# GHGenius 5.02b User Guide
# Hydrogenation-Derived Renewable Diesel (HDRD)

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# Executive Summary

This guide is intended to assist Hydrogenation-Derived Renewable Diesel (HDRD) producers and suppliers in determining the carbon intensity of fuel delivered to British Columbia (BC) using GHGenius 5.02b.

The guide covers the steps that a GHGenius user must use to model a specific HDRD pathway. This includes ensuring that Excel can properly run the model, setting up the model with correct region, year and using the Global Warming Potentials (GWPs) specified in the BC regulations, and inputting the plant specific data.

It covers running the model more than once for activities that occur in multiple regions and describes where the results are found.

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# Glossary

| | |
|---|---|
| AJF | Alternative Jet Fuel |
| BC | British Columbia |
| CCS | Carbon Capture and Storage |
| CI | Carbon Intensity |
| $CO_2$ | Carbon Dioxide |
| EPA | Environmental Protection Agency |
| GJ | Giga Joule ($10^9$ Joules) |
| GWP | Global Warming Potential |
| HDRD | Hydrogenation-Derived Renewable Diesel |
| HDRJ | Hydrogenation-Derived Renewable Jet Fuel |
| HDRP | Hydrogenation-Derived Renewable Propane |
| HVO | Hydrogenated Vegetable Oil |
| IPCC | Intergovernmental Panel on Climate Change |
| Kg | Kilogram |
| kWh | Kilowatt-hour |
| LCA | Lifecycle Analysis |
| LCFS | Low Carbon Fuel Standard |
| LNG | Liquified Natural Gas |
| LPG | Liquid Petroleum Gas |
| MJ | Mega Joule |
| NaOH | Sodium hydroxide, also know as caustic soda |
| PADD | Petroleum Administration for Defense Districts |
| UNFCCC | United Nations Framework Convention on Climate Change |

# 1 Introduction

This guide is intended to assist HDRD producers and suppliers in determining the carbon intensity of fuel delivered to BC using GHGenius 5.02b.

HDRD is also know as renewable diesel or hydrotreated vegetable oil (HVO).

GHGenius is an Excel based lifecycle assessment (LCA) model that has been developed over the past twenty years. It is available for download at www.ghgenius.ca.

The model has some unique features compared to some other models. In many instances it uses time series of data rather than single data points. The time series of data combined with the use of some government forecasts allows the model to be used to show how emissions have changed and could change in the future. These time series also allow the model to "refresh" itself as GHGenius users change the year. This has allowed the model to continually provide lifecycle emissions that are temporally relevant.

The model also has data for a number of countries and regions throughout the world. This allows the same process to be modelled in different regions to determine the impact of local conditions and allows the modelling of fuels that might be produced in one region of the world and used in another region.

## 1.1 Process Overview

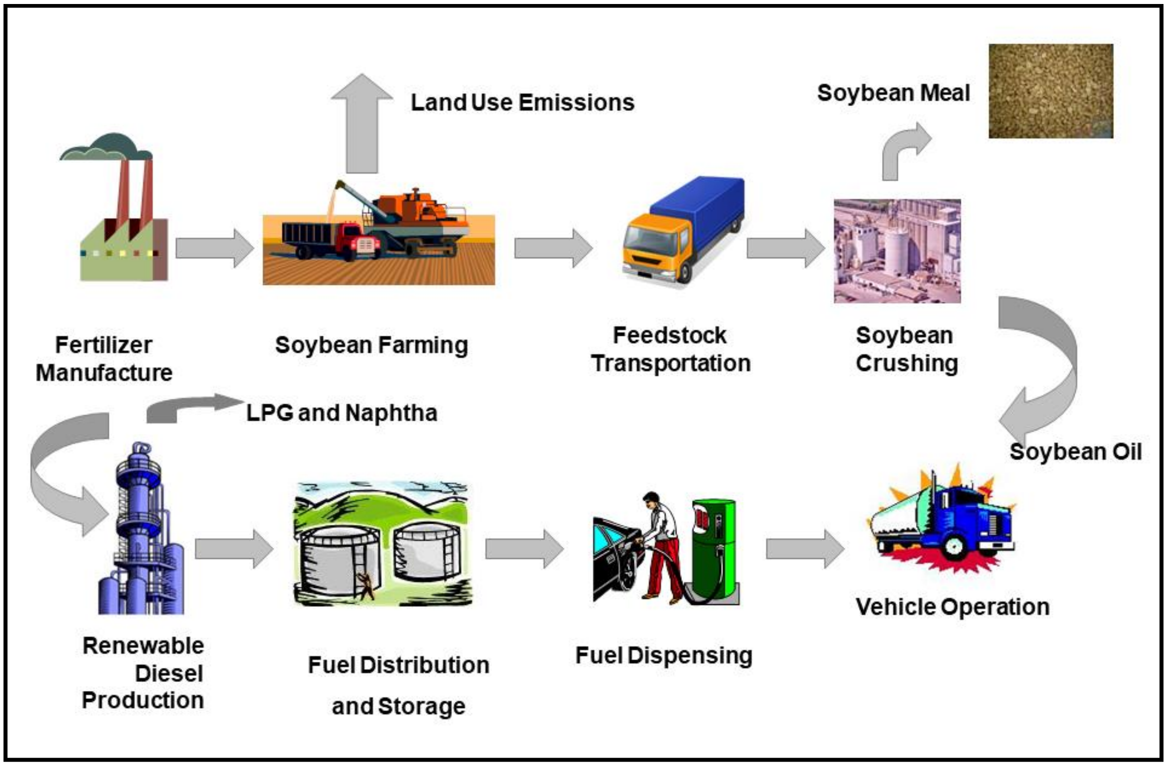
HDRD is produced from fats and oils throughout the world. There are more than 15 HDRD plants located in North America that process vegetable oils, animal fats and used cooking oils. The list of HDRD pathways in GHGenius are shown in the following table.

### Table 1-1 HDRD Pathways in GHGenius

| HDRD Feedstock | |
|---|---|
| Algae Oil | Palm Sludge Oil |
| Canola Oil | Soybean Oil |
| Camelina Oil | Spent Bleaching Earth (SBE) |
| Distillers Corn Oil (Corn Oil) | Tallow |
| Fish Oil | Tall Oil |
| Jatropha Oil | Yellow Grease (Used Cooking Oil) |
| Palm Oil | |

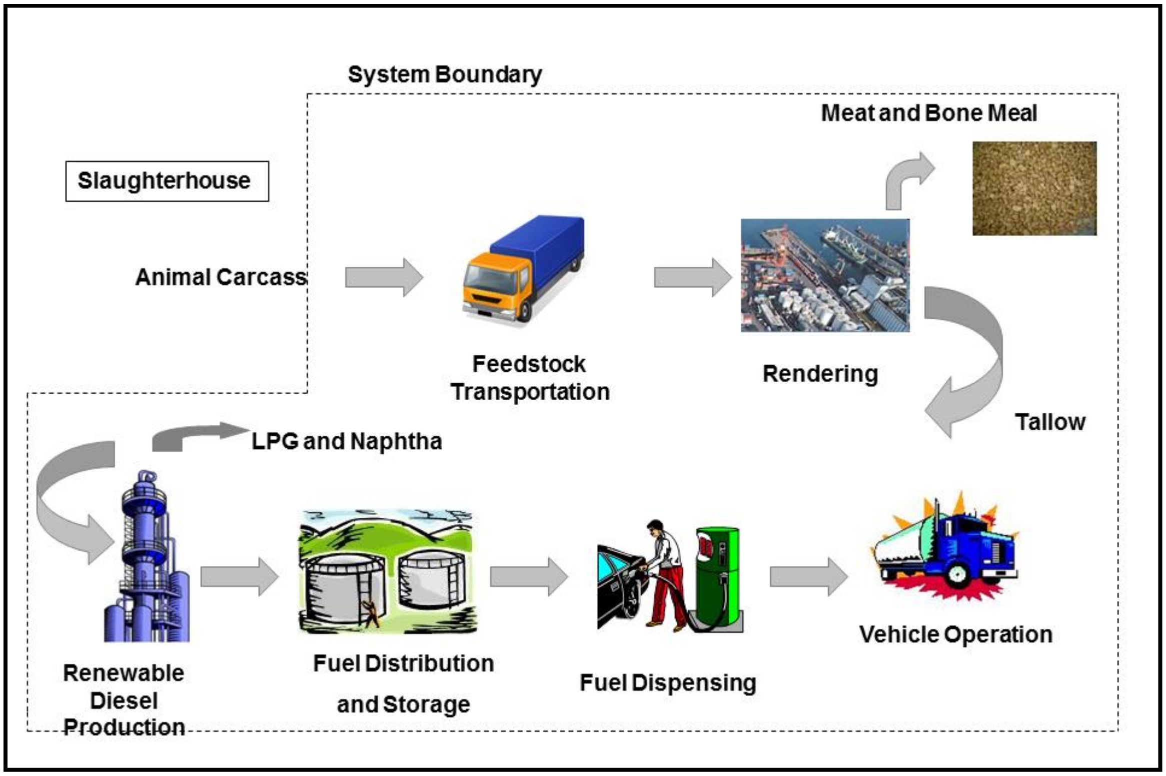
The lifecycle system boundary for soybean HDRD is shown in the following figure. Other crops have similar system boundaries.

### Figure 1-1 Soybean HDRD System Boundary



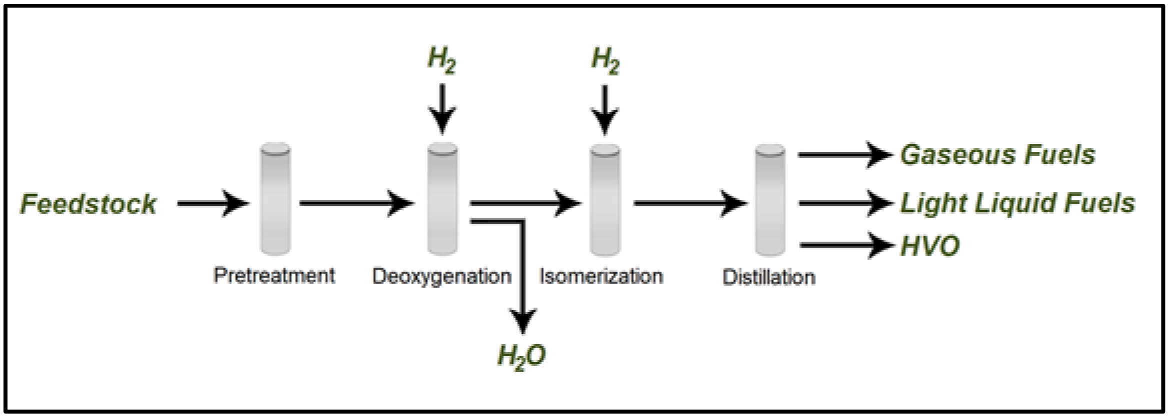

Waste based HDRD can have different system boundaries. The animal fat to HDRD system is shown in the following figure.

### Figure 1-2 Animal Fat Biodiesel




There are several process developers that offer this HDRD technology including Topsoe, UOP, Axens, Shell and others. Currently, Topsoe have more plants in North America than the other HDRD technology providers. There are plants that only process vegetable oils and plants that only process multi-feedstock. There are quality criteria for the feedstock, particularly the phosphorus content, and some plants include pre-treatment units to lower the contaminants and prolong catalyst life. The basic process is similar and is shown in the following figure.

### Figure 1-3 Basic HDRD Process Diagram




# 2 Initializing the Model

GHGenius is available to download at https://ghgenius.ca/index.php/downloads/74-ghgenius-5-02b. There is no cost to download the model, but GHGenius users must register at the website to be able to access the model.

When the model is downloaded, and the file unzipped it is an .xls file. This provides maximum compatibility with older versions of Excel. While this .xls file is larger than if it was saved as a .xlsm file, it will run faster and it will zip to a smaller file size. The.xls file cannot be saved as a .xlsx file due to the macros included in the file. If the file is converted to a .xlsm file, it cannot be converted back to an .xls file or .xlsx file. Some of the macro buttons in a converted .xlsm file will lose their functionality unless they are manually reassigned. It is best to run the model as a .xls file.

Before any facility specific data is entered in the model there are certain selections that must be made in the model.

## 2.1 Excel Macro Settings

GHGenius relies on macros to set up appropriate Excel settings, calculate many output values, and provide additional tools for GHGenius users. The model will not function properly without macros enabled.

To make Microsoft Office more secure, macros have become more difficult to enable when a file is downloaded from the internet. After downloading the model, macros can be unblocked by navigating to the file in File Explorer, right-clicking on the file, choosing Properties, and selecting Unblock on the General tab.

More information about this change and alternative ways to unblock macros can be found at https://learn.microsoft.com/en-us/deployoffice/security/internet-macros-blocked.

## 2.2 Reset Model

The Reset Model macro will run a series of smaller macros in an attempt to return GHGenius to the state in which it was downloaded. It will run the Canada regional default, set the GWP settings to the 2013 100-year values and the short-lived gases to carbon weighted, run most default buttons on the Input sheet and the Chemical Defaults button on the Alt Fuel Prod sheet. It does not set the year for the model.

The Reset Model macro can not fix any broken formulas or changes made outside of those stated above.

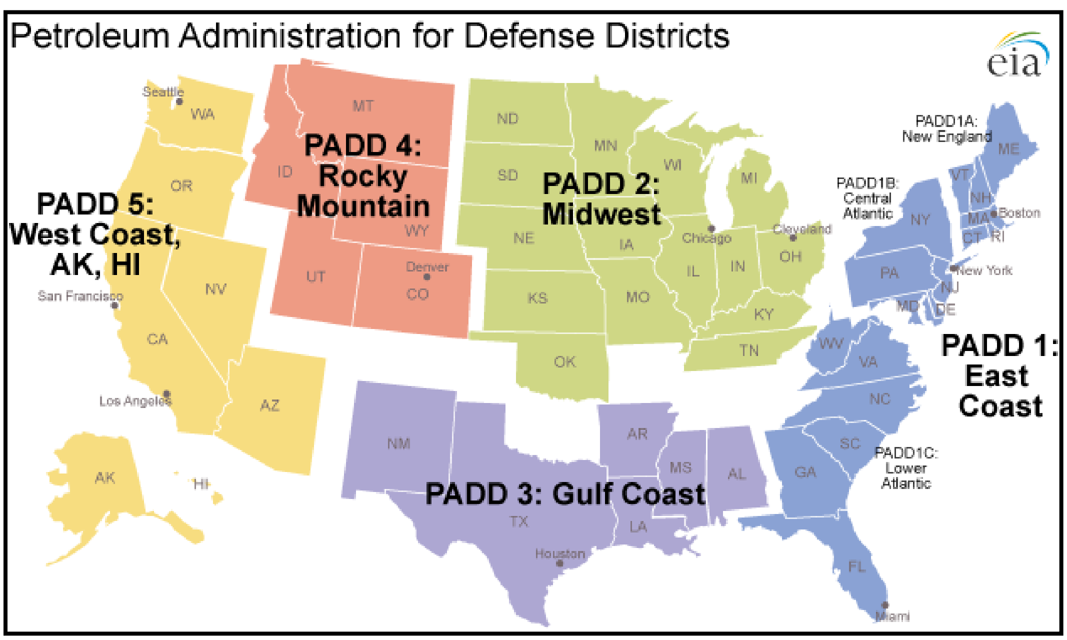
The Reset Model macro does not make any changes to the Coprods sheet. Nor does it change any of the values on the Alt Fuel Prod sheet related to the emission intensity of the chemicals included on the sheet.

If the file is closed without saving, the next time it opens it will open to the last saved version of the file.

## 2.3 Production Region

The region in which a plant is in should be selected. This region should be the province in Canada or the region in the United States. The US regions are aligned with the Energy Information Administration PADDs as shown in the following figure and table.

### Figure 2-1 US Regions




Source: US Energy Information Administration

The GHGenius regions are listed in the following table.

### Table 2-1 GHGenius Regions

| GHGenius Region | Province or PADD |
|---|---:|
| US East | 1 |
| US Central | 2 and 3 |
| US West | 4 and 5 |
| Canada West | BC, Alberta, Saskatchewan, Manitoba |
| Canada Central | Ontario, Quebec |
| Canada East | New Brunswick, Nova Scotia. Prince Edward Island, Newfoundland |

HDRD plants are different than ethanol and biodiesel plants in that they do not draw all of their feedstock from the same PADD that the plant is located in. Some HDRD plants move the feedstock a long distance or the feedstock is produced in one region and processed in another. Modelling this scenario is discussed later. The most carbon intensive region for electricity and petroleum products is the US Central region and so using that region can be a conservative option where feedstock comes from more than one region.

For plants that process soybean oil, canola oil or tallow in the US, the model should first be reset (~F4) and then choose the actual feedstock production region and the "Install Regional Defaults" button.

Check to ensure the appropriate region has a 1.00 in row 9.

## 2.4 Model Year

The model should be set up for the same year as the data entered into the model represents. When the data extends over two or more years the model should be set for the latest year in the data set. The year must be input in two places in the model, in cell Input B7 (Target Year) and in row 241 (Base year for Alt Fuel Production) on the Input sheet.

## 2.5 GWP

The default GWP values that are selected by the model are the IPCC 5$^{th}$ Assessment Report values (cell B11 (2013 100 years) and D11 "Carbon Weighted" on the Input sheet). These are also selected if the Reset Model button is pushed.

To change the GWP values used in the model a GHGenius user can select alternative values in the drop-down menus in cells B11 and D11(GWP Selector & Short-Lived Gases).

# 3 Feedstock

If the plant processes more than one feedstock, the model must be run for each feedstock separately. Since it is unlikely that the plant will have separate data on the energy requirements, HDRD yield and chemical requirements, the same values should be used for each feedstock.

The feedstock weights are entered on an as received basis. There is no requirement to adjust them to dry weight.

## 3.1 Feedstock Production

If feedstock production data is not available, model defaults for feedstock production should be used. Currently, no HDRD plant is integrated with a crushing facility, therefore no change is required for the feedstock production parameters. If that changes in the future, then section 3.3 describes the changes.

Some feedstock producing regions are selected by the model when the range is selected but this is not the case for every feedstock. GHGenius users should ensure that the appropriate feedstock region is selected for modeling the specific feedstock. These values are found on the Input sheet in rows 153 to 236 and in columns B to Q. An example is shown in the following figure.

### Figure 3-1 Feedstock Production Region

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 153 | FERTILIZER MANUFACTURE, APPLICATION; NUTRIENT LOSS; LAND USE (Sheet: Fertilizers) | | | | | | |
| 154 | Country data on yields and fertilizer use for: | Canada East | Canada Central | Canada West | US East | US Central | US West |
| 155 | Corn harvest yield, 1994 (tonne/hectare) | 7.20 | 7.20 | 4.70 | 7.60 | 7.60 | 7.60 |
| 156 | Change in corn harvest yield (Exp) | 1.50 | 1.50 | 2.10 | 1.60 | 1.60 | 1.60 |
| 157 | N rate, corn (kg/tonne) | 13.00 | 13.00 | 13.00 | 19.20 | 19.20 | 19.20 |
| 158 | Corn Producing Region | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 |
| 159 | Wheat harvest yield, 2000 (tonne/hectare) | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 |
| 160 | Change in wheat harvest yield (Exp) | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |
| 161 | N rate, wheat (kg/tonne) | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 162 | Wheat Producing Region | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 |
| 163 | Barley harvest yield, 1994 (tonne/hectare) | 2.80 | 2.80 | 2.80 | 2.80 | 2.80 | 2.80 |
| 164 | Change in barley harvest yield (Exp) | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 |
| 165 | N rate, barley (kg/tonne) | 23.00 | 23.00 | 23.00 | 23.00 | 23.00 | 23.00 |
| 166 | Barley Producing Region | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| 167 | Peas harvest yield, 1994 (tonne/hectare) | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| 168 | Change in peas harvest yield (Exp) | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 |
| 169 | N rate, peas (kg/tonne) | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| 170 | Peas Producing Region | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 |
| 171 | Soy harvest yield, 1994 (tonne/hectare) | 2.50 | 2.50 | 2.50 | 2.40 | 2.40 | 2.40 |
| 172 | Change in soy harvest yield (Exp) | 0.90 | 0.90 | 0.90 | 1.30 | 1.30 | 1.30 |
| 173 | N rate, Soybean (kg/tonne) | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 |
| 174 | Soybean Producing Region | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 |
| 175 | Canola harvest yield, 1994 (tonne/hectare) | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |
| 176 | Change in Canola harvest yield (Exp) | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 |
| 177 | N rate, Canola (kg/tonne) | 51.00 | 51.00 | 51.00 | 51.00 | 51.00 | 51.00 |
| 178 | Canola Producing Region | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| 179 | Palm harvest yield, 2000 (tonne/hectare) | 18.30 | 18.30 | 18.30 | 18.30 | 18.30 | 18.30 |

## 3.2 Feedstock Transportation

Feedstock transportation is set on the Input sheet in rows 76 though 86. The one-way distance in kilometres is input in rows 76 to 80. The tonnes-shipped/tonnes-produced (rows 82 to 86) will add up to 1.00 or greater, but it should not be less than one. A sum greater than one would indicate a multi-modal route where the feedstock might be shipped by truck to a rail loading facility and then shipped by rail to the ethanol plant.

This area of the Input sheet is shown in the following figure.

### Figure 3-2 Transportation Inputs

| | A | E | F |
|---|---|---|---|
| 73 | **TRANSPORTATION OF FEEDSTOCKS** | | |
| 74 | | **Coal** | **Corn** |
| 75 | **Average km shipped** | **to H2** | **to Plant** |
| 76 | By Rail | 0 | 0 |
| 77 | Domestic water | 0 | 0 |
| 78 | International water | 0 | 0 |
| 79 | Pipeline, tram, conveyor | 10 | 0 |
| 80 | Truck     Defaults | 0 | 100 |
| 81 | Tonnes-shipped/tonne-produced | | |
| 82 | By Rail | 0.00 | 0.00 |
| 83 | Domestic water | 0.00 | 0.00 |
| 84 | International water | 0.00 | 0.00 |
| 85 | Pipeline, tram, conveyor | 1.00 | 0.00 |
| 86 | Truck | 0.00 | 1.00 |

## 3.3 Oil Extraction from Feedstocks

If primary data (data measured at the facility) is available for the extraction process, then this can be used in the modelling in place of using the default values. This information is added in rows 239 to 248 on the input sheet. The quantity of hexane (petroleum is used as a proxy for hexane) used in solvent extraction processes can be entered on the Alt Fuel Prod sheet in row 60 and the appropriate column for the feedstock (columns BB to CA).

The section of the Input sheet is shown in the following figure.

### Figure 3-3 Oil Extraction Inputs

| | A | AS | AT | AU |
|---|---|---|---|---|
| 238 | **ALTERNATIVE FUEL PRODUCTION (Sheet: Alt Fuel Prod)** | | | |
| 239 | **Fuel -->** | **Canola Oil** | **Soybean Oil** | **Palm oil** |
| 240 | **Feedstock -->** | **Canola** | **Soybean** | **Palm** |
| 241 | Base year --> | *2010* | *2008* | *2005* |
| 242 | Inputs (below) per output --> | litre | litre | litre |
| 243 | Net electricity purchased (kWh) (base year) | *0.10* | *0.26* | *0.00* |
| 244 | Diesel (litres) (base year) | *0.00* | *0.00* | *0.00* |
| 245 | Natural gas (MJ) (base year) | *2.14* | *5.75* | *0.00* |
| 246 | Coal (kg) (base year) [Defaults] | *0.00* | *0.00* | *0.00* |
| 247 | Wood, grass, crop residue, MSW, RDF ( dry kg) (base year) | *0.00* | *0.00* | *0.16* |
| 248 | Corn/soybeans/Canola/wheat (base year), Rendering , Fish Oil (kg) | *2.10* | *4.79* | *4.00* |
| 249 | | | | |

# 4 HDRD Production

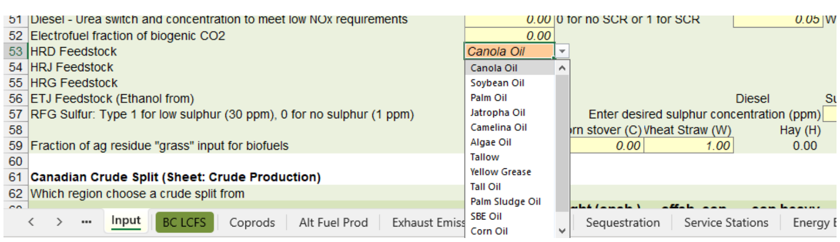
The input data for the HDRD pathway is input into the model on a per litre of HDRD basis. The volume should be before any diesel fuel is added to the HDRD to collect the US Blenders Tax Credit.

**Note: the model labels HDRD as HRD.**

## 4.1 Feedstock

While all the lipid feedstocks can be used for HDRD production there is only one output column on the Upstream Emissions HHV and BC LCFS sheet. The selection of the feedstock is made using the drop-down menu in cell B53 on the Input sheet, see figure below.

### Figure 4-1 Feedstock Drop-down Menu




## 4.2 Model Year

When modelling a specific plant, it is important to match the model year in B7, the base year in row 241, and the date that data was collected.

## 4.3 Mass and Energy

The main mass and energy inputs are on the Input sheet in rows 243 to 248. These values should be for the fuel's active year, as defined in row 241. Column CD is the column for a HDRD plant.

### 4.3.1 Electricity

The net electricity purchased is based on the generic power of the region in which the model is run. This value is entered in cell CD243. The input unit for electricity is kilowatt-hours (kWh) per litre of HDRD.

### 4.3.2 Diesel Fuel

There can be a small amount of diesel fuel used at some HDRD plants for rail car shuttles, front end loaders, etc. This value, litres of diesel/litre of HDRD, is entered in CD244.

### 4.3.3 Natural Gas

The natural gas carbon intensity is not strongly regional. The value is entered in cell CD245. The input unit for natural gas is megajoules per litre (MJ/litre) on a higher heating value basis. If the HDRD plant produced its own hydrogen, then the model input includes the gas used for the production of hydrogen as well as natural gas used for other purposes in the plant. If the hydrogen is purchased, the quantity of hydrogen is entered on the Alt Fuel Prod sheet and the natural gas value is just for those other applications in the plant.

### 4.3.4 Feedstock

The feedstock input for the HDRD pathway is in CD248. The input is kg of oil per litre of HDRD.

### 4.3.5 Chemicals

Chemical inputs into a HDRD pathway can be specified on the Alt Fuel Prod sheet. The HDRD Column is CM. The most common input is hydrogen. Plants may also use acids and bases for pretreatment of the feedstock.

All chemical inputs are based on 100% purity and input values may need to be adjusted based on their purity. For example, a 93% pure sulphuric acid should be multiplied by 0.93 before being input into the model.

**Table 4-1 Chemical Inputs**

| Chemical | Row on Alt Fuel Prod |
|---|---|
| Citric acid | 36 |
| Hydrogen | 44 |
| NaOH | 53 |
| Nitrogen - gaseous | 56 |
| Phosphoric acid | 62 |

## 4.4 Coproducts

HDRD production produces several coproducts, which can be consumed in the plant as a fuel or a feedstock to produce hydrogen, sold as products, or sold as fuel to adjacent facilities. All three scenarios can be found in North American HDRD plants. GHGenius includes the following HDRD coproducts:

- LPG,
- Naphtha.
- Fuel gas (by mass), Fuel gas by energy can be modelled as RNG, and
- Hydrogenation-Derived Renewable Jet fuel (HDRJ)

The quantities of coproducts are entered on the Coprods sheet in column BC, rows 135 (LPG), 137 (naphtha), 138 (RNG), 141 (fuel gas), and 143 (HDRJ). See figure 4-2 below with modifiable cells' values bolded.

**Note: The coproduct sponge gas is not a default modifiable cell (BC142) for this pathway and should not be highlighted yellow.**

### Figure 4-2 HDRD Coproduct Quantities

| | | |
|---|---|---|
| 134 | LPG (displacing bio-LPG) (L) | 0.00 |
| 135 | LPG (displacing fossil-LPG) (L) | ***0.05*** |
| 136 | Naphtha (displacing bio-naphtha) (L) | 0.00 |
| 137 | Naphtha (displacing fossil-naphtha) (L) | ***0.00*** |
| 138 | Renewable Natural Gas (MJ) | ***0.00*** |
| 139 | Propylene Glycol (kg) | 0.00 |
| 140 | Xylitol (kg) | 0.00 |
| 141 | Fuel Gas (kg) | **0.00** |
| 142 | Sponge Gas (kg) | *0.00* |
| 143 | HRJ (L) | **0.00** |

When the coproducts can be used as a drop-in fuel for transportation or can be upgraded and used as transportation fuels, their emissions should be allocated based on their energy content. This applies to naphtha, LPG (see below), and HDRJ.

GHGenius allocates emissions for LPG coproducts using the displacement method by default. However, applicants must choose the energy allocation method if the LPG meets specific criteria (Refer to the definition of Grade 1 Propane in CAN/CGSB-3.14-2023 for composition details):

- Propane volume percentage exceeding 90%, and
- Propene volume percentage less than 5%, and
- Butane and heavier hydrocarbons combined volume percentage less than 2.5%

If the LPG composition aligns with above specifications, you must manually change the allocation method in cells B189 and B190 of the Coprods sheet to "energy". For LPG composition which falls outside above limits, the displacement method remains the default approach in GHGenius. If an applicant has a compelling reason to use the displacement allocation method, they should submit an application for review by the LCFB. This application should be accompanied by evidence supporting the LPG's composition and justifying the use of the alternative method.

### Figure 4-3 HDRD Coproduct Displacement method

| | | |
|---|---|---|
| 189 | LPG (displacing bio-LPG) (L) | *Energy* |
| 190 | LPG (displacing fossil-LPG) (L) | *Energy* |
| 191 | Naphtha (displacing bio-naphtha) (L) | *Energy* |
| 192 | Naphtha (displacing fossil-naphtha) (L) | *Energy* |
| 193 | Renewable Natural Gas | *Energy* |
| 194 | Propylene Glycol (kg) | *Displacement* |
| 195 | Xylitol (kg) | *Displacement* |
| 196 | Fuel Gas (kg) | *Displacement* |
| 197 | Sponge Gas (kg) | *Displacement* |
| 198 | HRJ (L) | *Energy* |

LPG is entered in cell BC135 on a litre of LPG/litre of HDRD basis. The naphtha is entered in cell BC137 on a litres of naphtha per litre of HDRD basis. Fuel gas is usually available on an energy content basis, and it can be entered in cell BC138 (RNG) on a MJ/litre of HDRD basis. There is an entry for fuel gas on a mass basis (row 141), but this would assume that the fuel gas has the same energy density as natural gas, which may not be accurate. HDRJ is entered in cell BC143 on a litre of HDRJ/litre of HDRD basis.

#### 4.4.1 Renewable Naphtha Emissions

The applicant has the option to receive a unique fuel code for the renewable naphtha coproduct, also referred to as Hydrogenation-Derived Renewable Gasoline (HDRG), to be used as a transportation fuel. The renewable naphtha will have the same carbon intensity (CI) as HDRD, except it will have higher exhaust emissions, and slightly different fuel distribution and storage, and fuel dispensing emissions.

These results are obtained during the model run for the BC region to calculate final distribution of 80 km, dispensing, and fuel use emissions. The results for renewable naphtha are found on the BC LCFS sheet, column AM, rows 16 to 18. Typically exhaust emissions for renewable naphtha are 0.5 $gCO_2e/MJ$ higher than HDRD.

#### 4.4.2 Renewable Propane Emissions

The applicant has the option to receive a separate unique fuel code for the LPG coproduct, also referred to as renewable propane or Hydrogenation-Derived Renewable Propane (HDRP), to be used as a transportation fuel. The renewable propane will have the same carbon intensity (CI) as HDRD, except it will have higher exhaust emissions, and slightly different fuel distribution and storage, and fuel dispensing emissions.

These results are obtained during the model run for the BC region to calculate final distribution of 80 km, dispensing, and fuel use emissions. The results for renewable propane are found on the BC LCFS sheet, column AN, rows 16 to 18. Typically exhaust emissions for renewable propane are 1.5 $gCO_2e/MJ$ higher than HDRD.

#### 4.4.3 Alternative Jet Fuel Emissions

The applicant has the option to receive a separate fuel code for the HDRJ (alternative jet fuel) coproduct to be used as a transportation fuel. The HDRJ will have the same carbon intensity (CI) as HDRD, except it will have lower exhaust emissions, and slightly different fuel distribution and storage, and fuel dispensing emissions.

These results are obtained during the model run for the BC region to calculate final distribution of 80 km, dispensing, and fuel use emissions. The results for HDRJ are found on the BC LCFS sheet, column AL, rows 16 to 18. Typically exhaust emissions for HDRJ are 1 g$CO_2$e/MJ lower than HDRD.

### 4.5 Carbon Capture and Sequestration

The $CO_2$ emissions from HDRD plants are much lower than they are for ethanol plants because the energy use for the process is lower; and there is much less $CO_2$ released during the process and only if the hydrogen is being produced by the plant. GHGenius 5.02b does not have the capacity to model captured $CO_2$ as part of the carbon intensity modelling of HDRD.

### 4.6 HDRD Transportation

The HDRD transportation parameters are in column AZ on the Input sheet. On row 91 of the Input sheet is a dropdown asking if transloading should be included. Most modelled scenarios will include these emissions once, while some will include the emissions multiple times if there are multiple locations where the fuel is stored while awaiting a change of transportation mode.

In a typical HDRD plant, the dropdown will be set to “No” when running results in the production region and “Yes” when running results in BC for final distribution.

All fuels will have 80 km of truck transportation in the BC region, in addition to any other known transportation distances. When the BC distribution emissions are being modelled AZ91 should be set to “YES” to capture the energy used for blending and truck loading.

# 5 Soybean Oil HDRD Example

Any fuels produced outside of BC will require at least two runs of the model to accurately calculate the results. In the case of HDRD, a common scenario is feedstock and fuels produced in US Central and moved via rail to BC. Below is an example of that using some assumptions. This HDRD is produced from soybean oil (SBO) with the feedstock and HDRD production in the same region.

The first run will be in the US Central region. Be sure to click the Apply Regional Defaults button after setting cell B4 to the appropriate region, as shown in the figure below.

The following table shows the values used for this modelling exercise. A GHGenius user would replace these values with their actual values. For this example, the HDRD plant operator will be buying SBO from a crusher. Only the transportation distances for the SBO will be known, while all other feedstock inputs will retain the model's defaults.

All HDRD pathways share the same inputs and output, with the feedstock selected via a dropdown. This exercise also details the steps of how to model renewable propane, naphtha and HDRJ coproducts which can receive a fuel code.

The output coproduct LPG/renewable propane/HDRP was tested and meets the specifications required for use as a transportation fuel under CAN/CGSB-3.14-2023 and must be allocated by energy.

### Table 5-1 Model Inputs for US Central Emissions Run

| Sheet | Cell | Description | Value |
|---|---|---|---|
| Input | B4 | Region | US Central |
| Input | B7 | Year | 2023 |
| Input | B53 | HRD Feedstock | Soybean Oil |
| Input | N76 | SBO Rail distance | 300 |
| Input | N80 | SBO Truck distance | 0 |
| Input | N82 | SBO Rail mode | 1 |
| Input | N86 | SBO Truck mode | 0 |
| Input | AZ91 | HRD Transloading | No |
| Input | AZ92 | HRD Rail Distance | 3000 |
| Input | AZ96 | HRD Truck distance | 0 |
| Input | AZ98 | HRD Rail mode | 1 |
| Input | AZ102 | HRD Truck mode | 0 |
| Input | CD241 | Year | 2023 |
| Input | CD243 | Electricity | 0.05 |
| Input | CD245 | NG | 0.2 |
| Input | CD248 | HRD Feedstock | 0.95 |
| Alt Fuel Prod | CM44 | Hydrogen | 0.03 |
| Alt Fuel Prod | CM53 | NaOH | 0 |
| Alt Fuel Prod | CM55 | Nitrogen | 0 |
| Alt Fuel Prod | CM62 | Phosphoric acid | 0 |
| Coprods | BC135 | LPG (displacing fossil-LPG) (L) | 0.02 |
| Coprods | BC137 | Naphtha (displacing fossil-naphtha) (L) | 0.015 |
| Coprods | BC143 | HRJ (L) | 0.015 |
| Coprods | A154 | Order of operations | After displacement |
| Coprods | B190 | Allocation by | Energy |

The results for the year 2023 are shown in the following table. These values are from the BC LCFS sheet. Column AK, rows 8 to 16. Note your results may differ slightly to the results below.

### Table 5-2 US Central Emissions 2023

| Stage | Emissions, g $CO_2$eq/GJ (HHV) |
|---|---:|
| Direct land use change | 0 |
| Feedstock production or cultivation | 34,260 |
| Feedstock upgrading | 15,076 |
| Feedstock transport | 1,910 |
| Feedstock coproducts production | -41,193 |
| Avoided emissions | 0 |
| Fuel production | 11,256 |
| Fuel coproducts production | -848 |
| Fuel distribution and storage | 1,246 |

The second run will be in the BC region to calculate final distribution of 80 km, dispensing, and fuel use emissions. Most of the inputs can be left the same as the first US Central run. Changes are outlined in the following table.

### Table 5-3 Model Inputs for BC Emissions Run

| Sheet | Cell | Description | Value |
|---|---:|---:|---:|
| Input | B4 | Region | BC |
| Input | AZ91 | HRD Transloading | Yes |
| Input | AZ92 | HRD Rail distance | 0 |
| Input | AZ96 | HRD Truck Distance | 80 |
| Input | AZ98 | HRD Rail mode | 0 |
| Input | AZ102 | HRD Truck mode | 1 |

The results for the BC region are below. These are again from the BC LCFS sheet, column AK rows 16 to18.

### Table 5-4 BC Emissions 2023

| Stage | Emissions, g $CO_2$eq/GJ (HHV) |
|---|---:|
| Fuel distribution and storage | 395 |
| Fuel dispensing | 82 |
| Vehicle or Vessel operation | 1,524 |

The results from the two regions can be combined to produce a final CI of 23.71g $CO_2$eq/MJ. The values in the first two columns are summed to produce the values in the right-hand column.

### Table 5-5 Total Emissions 2023

| Stage | US Central Emissions | BC Emissions | Total Emissions |
|---|---|---|---|
| | g $CO_2$eq/GJ (HHV) | | |
| Direct land use change | 0 | | 0 |
| Feedstock production or cultivation | 34,260 | | 34,260 |
| Feedstock upgrading | 15,076 | | 15,076 |
| Feedstock transport | 1,910 | | 1,910 |
| Feedstock coproducts production | -41,193 | | -41,193 |
| Avoided emissions | 0 | | 0 |
| Fuel production | 11,256 | | 11,256 |
| Fuel coproducts production | -848 | | -848 |
| Fuel distribution and storage | 1,246 | 395 | 1,641 |
| Fuel dispensing | | 82 | 82 |
| Vehicle or Vessel operation | | 1,524 | 1,524 |
| **Total** | 21,706 | 2,000 | 23,706 |
| **Total, g $CO_2$eq/MJ** | | | 23.71 |

## 5.1 Soybean Oil Renewable Naphtha Example

Renewable naphtha is a coproduct of HDRD, because of this it will have the same CI as the HDRD it is produced with, except it will have higher exhaust emissions, and slightly different fuel distribution and storage, and fuel dispensing emissions. To model the renewable naphtha BC run, we use the inputs in the table below.

### Table 5-6 Model Inputs for Renewable Naphtha BC Emissions Run

| Sheet | Cell | Description | Value |
|---|---|---|---|
| Input | B4 | Region | BC |
| Input | B55 | HRG Feedstock | Soybean Oil |
| Input | BB91 | HRG Transloading | Yes |
| Input | BB92 | HRG Rail distance | 0 |
| Input | BB96 | HRG Truck Distance | 80 |
| Input | BB98 | HRG Rail mode | 0 |
| Input | BB102 | HRG Truck mode | 1 |

When doing the BC run, the results for renewable naphtha are found on the BC LCFS sheet, column AM (HRG), rows 16 to 18. Renewable naphtha produced from the same feedstock will have a CI of 24.19 $gCO_2e/MJ$ in this example.

### Table 5-7 Total Emissions 2023 Renewable Naphtha

| Stage | US Central Emissions | BC Emissions | Total Emissions |
|---|---|---|---|
| | g $CO_2$eq/GJ (HHV) | | |
| Direct land use change | 0 | | 0 |
| Feedstock production or cultivation | 34,260 | | 34,260 |
| Feedstock upgrading | 15,076 | | 15,076 |
| Feedstock transport | 1,910 | | 1,910 |
| Feedstock coproducts production | -41,193 | | -41,193 |
| Avoided emissions | 0 | | 0 |
| Fuel production | 11,256 | | 11,256 |
| Fuel coproducts production | -848 | | -848 |
| Fuel distribution and storage | 1,246 | 409 | 1,655 |
| Fuel dispensing | | 85 | 85 |
| Vehicle or Vessel operation | | 1,993 | 1,993 |
| **Total** | **21,706** | **2,487** | **24,193** |
| **Total, g $CO_2$eq/MJ** | | | **24.19** |

## 5.2 Soybean Oil Renewable Propane Example

Renewable propane (LPG) is a coproduct of HDRD, because of this it will have the same CI as the HDRD it is produced with, except it will have higher exhaust emissions, and slightly different fuel distribution and storage, and fuel dispensing emissions. As mentioned previously, the renewable propane produced here meets the specifications for grade 1 propane under CAN/CGSB-3.14-2023, and therefore is modelled using energy allocation. To model the renewable propane BC run, we use the inputs in the table below.

### Table 5-8 Model Inputs for Renewable Propane BC Emissions Run

| Sheet | Cell | Description | Value |
|---|---|---|---|
| Input | B4 | Region | BC |
| Input | B53 | HRD Feedstock | Soybean Oil |
| Input | BC91 | HRP Transloading | Yes |
| Input | BC92 | HRP Rail distance | 0 |
| Input | BC96 | HRP Truck Distance | 80 |
| Input | BC98 | HRP Rail mode | 0 |
| Input | BC102 | HRP Truck mode | 1 |

When doing the BC run, the results for renewable propane are found on the BC LCFS sheet, column AN, rows 16 to 18. Renewable propane produced from the same feedstock will have a CI of 25.15 g$CO_2$e/MJ in this example.

### Table 5-9 Total Emissions 2023 Renewable Propane

| Stage | US Central Emissions | BC Emissions | Total Emissions |
|---|---|---|---|
| | g $CO_2$eq/GJ (HHV) | | |
| Direct land use change | 0 | | 0 |
| Feedstock production or cultivation | 34,260 | | 34,260 |
| Feedstock upgrading | 15,076 | | 15,076 |
| Feedstock transport | 1,910 | | 1,910 |
| Feedstock coproducts production | -41,193 | | -41,193 |
| Avoided emissions | 0 | | 0 |
| Fuel production | 11,256 | | 11,256 |
| Fuel coproducts production | -848 | | -848 |
| Fuel distribution and storage | 1,246 | 457 | 1,703 |
| Fuel dispensing | | 87 | 87 |
| Vehicle or Vessel operation | | 2,896 | 2,896 |
| **Total** | **21,706** | **3,441** | **25,147** |
| **Total, g $CO_2$eq/MJ** | | | **25.15** |

## 5.3 Soybean Oil HDRJ Example

HDRJ (alternative jet fuel) is a coproduct of HDRD, because of this it will have the same CI as the HDRD it is produced with, except it will have lower exhaust emissions, and slightly different fuel distribution and storage, and fuel dispensing emissions. To model the HDRJ BC run, we use the inputs in the table below.

### Table 5-10 Model Inputs for HDRJ BC Emissions Run

| Sheet | Cell | Description | Value |
|---|---|---|---|
| Input | B4 | Region | BC |
| Input | B54 | HRJ Feedstock | Soybean Oil |
| Input | BA91 | HRJ Transloading | Yes |
| Input | BA92 | HRJ Rail distance | 0 |
| Input | BA96 | HRJ Truck Distance | 80 |
| Input | BA98 | HRJ Rail mode | 0 |
| Input | BA102 | HRJ Truck mode | 1 |

When doing the BC run, the results for HRJ are found on the BC LCFS sheet, column AL, rows 16 to 18. HRJ produced from the same feedstock will have a CI of 22.77 g$CO_2$e/MJ in this example.

### Table 5-11 Total Emissions 2023 HDRJ

| Stage | US Central Emissions | BC Emissions | Total Emissions |
|---|---|---|---|
| | g $CO_2$eq/GJ (HHV) | | |
| Direct land use change | 0 | | 0 |
| Feedstock production or cultivation | 34,260 | | 34,260 |
| Feedstock upgrading | 15,076 | | 15,076 |
| Feedstock transport | 1,910 | | 1,910 |
| Feedstock coproducts production | -41,193 | | -41,193 |
| Avoided emissions | 0 | | 0 |
| Fuel production | 11,256 | | 11,256 |
| Fuel coproducts production | -848 | | -848 |
| Fuel distribution and storage | 1,246 | 404 | 1,650 |
| Fuel dispensing | | 84 | 84 |
| Vehicle or Vessel operation | | 572 | 572 |
| **Total** | **21,706** | **1,059** | **22,765** |
| **Total, g $CO_2$eq/MJ** | | | **22.77** |

# 6 Tallow HDRD Example

Any fuels produced outside of BC will require at least two runs of the model to accurately calculate the results. HDRD plants will not always be in the same region as where the feedstocks are produced. Below is an example of that, using the assumed inputs of tallow produced in US Central and HDRD produced in US West. This scenario requires three model runs.

The first run will be in the US Central region. Be sure to click the Apply Regional Defaults button after setting cell B4 to the appropriate region. The following table shows the values used for this modelling exercise. A GHGenius user would replace these values with their actual values. For this example, the HDRD plant operator will be buying tallow from a renderer. Only the transportation distances for the tallow will be known, while all other feedstock inputs will retain the model's defaults.

All HDRD pathways share the same inputs and outputs, with the feedstock selected via a dropdown. This exercise also details the steps of how to model naphtha coproducts which can receive a fuel code. The LPG produced was tested and does not meet the specifications for grade 1 propane under CAN/CGSB-3.14-2023, and as such, cannot receive a fuel code under the BC LCFS. As a result, LPG emissions are allocated based on displacement rather than energy as in the previous example.

**Note: GHGenius labels HDRD as HRD**

### Table 6-1 Model Inputs for US Central Emissions Run

| Sheet | Cell | Description | Value |
|---|---:|---:|---:|
| Input | B4 | Region | US Central |
| Input | B7 | Year | 2023 |
| Input | B53 | HRD Feedstock | Tallow |
| Input | X76 | Tallow Rail distance | 2,000 |
| Input | X80 | Tallow Truck distance | 0 |
| Input | X82 | Tallow Rail mode | 1 |
| Input | X86 | Tallow Truck mode | 0 |
| Input | CD241 | Year | 2023 |
| Input | CD248 | HRD Feedstock | 0.95 |

The results for the year 2023 are shown in the following table. These values are from the BC LCFS sheet. Column AK, rows 8 to 13.

### Table 6-2 US Central Emissions 2023

| Stage | Emissions, g $CO_2$eq/GJ (HHV) |
|---|---:|
| Direct land use change | 0 |
| Feedstock production or cultivation | 0 |
| Feedstock upgrading | 19,248 |
| Feedstock transport | 2,442 |
| Feedstock coproducts production | -10,460 |
| Avoided emissions | 0 |

The second region will be a US West run, that accounts for fuel production from the tallow. For now, the naphtha coproduct will be entered as zero (Coprods BC137) as this credit needs to be calculated outside of the model. Be sure to hit the Apply Regional Defaults button after setting cell B4 to the appropriate region (US West).

### Table 6-3 Model Inputs for US West Emissions Run

| Sheet | Cell | Description | Value |
|---|---:|---:|---:|
| Input | B4 | Region | US West |
| Input | B7 | Year | 2023 |
| Input | B53 | Feedstock | Tallow |
| Input | AZ91 | HRD Transloading | No |
| Input | AZ92 | HRD Rail distance | 2,000 |
| Input | AZ96 | HRD Truck distance | 0 |
| Input | AZ98 | HRD Rail mode | 1 |
| Input | AZ102 | HRD Truck mode | 0 |
| Input | CD241 | Year | 2023 |
| Input | CD243 | Electricity | 0.05 |
| Input | CD245 | NG | 0.2 |
| Input | CD248 | HRD Feedstock | 0.95 |
| Alt Fuel Prod | CM44 | Hydrogen | 0.03 |
| Alt Fuel Prod | CM53 | NaOH | 0 |
| Alt Fuel Prod | CM55 | Nitrogen | 0 |
| Alt Fuel Prod | CM62 | Phosphoric acid | 0 |
| Coprods | BC135 | LPG | 0.02 |
| Coprods | BC137 | Naphtha | 0 |
| Coprods | B190 | Allocation by | Displacement |

The results for the year 2023 are shown in the following table. These values are from the BC LCFS sheet. Column AK, rows 14 to 16.

### Table 6-4 US West Emissions 2023

| Stage | Emissions, g $CO_2$eq/GJ (HHV) |
|---|---:|
| Fuel production | 11,285 |
| Fuel coproducts production | -961 |
| Fuel distribution and storage | 838 |

We want to model an additional 0.03 L of naphtha coproduct produced. Because this pathway is across multiple regions, any coproducts using energy allocation must be handled separately. By entering 0.03 in cell BC137 on Coprods, the fraction of energy coproducts can be found in cell BC163. The result is 0.026598683 (unitless). To calculate the naphtha coproduct emissions, use the fraction and multiply by the sum of emissions of all previous stages including the non-energy coproducts. Do not include fuel distribution, dispensing, or vehicle operation. This is shown in the following table with the bolded cells summed.

### Table 6-5 Out-of-model Energy Allocation Calculation

| | USC | USW | Out of model energy allocation calculation |
|---|---:|---:|---|
| Direct land use change | **0** | | |
| Feedstock production or cultivation | **0** | | |
| Feedstock upgrading | **19,248** | | |
| Feedstock transport | **2,442** | | |
| Feedstock coproducts production | **-10,460** | | |
| Avoided emissions | **0** | | |
| Fuel production | | **11,285** | |
| Fuel coproducts production | | **-961** | **-573** = -0.026598683* (19,248 + 2,442 + -10,460 +11,285-961) |
| Fuel distribution and storage | | 838 | |
| Fuel dispensing | | | |
| Vehicle or Vessel operation | | | |

The third run will be in the BC region to calculate final distribution of 80km, dispensing, and fuel use emissions. Most of the inputs can be left the same as the first US Central run. Changes are outlined in the following table.

### Table 6-6 Model Inputs for BC Emissions Run

| Sheet | Cell | Description | Value |
|---|---|---|---|
| Input | B4 | Region | BC |
| Input | AZ91 | HRD Transloading | Yes |
| Input | AZ92 | HRD Rail distance | 0 |
| Input | AZ96 | HRD Truck Distance | 80 |
| Input | AZ102 | HRD Truck mode | 1 |

The results for the BC region are below. These are again from the BC LCFS sheet, column AK rows 16 to 18.

### Table 6-7 BC Emissions 2023

| Stage | Emissions, g $CO_2$eq/GJ (HHV) |
|---|---|
| Fuel distribution and storage | 395 |
| Fuel dispensing | 82 |
| Vehicle or Vessel operation | 1,524 |

The results from the three regions can be combined to produce a final CI of 23.82 g $CO_2$eq/MJ. The values in the first four columns are summed to produce the values in the right-hand column.

**Table 6-8 Total Emissions 2023**

| Stage | US Central Emissions | US West Emissions | Energy Coproduct | BC Emissions | Total Emissions |
|---|---|---|---|---|---|
| | g $CO_2$eq/GJ (HHV) | | | | |
| Direct land use change | 0 | | | | 0 |
| Feedstock production or cultivation | 0 | | | | 0 |
| Feedstock upgrading | 19,248 | | | | 19,248 |
| Feedstock transport | 2,442 | | | | 2,442 |
| Feedstock coproducts production | -10,460 | | | | -10,460 |
| Avoided emissions | 0 | | | | 0 |
| Fuel production | | 11,285 | | | 11,285 |
| Fuel coproducts production | | -961 | -573 | | -1,535 |
| Fuel distribution and storage | | 838 | | 395 | 1,233 |
| Fuel dispensing | | | | 82 | 82 |
| Vehicle or Vessel operation | | | | 1,524 | 1,524 |
| **Total** | **11,231** | **11,162** | **-573** | **2,000** | **23,820** |
| **Total, g $CO_2$eq/MJ** | | | | | **23.82** |

## 6.1 Tallow Renewable Naphtha Example

Renewable naphtha is a coproduct of HDRD, because of this it will have the same CI as the HDRD it is produced with, except it will have higher exhaust emissions, and slightly different fuel distribution and storage, and fuel dispensing emissions. To model the renewable naphtha BC run, we use the inputs in the table below.

### Table 6-9 Model Inputs for Renewable Naphtha BC Emissions Run

| Sheet | Cell | Description | Value |
|---|---:|---:|---:|
| Input | B4 | Region | BC |
| Input | B55 | HRG Feedstock | Tallow |
| Input | BB91 | HRG Transloading | Yes |
| Input | BB92 | HRG Rail distance | 0 |
| Input | BB96 | HRG Truck Distance | 80 |
| Input | BB98 | HRG Rail mode | 0 |
| Input | BB102 | HRG Truck mode | 1 |

When doing the BC run, the results for renewable naphtha are found on the BC LCFS sheet, column AM, rows 16 to 18. Renewable naphtha produced from the same feedstock will have a CI of 24.31 g$CO_2$e/MJ in this example.

### Table 6-10 Total Emissions 2023 Renewable Naphtha

| Stage | US Central Emissions | US West Emissions | Energy Coproduct | BC Emissions | Total Emissions |
|---|---|---|---|---|---|
| | g $CO_2$eq/GJ (HHV) | | | | |
| Direct land use change | 0 | | | | 0 |
| Feedstock production or cultivation | 0 | | | | 0 |
| Feedstock upgrading | 19,248 | | | | 19,248 |
| Feedstock transport | 2,442 | | | | 2,442 |
| Feedstock coproducts production | -10,460 | | | | -10,460 |
| Avoided emissions | 0 | | | | 0 |
| Fuel production | | 11,285 | | | 11,285 |
| Fuel coproducts production | | -961 | -573 | | -1,535 |
| Fuel distribution and storage | | 838 | | 409 | 1,248 |
| Fuel dispensing | | | | 85 | 85 |
| Vehicle or Vessel operation | | | | 1,993 | 1,993 |
| **Total** | **11,231** | **11,162** | **-573** | **2,487** | **24,307** |
| **Total, g $CO_2$eq/MJ** | | | | | **24.31** |

# 7 Canola HDRD Example

Any fuels produced outside of BC will require at least two runs, and sometimes more, of the model to accurately calculate the results. HDRD plants will not always be in the same region as where the feedstocks are produced. Below is an example of that using assumed inputs. Three runs are required. This plant will consume the coproducts to produce hydrogen, causing a reduction in the amount of natural gas required to produce the hydrogen.

The first run will be in the Alberta region. Be sure to click the Apply Regional Defaults button after setting cell B4 to the appropriate region. The following table shows the values used for this modelling exercise. A GHGenius user would replace these values with their actual values.

In this example the HDRD plant operator will be buying canola oil from a crusher. Only the transportation distances for the canola oil will be known, while all other feedstock inputs will retain the model's defaults.

All HDRD pathways share the same inputs and output, with the feedstock selected via a dropdown.

**Note: GHGenius labels HDRD as HRD**

**Table 7-1 Model Inputs for Alberta Emissions Run**

| Sheet | Cell | Description | Value |
|---|---:|---:|---:|
| Input | B4 | Region | Alberta |
| Input | B7 | Year | 2023 |
| Input | B53 | HRD Feedstock | Canola Oil |
| Input | L76 | Canola Oil Rail distance | 2,500 |
| Input | L80 | Canola Oil Truck distance | 0 |
| Input | L82 | Canola Oil Rail mode | 1 |
| Input | L86 | Canola Oil Truck mode | 0 |
| Input | CD241 | Year | 2023 |
| Input | CD248 | HRD Feedstock | 0.95 |

The results for the year 2023 are shown in the following table. These values are from the BC LCFS sheet. Column AK, rows 8 to 13.

**Table 7-2 Alberta Emissions 2023**

| Stage | Emissions, g $CO_2$eq/GJ (HHV) |
|---|---|
| Direct land use change | 0 |
| Feedstock production or cultivation | 14,817 |
| Feedstock upgrading | 5,013 |
| Feedstock transport | 1,823 |
| Feedstock coproducts production | -11,507 |
| Avoided emissions | 0 |

The second region will be a US West run, that accounts for fuel production from the canola oil. Instead of producing coproducts, they will be used internally to offset purchased hydrogen. If an output is used internally then it is not entered into GHGenius.

**Table 7-3 Model Inputs for US West Emissions Run**

| Sheet | Cell | Description | Value |
|---|---|---|---|
| Input | B4 | Region | US West |
| Input | B7 | Year | 2023 |
| Input | B53 | Feedstock | Canola Oil |
| Input | AZ91 | HRD Transloading | No |
| Input | AZ92 | HRD Rail Distance | 2,000 |
| Input | AZ96 | HRD Truck Distance | 0 |
| Input | AZ98 | HRD Rail mode | 1 |
| Input | AZ102 | HRD Truck mode | 0 |
| Input | CD241 | Year | 2023 |
| Input | CD243 | Electricity | 0.05 |
| Input | CD245 | NG | 0.2 |
| Input | CD248 | RD Feedstock | 0.95 |
| Alt Fuel Prod | CM44 | Hydrogen | 0.015 |
| Alt Fuel Prod | CM53 | NaOH | 0 |
| Alt Fuel Prod | CM55 | Nitrogen | 0 |
| Alt Fuel Prod | CM62 | Phosphoric acid | 0 |
| Coprods | BC135 | LPG | 0 |
| Coprods | BC137 | Naphtha | 0 |
| Coprods | B190 | Allocation by | Energy |

The results for the year 2023 are shown in the following table. These values are from the BC LCFS sheet. Column AK, rows 14 to 16.

### Table 7-4 US West Emissions 2023

| Stage | Emissions, g $CO_2$eq/GJ (HHV) |
|---|---|
| Fuel production | 6,067 |
| Fuel coproducts production | 0 |
| Fuel distribution and storage | 838 |

The third run will be in the BC region to calculate final distribution of 80km, dispensing, and fuel use emissions. Most of the inputs can be left the same as the other two runs. Changes are outlined in the following table.

### Table 7-5 Model Inputs for BC Emissions Run

| Sheet | Cell | Description | Value |
|---|---|---|---|
| Input | B4 | Region | BC |
| Input | AZ91 | HRD Transloading | Yes |
| Input | AZ92 | HRD Rail Distance | 0 |
| Input | AZ96 | HRD Truck Distance | 80 |
| Input | AZ98 | HRD Rail mode | 0 |
| Input | AZ102 | HRD Truck mode | 1 |

The results for the BC region are below. These are again from the BC LCFS sheet, column AK rows 16 to18.

### Table 7-6 BC Emissions 2023

| Stage | Emissions, g $CO_2$eq/GJ (HHV) |
|---|---|
| Fuel distribution and storage | 395 |
| Fuel dispensing | 82 |
| Vehicle or Vessel operation | 1,524 |

The results from the three regions can be combined to produce a final CI of 19.05 g $CO_2$eq/MJ. The values in the first three columns are summed to produce the values in the right-hand column.

### Table 7-7 Total Emissions 2023

| Stage | Alberta Emissions | US West Emissions | BC Emissions | Total Emissions |
|---|---|---|---|---|
| | g $CO_2$eq/GJ (HHV) | | | |
| Direct land use change | 0 | | | 0 |
| Feedstock production or cultivation | 14,817 | | | 14,817 |
| Feedstock upgrading | 5,013 | | | 5,013 |
| Feedstock transport | 1,823 | | | 1,823 |
| Feedstock coproducts production | -11,507 | | | -11,507 |
| Avoided emissions | 0 | | | 0 |
| Fuel production | | 6,067 | | 6,067 |
| Fuel coproducts production | | 0 | | 0 |
| Fuel distribution and storage | | 838 | 395 | 1,233 |
| Fuel dispensing | | | 82 | 82 |
| Vehicle or Vessel operation | | | 1,524 | 1,524 |
| **Total** | **10,146** | **6,906** | **2,000** | **19,052** |
| **Total, g $CO_2$eq/MJ** | | | | **19.05** |

### Need more information?

Please see the Renewable and Low Carbon Fuel website at http://gov.bc.ca/lowcarbonfuels or email us at lcfs@gov.bc.ca

This information is for your convenience and guidance only and does not replace or constitute a legal interpretation of the legislation. It is recommended that parties who may be a Fuel Supplier review the Low Carbon Fuels Act (Act), the Low Carbon Fuels (General) Regulation and the Low Carbon Fuels (Technical) Regulation, and seek independent legal advice to confirm their status, legal obligations and opportunities. The Act and regulations can be found on the internet at: http://www.bclaws.ca.