel in diesel	% by Energy	1.2%	1.3%	1.7%	2.1%
Renewable Diesel (HDRD) in diesel	% by Energy	1.2%	1.6%	2.3%	3.2%
Biomass based diesel in LFO	% by Energy	2.0%	2.5%	3.5%	4.8%
Biodiesel in LFO	% by Energy	1.0%	1.2%	1.6%	2.1%
HDRD in LFO	% by Energy	1.0%	1.3%	1.9%	2.7%
Pyrolisis oil (Biocrude) in HFO	% by Energy	4.9%	4.9%	4.9%	4.9%
Biojet in aviation turbo fuel	% by Energy	1.0%	1.0%	1.0%	1.0%

Canada CFS Compliance Credits and Debits: Scenario FF-CC1

Calendar Year	Units	2022	2026	2028	2030
Debits					
Fossil Fuels					
Motor Gasoline	tCO2e	1,589,601	8,922,297	11,476,598	13,874,110
Diesel fuel oil	tCO2e	1,453,359	8,665,392	11,392,570	14,023,463
Light fuel oil	tCO2e	93,678	517,311	657,103	778,172
Heavy fuel oil	tCO2e	119,790	706,824	938,719	1,172,964
Aviation turbo fuel (Domestic Only)	tCO2e	115,636	713,179	972,648	1,247,613
Kerosene & stove oil	tCO2e	20,025	111,021	142,906	173,015
Total Debits	tCO2e	3,392,089	19,636,024	25,580,544	31,269,337
CFS Compliance Credits					
Compliance Category 1					
CCS	tCO2e	1,300,000	4,150,000	5,575,000	7,000,000
Upstream Improvements	tCO2e	0	875,000	1,312,500	1,750,000
Reductions in Refineries	tCO2e	200,000	975,000	1,362,500	1,750,000
Incremental Methane Reductions - Conventional Oil	tCO2e	546,746	2,023,373	2,761,687	3,500,000
Subtotal Compliance Category 1	tCO2e	2,046,746	8,023,373	11,011,687	14,000,000
Compliance Category 2					
Bank Renewable Fuel Regulation (RFR)	tCO2e	1,400,000	0	0	0
Ethanol	tCO2e	3,732,906	3,325,176	3,649,191	4,172,224
Ethanol from corn	tCO2e	3,077,540	2,814,807	3,096,291	3,570,674
Ethanol from wheat	tCO2e	655,366	510,369	552,900	601,549
Biodiesel	tCO2e	1,241,568	1,205,868	1,567,172	1,929,083
Biodiesel from canola oil	tCO2e	705,751	663,058	912,113	1,187,105
Biodiesel from inedible tallow	tCO2e	0	0	0	0
Biodiesel from soybean oil	tCO2e	405,077	415,513	490,034	539,392
Biodiesel from yellow grease	tCO2e	95,357	92,804	120,313	147,697
Biodiesel from distillers corn oil	tCO2e	35,382	34,493	44,712	54,888
Biodiesel from unknown	tCO2e	0	0	0	0
Renewable Diesel (HDRD)	tCO2e	1,202,390	1,538,118	2,118,400	2,954,127
Renewable diesel from palm oil	tCO2e	7,122	6,033	5,439	5,031
Renewable diesel from canola oil	tCO2e	0	391,807	948,079	1,670,347
Renewable diesel from palm sludge oil	tCO2e	0	0	0	0
Renewable diesel from tallow	tCO2e	914,847	853,347	846,237	902,865
Renewable diesel from yellow grease	tCO2e	197,022	183,579	180,872	189,400
Renewable diesel from soybean oil	tCO2e	14,722	39,609	74,996	120,549
Renewable diesel from spent bleaching earth	tCO2e	68,676	63,743	62,777	65,934
Pyrolisis Oil (Biocrude)	tCO2e	328,698	326,629	324,679	324,156
Biojet	tCO2e	172,590	167,267	164,469	162,139
Subtotal Compliance Category 2	tCO2e	8,078,151	6,563,056	7,823,911	9,541,729
Compliance Category 3					
Diesel Displaced by Propane	tCO2e	154,600	209,538	218,457	218,219
Diesel Displaced by Natural Gas	tCO2e	159,173	224,188	241,420	251,110
Gasoline Displaced by Electric Vehicles	tCO2e	1,200,000	1,333,333	1,416,667	1,500,000
Diesel Displaced by Electric Vehicles	tCO2e	1,200,000	1,333,333	1,416,667	1,500,000
Subtotal Compliance Category 3	tCO2e	2,713,774	3,100,393	3,293,211	3,469,329
External Credit Sources					
Cross Steam Credits	tCO2e	339,209	1,963,602	2,558,054	3,126,934
Compliance Fund	tCO2e	0	0	0	0
Emerging Tech Credit Generation	tCO2e	0	0	0	0
Total Credits		13,177,879	19,650,425	24,686,863	30,137,992
Banked for the Year	tCO2e	9,785,790	14,400	-893,681	-1,131,345
Running Net Credit Balance	tCO2e	9,785,790	18,238,768	16,737,682	14,591,415
CFS Compliance Credit Price	C$/MT	24	9	39	82
Maximum CFS Compliance Credit Price	C$/MT	350	368	377	387

Value of Canada Compliance Credits By Feedstock Pathway: Scenario FF-CC1

Calendar Year	Units	2022	2026	2028	2030
Ethanol					
Ethanol from corn	C$/liter	0.03	0.01	0.04	0.08
Ethanol from wheat	C$/liter	0.03	0.01	0.04	0.09
Biodiesel					
Biodiesel from canola oil	C$/liter	0.07	0.02	0.10	0.21
Biodiesel from inedible tallow	C$/liter	0.08	0.03	0.12	0.24
Biodiesel from soybean oil	C$/liter	0.06	0.02	0.09	0.19
Biodiesel from yellow grease	C$/liter	0.07	0.03	0.11	0.23
Biodiesel from distillers corn oil	C$/liter	0.06	0.02	0.09	0.19
Renewable Diesel	C$/liter				
Renewable Diesel from palm oil	C$/liter	0.01	0.00	0.02	0.04
Renewable Diesel from canola oil	C$/liter	0.07	0.03	0.11	0.22
Renewable diesel from palm sludge oil	C$/liter	0.07	0.02	0.10	0.21
Renewable diesel from tallow	C$/liter	0.07	0.03	0.11	0.22
Renewable diesel from yellow grease	C$/liter	0.07	0.02	0.10	0.21
Renewable diesel from soybean oil	C$/liter	0.05	0.02	0.08	0.16
Renewable diesel from spent bleaching earth	C$/liter	0.06	0.02	0.09	0.19

Biofuel Feedstocks Used for Canadian Domestic Consumption: Scenario FF-CC1

Calendar Year	Units	2022	2026	2028	2030
Ethanol Feedstocks					
Corn	1000 MT	2,945	2,769	3,123	3,690
Wheat	1000 MT	558	450	501	561
Biodiesel Feedstocks					
Canola Oil	1000 MT	227	222	312	417
Inedible Tallow	1000 MT	0	0	0	0
Soybean Oil	1000 MT	144	153	185	209
Yellow Grease	1000 MT	31	31	41	52
Distillers Corn Oil	1000 MT	13	13	17	21
Unknown	1000 MT	0	0	0	0
Renewable Diesel Feedstocks					
Feedstocks Used for Domestic Production					
Canola Oil	1000 MT	0	141	351	633
Feedstocks Used for Imports (Approximation)					
Palm Oil	1000 MT	11	11	11	11
Palm Sludge Oil	1000 MT	0	0	0	0
Inedible Tallow	1000 MT	293	284	289	316
Yellow Grease	1000 MT	68	66	67	72
Soybean Oil	1000 MT				
Spent Bleaching Earth	1000 MT	26	25	25	27

Canada Grains Supply and Demand: Scenario FF-CC1

	Units	22/23	24/25	26/27	28/29	30/31
Corn						
Area Harvested	1000 ha	1,415	1,421	1,419	1,419	1,420
Yield	mt per ha	9.98	10.21	10.44	10.67	10.90
Supply						
Beginning Stocks	1000 mt	2,211	2,234	2,285	2,348	2,393
Production	1000 mt	14,116	14,499	14,810	15,129	15,476
Imports	1000 mt	2,060	1,703	1,756	2,526	3,157
Total Supply	1000 mt	18,388	18,436	18,851	20,004	21,025
Domestic Disappearance						
Feed & Residual Use	1000 mt	8,975	9,087	9,229	9,295	9,310
Food, Seed, and Industrial Use	1000 mt	6,541	6,454	6,664	7,697	8,650
Bioethanol Use	1000 mt	3,917	3,789	3,937	4,916	5,814
Total Domestic Disappearance	1000 mt	15,517	15,541	15,893	16,992	17,960
Exports	1000 mt	641	641	641	641	641
Ending Stocks	1000 mt	2,230	2,254	2,317	2,371	2,424
Wheat						
Area Harvested	1000 ha	9,787	9,842	9,833	9,786	9,771
Yield	mt per ha	3.38	3.43	3.47	3.51	3.56
Supply						
Beginning Stocks	1000 mt	6,743	6,936	7,230	7,650	7,984
Production	1000 mt	33,090	33,712	34,116	34,385	34,763
Imports	1000 mt	501	501	501	501	501
Total Supply	1000 mt	40,333	41,149	41,846	42,537	43,248
Domestic Disappearance						
Feed & Residual Use	1000 mt	5,160	5,170	5,232	5,207	5,191
Food, Seed, and Industrial Use	1000 mt	5,498	5,408	5,349	5,678	5,995
Bioethanol Use	1000 mt	1,415	1,277	1,158	1,436	1,699
Total Domestic Disappearance	1000 mt	10,658	10,578	10,580	10,886	11,186
Exports	1000 mt	22,801	23,560	23,806	23,855	23,874
Ending Stocks	1000 mt	6,875	7,011	7,460	7,796	8,187
Grain Prices						
Barley, #1 Feed, Alberta	CAD/mt	205	213	213	216	218
Barley Farm Price	CAD/mt	236	241	242	244	245
Corn #2, CE Cash, Chatham	CAD/mt	178	187	189	193	197
Wheat, Western Red Spring, 12.5% Protein	CAD/mt	207	232	239	255	267
Wheat Producer Price, Ontario	CAD/mt	216	241	248	264	275

Canada Canola and Canola Products Supply and Demand: Scenario FF-CC1

	Units	22/23	24/25	26/27	28/29	30/31
Canola						
Area Harvested	1000 ha	8,038	7,891	7,796	7,886	7,986
Yield	mt per ha	2.36	2.40	2.45	2.49	2.54
Supply						
Beginning Stocks	1000 mt	3,548	3,186	3,177	3,267	3,402
Production	1000 mt	18,973	18,975	19,091	19,659	20,260
Imports	1000 mt	150	150	150	150	150
Total Supply	1000 mt	22,670	22,311	22,418	23,076	23,812
Domestic Disappearance						
Crush	1000 mt	9,686	9,602	9,569	9,785	10,056
Food	1000 mt	0	0	0	0	0
Feed, Seed, Waste	1000 mt	509	508	510	509	510
Total Domestic Disappearance	1000 mt	10,195	10,110	10,080	10,294	10,565
Exports	1000 mt	9,249	9,025	9,106	9,441	9,763
Ending Stocks	1000 mt	3,227	3,176	3,232	3,341	3,483
Canola Meal						
Extraction Rate	kg/kg	0.56	0.56	0.56	0.56	0.56
Supply						
Beginning Stocks	1000 mt	59	53	50	52	57
Production	1000 mt	5,465	5,418	5,399	5,521	5,674
Imports	1000 mt	5	5	5	5	5
Total Supply	1000 mt	5,529	5,476	5,455	5,578	5,736
Domestic Disappearance						
Food	1000 mt	0	0	0	0	0
Feed & Residual	1000 mt	690	699	717	739	767
Industrial	1000 mt	0	0	0	0	0
Total Domestic Disappearance	1000 mt	690	699	717	739	767
Exports	1000 mt	4,784	4,725	4,687	4,784	4,909
Ending Stocks	1000 mt	55	51	51	55	61
Canola Oil						
Extraction Rate	kg/kg	0.44	0.44	0.44	0.44	0.44
Supply						
Beginning Stocks	1000 mt	339	333	342	346	346
Production	1000 mt	4,305	4,268	4,254	4,349	4,470
Imports	1000 mt	16	16	16	16	16
Total Supply	1000 mt	4,660	4,617	4,612	4,712	4,832
Domestic Disappearance						
Food	1000 mt	697	706	718	718	719
Feed & Residual	1000 mt	0	0	0	0	0
Industrial	1000 mt	404	441	520	826	1,118
Total Domestic Disappearance	1000 mt	1,101	1,147	1,239	1,544	1,837
Exports	1000 mt	3,223	3,133	3,026	2,822	2,646
Ending Stocks	1000 mt	336	337	347	346	349
Canola and Derivative Prices						
Canola Average Farm Price, Saskatchewan	CAD/mt	458	475	475	492	502
Canola Seed Average Price, Pacific Coast	CAD/mt	485	503	503	521	531
Canola Oil FOB Plants, Crude Degummed	CAD/mt	821	822	803	851	890
Canola Meal FOB Plant	CAD/mt	335	354	361	363	356

Results for Scenario ECCC-TT

Canada Ethanol Supply and Demand: Scenario ECCC-TT

Calendar Year	Units	2022	2024	2026	2028	2030
Supply & Demand						
Beginning Stocks	Million Liters	0	0	0	0	0
Production	Million Liters	2,317	2,203	2,050	2,526	3,160
Imports	Million Liters	1,203	1,288	1,260	1,247	1,272
Total Supply	Million Liters	3,519	3,491	3,310	3,773	4,432
Domestic Use	Million Liters	3,505	3,476	3,295	3,759	4,418
Exports	Million Liters	14	14	14	14	14
Ending Stocks	Million Liters	0	0	0	0	0
Total Demand	Million Liters	3,519	3,491	3,310	3,773	4,432
Feedstocks						
Corn	1000 Metric Tons	4,164	3,997	3,825	4,702	5,911
Wheat	1000 Metric Tons	1,476	1,363	1,157	1,437	1,768
Feedstock Yield						
Corn	1000 Liters/MT	0.42	0.42	0.42	0.42	0.42
Wheat	1000 Liters/MT	0.39	0.39	0.39	0.39	0.39
Distillers' Grains Production						
Corn	1000 Metric Tons	1,264	1,214	1,161	1,427	1,795
Wheat	1000 Metric Tons	448	414	351	436	537
Wholesale Ethanol Price (excludes CFS Credit Value)	CAD/Liter	0.59	0.61	0.61	0.62	0.65

Canada Biomass Based Diesel Supply and Demand: Scenario ECCC-TT

Calendar Year	Units	2022	2024	2026	2028	2030
Biodiesel Supply & Use						
Beginning Stocks	Million Liters	0	0	0	0	0
Production	Million Liters	411	395	400	481	581
Imports	Million Liters	341	343	381	460	516
Total Supply	Million Liters	752	738	781	941	1,097
Domestic Use	Million Liters	456	443	487	645	799
Exports	Million Liters	296	295	294	296	298
Ending Stocks	Million Liters	0	0	0	0	0
Total Demand	Million Liters	752	738	781	941	1,097
Renewable Diesel Supply & Use						
Beginning Stocks	Million Liters	0	0	0	0	0
Production	Million Liters	0	210	214	518	904
Imports	Million Liters	426	423	415	425	464
Total Supply	Million Liters	426	633	629	943	1,368
Domestic Use	Million Liters	426	633	629	943	1,368
Exports	Million Liters	0	0	0	0	0
Ending Stocks	Million Liters	0	0	0	0	0
Total Demand	Million Liters	426	633	629	943	1,368
Domestic Feedstocks						
Canola Oil (Biodiesel Plants)	1000 Metric Tons	260	247	250	299	359
Canola Oil (Renewable Diesel Plants)	1000 Metric Tons	0	193	196	475	829
Inedible Tallow	1000 Metric Tons	0	0	0	2	7
Soybean Oil	1000 Metric Tons	71	71	72	85	100
Yellow Grease	1000 Metric Tons	26	26	26	31	37
Choice White Grease	1000 Metric Tons	0	0	0	0	0
Domestic Feedstock Yield						
Canola Oil	1000 Liters/MT	1.11	1.11	1.11	1.11	1.11
Inedible Tallow	1000 Liters/MT	1.04	1.04	1.04	1.04	1.04
Soybean Oil	1000 Liters/MT	1.11	1.11	1.11	1.11	1.11
Yellow Grease	1000 Liters/MT	1.04	1.04	1.04	1.04	1.04
Choice White Grease	1000 Liters/MT	0.00	0.00	0.00	0.00	0.00
Biomass-based Diesel Prices						
BC/AB Canada B99 Rack Price	CAD/Liter	0.71	0.74	0.74	0.79	0.85
Canada HDRD Wholesale Price	CAD/Liter	1.40	1.42	1.42	1.48	1.55

Canada CFS Program Parameters: Scenario ECCC-TT

Calendar Year	Units	2022	2026	2028	2030
Program Goals					
2016 Stream Carbon Intensity	tCO2e/TJ	91.6	91.6	91.6	91.6
Credit Stream Carbon Intensity Reference	tCO2e/TJ	88.4	85.1	82.9	80.9
Obligated Fossil Fuel Carbon Intensity Reduction	tCO2e/TJ	2.4	7.2	9.6	12.0
Obligated Jet Fuel Carbon Intensity Reduction	tCO2e/TJ	2.4	7.2	9.6	12.0
Energy Economy Ratios					
Hydrogen (Gasoline)	Ratio	2.1	2.1	2.1	2.1
Hydrogen (Diesel)	Ratio	1.9	1.9	1.9	1.9
CNG (Diesel)	Ratio	1	1	1	1
EV (Gasoline)	Ratio	4.1	4.1	4.1	4.1
EV (Diesel)	Ratio	5	5	5	5
Energy Density of Fuels					
Gasoline	MJ/Liter	34.69	34.69	34.69	34.69
Diesel	MJ/Liter	38.65	38.65	38.65	38.65
Aviation Fuel	MJ/Liter	35.46	35.46	35.46	35.46
Ethanol	MJ/Liter	23.58	23.58	23.58	23.58
Biodiesel	MJ/Liter	35.40	35.40	35.40	35.40
Renewable Diesel (HDRD)	MJ/Liter	36.51	36.51	36.51	36.51
Biojet	MJ/Liter	34.81	34.81	34.81	34.81
Electricity	MJ/kWh	3.60	3.60	3.60	3.60
LFO	MJ/Liter	38.80	38.80	38.80	38.80
Kerosene	MJ/Liter	37.68	37.68	37.68	37.68
Pyrolisis Oil (Biocrude)	MJ/Liter	21.35	21.35	21.35	21.35
HFO	MJ/Liter	41.10	41.10	41.10	41.10

Canada CFS Carbon Intensity Average Scores: Scenario ECCC-TT

Calendar Year	Units	2022	2026	2028	2030
Motor gasoline	tCO2e/TJ	91.9	91.9	91.9	91.9
Ethanol	tCO2e/TJ				
Ethanol from corn	tCO2e/TJ	44.1	41.9	40.9	39.8
Ethanol from wheat	tCO2e/TJ	38.6	37.0	36.2	35.3
Diesel fuel oil	tCO2e/TJ	97.1	97.1	97.1	97.1
Biodiesel	tCO2e/TJ				
Biodiesel from canola oil	tCO2e/TJ	9.6	9.1	8.8	8.6
Biodiesel from inedible tallow	tCO2e/TJ	-1.2	-1.7	-1.9	-2.1
Biodiesel from soybean oil	tCO2e/TJ	16.8	16.1	15.8	15.5
Biodiesel from yellow grease	tCO2e/TJ	4.2	3.9	3.8	3.7
Biodiesel from distillers corn oil	tCO2e/TJ	16.7	15.9	15.4	15.0
Biodiesel from unknown	tCO2e/TJ	3.8	3.8	3.8	3.8
Renewable diesel (HDRD) (weighted avg)	tCO2e/TJ				
Renewable diesel from palm oil	tCO2e/TJ	71.7	70.3	69.6	68.9
Renewable diesel from canola oil	tCO2e/TJ	9.6	9.1	8.8	8.6
Renewable diesel from palm sludge oil	tCO2e/TJ	11.2	11.0	10.9	10.9
Renewable diesel from tallow	tCO2e/TJ	7.2	6.9	6.7	6.5
Renewable diesel from yellow grease	tCO2e/TJ	12.7	12.4	12.3	12.2
Renewable diesel from soybean oil	tCO2e/TJ	30.8	30.0	29.6	29.2
Renewable diesel from spent bleaching earth	tCO2e/TJ	18.6	18.0	17.8	17.5
Light fuel oil	tCO2e/TJ	87.0	87.0	87.0	87.0
Kerosene & stove oil	tCO2e/TJ	82.0	82.0	82.0	82.0
Heavy fuel oil	tCO2e/TJ	91.0	91.0	91.0	91.0
Pyrolisis Oil (Biocrude)	tCO2e/TJ	25.0	21.0	19.0	17.0
Aviation gasoline	tCO2e/TJ	94.0	94.0	94.0	94.0
Aviation turbo fuel	tCO2e/TJ	90.1	90.1	90.1	90.1
Biojet	tCO2e/TJ	30.0	30.0	30.0	30.0
Propane Vehicle	tCO2e/TJ	68.0	68.0	68.0	68.0
Natural Gas Vehicle	tCO2e/TJ	62.9	62.9	62.9	62.9
EV (Gasoline)	tCO2e/TJ	21.7	21.7	21.7	21.7

Canada Fuel Consumption Volumes in Million Liters: Scenario ECCC-TT

Calendar Year	Units	2022	2026	2028	2030
Blended Gasoline (volumetric total)	million liters	41,689	38,966	38,129	37,633
Motor gasoline	million liters	38,185	35,670	34,370	33,215
Ethanol	million liters	3,505	3,295	3,759	4,418
Ethanol from corn	million liters	2,946	2,834	3,239	3,835
Ethanol from wheat	million liters	559	461	520	583
Blended Diesel (volumetric total)	million liters	32,175	32,123	32,062	32,080
Diesel fuel oil	million liters	31,339	31,063	30,551	30,014
Biomass Based Diesel	million liters	837	1,060	1,512	2,066
Biodiesel	million liters	432	461	611	758
Biodiesel from canola oil	million liters	236	247	346	451
Biodiesel from inedible tallow	million liters	0	0	0	0
Biodiesel from soybean oil	million liters	153	168	204	231
Biodiesel from yellow grease	million liters	30	32	43	53
Biodiesel from distillers corn oil	million liters	13	14	19	23
Biodiesel made from unknown	million liters	0	0	0	0
Renewable Diesel (HDRD)	million liters	404	599	901	1,308
Renewable diesel made from palm oil	million liters	11	11	11	11
Renewable diesel made from canola oil	million liters	0	187	454	793
Renewable diesel made from palm sludge oil	million liters	0	0	0	0
Renewable diesel made from tallow	million liters	293	287	295	325
Renewable diesel made from yellow grease	million liters	68	66	68	74
Renewable diesel made from soybean oil	million liters	7	24	48	78
Renewable diesel made from spent bleaching earth	million liters	26	25	26	28
Blended Light Fuel Oil		2,057	1,903	1,833	1,762
Light diesel fuel oil	million liters	2,012	1,848	1,757	1,661
Biomass Based Diesel	million liters	44	55	77	101
Biodiesel	million liters	23	26	34	42
Biodiesel from canola oil	million liters	13	14	19	25
Biodiesel from inedible tallow	million liters	0	0	0	0
Biodiesel from soybean oil	million liters	8	9	11	13
Biodiesel from yellow grease	million liters	2	2	2	3
Biodiesel from distillers corn oil	million liters	1	1	1	1
Biodiesel from unknown	million liters	0	0	0	0
Renewable Diesel (HDRD)	million liters	21	29	43	60
Renewable diesel made from palm oil	million liters	1	1	1	1
Renewable diesel made from canola oil	million liters	0	9	22	36
Renewable diesel made from palm sludge oil	million liters	0	0	0	0
Renewable diesel made from tallow	million liters	15	14	14	15
Renewable diesel made from yellow grease	million liters	4	3	3	3
Renewable diesel made from soybean oil	million liters	0	1	2	4
Renewable diesel made from spent bleaching earth	million liters	1	1	1	1
Blended Heavy Fuel Oil		2,672	2,628	2,617	2,616
Heavy fuel oil	million liters	2,429	2,389	2,379	2,378
Pyrolisis Oil (Biocrude)	million liters	243	239	238	238
Blended Jet Fuel		8,577	8,817	9,018	9,254
Aviation turbo fuel	million liters	8,492	8,729	8,929	9,162
Biojet	million liters	85	87	89	92
Kerosene & stove oil	million liters	443	409	395	383

Canada Fuel Consumption Volumes in Terajoules: Scenario ECCC-TT

Calendar Year	Units	2022	2026	2028	2030
Blended Gasoline	terajoules	1,407,269	1,315,108	1,280,934	1,256,407
Motor Gasoline	terajoules	1,324,623	1,237,405	1,192,308	1,152,239
Ethanol	terajoules	82,646	77,703	88,626	104,169
Ethanol from corn	terajoules	69,472	66,835	76,365	90,430
Ethanol from wheat	terajoules	13,174	10,868	12,261	13,738
Blended Diesel	terajoules	1,241,308	1,238,776	1,235,292	1,234,628
Diesel fuel oil	terajoules	1,211,233	1,200,571	1,180,777	1,160,026
Biodiesel	terajoules	15,308	16,328	21,634	26,829
Biodiesel from canola oil	terajoules	8,371	8,743	12,234	15,958
Biodiesel from inedible tallow	terajoules	0	0	0	0
Biodiesel from soybean oil	terajoules	5,404	5,949	7,233	8,183
Biodiesel from yellow grease	terajoules	1,068	1,139	1,509	1,872
Biodiesel from distillers corn oil	terajoules	465	496	658	815
Biodiesel from unknown	terajoules	0	0	0	0
Renewable Diesel (HDRD)	terajoules	14,767	21,878	32,880	47,773
Renewable diesel made from palm oil	terajoules	406	391	391	405
Renewable diesel made from canola oil	terajoules	0	6,830	16,559	28,953
Renewable diesel made from palm sludge oil	terajoules	0	0	0	0
Renewable diesel made from tallow	terajoules	10,710	10,465	10,782	11,865
Renewable diesel made from yellow grease	terajoules	2,473	2,422	2,480	2,685
Renewable diesel made from soybean oil	terajoules	243	858	1,734	2,850
Renewable diesel made from spent bleaching earth	terajoules	935	911	933	1,014
Blended Light Fuel Oil	terajoules	79,665	73,678	70,918	68,097
Light fuel oil	terajoules	78,070	71,699	68,158	64,448
Biodiesel	terajoules	824	907	1,200	1,469
Biodiesel from canola oil	terajoules	451	485	679	874
Biodiesel from inedible tallow	terajoules	0	0	0	0
Biodiesel from soybean oil	terajoules	291	330	401	448
Biodiesel from yellow grease	terajoules	58	63	84	103
Biodiesel from distillers corn oil	terajoules	25	28	36	45
Biodiesel from unknown	terajoules	0	0	0	0
Renewable Diesel (HDRD)	terajoules	771	1,072	1,560	2,180
Renewable diesel made from palm oil	terajoules	21	19	19	18
Renewable diesel made from canola oil	terajoules	0	335	785	1,321
Renewable diesel made from palm sludge oil	terajoules	0	0	0	0
Renewable diesel made from tallow	terajoules	559	513	511	541
Renewable diesel made from yellow grease	terajoules	129	119	118	123
Renewable diesel made from soybean oil	terajoules	13	42	82	130
Renewable diesel made from spent bleaching earth	terajoules	49	45	44	46
Blended Heavy Fuel Oil	terajoules	105,011	103,270	102,863	102,825
Heavy fuel oil	terajoules	99,825	98,170	97,783	97,747
Pyrolisis Oil (Biocrude)	terajoules	5,186	5,100	5,080	5,078
Blended Jet Fuel	terajoules	304,091	312,578	319,725	328,089
Aviation turbo fuel	terajoules	301,135	309,540	316,617	324,899
Biojet	terajoules	2,956	3,039	3,108	3,189
Kerosene & stove oil	terajoules	16,688	15,420	14,886	14,418
Propane Vehicle	terajoules	7,585	12,292	14,646	17,000
Natural Gas Vehicle	terajoules	6,246	10,123	12,062	14,000
Electric Vehicles (Gasoline) Assumption	terajoules	3,476	4,095	4,487	4,904
Electric Vehicles (Diesel) Assumption	terajoules	2,655	3,116	3,406	3,713

Canada Fuel Blend Rates: Scenario ECCC-TT

Calendar Year	Units	2022	2026	2028	2030
Ethanol in gasoline	% by Volume	8.4%	8.5%	9.9%	11.7%
Biomass based diesel in diesel	% by Volume	2.6%	3.3%	4.7%	6.4%
Biodiesel in diesel	% by Volume	1.3%	1.4%	1.9%	2.4%
Renewable Diesel (HDRD) in diesel	% by Volume	1.3%	1.9%	2.8%	4.1%
Biomass based diesel in LFO	% by Volume	2.2%	2.9%	4.2%	5.7%
Biodiesel in LFO	% by Volume	1.1%	1.3%	1.8%	2.4%
Renewable Diesel (HDRD) in LFO	% by Volume	1.0%	1.5%	2.3%	3.4%
Pyrolisis oil (Biocrude) in HFO	% by Volume	9.1%	9.1%	9.1%	9.1%
Biojet in aviation turbo fuel	% by Volume	1.0%	1.0%	1.0%	1.0%
Ethanol in gasoline	% by Energy	5.9%	5.9%	6.9%	8.3%
Biomass based diesel in diesel	% by Energy	2.4%	3.1%	4.4%	6.0%
Biodiesel in diesel	% by Energy	1.2%	1.3%	1.8%	2.2%
Renewable Diesel (HDRD) in diesel	% by Energy	1.2%	1.8%	2.7%	3.9%
Biomass based diesel in LFO	% by Energy	2.0%	2.7%	3.9%	5.4%
Biodiesel in LFO	% by Energy	1.0%	1.2%	1.7%	2.2%
HDRD in LFO	% by Energy	1.0%	1.5%	2.2%	3.2%
Pyrolisis oil (Biocrude) in HFO	% by Energy	4.9%	4.9%	4.9%	4.9%
Biojet in aviation turbo fuel	% by Energy	1.0%	1.0%	1.0%	1.0%

Canada CFS Compliance Credits and Debits: Scenario ECCC-TT

Calendar Year	Units	2022	2026	2028	2030
Debits					
Fossil Fuels					
Motor Gasoline	tCO2e	1,589,547	8,909,319	11,446,155	13,826,864
Diesel fuel oil	tCO2e	1,453,480	8,644,108	11,335,462	13,920,311
Light fuel oil	tCO2e	93,684	516,230	654,318	773,375
Heavy fuel oil	tCO2e	119,790	706,824	938,719	1,172,964
Aviation turbo fuel (Domestic Only)	tCO2e	115,636	713,179	972,648	1,247,613
Kerosene & stove oil	tCO2e	20,025	111,021	142,906	173,015
Total Debits	tCO2e	3,392,162	19,600,681	25,490,209	31,114,141
CFS Compliance Credits					
Compliance Category 1					
CCS	tCO2e	1,300,000	2,650,000	3,325,000	4,000,000
Upstream Improvements	tCO2e	0	500,000	750,000	1,000,000
Reductions in Refineries	tCO2e	200,000	600,000	800,000	1,000,000
Incremental Methane Reductions - Conventional Oil	tCO2e	546,746	1,273,373	1,636,687	2,000,000
Subtotal Compliance Category 1	tCO2e	2,046,746	5,023,373	6,511,687	8,000,000
Compliance Category 2					
Bank Renewable Fuel Regulation (RFR)	tCO2e	1,400,000	0	0	0
Ethanol	tCO2e	3,734,951	3,404,715	3,786,364	4,339,856
Ethanol from corn	tCO2e	3,079,226	2,882,146	3,212,704	3,714,184
Ethanol from wheat	tCO2e	655,725	522,569	573,660	625,673
Biodiesel	tCO2e	1,232,938	1,267,698	1,642,235	1,990,185
Biodiesel from canola oil	tCO2e	695,432	701,204	956,912	1,216,683
Biodiesel from inedible tallow	tCO2e	0	0	0	0
Biodiesel from soybean oil	tCO2e	407,633	432,726	512,424	564,439
Biodiesel from yellow grease	tCO2e	94,726	97,522	126,053	152,417
Biodiesel from distillers corn oil	tCO2e	35,147	36,246	46,846	56,645
Biodiesel from unknown	tCO2e	0	0	0	0
Renewable Diesel (HDRD)	tCO2e	1,202,417	1,707,164	2,496,053	3,530,009
Renewable diesel from palm oil	tCO2e	7,123	6,049	5,472	5,078
Renewable diesel from canola oil	tCO2e	0	544,416	1,285,307	2,188,301
Renewable diesel from palm sludge oil	tCO2e	0	0	0	0
Renewable diesel from tallow	tCO2e	914,869	858,560	861,228	922,711
Renewable diesel from yellow grease	tCO2e	197,026	184,500	183,487	192,859
Renewable diesel from soybean oil	tCO2e	14,722	49,562	96,841	153,878
Renewable diesel from spent bleaching earth	tCO2e	68,678	64,077	63,717	67,181
Pyrolisis Oil (Biocrude)	tCO2e	328,698	326,667	324,780	324,339
Biojet	tCO2e	172,590	167,289	164,531	162,254
Subtotal Compliance Category 2	tCO2e	8,071,594	6,873,532	8,413,962	10,346,643
Compliance Category 3					
Diesel Displaced by Propane	tCO2e	154,600	209,628	218,747	218,830
Diesel Displaced by Natural Gas	tCO2e	159,173	224,262	241,659	251,613
Gasoline Displaced by Electric Vehicles	tCO2e	1,200,000	1,333,333	1,416,667	1,500,000
Diesel Displaced by Electric Vehicles	tCO2e	1,200,000	1,333,333	1,416,667	1,500,000
Subtotal Compliance Category 3	tCO2e	2,713,774	3,100,557	3,293,740	3,470,443
External Credit Sources					
Cross Steam Credits	tCO2e	339,216	1,960,068	2,549,021	3,111,414
Compliance Fund	tCO2e	0	1,500,000	2,250,000	3,000,000
Emerging Tech Credit Generation	tCO2e	0	1,000,000	1,500,000	2,000,000
Total Credits		13,171,330	19,457,530	24,518,409	29,928,500
Banked for the Year	tCO2e	9,779,168	1,356,849	1,278,201	1,814,358
Running Net Credit Balance	tCO2e	9,779,168	17,774,641	16,082,365	13,820,617
CFS Compliance Credit Price	C$/MT	24	15	48	94
Maximum CFS Compliance Credit Price	C$/MT	350	368	377	387

Value of Canada Compliance Credits By Feedstock Pathway: Scenario ECCC-TT

	Calendar Year	Units	2022	2026	2028	2030
Ethanol						
Ethanol from corn		C$/liter	0.03	0.01	0.05	0.09
Ethanol from wheat		C$/liter	0.03	0.02	0.05	0.10
Biodiesel						
Biodiesel from canola oil		C$/liter	0.07	0.04	0.13	0.24
Biodiesel from inedible tallow		C$/liter	0.08	0.04	0.15	0.28
Biodiesel from soybean oil		C$/liter	0.06	0.04	0.12	0.22
Biodiesel from yellow grease		C$/liter	0.07	0.04	0.14	0.26
Biodiesel from distillers corn oil		C$/liter	0.06	0.04	0.12	0.22
Renewable Diesel		C$/liter				
Renewable Diesel from palm oil		C$/liter	0.01	0.01	0.02	0.04
Renewable Diesel from canola oil		C$/liter	0.07	0.04	0.13	0.25
Renewable diesel from palm sludge oil		C$/liter	0.07	0.04	0.13	0.24
Renewable diesel from tallow		C$/liter	0.07	0.04	0.13	0.25
Renewable diesel from yellow grease		C$/liter	0.07	0.04	0.12	0.24
Renewable diesel from soybean oil		C$/liter	0.05	0.03	0.09	0.18
Renewable diesel from spent bleaching earth		C$/liter	0.06	0.04	0.12	0.22

Biofuel Feedstocks Used for Canadian Domestic Consumption: Scenario ECCC-TT

	Calendar Year	Units	2022	2026	2028	2030
Ethanol Feedstocks						
Corn		1000 MT	2,946	2,834	3,239	3,835
Wheat		1000 MT	559	461	520	583
Biodiesel Feedstocks						
Canola Oil		1000 MT	224	234	328	427
Inedible Tallow		1000 MT	0	0	0	0
Soybean Oil		1000 MT	145	159	194	219
Yellow Grease		1000 MT	30	33	43	53
Distillers Corn Oil		1000 MT	12	13	18	22
Unknown		1000 MT	0	0	0	0
Renewable Diesel Feedstocks						
Feedstocks Used for Domestic Production						
Canola Oil		1000 MT	0	196	475	829
Feedstocks Used for Imports (Approximation)						
Palm Oil		1000 MT	11	11	11	11
Palm Sludge Oil		1000 MT	0	0	0	0
Inedible Tallow		1000 MT	293	286	294	323
Yellow Grease		1000 MT	68	66	68	73
Soybean Oil		1000 MT				
Spent Bleaching Earth		1000 MT	26	25	25	28

Canada Grains Supply and Demand: Scenario ECCC-TT

	Units	22/23	24/25	26/27	28/29	30/31
Corn						
Area Harvested	1000 ha	1,415	1,421	1,419	1,419	1,420
Yield	mt per ha	9.98	10.21	10.44	10.67	10.90
Supply						
Beginning Stocks	1000 mt	2,211	2,234	2,285	2,348	2,392
Production	1000 mt	14,116	14,499	14,810	15,130	15,476
Imports	1000 mt	2,076	1,752	1,917	2,756	3,416
Total Supply	1000 mt	18,403	18,485	19,012	20,234	21,284
Domestic Disappearance						
Feed & Residual Use	1000 mt	8,976	9,084	9,224	9,283	9,295
Food, Seed, and Industrial Use	1000 mt	6,557	6,507	6,831	7,940	8,926
Bioethanol Use	1000 mt	3,933	3,841	4,104	5,160	6,090
Total Domestic Disappearance	1000 mt	15,532	15,590	16,055	17,223	18,221
Exports	1000 mt	641	641	641	641	641
Ending Stocks	1000 mt	2,230	2,254	2,317	2,370	2,423
Wheat						
Area Harvested	1000 ha	9,787	9,843	9,834	9,788	9,774
Yield	mt per ha	3.38	3.43	3.47	3.51	3.56
Supply						
Beginning Stocks	1000 mt	6,743	6,935	7,227	7,646	7,977
Production	1000 mt	33,090	33,714	34,119	34,392	34,773
Imports	1000 mt	501	501	501	501	501
Total Supply	1000 mt	40,333	41,150	41,847	42,538	43,251
Domestic Disappearance						
Feed & Residual Use	1000 mt	5,159	5,168	5,225	5,196	5,178
Food, Seed, and Industrial Use	1000 mt	5,502	5,428	5,406	5,765	6,095
Bioethanol Use	1000 mt	1,419	1,297	1,215	1,522	1,799
Total Domestic Disappearance	1000 mt	10,662	10,596	10,631	10,961	11,273
Exports	1000 mt	22,797	23,545	23,760	23,787	23,798
Ending Stocks	1000 mt	6,875	7,010	7,457	7,790	8,180
Grain Prices						
Barley, #1 Feed, Alberta	CAD/mt	205	213	213	216	218
Barley Farm Price	CAD/mt	236	241	242	244	245
Corn #2, CE Cash, Chatham	CAD/mt	178	187	189	194	198
Wheat, Western Red Spring, 12.5% Protein	CAD/mt	207	232	239	255	267
Wheat Producer Price, Ontario	CAD/mt	216	241	248	264	276

Canada Canola and Canola Products Supply and Demand: Scenario ECCC-TT

	Units	22/23	24/25	26/27	28/29	30/31
Canola						
Area Harvested	1000 ha	8,040	7,900	7,815	7,922	8,038
Yield	mt per ha	2.36	2.40	2.45	2.49	2.54
Supply						
Beginning Stocks	1000 mt	3,547	3,188	3,182	3,277	3,419
Production	1000 mt	18,978	18,996	19,137	19,750	20,392
Imports	1000 mt	150	150	150	150	150
Total Supply	1000 mt	22,675	22,334	22,469	23,177	23,961
Domestic Disappearance						
Crush	1000 mt	9,688	9,612	9,592	9,831	10,124
Food	1000 mt	0	0	0	0	0
Feed, Seed, Waste	1000 mt	509	508	510	509	509
Total Domestic Disappearance	1000 mt	10,197	10,120	10,102	10,340	10,634
Exports	1000 mt	9,251	9,035	9,128	9,483	9,823
Ending Stocks	1000 mt	3,228	3,179	3,239	3,355	3,504
Canola Meal						
Extraction Rate	kg/kg	0.56	0.56	0.56	0.56	0.56
Supply						
Beginning Stocks	1000 mt	59	53	51	53	58
Production	1000 mt	5,466	5,424	5,412	5,547	5,713
Imports	1000 mt	5	5	5	5	5
Total Supply	1000 mt	5,530	5,482	5,468	5,605	5,776
Domestic Disappearance						
Food	1000 mt	0	0	0	0	0
Feed & Residual	1000 mt	690	699	717	741	769
Industrial	1000 mt	0	0	0	0	0
Total Domestic Disappearance	1000 mt	690	699	717	741	769
Exports	1000 mt	4,785	4,730	4,699	4,809	4,945
Ending Stocks	1000 mt	55	52	51	56	62
Canola Oil						
Extraction Rate	kg/kg	0.44	0.44	0.44	0.44	0.44
Supply						
Beginning Stocks	1000 mt	339	333	341	345	344
Production	1000 mt	4,306	4,273	4,264	4,370	4,500
Imports	1000 mt	16	16	16	16	16
Total Supply	1000 mt	4,661	4,622	4,621	4,731	4,861
Domestic Disappearance						
Food	1000 mt	697	706	717	716	716
Feed & Residual	1000 mt	0	0	0	0	0
Industrial	1000 mt	418	474	606	977	1,321
Total Domestic Disappearance	1000 mt	1,115	1,179	1,323	1,693	2,037
Exports	1000 mt	3,210	3,106	2,952	2,693	2,477
Ending Stocks	1000 mt	335	337	346	345	347
Canola and Derivative Prices						
Canola Average Farm Price, Saskatchewan	CAD/mt	458	475	476	494	505
Canola Seed Average Price, Pacific Coast	CAD/mt	485	503	504	523	534
Canola Oil FOB Plants, Crude Degummed	CAD/mt	822	825	809	862	904
Canola Meal FOB Plant	CAD/mt	335	353	361	361	353

Table Results for Scenario EV-CC3

Canada Ethanol Supply and Demand: Scenario EV-CC3

Calendar Year	Units	2022	2024	2026	2028	2030
Supply & Demand						
Beginning Stocks	Million Liters	0	0	0	0	0
Production	Million Liters	2,314	2,186	2,268	2,794	3,371
Imports	Million Liters	1,203	1,291	1,266	1,277	1,302
Total Supply	Million Liters	3,517	3,476	3,533	4,071	4,673
Domestic Use	Million Liters	3,502	3,462	3,519	4,057	4,658
Exports	Million Liters	14	14	14	14	14
Ending Stocks	Million Liters	0	0	0	0	0
Total Demand	Million Liters	3,517	3,476	3,533	4,071	4,673
Feedstocks						
Corn	1000 Metric Tons	4,160	3,967	4,211	5,180	6,287
Wheat	1000 Metric Tons	1,474	1,352	1,303	1,614	1,907
Feedstock Yield						
Corn	1000 Liters/MT	0.42	0.42	0.42	0.42	0.42
Wheat	1000 Liters/MT	0.39	0.39	0.39	0.39	0.39
Distillers' Grains Production						
Corn	1000 Metric Tons	1,263	1,204	1,278	1,573	1,909
Wheat	1000 Metric Tons	447	410	396	490	579
Wholesale Ethanol Price (excludes CFS Credit Value)	CAD/Liter	0.59	0.61	0.61	0.62	0.65

Canada Biomass Based Diesel Supply and Demand: Scenario EV-CC3

Calendar Year	Units	2022	2024	2026	2028	2030
Biodiesel Supply & Use						
Beginning Stocks	Million Liters	0	0	0	0	0
Production	Million Liters	411	393	431	521	613
Imports	Million Liters	346	355	422	497	545
Total Supply	Million Liters	756	748	852	1,017	1,158
Domestic Use	Million Liters	460	453	558	721	859
Exports	Million Liters	296	295	294	296	298
Ending Stocks	Million Liters	0	0	0	0	0
Total Demand	Million Liters	756	748	852	1,017	1,158
Renewable Diesel Supply & Use						
Beginning Stocks	Million Liters	0	0	0	0	0
Production	Million Liters	0	200	354	690	1,039
Imports	Million Liters	426	426	419	442	480
Total Supply	Million Liters	426	626	773	1,132	1,519
Domestic Use	Million Liters	426	626	773	1,132	1,519
Exports	Million Liters	0	0	0	0	0
Ending Stocks	Million Liters	0	0	0	0	0
Total Demand	Million Liters	426	626	773	1,132	1,519
Domestic Feedstocks						
Canola Oil (Biodiesel Plants)	1000 Metric Tons	260	245	271	324	379
Canola Oil (Renewable Diesel Plants)	1000 Metric Tons	0	183	325	633	954
Inedible Tallow	1000 Metric Tons	0	0	0	4	9
Soybean Oil	1000 Metric Tons	71	70	76	90	104
Yellow Grease	1000 Metric Tons	26	26	28	33	39
Choice White Grease	1000 Metric Tons	0	0	0	0	0
Domestic Feedstock Yield						
Canola Oil	1000 Liters/MT	1.11	1.11	1.11	1.11	1.11
Inedible Tallow	1000 Liters/MT	1.04	1.04	1.04	1.04	1.04
Soybean Oil	1000 Liters/MT	1.11	1.11	1.11	1.11	1.11
Yellow Grease	1000 Liters/MT	1.04	1.04	1.04	1.04	1.04
Choice White Grease	1000 Liters/MT	0.00	0.00	0.00	0.00	0.00
Biomass-based Diesel Prices						
BC/AB Canada B99 Rack Price	CAD/Liter	0.71	0.74	0.74	0.80	0.86
Canada HDRD Wholesale Price	CAD/Liter	1.40	1.43	1.43	1.49	1.56

Canada CFS Program Parameters: Scenario EV-CC3

Calendar Year	Units	2022	2026	2028	2030
Program Goals					
2016 Stream Carbon Intensity	tCO2e/TJ	91.6	91.6	91.6	91.6
Credit Stream Carbon Intensity Reference	tCO2e/TJ	88.4	85.1	83.0	80.9
Obligated Fossil Fuel Carbon Intensity Reduction	tCO2e/TJ	2.4	7.2	9.6	12.0
Obligated Jet Fuel Carbon Intensity Reduction	tCO2e/TJ	2.4	7.2	9.6	12.0
Energy Economy Ratios					
Hydrogen (Gasoline)	Ratio	2.1	2.1	2.1	2.1
Hydrogen (Diesel)	Ratio	1.9	1.9	1.9	1.9
CNG (Diesel)	Ratio	1	1	1	1
EV (Gasoline)	Ratio	4.1	4.1	4.1	4.1
EV (Diesel)	Ratio	5	5	5	5
Energy Density of Fuels					
Gasoline	MJ/Liter	34.69	34.69	34.69	34.69
Diesel	MJ/Liter	38.65	38.65	38.65	38.65
Aviation Fuel	MJ/Liter	35.46	35.46	35.46	35.46
Ethanol	MJ/Liter	23.58	23.58	23.58	23.58
Biodiesel	MJ/Liter	35.40	35.40	35.40	35.40
Renewable Diesel (HDRD)	MJ/Liter	36.51	36.51	36.51	36.51
Biojet	MJ/Liter	34.81	34.81	34.81	34.81
Electricity	MJ/kWh	3.60	3.60	3.60	3.60
LFO	MJ/Liter	38.80	38.80	38.80	38.80
Kerosene	MJ/Liter	37.68	37.68	37.68	37.68
Pyrolisis Oil (Biocrude)	MJ/Liter	21.35	21.35	21.35	21.35
HFO	MJ/Liter	41.10	41.10	41.10	41.10

Canada CFS Carbon Intensity Average Scores: Scenario EV-CC3

Calendar Year	Units	2022	2026	2028	2030
Motor gasoline	tCO2e/TJ	91.9	91.9	91.9	91.9
Ethanol	tCO2e/TJ				
Ethanol from corn	tCO2e/TJ	44.1	41.9	40.9	39.8
Ethanol from wheat	tCO2e/TJ	38.6	37.0	36.2	35.3
Diesel fuel oil	tCO2e/TJ	97.1	97.1	97.1	97.1
Biodiesel	tCO2e/TJ				
Biodiesel from canola oil	tCO2e/TJ	9.6	9.1	8.8	8.6
Biodiesel from inedible tallow	tCO2e/TJ	-1.2	-1.7	-1.9	-2.1
Biodiesel from soybean oil	tCO2e/TJ	16.8	16.1	15.8	15.5
Biodiesel from yellow grease	tCO2e/TJ	4.2	3.9	3.8	3.7
Biodiesel from distillers corn oil	tCO2e/TJ	16.7	15.9	15.4	15.0
Biodiesel from unknown	tCO2e/TJ	3.8	3.8	3.8	3.8
Renewable diesel (HDRD) (weighted avg)	tCO2e/TJ				
Renewable diesel from palm oil	tCO2e/TJ	71.7	70.3	69.6	68.9
Renewable diesel from canola oil	tCO2e/TJ	9.6	9.1	8.8	8.6
Renewable diesel from palm sludge oil	tCO2e/TJ	11.2	11.0	10.9	10.9
Renewable diesel from tallow	tCO2e/TJ	7.2	6.9	6.7	6.5
Renewable diesel from yellow grease	tCO2e/TJ	12.7	12.4	12.3	12.2
Renewable diesel from soybean oil	tCO2e/TJ	30.8	30.0	29.6	29.2
Renewable diesel from spent bleaching earth	tCO2e/TJ	18.6	18.0	17.8	17.5
Light fuel oil	tCO2e/TJ	87.0	87.0	87.0	87.0
Kerosene & stove oil	tCO2e/TJ	82.0	82.0	82.0	82.0
Heavy fuel oil	tCO2e/TJ	91.0	91.0	91.0	91.0
Pyrolisis Oil (Biocrude)	tCO2e/TJ	25.0	21.0	19.0	17.0
Aviation gasoline	tCO2e/TJ	94.0	94.0	94.0	94.0
Aviation turbo fuel	tCO2e/TJ	90.1	90.1	90.1	90.1
Biojet	tCO2e/TJ	30.0	30.0	30.0	30.0
Propane Vehicle	tCO2e/TJ	68.0	68.0	68.0	68.0
Natural Gas Vehicle	tCO2e/TJ	62.9	62.9	62.9	62.9
EV (Gasoline)	tCO2e/TJ	21.7	21.7	21.7	21.7

Canada Fuel Consumption Volumes in Million Liters: Scenario EV-CC3

Calendar Year	Units	2022	2026	2028	2030
Blended Gasoline (volumetric total)	million liters	41,689	38,949	38,042	37,427
Motor gasoline	million liters	38,186	35,430	33,985	32,769
Ethanol	million liters	3,502	3,519	4,057	4,658
Ethanol from corn	million liters	2,944	3,027	3,495	4,044
Ethanol from wheat	million liters	558	492	561	614
Blended Diesel (volumetric total)	million liters	32,176	32,076	31,954	31,901
Diesel fuel oil	million liters	31,335	30,810	30,190	29,633
Biomass Based Diesel	million liters	841	1,266	1,764	2,268
Biodiesel	million liters	437	529	683	815
Biodiesel from canola oil	million liters	239	291	396	491
Biodiesel from inedible tallow	million liters	0	0	0	0
Biodiesel from soybean oil	million liters	154	185	218	242
Biodiesel from yellow grease	million liters	30	37	48	57
Biodiesel from distillers corn oil	million liters	13	16	21	25
Biodiesel made from unknown	million liters	0	0	0	0
Renewable Diesel (HDRD)	million liters	404	737	1,081	1,453
Renewable diesel made from palm oil	million liters	11	11	11	11
Renewable diesel made from canola oil	million liters	0	310	604	912
Renewable diesel made from palm sludge oil	million liters	0	0	0	0
Renewable diesel made from tallow	million liters	293	290	308	337
Renewable diesel made from yellow grease	million liters	68	67	70	76
Renewable diesel made from soybean oil	million liters	7	35	61	89
Renewable diesel made from spent bleaching earth	million liters	26	25	26	29
Blended Light Fuel Oil		2,057	1,904	1,834	1,763
Light diesel fuel oil	million liters	2,012	1,838	1,745	1,652
Biomass Based Diesel	million liters	45	65	89	111
Biodiesel	million liters	24	29	38	45
Biodiesel from canola oil	million liters	13	16	22	27
Biodiesel from inedible tallow	million liters	0	0	0	0
Biodiesel from soybean oil	million liters	8	10	12	13
Biodiesel from yellow grease	million liters	2	2	3	3
Biodiesel from distillers corn oil	million liters	1	1	1	1
Biodiesel from unknown	million liters	0	0	0	0
Renewable Diesel (HDRD)	million liters	21	36	51	66
Renewable diesel made from palm oil	million liters	1	1	1	1
Renewable diesel made from canola oil	million liters	0	15	29	42
Renewable diesel made from palm sludge oil	million liters	0	0	0	0
Renewable diesel made from tallow	million liters	15	14	15	15
Renewable diesel made from yellow grease	million liters	4	3	3	3
Renewable diesel made from soybean oil	million liters	0	2	3	4
Renewable diesel made from spent bleaching earth	million liters	1	1	1	1
Blended Heavy Fuel Oil		2,672	2,628	2,617	2,616
Heavy fuel oil	million liters	2,429	2,389	2,379	2,378
Pyrolisis Oil (Biocrude)	million liters	243	239	238	238
Blended Jet Fuel		8,577	8,817	9,018	9,254
Aviation turbo fuel	million liters	8,492	8,729	8,929	9,162
Biojet	million liters	85	87	89	92
Kerosene & stove oil	million liters	443	409	395	383

Canada Fuel Consumption Volumes in Terajoules: Scenario EV-CC3

Calendar Year	Units	2022	2026	2028	2030
Blended Gasoline	terajoules	1,407,269	1,312,036	1,274,600	1,246,600
Motor Gasoline	terajoules	1,324,684	1,229,058	1,178,944	1,136,756
Ethanol	terajoules	82,585	82,978	95,655	109,843
Ethanol from corn	terajoules	69,420	71,373	82,421	95,357
Ethanol from wheat	terajoules	13,164	11,606	13,234	14,487
Blended Diesel	terajoules	1,241,308	1,236,439	1,230,483	1,227,201
Diesel fuel oil	terajoules	1,211,084	1,190,806	1,166,840	1,145,311
Biodiesel	terajoules	15,456	18,717	24,183	28,839
Biodiesel from canola oil	terajoules	8,446	10,308	14,030	17,390
Biodiesel from inedible tallow	terajoules	0	0	0	0
Biodiesel from soybean oil	terajoules	5,462	6,535	7,731	8,560
Biodiesel from yellow grease	terajoules	1,078	1,306	1,687	2,012
Biodiesel from distillers corn oil	terajoules	470	569	735	876
Biodiesel from unknown	terajoules	0	0	0	0
Renewable Diesel (HDRD)	terajoules	14,768	26,917	39,460	53,052
Renewable diesel made from palm oil	terajoules	406	392	396	409
Renewable diesel made from canola oil	terajoules	0	11,306	22,052	33,296
Renewable diesel made from palm sludge oil	terajoules	0	0	0	0
Renewable diesel made from tallow	terajoules	10,711	10,592	11,249	12,294
Renewable diesel made from yellow grease	terajoules	2,474	2,446	2,568	2,766
Renewable diesel made from soybean oil	terajoules	243	1,261	2,229	3,241
Renewable diesel made from spent bleaching earth	terajoules	935	921	967	1,045
Blended Light Fuel Oil	terajoules	79,665	73,678	70,918	68,097
Light fuel oil	terajoules	78,062	71,319	67,705	64,097
Biodiesel	terajoules	832	1,039	1,342	1,579
Biodiesel from canola oil	terajoules	455	572	778	952
Biodiesel from inedible tallow	terajoules	0	0	0	0
Biodiesel from soybean oil	terajoules	294	363	429	469
Biodiesel from yellow grease	terajoules	58	73	94	110
Biodiesel from distillers corn oil	terajoules	25	32	41	48
Biodiesel from unknown	terajoules	0	0	0	0
Renewable Diesel (HDRD)	terajoules	771	1,319	1,872	2,421
Renewable diesel made from palm oil	terajoules	21	19	19	19
Renewable diesel made from canola oil	terajoules	0	554	1,046	1,520
Renewable diesel made from palm sludge oil	terajoules	0	0	0	0
Renewable diesel made from tallow	terajoules	559	519	534	561
Renewable diesel made from yellow grease	terajoules	129	120	122	126
Renewable diesel made from soybean oil	terajoules	13	62	106	148
Renewable diesel made from spent bleaching earth	terajoules	49	45	46	48
Blended Heavy Fuel Oil	terajoules	105,011	103,270	102,863	102,825
Heavy fuel oil	terajoules	99,825	98,170	97,783	97,747
Pyrolisis Oil (Biocrude)	terajoules	5,186	5,100	5,080	5,078
Blended Jet Fuel	terajoules	304,091	312,578	319,725	328,089
Aviation turbo fuel	terajoules	301,135	309,540	316,617	324,899
Biojet	terajoules	2,956	3,039	3,108	3,189
Kerosene & stove oil	terajoules	16,688	15,420	14,886	14,418
Propane Vehicle	terajoules	7,585	12,292	14,646	17,000
Natural Gas Vehicle	terajoules	6,246	10,123	12,062	14,000
Electric Vehicles (Gasoline) Assumption	terajoules	3,476	7,167	10,821	14,711
Electric Vehicles (Diesel) Assumption	terajoules	2,655	5,452	8,214	11,140

Canada Fuel Blend Rates: Scenario EV-CC3

Calendar Year	Units	2022	2026	2028	2030
Ethanol in gasoline	% by Volume	8.4%	9.0%	10.7%	12.4%
Biomass based diesel in diesel	% by Volume	2.6%	3.9%	5.5%	7.1%
Biodiesel in diesel	% by Volume	1.4%	1.6%	2.1%	2.6%
Renewable Diesel (HDRD) in diesel	% by Volume	1.3%	2.3%	3.4%	4.6%
Biomass based diesel in LFO	% by Volume	2.2%	3.4%	4.9%	6.3%
Biodiesel in LFO	% by Volume	1.1%	1.5%	2.1%	2.5%
Renewable Diesel (HDRD) in LFO	% by Volume	1.0%	1.9%	2.8%	3.8%
Pyrolisis oil (Biocrude) in HFO	% by Volume	9.1%	9.1%	9.1%	9.1%
Biojet in aviation turbo fuel	% by Volume	1.0%	1.0%	1.0%	1.0%
Ethanol in gasoline	% by Energy	5.9%	6.3%	7.5%	8.8%
Biomass based diesel in diesel	% by Energy	2.4%	3.7%	5.2%	6.7%
Biodiesel in diesel	% by Energy	1.2%	1.5%	2.0%	2.3%
Renewable Diesel (HDRD) in diesel	% by Energy	1.2%	2.2%	3.2%	4.3%
Biomass based diesel in LFO	% by Energy	2.0%	3.2%	4.5%	5.9%
Biodiesel in LFO	% by Energy	1.0%	1.4%	1.9%	2.3%
HDRD in LFO	% by Energy	1.0%	1.8%	2.6%	3.6%
Pyrolisis oil (Biocrude) in HFO	% by Energy	4.9%	4.9%	4.9%	4.9%
Biojet in aviation turbo fuel	% by Energy	1.0%	1.0%	1.0%	1.0%

Canada CFS Compliance Credits and Debits: Scenario EV-CC3

Calendar Year	Units	2022	2026	2028	2030
Debits					
Fossil Fuels					
Motor Gasoline	tCO2e	1,589,621	8,849,217	11,317,866	13,641,077
Diesel fuel oil	tCO2e	1,453,300	8,573,801	11,201,664	13,743,730
Light fuel oil	tCO2e	93,675	513,497	649,965	769,163
Heavy fuel oil	tCO2e	119,790	706,824	938,719	1,172,964
Aviation turbo fuel (Domestic Only)	tCO2e	115,636	713,179	972,648	1,247,613
Kerosene & stove oil	tCO2e	20,025	111,021	142,906	173,015
Total Debits	tCO2e	3,392,046	19,467,539	25,223,768	30,747,561
CFS Compliance Credits					
Compliance Category 1					
CCS	tCO2e	1,300,000	2,150,000	2,575,000	3,000,000
Upstream Improvements	tCO2e	0	375,000	562,500	750,000
Reductions in Refineries	tCO2e	200,000	475,000	612,500	750,000
Incremental Methane Reductions - Conventional Oil	tCO2e	546,746	1,023,373	1,261,687	1,500,000
Subtotal Compliance Category 1	tCO2e	2,046,746	4,023,373	5,011,687	6,000,000
Compliance Category 2					
Bank Renewable Fuel Regulation (RFR)	tCO2e	1,400,000	0	0	0
Ethanol	tCO2e	3,732,176	3,637,508	4,089,894	4,580,429
Ethanol from corn	tCO2e	3,076,939	3,079,231	3,470,290	3,920,124
Ethanol from wheat	tCO2e	655,238	558,277	619,604	660,305
Biodiesel	tCO2e	1,244,818	1,455,702	1,839,227	2,142,151
Biodiesel from canola oil	tCO2e	701,697	826,905	1,097,877	1,326,537
Biodiesel from inedible tallow	tCO2e	0	0	0	0
Biodiesel from soybean oil	tCO2e	411,997	475,425	547,999	590,783
Biodiesel from yellow grease	tCO2e	95,641	111,816	140,965	163,913
Biodiesel from distillers corn oil	tCO2e	35,483	41,556	52,387	60,917
Biodiesel from unknown	tCO2e	0	0	0	0
Renewable Diesel (HDRD)	tCO2e	1,202,542	2,100,556	2,997,558	3,922,710
Renewable diesel from palm oil	tCO2e	7,123	6,079	5,545	5,145
Renewable diesel from canola oil	tCO2e	0	901,393	1,712,442	2,517,870
Renewable diesel from palm sludge oil	tCO2e	0	0	0	0
Renewable diesel from tallow	tCO2e	914,968	869,127	898,940	956,562
Renewable diesel from yellow grease	tCO2e	197,044	186,362	190,041	198,732
Renewable diesel from soybean oil	tCO2e	14,722	72,847	124,525	175,109
Renewable diesel from spent bleaching earth	tCO2e	68,685	64,749	66,066	69,292
Pyrolisis Oil (Biocrude)	tCO2e	328,698	326,766	324,952	324,531
Biojet	tCO2e	172,590	167,348	164,636	162,375
Subtotal Compliance Category 2	tCO2e	8,080,825	7,687,880	9,416,267	11,132,194
Compliance Category 3					
Diesel Displaced by Propane	tCO2e	154,600	209,867	219,243	219,472
Diesel Displaced by Natural Gas	tCO2e	159,173	224,460	242,067	252,142
Gasoline Displaced by Electric Vehicles	tCO2e	1,200,000	2,333,333	3,416,667	4,500,000
Diesel Displaced by Electric Vehicles	tCO2e	1,200,000	2,333,333	3,416,667	4,500,000
Subtotal Compliance Category 3	tCO2e	2,713,774	5,100,993	7,294,643	9,471,613
External Credit Sources					
Cross Steam Credits	tCO2e	339,205	1,946,754	2,522,377	3,074,756
Compliance Fund	tCO2e	0	0	0	0
Emerging Tech Credit Generation	tCO2e	0	0	0	0
Total Credits		13,180,549	18,759,000	24,244,974	29,678,564
Banked for the Year	tCO2e	9,788,503	-708,539	-978,794	-1,068,997
Running Net Credit Balance	tCO2e	9,788,503	13,475,921	11,587,486	9,519,138
CFS Compliance Credit Price	C$/MT	24	30	68	110
Maximum CFS Compliance Credit Price	C$/MT	350	368	377	387

Value of Canada Compliance Credits By Feedstock Pathway: Scenario EV-CC3

Calendar Year	Units	2022	2026	2028	2030
Ethanol					
Ethanol from corn	C$/liter	0.03	0.03	0.07	0.11
Ethanol from wheat	C$/liter	0.03	0.03	0.08	0.12
Biodiesel					
Biodiesel from canola oil	C$/liter	0.07	0.08	0.18	0.28
Biodiesel from inedible tallow	C$/liter	0.08	0.09	0.21	0.32
Biodiesel from soybean oil	C$/liter	0.06	0.07	0.16	0.25
Biodiesel from yellow grease	C$/liter	0.07	0.09	0.19	0.30
Biodiesel from distillers corn oil	C$/liter	0.06	0.07	0.16	0.26
Renewable Diesel	C$/liter				
Renewable Diesel from palm oil	C$/liter	0.01	0.02	0.03	0.05
Renewable Diesel from canola oil	C$/liter	0.07	0.08	0.18	0.29
Renewable diesel from palm sludge oil	C$/liter	0.07	0.08	0.18	0.28
Renewable diesel from tallow	C$/liter	0.07	0.09	0.19	0.30
Renewable diesel from yellow grease	C$/liter	0.07	0.08	0.18	0.28
Renewable diesel from soybean oil	C$/liter	0.05	0.06	0.13	0.21
Renewable diesel from spent bleaching earth	C$/liter	0.06	0.07	0.16	0.25

Biofuel Feedstocks Used for Canadian Domestic Consumption: Scenario ECCC-TT

Calendar Year	Units	2022	2026	2028	2030
Ethanol Feedstocks					
Corn	1000 MT	2,946	2,834	3,239	3,835
Wheat	1000 MT	559	461	520	583
Biodiesel Feedstocks					
Canola Oil	1000 MT	224	234	328	427
Inedible Tallow	1000 MT	0	0	0	0
Soybean Oil	1000 MT	145	159	194	219
Yellow Grease	1000 MT	30	33	43	53
Distillers Corn Oil	1000 MT	12	13	18	22
Unknown	1000 MT	0	0	0	0
Renewable Diesel Feedstocks					
Feedstocks Used for Domestic Production					
Canola Oil	1000 MT	0	196	475	829
Feedstocks Used for Imports (Approximation)					
Palm Oil	1000 MT	11	11	11	11
Palm Sludge Oil	1000 MT	0	0	0	0
Inedible Tallow	1000 MT	293	286	294	323
Yellow Grease	1000 MT	68	66	68	73
Soybean Oil	1000 MT				
Spent Bleaching Earth	1000 MT	26	25	25	28

Canada Grains Supply and Demand: Scenario EV-CC3

	Units	22/23	24/25	26/27	28/29	30/31
Corn						
Area Harvested	1000 ha	1,415	1,421	1,419	1,419	1,420
Yield	mt per ha	9.98	10.21	10.44	10.67	10.90
Supply						
Beginning Stocks	1000 mt	2,211	2,234	2,284	2,346	2,390
Production	1000 mt	14,116	14,499	14,811	15,131	15,477
Imports	1000 mt	2,145	1,837	2,346	3,178	3,757
Total Supply	1000 mt	18,472	18,570	19,442	20,655	21,625
Domestic Disappearance						
Feed & Residual Use	1000 mt	8,979	9,090	9,205	9,254	9,273
Food, Seed, and Industrial Use	1000 mt	6,623	6,586	7,281	8,392	9,290
Bioethanol Use	1000 mt	3,999	3,920	4,555	5,613	6,455
Total Domestic Disappearance	1000 mt	15,602	15,675	16,485	17,646	18,563
Exports	1000 mt	641	641	641	641	641
Ending Stocks	1000 mt	2,230	2,254	2,316	2,368	2,421
Wheat						
Area Harvested	1000 ha	9,787	9,843	9,837	9,792	9,778
Yield	mt per ha	3.38	3.43	3.47	3.51	3.56
Supply						
Beginning Stocks	1000 mt	6,743	6,935	7,221	7,636	7,967
Production	1000 mt	33,090	33,714	34,128	34,405	34,786
Imports	1000 mt	501	501	501	501	501
Total Supply	1000 mt	40,333	41,150	41,851	42,542	43,254
Domestic Disappearance						
Feed & Residual Use	1000 mt	5,159	5,168	5,204	5,174	5,160
Food, Seed, and Industrial Use	1000 mt	5,518	5,444	5,567	5,934	6,230
Bioethanol Use	1000 mt	1,436	1,313	1,376	1,692	1,934
Total Domestic Disappearance	1000 mt	10,677	10,612	10,771	11,108	11,390
Exports	1000 mt	22,783	23,530	23,632	23,656	23,694
Ending Stocks	1000 mt	6,874	7,008	7,448	7,778	8,170
Grain Prices						
Barley, #1 Feed, Alberta	CAD/mt	205	213	213	216	219
Barley Farm Price	CAD/mt	236	241	242	244	246
Corn #2, CE Cash, Chatham	CAD/mt	178	187	189	194	198
Wheat, Western Red Spring, 12.5% Protein	CAD/mt	207	232	240	256	268
Wheat Producer Price, Ontario	CAD/mt	216	241	248	265	276

Canada Canola and Canola Products Supply and Demand: Scenario EV-CC3

	Units	22/23	24/25	26/27	28/29	30/31
Canola						
Area Harvested	1000 ha	8,045	7,907	7,854	7,972	8,080
Yield	mt per ha	2.36	2.40	2.45	2.49	2.54
Supply						
Beginning Stocks	1000 mt	3,547	3,189	3,188	3,294	3,436
Production	1000 mt	18,989	19,013	19,232	19,874	20,499
Imports	1000 mt	150	150	150	150	150
Total Supply	1000 mt	22,686	22,353	22,570	23,318	24,085
Domestic Disappearance						
Crush	1000 mt	9,692	9,620	9,637	9,897	10,184
Food	1000 mt	0	0	0	0	0
Feed, Seed, Waste	1000 mt	509	508	510	508	509
Total Domestic Disappearance	1000 mt	10,201	10,128	10,146	10,405	10,693
Exports	1000 mt	9,256	9,043	9,172	9,539	9,870
Ending Stocks	1000 mt	3,229	3,181	3,252	3,374	3,522
Canola Meal						
Extraction Rate	kg/kg	0.56	0.56	0.56	0.56	0.56
Supply						
Beginning Stocks	1000 mt	59	53	51	54	60
Production	1000 mt	5,469	5,428	5,437	5,584	5,746
Imports	1000 mt	5	5	5	5	5
Total Supply	1000 mt	5,533	5,486	5,493	5,643	5,811
Domestic Disappearance						
Food	1000 mt	0	0	0	0	0
Feed & Residual	1000 mt	690	700	719	743	771
Industrial	1000 mt	0	0	0	0	0
Total Domestic Disappearance	1000 mt	690	700	719	743	771
Exports	1000 mt	4,788	4,735	4,723	4,844	4,977
Ending Stocks	1000 mt	55	52	52	57	63
Canola Oil						
Extraction Rate	kg/kg	0.44	0.44	0.44	0.44	0.44
Supply						
Beginning Stocks	1000 mt	339	333	340	343	343
Production	1000 mt	4,308	4,276	4,283	4,399	4,527
Imports	1000 mt	16	16	16	16	16
Total Supply	1000 mt	4,663	4,625	4,640	4,758	4,886
Domestic Disappearance						
Food	1000 mt	696	705	715	713	713
Feed & Residual	1000 mt	0	0	0	0	0
Industrial	1000 mt	445	504	780	1,148	1,459
Total Domestic Disappearance	1000 mt	1,142	1,209	1,495	1,861	2,172
Exports	1000 mt	3,186	3,080	2,801	2,554	2,368
Ending Stocks	1000 mt	335	336	344	343	346
Canola and Derivative Prices						
Canola Average Farm Price, Saskatchewan	CAD/mt	458	476	479	497	507
Canola Seed Average Price, Pacific Coast	CAD/mt	486	504	507	526	536
Canola Oil FOB Plants, Crude Degummed	CAD/mt	824	827	820	876	916
Canola Meal FOB Plant	CAD/mt	334	353	359	359	351

Table Results for Scenario RF-CC2

Canada Ethanol Supply and Demand: Scenario RF-CC2

Calendar Year	Units	2022	2023	2024	2025	2026	2027	2028	2029	2030
Supply & Demand										
Beginning Stocks	Million Liters	0	0	0	0	0	0	0	0	0
Production	Million Liters	2,314	2,194	2,181	2,189	2,421	2,776	3,170	3,592	3,981
Imports	Million Liters	1,203	1,254	1,291	1,275	1,271	1,282	1,304	1,327	1,354
Total Supply	Million Liters	3,517	3,448	3,472	3,463	3,692	4,058	4,473	4,920	5,335
Domestic Use	Million Liters	3,502	3,433	3,457	3,449	3,677	4,044	4,459	4,905	5,320
Exports	Million Liters	14	14	14	14	14	14	14	14	14
Ending Stocks	Million Liters	0	0	0	0	0	0	0	0	0
Total Demand	Million Liters	3,517	3,448	3,472	3,463	3,692	4,058	4,473	4,920	5,335
Feedstocks										
Corn	1000 Metric Tons	4,160	3,945	3,959	4,010	4,482	5,130	5,847	6,639	7,371
Wheat	1000 Metric Tons	1,474	1,397	1,349	1,315	1,405	1,622	1,861	2,097	2,308
Feedstock Yield										
Corn	1000 Liters/MT	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Wheat	1000 Liters/MT	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Distillers' Grains Production										
Corn	1000 Metric Tons	1,263	1,197	1,202	1,217	1,360	1,557	1,775	2,015	2,238
Wheat	1000 Metric Tons	448	424	409	399	427	492	565	636	701
Wholesale Ethanol Price (excludes CFS Credit Value)	CAD/Liter	0.59	0.60	0.61	0.62	0.61	0.62	0.63	0.64	0.65

Canada Biomass Based Diesel Supply and Demand: Scenario RF-CC2

Calendar Year	Units	2022	2023	2024	2025	2026	2027	2028	2029	2030
Biodiesel Supply & Use										
Beginning Stocks	Million Liters	0	0	0	0	0	0	0	0	0
Production	Million Liters	411	389	392	409	452	512	576	639	702
Imports	Million Liters	345	346	366	409	463	518	570	616	639
Total Supply	Million Liters	756	735	758	817	915	1,030	1,146	1,255	1,341
Domestic Use	Million Liters	460	439	463	523	620	734	849	957	1,042
Exports	Million Liters	296	296	295	295	295	296	297	298	299
Ending Stocks	Million Liters	0	0	0	0	0	0	0	0	0
Total Demand	Million Liters	756	735	758	817	915	1,030	1,146	1,255	1,341
Renewable Diesel Supply & Use										
Beginning Stocks	Million Liters	0	0	0	0	0	0	0	0	0
Production	Million Liters	0	210	197	264	452	683	928	1,173	1,428
Imports	Million Liters	426	436	426	424	423	436	459	485	510
Total Supply	Million Liters	426	646	623	688	876	1,120	1,387	1,658	1,938
Domestic Use	Million Liters	426	646	623	688	876	1,120	1,387	1,658	1,938
Exports	Million Liters	0	0	0	0	0	0	0	0	0
Ending Stocks	Million Liters	0	0	0	0	0	0	0	0	0
Total Demand	Million Liters	426	646	623	688	876	1,120	1,387	1,658	1,938
Domestic Feedstocks										
Canola Oil (Biodiesel Plants)	1000 Metric Tons	260	244	245	256	285	321	359	396	435
Canola Oil (Renewable Diesel Plants)	1000 Metric Tons	0	193	181	242	415	627	852	1,076	1,310
Inedible Tallow	1000 Metric Tons	0	0	0	0	0	4	7	11	14
Soybean Oil	1000 Metric Tons	71	69	70	73	79	88	97	107	116
Yellow Grease	1000 Metric Tons	26	26	26	27	29	32	36	40	44
Choice White Grease	1000 Metric Tons	0	0	0	0	0	0	0	0	0
Domestic Feedstock Yield										
Canola Oil	1000 Liters/MT	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11
Inedible Tallow	1000 Liters/MT	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
Soybean Oil	1000 Liters/MT	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11
Yellow Grease	1000 Liters/MT	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
Choice White Grease	1000 Liters/MT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biomass-based Diesel Prices										
BC/AB Canada B99 Rack Price	CAD/Liter	0.71	0.73	0.74	0.74	0.75	0.77	0.81	0.85	0.88
Canada HDRD Wholesale Price	CAD/Liter	1.40	1.41	1.43	1.42	1.43	1.46	1.50	1.54	1.57

Canada CFS Program Parameters: Scenario RF-CC2

Calendar Year	Units	2022	2023	2024	2025	2026	2028	2030
Program Goals								
2016 Stream Carbon Intensity	tCO2e/TJ	91.6	91.6	91.6	91.6	91.6	91.6	91.6
Credit Stream Carbon Intensity Reference	tCO2e/TJ	88.4	88.3	87.2	86.2	85.1	83.0	81.0
Obligated Fossil Fuel Carbon Intensity Reduction	tCO2e/TJ	2.4	3.6	4.8	6.0	7.2	9.6	12.0
Obligated Jet Fuel Carbon Intensity Reduction	tCO2e/TJ	2.4	3.6	4.8	6.0	7.2	9.6	12.0
Energy Economy Ratios								
Hydrogen (Gasoline)	Ratio	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Hydrogen (Diesel)	Ratio	1.9	1.9	1.9	1.9	1.9	1.9	1.9
CNG (Diesel)	Ratio	1.0	1.0	1.0	1.0	1.0	1.0	1.0
EV (Gasoline)	Ratio	4.1	4.1	4.1	4.1	4.1	4.1	4.1
EV (Diesel)	Ratio	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Energy Density of Fuels								
Gasoline	MJ/Liter	34.69	34.69	34.69	34.69	34.69	34.69	34.69
Diesel	MJ/Liter	38.65	38.65	38.65	38.65	38.65	38.65	38.65
Aviation Fuel	MJ/Liter	35.46	35.46	35.46	35.46	35.46	35.46	35.46
Ethanol	MJ/Liter	23.58	23.58	23.58	23.58	23.58	23.58	23.58
Biodiesel	MJ/Liter	35.40	35.40	35.40	35.40	35.40	35.40	35.40
Renewable Diesel (HDRD)	MJ/Liter	36.51	36.51	36.51	36.51	36.51	36.51	36.51
Biojet	MJ/Liter	34.81	34.81	34.81	34.81	34.81	34.81	34.81
Electricity	MJ/kWh	3.60	3.60	3.60	3.60	3.60	3.60	3.60
LFO	MJ/Liter	38.80	38.80	38.80	38.80	38.80	38.80	38.80
Kerosene	MJ/Liter	37.68	37.68	37.68	37.68	37.68	37.68	37.68
Pyrolisis Oil (Biocrude)	MJ/Liter	21.35	21.35	21.35	21.35	21.35	21.35	21.35
HFO	MJ/Liter	41.10	41.10	41.10	41.10	41.10	41.10	41.10

Canada CFS Carbon Intensity Average Scores: Scenario RF-CC2

Calendar Year	Units	2022	2023	2024	2025	2026	2028	2030
Motor gasoline	tCO2e/TJ	91.9	91.9	91.9	91.9	91.9	91.9	91.9
Ethanol	tCO2e/TJ							
Ethanol from corn	tCO2e/TJ	44.1	43.5	43.0	42.5	41.9	40.9	39.8
Ethanol from wheat	tCO2e/TJ	38.6	38.2	37.8	37.4	37.0	36.2	35.3
Diesel fuel oil	tCO2e/TJ	97.1	97.1	97.1	97.1	97.1	97.1	97.1
Biodiesel	tCO2e/TJ							
Biodiesel from canola oil	tCO2e/TJ	9.6	9.4	9.3	9.2	9.1	8.8	8.6
Biodiesel from inedible tallow	tCO2e/TJ	-1.2	-1.3	-1.4	-1.5	-1.7	-1.9	-2.1
Biodiesel from soybean oil	tCO2e/TJ	16.8	16.6	16.5	16.3	16.1	15.8	15.5
Biodiesel from yellow grease	tCO2e/TJ	4.2	4.2	4.1	4.0	3.9	3.8	3.7
Biodiesel from distillers corn oil	tCO2e/TJ	16.7	16.5	16.3	16.1	15.9	15.4	15.0
Biodiesel from unknown	tCO2e/TJ	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Renewable diesel (HDRD) (weighted avg)	tCO2e/TJ							
Renewable diesel from palm oil	tCO2e/TJ	71.7	71.3	71.0	70.6	70.3	69.6	68.9
Renewable diesel from canola oil	tCO2e/TJ	9.6	9.4	9.3	9.2	9.1	8.8	8.6
Renewable diesel from palm sludge oil	tCO2e/TJ	11.2	11.1	11.1	11.1	11.0	10.9	10.9
Renewable diesel from tallow	tCO2e/TJ	7.2	7.1	7.0	6.9	6.9	6.7	6.5
Renewable diesel from yellow grease	tCO2e/TJ	12.7	12.6	12.6	12.5	12.4	12.3	12.2
Renewable diesel from soybean oil	tCO2e/TJ	30.8	30.6	30.4	30.2	30.0	29.6	29.2
Renewable diesel from spent bleaching earth	tCO2e/TJ	18.6	18.4	18.3	18.2	18.0	17.8	17.5
Light fuel oil	tCO2e/TJ	87.0	87.0	87.0	87.0	87.0	87.0	87.0
Kerosene & stove oil	tCO2e/TJ	82.0	82.0	82.0	82.0	82.0	82.0	82.0
Heavy fuel oil	tCO2e/TJ	91.0	91.0	91.0	91.0	91.0	91.0	91.0
Pyrolisis Oil (Biocrude)	tCO2e/TJ	25.0	24.0	23.0	22.0	21.0	19.0	17.0
Aviation gasoline	tCO2e/TJ	94.0	94.0	94.0	94.0	94.0	94.0	94.0
Aviation turbo fuel	tCO2e/TJ	90.1	90.1	90.1	90.1	90.1	90.1	90.1
Biojet	tCO2e/TJ	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Propane Vehicle	tCO2e/TJ	68.0	68.0	68.0	68.0	68.0	68.0	68.0
Natural Gas Vehicle	tCO2e/TJ	62.9	62.9	62.9	62.9	62.9	62.9	62.9
EV (Gasoline)	tCO2e/TJ	21.7	21.7	21.7	21.7	21.7	21.7	21.7

Canada Fuel Consumption Volumes in Million Liters: Scenario RF-CC2

Calendar Year	Units	2022	2023	2024	2025	2026	2028	2030
Blended Gasoline (volumetric total)	million liters	41,689	41,033	40,353	39,618	39,044	38,262	37,781
Motor gasoline	million liters	38,186	37,599	36,896	36,169	35,366	33,803	32,460
Ethanol	million liters	3,502	3,433	3,457	3,449	3,677	4,459	5,320
Ethanol from corn	million liters	2,944	2,890	2,922	2,938	3,163	3,842	4,619
Ethanol from wheat	million liters	558	544	535	511	514	617	702
Blended Diesel (volumetric total)	million liters	32,176	32,207	32,172	32,143	32,117	32,040	32,033
Diesel fuel oil	million liters	31,335	31,176	31,140	30,993	30,694	29,911	29,192
Biomass Based Diesel	million liters	841	1,031	1,032	1,151	1,423	2,129	2,841
Biodiesel	million liters	436	417	439	495	588	804	988
Biodiesel from canola oil	million liters	239	222	234	268	329	480	615
Biodiesel from inedible tallow	million liters	0	0	0	0	0	0	0
Biodiesel from soybean oil	million liters	154	153	161	178	200	244	274
Biodiesel from yellow grease	million liters	30	29	31	35	41	56	69
Biodiesel from distillers corn oil	million liters	13	13	13	15	18	24	30
Biodiesel made from unknown	million liters	0	0	0	0	0	0	0
Renewable Diesel (HDRD)	million liters	404	614	593	655	835	1,325	1,854
Renewable diesel made from palm oil	million liters	11	11	11	11	11	11	11
Renewable diesel made from canola oil	million liters	0	183	172	231	396	813	1,253
Renewable diesel made from palm sludge oil	million liters	0	0	0	0	0	0	0
Renewable diesel made from tallow	million liters	293	302	295	293	293	321	360
Renewable diesel made from yellow grease	million liters	68	69	68	68	68	73	80
Renewable diesel made from soybean oil	million liters	7	23	22	27	42	80	119
Renewable diesel made from spent bleaching earth	million liters	26	26	26	25	25	27	30
Blended Light Fuel Oil		2,057	2,017	1,979	1,941	1,904	1,835	1,765
Light diesel fuel oil	million liters	2,012	1,963	1,925	1,881	1,831	1,728	1,626
Biomass Based Diesel	million liters	45	54	54	60	74	107	139
Biodiesel	million liters	23	23	24	27	33	45	54
Biodiesel from canola oil	million liters	13	12	13	15	18	27	34
Biodiesel from inedible tallow	million liters	0	0	0	0	0	0	0
Biodiesel from soybean oil	million liters	8	8	9	10	11	14	15
Biodiesel from yellow grease	million liters	2	2	2	2	2	3	4
Biodiesel from distillers corn oil	million liters	1	1	1	1	1	1	2
Biodiesel from unknown	million liters	0	0	0	0	0	0	0
Renewable Diesel (HDRD)	million liters	21	32	30	33	41	63	85
Renewable diesel made from palm oil	million liters	1	1	1	1	1	1	1
Renewable diesel made from canola oil	million liters	0	9	9	12	19	39	57
Renewable diesel made from palm sludge oil	million liters	0	0	0	0	0	0	0
Renewable diesel made from tallow	million liters	15	16	15	15	14	15	16
Renewable diesel made from yellow grease	million liters	4	4	3	3	3	3	4
Renewable diesel made from soybean oil	million liters	0	1	1	1	2	4	5
Renewable diesel made from spent bleaching earth	million liters	1	1	1	1	1	1	1
Blended Heavy Fuel Oil		2,672	2,664	2,652	2,640	2,628	2,617	2,616
Heavy fuel oil	million liters	2,429	2,421	2,411	2,400	2,389	2,379	2,378
Pyrolisis Oil (Biocrude)	million liters	243	242	241	240	239	238	238
Blended Jet Fuel		8,577	8,621	8,672	8,737	8,817	9,018	9,254
Aviation turbo fuel	million liters	8,492	8,536	8,586	8,650	8,729	8,929	9,162
Biojet	million liters	85	85	86	87	87	89	92
Kerosene & stove oil	million liters	443	434	425	417	409	395	383

Canada Fuel Consumption Volumes in Terajoules: Scenario RF-CC2

Calendar Year	Units	2022	2023	2024	2025	2026	2028	2030
Blended Gasoline	terajoules	1,407,269	1,385,278	1,361,443	1,336,033	1,313,572	1,277,767	1,251,503
Motor Gasoline	terajoules	1,324,681	1,304,323	1,279,920	1,254,710	1,226,862	1,172,629	1,126,050
Ethanol	terajoules	82,587	80,955	81,523	81,324	86,711	105,138	125,453
Ethanol from corn	terajoules	69,422	68,135	68,897	69,276	74,583	90,592	108,908
Ethanol from wheat	terajoules	13,165	12,820	12,626	12,048	12,128	14,546	16,545
Blended Diesel	terajoules	1,241,308	1,242,131	1,240,743	1,239,333	1,237,608	1,232,887	1,230,915
Diesel fuel oil	terajoules	1,211,090	1,204,962	1,203,560	1,197,865	1,186,322	1,156,057	1,128,270
Biodiesel	terajoules	15,450	14,746	15,537	17,537	20,809	28,468	34,967
Biodiesel from canola oil	terajoules	8,443	7,857	8,268	9,476	11,653	16,994	21,764
Biodiesel from inedible tallow	terajoules	0	0	0	0	0	0	0
Biodiesel from soybean oil	terajoules	5,460	5,412	5,713	6,304	7,072	8,622	9,701
Biodiesel from yellow grease	terajoules	1,078	1,029	1,084	1,223	1,452	1,986	2,439
Biodiesel from distillers corn oil	terajoules	470	448	472	533	632	865	1,063
Biodiesel from unknown	terajoules	0	0	0	0	0	0	0
Renewable Diesel (HDRD)	terajoules	14,768	22,423	21,646	23,932	30,476	48,362	67,677
Renewable diesel made from palm oil	terajoules	406	401	398	397	393	400	417
Renewable diesel made from canola oil	terajoules	0	6,685	6,275	8,433	14,441	29,687	45,741
Renewable diesel made from palm sludge oil	terajoules	0	0	0	0	0	0	0
Renewable diesel made from tallow	terajoules	10,711	11,012	10,754	10,701	10,703	11,706	13,131
Renewable diesel made from yellow grease	terajoules	2,474	2,526	2,478	2,468	2,467	2,653	2,922
Renewable diesel made from soybean oil	terajoules	243	845	808	1,002	1,543	2,916	4,361
Renewable diesel made from spent bleaching earth	terajoules	935	953	934	930	929	1,001	1,106
Blended Light Fuel Oil	terajoules	79,665	78,129	76,628	75,136	73,678	70,918	68,097
Light fuel oil	terajoules	78,063	76,171	74,675	72,971	71,028	67,045	63,094
Biodiesel	terajoules	832	805	856	972	1,155	1,579	1,915
Biodiesel from canola oil	terajoules	455	429	456	525	647	943	1,192
Biodiesel from inedible tallow	terajoules	0	0	0	0	0	0	0
Biodiesel from soybean oil	terajoules	294	295	315	349	393	478	531
Biodiesel from yellow grease	terajoules	58	56	60	68	81	110	134
Biodiesel from distillers corn oil	terajoules	25	24	26	30	35	48	58
Biodiesel from unknown	terajoules	0	0	0	0	0	0	0
Renewable Diesel (HDRD)	terajoules	771	1,153	1,097	1,193	1,494	2,294	3,089
Renewable diesel made from palm oil	terajoules	21	21	20	20	19	19	19
Renewable diesel made from canola oil	terajoules	0	344	318	420	708	1,408	2,087
Renewable diesel made from palm sludge oil	terajoules	0	0	0	0	0	0	0
Renewable diesel made from tallow	terajoules	559	567	545	533	525	555	599
Renewable diesel made from yellow grease	terajoules	129	130	126	123	121	126	133
Renewable diesel made from soybean oil	terajoules	13	43	41	50	76	138	199
Renewable diesel made from spent bleaching earth	terajoules	49	49	47	46	46	47	50
Blended Heavy Fuel Oil	terajoules	105,011	104,684	104,241	103,763	103,270	102,863	102,825
Heavy fuel oil	terajoules	99,825	99,514	99,093	98,639	98,170	97,783	97,747
Pyrolisis Oil (Biocrude)	terajoules	5,186	5,170	5,148	5,124	5,100	5,080	5,078
Blended Jet Fuel	terajoules	304,091	305,656	307,439	309,743	312,578	319,725	328,089
Aviation turbo fuel	terajoules	301,135	302,684	304,450	306,732	309,540	316,617	324,899
Biojet	terajoules	2,956	2,971	2,989	3,011	3,039	3,108	3,189
Kerosene & stove oil	terajoules	16,688	16,340	16,019	15,713	15,420	14,886	14,418
Propane Vehicle	terajoules	7,585	8,762	9,938	11,115	12,292	14,646	17,000
Natural Gas Vehicle	terajoules	6,246	7,215	8,185	9,154	10,123	12,062	14,000
Electric Vehicles (Gasoline) Assumption	terajoules	3,476	3,526	3,727	4,665	5,631	7,654	9,807
Electric Vehicles (Diesel) Assumption	terajoules	2,655	2,691	2,841	3,553	4,284	5,810	7,427

Canada Fuel Blend Rates: Scenario RF-CC2

Calendar Year	Units	2022	2023	2024	2025	2026	2028	2030
Ethanol in gasoline	% by Volume	8.4%	8.4%	8.6%	8.7%	9.4%	11.7%	14.1%
Biomass based diesel in diesel	% by Volume	2.6%	3.2%	3.2%	3.6%	4.4%	6.6%	8.9%
Biodiesel in diesel	% by Volume	1.4%	1.3%	1.4%	1.5%	1.8%	2.5%	3.1%
Renewable Diesel (HDRD) in diesel	% by Volume	1.3%	1.9%	1.8%	2.0%	2.6%	4.1%	5.8%
Biomass based diesel in LFO	% by Volume	2.2%	2.7%	2.7%	3.1%	3.9%	5.9%	7.9%
Biodiesel in LFO	% by Volume	1.1%	1.1%	1.2%	1.4%	1.7%	2.4%	3.1%
Renewable Diesel (HDRD) in LFO	% by Volume	1.0%	1.6%	1.5%	1.7%	2.1%	3.4%	4.8%
Pyrolisis oil (Biocrude) in HFO	% by Volume	9.1%	9.1%	9.1%	9.1%	9.1%	9.1%	9.1%
Biojet in aviation turbo fuel	% by Volume	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Ethanol in gasoline	% by Energy	5.9%	5.8%	6.0%	6.1%	6.6%	8.2%	10.0%
Biomass based diesel in diesel	% by Energy	2.4%	3.0%	3.0%	3.3%	4.1%	6.2%	8.3%
Biodiesel in diesel	% by Energy	1.2%	1.2%	1.3%	1.4%	1.7%	2.3%	2.8%
Renewable Diesel (HDRD) in diesel	% by Energy	1.2%	1.8%	1.7%	1.9%	2.5%	3.9%	5.5%
Biomass based diesel in LFO	% by Energy	2.0%	2.5%	2.5%	2.9%	3.6%	5.5%	7.3%
Biodiesel in LFO	% by Energy	1.0%	1.0%	1.1%	1.3%	1.6%	2.2%	2.8%
HDRD in LFO	% by Energy	1.0%	1.5%	1.4%	1.6%	2.0%	3.2%	4.5%
Pyrolisis oil (Biocrude) in HFO	% by Energy	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%
Biojet in aviation turbo fuel	% by Energy	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%

Canada CFS Compliance Credits and Debits: Scenario RF-CC2

Calendar Year	Units	2022	2023	2024	2025	2026	2028	2030
Debits								
Fossil Fuels								
Motor Gasoline	tCO2e	1,589,618	4,695,564	6,143,614	7,528,257	8,833,403	11,257,239	13,512,603
Diesel fuel oil	tCO2e	1,453,308	4,337,865	5,777,087	7,187,187	8,541,520	11,098,148	13,539,244
Light fuel oil	tCO2e	93,675	274,215	358,438	437,827	511,404	643,629	757,126
Heavy fuel oil	tCO2e	119,790	358,250	475,647	591,832	706,824	938,719	1,172,964
Aviation turbo fuel (Domestic Only)	tCO2e	115,636	348,692	467,636	588,925	713,179	972,648	1,247,613
Kerosene & stove oil	tCO2e	20,025	58,825	76,893	94,279	111,021	142,906	173,015
Total Debits	tCO2e	3,392,051	10,073,411	13,299,316	16,428,307	19,417,352	25,053,290	30,402,565
CFS Compliance Credits								
Compliance Category 1								
CCS	tCO2e	1,300,000	1,512,500	1,725,000	1,937,500	2,150,000	2,575,000	3,000,000
Upstream Improvements	tCO2e	0	93,750	187,500	281,250	375,000	562,500	750,000
Reductions in Refineries	tCO2e	200,000	268,750	337,500	406,250	475,000	612,500	750,000
Incremental Methane Reductions - Conventional Oil	tCO2e	546,746	665,903	785,060	904,217	1,023,373	1,261,687	1,500,000
Subtotal Compliance Category 1	tCO2e	2,046,746	2,540,903	3,035,060	3,529,217	4,023,373	5,011,687	6,000,000
Compliance Category 2								
Bank Renewable Fuel Regulation (RFR)	tCO2e	1,400,000	0	0	0	0	0	0
Ethanol	tCO2e	3,732,292	3,695,701	3,672,496	3,614,199	3,802,279	4,499,788	5,241,830
Ethanol from corn	tCO2e	3,077,034	3,052,963	3,048,156	3,026,611	3,218,729	3,818,145	4,486,308
Ethanol from wheat	tCO2e	655,258	642,738	624,340	587,588	583,550	681,643	755,522
Biodiesel	tCO2e	1,244,327	1,188,237	1,236,779	1,379,862	1,620,204	2,169,905	2,605,354
Biodiesel from canola oil	tCO2e	701,429	653,811	679,789	769,701	935,031	1,330,599	1,662,090
Biodiesel from inedible tallow	tCO2e	0	0	0	0	0	0	0
Biodiesel from soybean oil	tCO2e	411,825	409,144	426,538	464,684	514,623	611,568	670,349
Biodiesel from yellow grease	tCO2e	95,603	91,329	95,101	106,058	124,339	166,030	198,958
Biodiesel from distillers corn oil	tCO2e	35,469	33,952	35,351	39,420	46,212	61,707	73,956
Biodiesel from unknown	tCO2e	0	0	0	0	0	0	0
Renewable Diesel (HDRD)	tCO2e	1,202,539	1,824,768	1,737,193	1,893,875	2,378,578	3,676,182	5,010,643
Renewable diesel from palm oil	tCO2e	7,123	7,157	6,789	6,471	6,103	5,621	5,276
Renewable diesel from canola oil	tCO2e	0	554,648	513,759	681,337	1,151,541	2,306,664	3,462,926
Renewable diesel from palm sludge oil	tCO2e	0	0	0	0	0	0	0
Renewable diesel from tallow	tCO2e	914,965	940,462	906,287	889,908	878,435	935,982	1,022,811
Renewable diesel from yellow grease	tCO2e	197,044	201,136	194,425	190,863	187,996	196,487	210,216
Renewable diesel from soybean oil	tCO2e	14,722	51,292	48,255	58,877	89,166	163,048	236,002
Renewable diesel from spent bleaching earth	tCO2e	68,685	70,074	67,678	66,419	65,338	68,379	73,414
Pyrolisis Oil (Biocrude)	tCO2e	328,698	332,595	330,684	328,728	326,835	325,167	324,955
Biojet	tCO2e	172,590	173,335	171,065	169,078	167,389	164,767	162,641
Subtotal Compliance Category 2	tCO2e	8,080,446	7,214,636	7,148,217	7,385,742	8,295,285	10,835,808	13,345,422
Compliance Category 3								
Diesel Displaced by Propane	tCO2e	154,600	178,168	191,189	201,762	210,032	219,863	220,892
Diesel Displaced by Natural Gas	tCO2e	159,173	183,525	199,191	212,841	224,596	242,577	253,311
Gasoline Displaced by Electric Vehicles	tCO2e	1,200,000	1,200,000	1,250,000	1,541,667	1,833,333	2,416,667	3,000,000
Diesel Displaced by Electric Vehicles	tCO2e	1,200,000	1,200,000	1,250,000	1,541,667	1,833,333	2,416,667	3,000,000
Subtotal Compliance Category 3	tCO2e	2,713,774	2,761,693	2,890,380	3,497,936	4,101,295	5,295,773	6,474,202
External Credit Sources								
Cross Steam Credits	tCO2e	339,205	1,007,341	1,329,932	1,642,831	1,941,735	2,505,329	3,040,256
Compliance Fund	tCO2e	0	0	0	0	0	0	0
Emerging Tech Credit Generation	tCO2e	0	0	0	0	0	0	0
Total Credits		13,180,171	13,524,574	14,403,589	16,055,726	18,361,687	23,648,598	28,859,881
Banked for the Year	tCO2e	9,788,120	3,451,163	1,104,273	-372,581	-1,055,664	-1,404,692	-1,542,684
Running Net Credit Balance	tCO2e	9,788,120	13,239,282	14,343,556	13,970,974	12,915,310	10,201,348	7,214,992
CFS Compliance Credit Price	C$/MT	24	15	13	21	42	96	156
Maximum CFS Compliance Credit Price	C$/MT	350	354	359	363	368	377	387

Value of Canada Compliance Credits By Feedstock Pathway: Scenario RF-CC2

Calendar Year	Units	2022	2023	2024	2025	2026	2028	2030
Ethanol								
Ethanol from corn	C$/liter	0.03	0.02	0.01	0.02	0.04	0.10	0.15
Ethanol from wheat	C$/liter	0.03	0.02	0.02	0.02	0.05	0.11	0.17
Biodiesel								
Biodiesel from canola oil	C$/liter	0.07	0.04	0.04	0.06	0.11	0.25	0.40
Biodiesel from inedible tallow	C$/liter	0.08	0.05	0.04	0.06	0.13	0.29	0.46
Biodiesel from soybean oil	C$/liter	0.06	0.04	0.03	0.05	0.10	0.23	0.36
Biodiesel from yellow grease	C$/liter	0.07	0.04	0.04	0.06	0.12	0.27	0.43
Biodiesel from distillers corn oil	C$/liter	0.06	0.04	0.03	0.05	0.10	0.23	0.36
Renewable Diesel	C$/liter							
Renewable Diesel from palm oil	C$/liter	0.01	0.01	0.01	0.01	0.02	0.05	0.07
Renewable Diesel from canola oil	C$/liter	0.07	0.04	0.04	0.06	0.12	0.26	0.41
Renewable diesel from palm sludge oil	C$/liter	0.07	0.04	0.04	0.06	0.11	0.25	0.40
Renewable diesel from tallow	C$/liter	0.07	0.04	0.04	0.06	0.12	0.27	0.42
Renewable diesel from yellow grease	C$/liter	0.07	0.04	0.04	0.05	0.11	0.25	0.39
Renewable diesel from soybean oil	C$/liter	0.05	0.03	0.03	0.04	0.08	0.19	0.29
Renewable diesel from spent bleaching earth	C$/liter	0.06	0.04	0.03	0.05	0.10	0.23	0.36

Biofuel Feedstocks Used for Canadian Domestic Consumption

Calendar Year	Units	2022	2023	2024	2025	2026	2028	2030
Ethanol Feedstocks								
Corn	1000 MT	2,944	2,890	2,922	2,938	3,163	3,842	4,619
Wheat	1000 MT	558	544	535	511	514	617	702
Biodiesel Feedstocks								
Canola Oil	1000 MT	226	210	221	254	312	455	583
Inedible Tallow	1000 MT	0	0	0	0	0	0	0
Soybean Oil	1000 MT	146	145	153	169	189	231	260
Yellow Grease	1000 MT	31	29	31	35	42	57	70
Distillers Corn Oil	1000 MT	13	12	13	14	17	23	28
Unknown	1000 MT	0	0	0	0	0	0	0
Renewable Diesel Feedstocks								
Feedstocks Used for Domestic Production								
Canola Oil	1000 MT	0	193	181	242	415	852	1,310
Feedstocks Used for Imports (Approximation)								
Palm Oil	1000 MT	11	11	11	11	11	11	11
Palm Sludge Oil	1000 MT	0	0	0	0	0	0	0
Inedible Tallow	1000 MT	293	301	294	293	292	319	357
Yellow Grease	1000 MT	68	69	68	67	67	72	80
Soybean Oil	1000 MT							
Spent Bleaching Earth	1000 MT	26	26	26	25	25	27	30

Canada Grains Supply and Demand: Scenario RF-CC2

	Units	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31
Corn										
Area Harvested	1000 ha	1,415	1,417	1,421	1,420	1,419	1,419	1,419	1,419	1,421
Yield	mt per ha	9.98	10.09	10.21	10.32	10.44	10.55	10.67	10.78	10.90
Supply										
Beginning Stocks	1000 mt	2,211	2,230	2,234	2,253	2,284	2,315	2,345	2,364	2,387
Production	1000 mt	14,116	14,300	14,499	14,654	14,812	14,975	15,132	15,303	15,480
Imports	1000 mt	2,144	1,959	1,917	2,237	2,748	3,342	3,968	4,560	4,868
Total Supply	1000 mt	18,472	18,489	18,650	19,144	19,843	20,632	21,444	22,227	22,735
Domestic Disappearance										
Feed & Residual Use	1000 mt	8,979	9,019	9,093	9,160	9,195	9,225	9,221	9,208	9,214
Food, Seed, and Industrial Use	1000 mt	6,622	6,595	6,662	7,060	7,693	8,422	9,218	9,991	10,463
Bioethanol Use	1000 mt	3,998	3,956	3,997	4,364	4,968	5,668	6,441	7,188	7,631
Total Domestic Disappearance	1000 mt	15,601	15,614	15,756	16,220	16,888	17,647	18,439	19,199	19,677
Exports	1000 mt	641	641	641	641	641	641	641	641	641
Ending Stocks	1000 mt	2,230	2,234	2,253	2,284	2,315	2,345	2,364	2,387	2,417
Wheat										
Area Harvested	1000 ha	9,787	9,804	9,843	9,875	9,839	9,807	9,797	9,806	9,787
Yield	mt per ha	3.38	3.40	3.43	3.45	3.47	3.49	3.51	3.54	3.56
Supply										
Beginning Stocks	1000 mt	6,743	6,874	6,935	7,007	7,217	7,440	7,624	7,760	7,944
Production	1000 mt	33,090	33,364	33,714	34,042	34,135	34,240	34,423	34,671	34,819
Imports	1000 mt	501	501	501	501	501	501	501	501	501
Total Supply	1000 mt	40,333	40,739	41,150	41,550	41,853	42,181	42,548	42,932	43,264
Domestic Disappearance										
Feed & Residual Use	1000 mt	5,159	5,161	5,167	5,189	5,189	5,168	5,139	5,119	5,106
Food, Seed, and Industrial Use	1000 mt	5,518	5,479	5,462	5,521	5,704	5,959	6,220	6,470	6,651
Bioethanol Use	1000 mt	1,435	1,373	1,332	1,360	1,514	1,742	1,979	2,202	2,356
Total Domestic Disappearance	1000 mt	10,677	10,640	10,629	10,709	10,892	11,126	11,359	11,590	11,757
Exports	1000 mt	22,783	23,164	23,514	23,624	23,520	23,431	23,429	23,398	23,364
Ending Stocks	1000 mt	6,874	6,935	7,007	7,217	7,440	7,624	7,760	7,944	8,143
Grain Prices										
Barley, #1 Feed, Alberta	CAD/mt	205	210	213	213	213	214	217	219	220
Barley Farm Price	CAD/mt	236	239	241	242	242	243	244	246	246
Corn #2, CE Cash, Chatham	CAD/mt	178	185	187	188	189	191	195	197	199
Wheat, Western Red Spring, 12.5% Pr	CAD/mt	207	220	233	236	240	247	257	264	270
Wheat Producer Price, Ontario	CAD/mt	216	230	241	245	249	256	266	272	278

Canada Canola and Canola Products Supply and Demand: Scenario RF-CC2

	Units	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31
Canola										
Area Harvested	1000 ha	8,045	8,005	7,912	7,847	7,887	7,944	8,047	8,123	8,195
Yield	mt per ha	2.36	2.38	2.40	2.43	2.45	2.47	2.49	2.51	2.54
Supply										
Beginning Stocks	1000 mt	3,547	3,229	3,189	3,183	3,193	3,263	3,313	3,401	3,472
Production	1000 mt	18,989	19,072	19,026	19,043	19,314	19,629	20,061	20,429	20,791
Imports	1000 mt	150	150	150	150	150	150	150	150	150
Total Supply	1000 mt	22,686	22,451	22,365	22,375	22,657	23,041	23,524	23,980	24,413
Domestic Disappearance										
Crush	1000 mt	9,692	9,672	9,625	9,597	9,675	9,803	9,990	10,166	10,335
Food	1000 mt	0	0	0	0	0	0	0	0	0
Feed, Seed, Waste	1000 mt	509	507	508	508	509	508	507	507	508
Total Domestic Disappearance	1000 mt	10,201	10,179	10,133	10,105	10,184	10,311	10,497	10,673	10,843
Exports	1000 mt	9,256	9,082	9,050	9,077	9,211	9,417	9,626	9,836	10,004
Ending Stocks	1000 mt	3,229	3,189	3,183	3,193	3,263	3,313	3,401	3,472	3,567
Canola Meal										
Extraction Rate	kg/kg	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
Supply										
Beginning Stocks	1000 mt	59	55	53	52	51	53	55	58	62
Production	1000 mt	5,469	5,458	5,431	5,415	5,459	5,532	5,637	5,736	5,831
Imports	1000 mt	5	5	5	5	5	5	5	5	5
Total Supply	1000 mt	5,533	5,517	5,489	5,472	5,515	5,589	5,696	5,799	5,898
Domestic Disappearance										
Food	1000 mt	0	0	0	0	0	0	0	0	0
Feed & Residual	1000 mt	690	692	700	708	720	731	745	759	775
Industrial	1000 mt	0	0	0	0	0	0	0	0	0
Total Domestic Disappearance	1000 mt	690	692	700	708	720	731	745	759	775
Exports	1000 mt	4,788	4,772	4,737	4,713	4,743	4,803	4,893	4,979	5,057
Ending Stocks	1000 mt	55	53	52	51	53	55	58	62	66
Canola Oil										
Extraction Rate	kg/kg	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Supply										
Beginning Stocks	1000 mt	339	335	333	336	340	343	341	340	339
Production	1000 mt	4,308	4,299	4,278	4,266	4,300	4,358	4,440	4,519	4,594
Imports	1000 mt	16	16	16	16	16	16	16	16	16
Total Supply	1000 mt	4,663	4,650	4,627	4,618	4,656	4,716	4,797	4,875	4,949
Domestic Disappearance										
Food	1000 mt	696	698	705	710	713	710	708	706	707
Feed & Residual	1000 mt	0	0	0	0	0	0	0	0	0
Industrial	1000 mt	445	481	533	703	939	1,198	1,459	1,729	1,904
Total Domestic Disappearance	1000 mt	1,141	1,179	1,238	1,413	1,652	1,908	2,167	2,435	2,611
Exports	1000 mt	3,186	3,139	3,053	2,865	2,661	2,467	2,290	2,101	1,997
Ending Stocks	1000 mt	335	333	336	340	343	341	340	339	341
Canola and Derivative Prices										
Canola Average Farm Price, Saskatchewan	CAD/mt	458	472	476	480	481	494	501	512	513
Canola Seed Average Price, Pacific Coast	CAD/mt	486	500	504	508	509	523	531	542	543
Canola Oil FOB Plants, Crude Degummed	CAD/mt	824	839	829	822	830	865	898	934	950
Canola Meal FOB Plant	CAD/mt	334	346	353	359	358	360	356	353	346