GHGenius 5.02

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Today's Agenda

- RNG
- Renewable Diesel Pathways
  - The RD Process
  - Modelling an RD plant
- Biodiesel Pathways
  - Biodiesel processes
  - Modelling Biodiesel systems

4.03 vs 5.02

- There were very few RNG facilities supplying the fuel market when 4.03 was introduced.
  - The model has a wood thermochemical pathway, a manure/grass pathway, and landfill gas.
- 5.02 has a number of additional pathways
  - Wood pellet and MSW thermochemical pathways
  - Organic waste (including manure)
  - RNG from electricity.

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Commercial Pathways

- The most common commercial pathways are the landfill gas to RNG, the manure pathways and the organics pathway.
- The Landfill gas pathway is straightforward as long as you exclude any avoided landfill gas emissions.
  - The assumption is that the gas would have been captured and flared as the baseline.
  - This has been the BC policy since the first application for this pathway.

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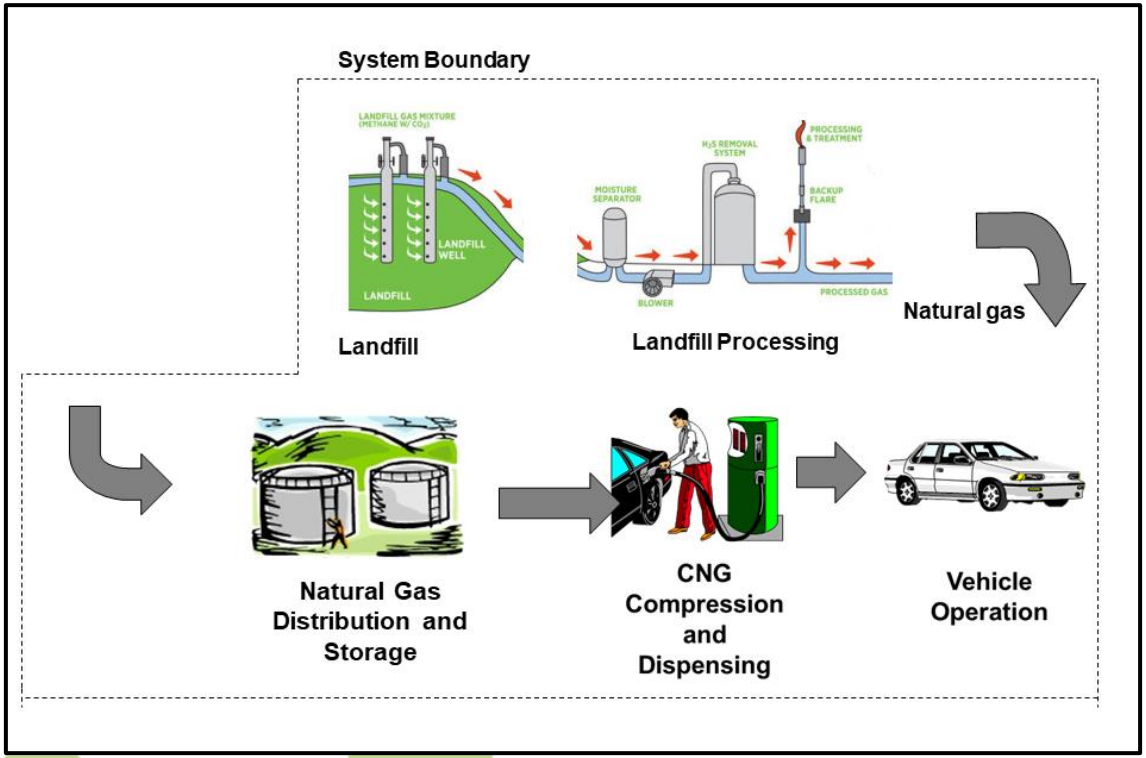
Landfill Gas to RNG



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Landfill Gas Processing

- There are a number of different technologies that can be used to process the raw LFG to pipeline quality.
- All will consume some electricity, some might use some natural gas for pilots for flares, one technology uses a cryogenic process and liquid nitrogen.
- The example is located in BC and injects the RNG into the local distribution system.

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LFG Model Inputs

Sheet	Cell	Description	Value
Input	B4	Region	BC
Input	B7	Year	2023
Input	F46	Methane Slip	0.0
Input	BJ96	Pipeline distance	0
Input	BJ101	Pipeline mode	1.0
Input	BZ241	Year	2023
Input	BZ243	kWh/GJ	20
Input	BZ244	Diesel, l/GJ	0
Input	BZ245	NG, MJ/GJ	0
Input	BZ247	Feedstock	0

LFG Results

Stage	Total Emissions
	g CO_2eq/GJ (HHV)
Direct land use change	0
Feedstock production or cultivation	0
Feedstock upgrading	854
Feedstock transport	0
Feedstock coproducts production	0
Avoided emissions	0
Fuel production	0
Fuel coproducts production	0
Fuel distribution and storage	323
Fuel dispensing	752
Vehicle or Vessel operation	9,034
Total	10,963
Total, g CO_2eq/MJ	10.96

This example uses a LDV for the vehicle operation stage.

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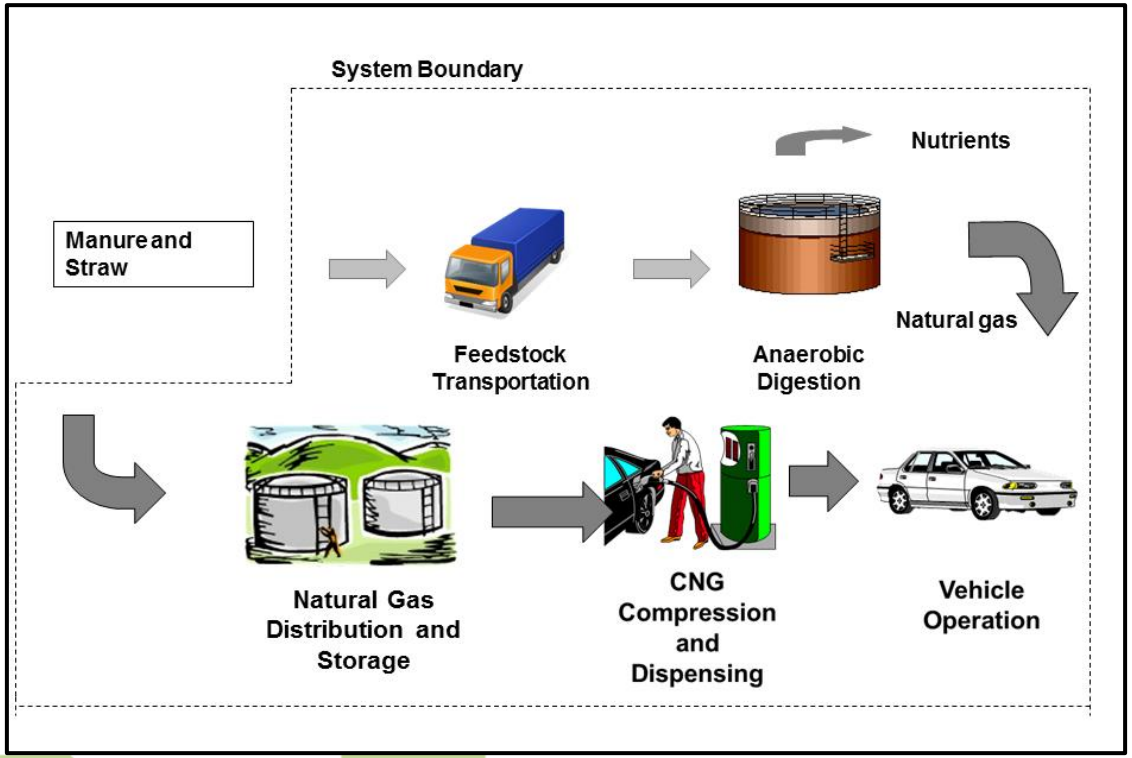
Anerobic Digestion



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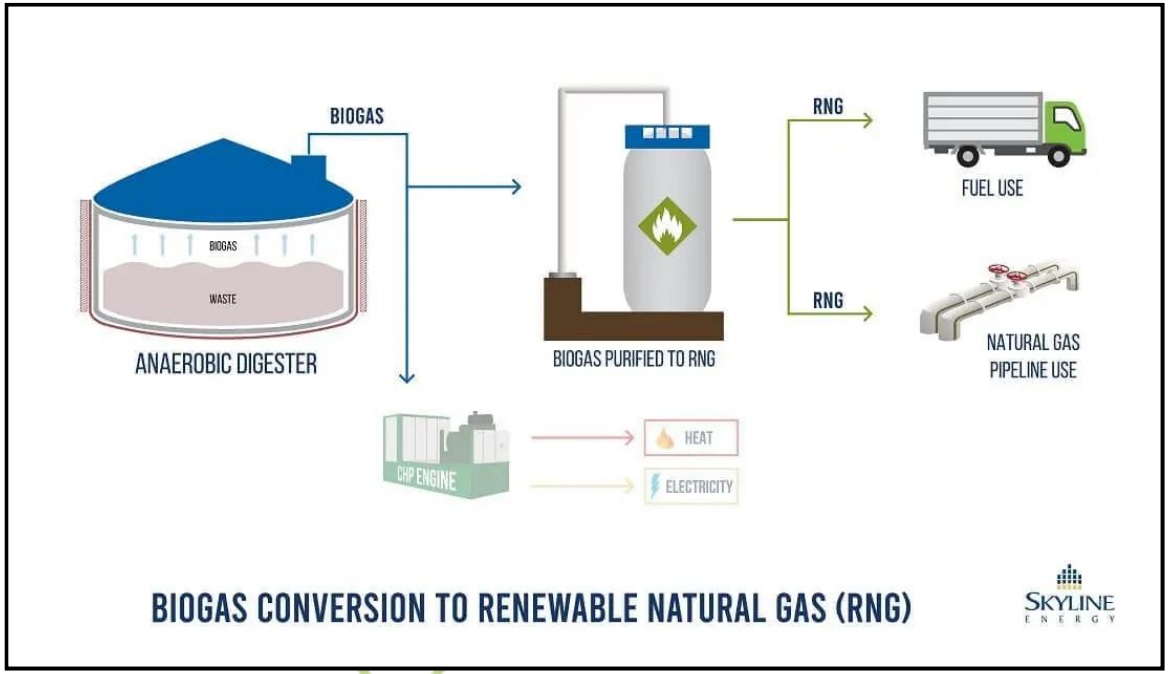
Anerobic Digestion



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AD Systems

- The big issue with AD systems is the calculation of avoided emissions.
- Manure generates methane at the farm before it is land applied and feedstocks that go to landfill create methane emissions.
  - Quantifying both has been an issue.
  - Many project developers have expectations for large negative numbers.

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Manure Emissions

- GHGenius 5.02 uses the average methane emissions for different species from the Canadian and US Common Reporting Forms that accompany the National Inventory Reports.
- Methane from manure is a function of temperature and management system.
- The CARB approach rewards the bad actors, GHGenius provides a credit against the average performance.

Manure Emissions

	Canada	US
	Emissions displaced by anaerobic digestion, g CH_4/kg Manure (dry)	
Dairy Cows	**13.3**	**38.7**
Other Cattle	**2.3**	**2.3**
Swine Manure	**44.8**	**92.0**
Poultry Manure	**5.2**	**7.8**

The CARB dairy avoided emissions can be as high as 150 g CH_4/kg manure.

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Landfill Emissions

- We have reasonable estimates of emissions from landfills.
  - These are about 60 g CH_4/kg MSW (as received)
  - Maybe 90 g CH_4/kg MSW (dry).
- But AD systems generally only take a portion of the MSW. SSO is source separated organics.

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EPA Warms Model

	A	B	C	D	E
46	User Defined	*10.00*			
47					
48	**EMISSIONS DISPLACED BY AVOIDING LANDFILLING, g CH4/kg Feedstock (dry)**			**N2O Emissions Avoided, g N**	
49	10.0	*Composted Bio* active		0.6	
50	125.0	Corrugated Containers			
51	51.0	Magazines/Third-Class Mail			
52	48.0	Newspaper			
53	170.0	Office Paper			
54	48.0	Phonebooks			
55	170.0	Textbooks			
56	9.0	Dimensional Lumber			
57	3.0	Medium-Density Fiberboard			
58	239.0	Food Waste			
59	125.0	Grass			
60	42.0	Leaves			
61	68.0	Branches			
62	80.0	Mixed MSW			
63	0.0	Drywall			
64	10.0	Wood Flooring			
65	105.0	Sewage Sludge			
66	10.0	Composted Biosolids/Manure		0.6	
67	4.0	Composted Other Organic Waste		0.3	
68	*80.00*	User Define Mix			

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BC Approach

- For natural gas produced from diverted organic food or yard waste in a biodigester, BC intends to calculate avoided emissions based on composting being the alternative disposal method and not landfilling.
- There are still some GHG emissions from composting but they are less than landfilling.
- GHGenius use IPCC default values for composting emissions and there are only two options,
  - Composted biosolids/manure
  - Composted other organic waste.
- For natural gas produced from manure processed in a biodigester, BC intends to calculate the avoided emissions based on storage of the manure according to the national average until applied to land.

Manure Example

- The first example is an anaerobic digestion system that processes only dairy manure. It is located in British Columbia and injects the gas into the local distribution system. The RNG is used for vehicle fuel in a heavy-duty truck. Only one run of the model is required.
- 50% of the manure is produced at the site of the AD system and the rest of manure is trucked an average distance of 15 km.

Manure Example

Sheet	Cell	Description	Value
Input	B4	Region	BC
Input	B7	year	2023
Input	AZ80	Truck Mileage	15
Input	AZ86	Truck Fraction	0.5
Input	BJ95	LDC	0
Input	BJ241	Year	2023
Input	BJ243	kWh/GJ	35
Input	BJ245	MJ/GJ	200
Input	BJ247		0
Input	BJ248	Dry kg Manure	70
Input	F46	Methane Slip	0.02
Input	Column AQ rows 277 to 281	No Chemicals	0
Fuel Char	J142	Manure Moisture	0.85
Coprods	A41	Manure Source	Dairy Cows

Manure RNG Results

Stage	Total Emissions
	g CO_2eq/GJ (HHV)
Direct land use change	0
Feedstock production or cultivation	0
Feedstock upgrading	0
Feedstock transport	2,983
Feedstock coproducts production	0
Avoided emissions	-26,117
Fuel production	23,967
Fuel coproducts production	0
Fuel distribution and storage	324
Fuel dispensing	752
Vehicle or Vessel operation	3,732
Total	5,640
Total, g CO_2eq/MJ	**5.64**

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Organics Example

- BC facility.
- Diverted from composting.
- Credit for the digestate nutrients.

Organics Example

Sheet	Cell	Description	Value
Input	B4	Region	BC
Input	B7	Year	2023
Input	F45	Methane destruction	0.00
Input	F46	Methane slip	0.02
Input	BA80	Trucking distance	50
Input	BA86	Trucking fraction	1.0
Input	BK241	Year	2023
Input	BK243	kWh/GJ	40
Input	BK245	MJ/GJ	200
Input	BK247	Feedstock	90
Input	AR277	Kg N/GJ	2.40
Input	AR278	Kg P/GJ	0.30
Input	AR279	Kg K/GJ	0.10
Input	AR280	Kg S/GJ	0.00
Fuel Char	J144	Organics moisture	0.25
Coprods	B49	Avoided emission factors	Composted Other Organic Wastes

Organics RNG Results

Stage	Total Emissions
	g CO_2eq/GJ (HHV)
Direct land use change	0
Feedstock production or cultivation	0
Feedstock upgrading	0
Feedstock transport	795
Feedstock coproducts production	0
Avoided emissions	-17,267
Fuel production	24,180
Fuel coproducts production	-8,883
Fuel distribution and storage	323
Fuel dispensing	752
Vehicle or Vessel operation	3,732
Total	3,632
Total, g CO_2eq/MJ	**3.63**

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Questions?

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- For BD and RD pathways the big improvement is separating the co-products from the feedstock production and the fuel co-products.
- This eliminates the need to zero some portion of the co-products calculation or to use the yellow grease pathway to get the fuel co-products.
- If the activities are all in one region, then only one run is necessary for the mix of displacement and energy allocation for the fuel co-products.

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	BC LCFS Stages					
2						
3	CO2-EQUIVALENT EMISSIONS PE					
4	AND FEEDSTOCK/FUEL COMBIN/					
5						
6	**Fuel ------>**	**Biodiesel**	**HRD**	**HRJ**	**HRG**	**HRP**
7	**Feedstock ------>**	**Fish Oil**	**Canola Oil**	**Corn Oil**	**Soybean Oil**	**Canola Oil**
8	Direct land use change	0	0	0	0	0
9	Feedstock production or cultivation	55,158	6,929	12,385	30,886	6,929
10	Feedstock upgrading	96,944	4,037	61	12,722	4,037
11	Feedstock transport	1,516	897	450	2,019	897
12	Feedstock coproducts production	-33,112	-6,544	0	-36,650	-6,544
13	Avoided emissions	0	0	0	0	0
14	Fuel production	3,217	10,413	15,683	22,243	10,413
15	Fuel coproducts production	-8,756	-2,243	-22,789	-2,549	-2,243
16	Fuel distribution and storage	995	820	920	932	989
17	Fuel dispensing	217	179	183	185	190
18	Vehicle or Vessel operation	1,533	1,524	572	1,974	2,867
19	**Total**	**117,712**	**16,012**	**7,466**	**31,762**	**17,535**
20	**Total, g CO2eq/MJ**	**117.71**	**16.01**	**7.47**	**31.76**	**17.54**

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Renewable Diesel Pathways

- Three new feedstocks compared to 4.03.
  - Tall oil
  - Palm sludge oil
  - Spent bleaching earth oil
- 4.03 feedstocks
  - Canola
  - Soy
  - Corn oil
  - Tallow
  - Yellow Grease
  - Camelina
  - Jatropha
  - Palm oil
  - Fish oil
  - Algae

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New Related Pathways

- Hydrogenated Renewable Gasoline
  - This pathway may be useful for FCC co-processing
- Hydrogenated Renewable Propane
  - Probably won't be a commercial pathway.
  - Producers could increase cracking to produce much higher levels of propane.

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System Boundaries

- No Change in System Boundaries between 4.03 and 5.02.

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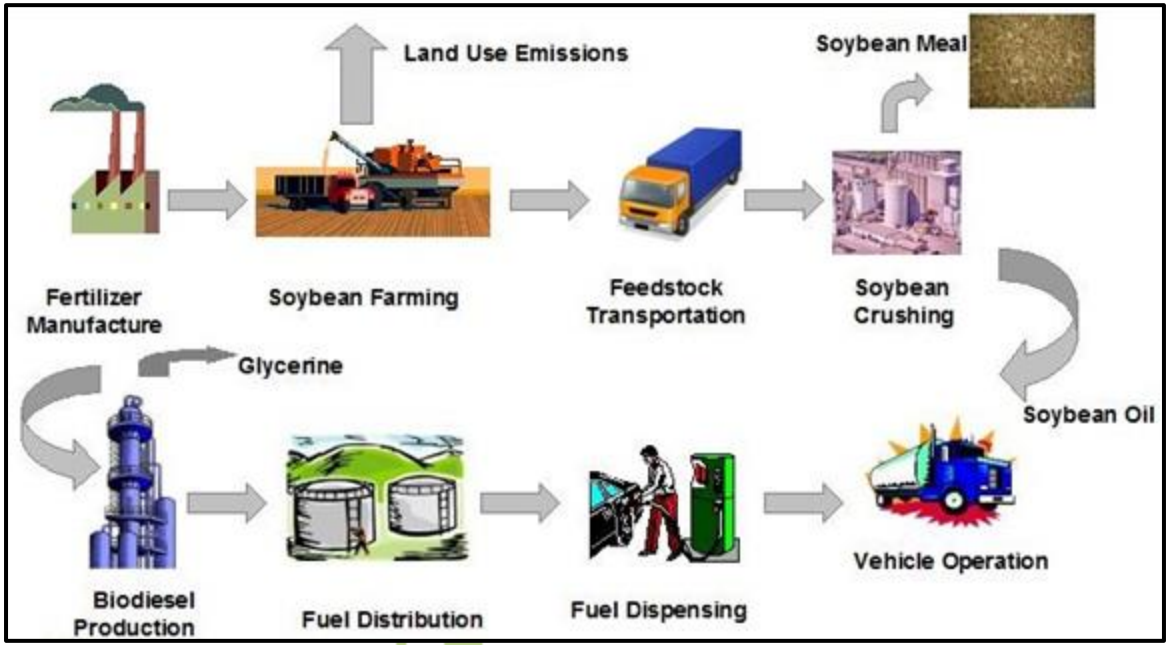
Vegetable Oil Feedstocks



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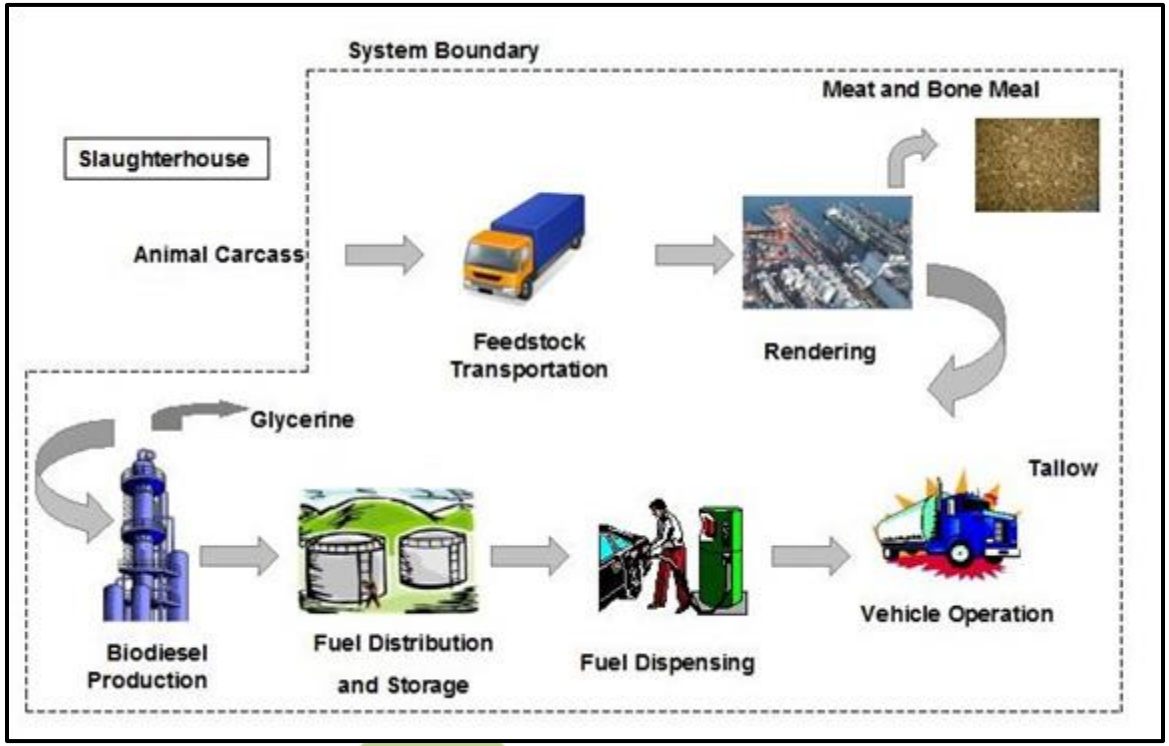
Waste Feedstocks



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Renewable Diesel

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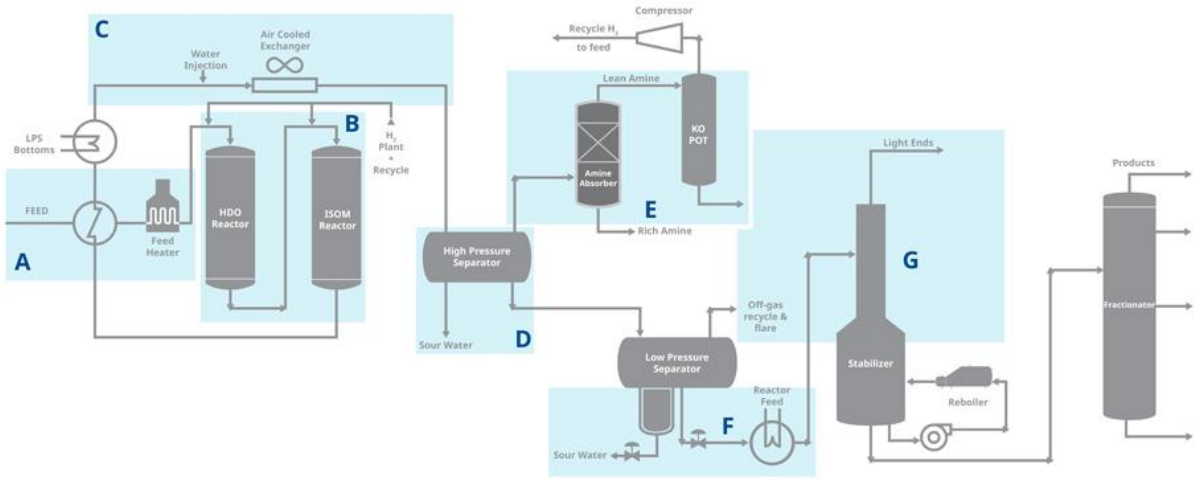
Renewable Diesel Process



A Acidic Corrosion (Fatty acids)
B HTHA, H_2/H_2S Corrosion
C Ammonium Bisulfide, Ammonium Chloride, HCl Corrosion, Erosion and Erosion Corrosion
D Ammonium Bisulfide, Erosion
E Amine Corrosion
F Ammonium Bisulfide, Ammonium Chloride Corrosion, Erosion and Erosion Corrosion
G Ammonium Chloride Corrosion

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RD Plants

- Most RD plants are multi-feedstock plants.
- The large size of the plants results in feedstock being sourced globally in some cases.
- Some operators have suggested that feedstock blends are easier to process than single feedstocks.

US RD Plants

PADD	Number of Plants	Production Capacity, million litre/year
1	0	0
2	3	1,506
3	6	6,960
4	3	1,487
5	2	840
Total	14	10,793

The list is as of Jan 2023. At least two additional plants have started up since then. Many US producers are interested in the BC market.

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Co-products

- The RD plants produce
  - Fuel gas (CO, methane, ethane, hydrogen)
  - Propane
  - Butane
  - Naphtha (C5+ material)
- Metering some of these streams can be a challenge and plants may use a combination of metering and Gas Chromatographs to get the quantities and composition of the four streams.
- Some plants are using the co-products to produce the hydrogen consumed. This results in a low CI.

Renewable Diesel Transportation

- No more adjustment for double counting!
- On the Input sheet in row 91 there is a switch (yes/no) for including transloading.
- Transloading is when the product is transferred from one mode of transport to another.
- For RD plants that load directly into a rail car or a ship, AD91 is set to “No”. This eliminates the electricity use that is built into the model for product storage.
- Not sure that transloading will ever be required for a BC pathway.

RD Storage

- When the BC region is run for the fuels storage, fuel dispensing and fuel use emissions, the value in AD 91 is set to “Yes”.
- This accounts for the electricity use at the distribution and blending facility is BC.

Sequestration

- There is not an option for CO_2 sequestration for this pathway.
  - Energy use is low making CCS unlikely.
  - Some plants are looking at CCS from hydrogen production but because the hydrogen could be produced from internally produced biogenic fuels as well as natural gas, it is not straightforward to calculate the CO_2 available for CCS.
  - We could look at CCS being a manual input.

First Example

- RD plant located in US Central and feedstock from US Central.
- Two model runs
  - US Central
  - BC
- No outside of the model calculations.

Inputs

Sheet	Cell	Description	Value
Input	B4	Region	US Central
Input	B7	Year	2023
Input	B53	Feedstock	Soybean Oil
Input	N76	Rail Distance	300
Input	N80	Truck Distance	0
Input	N82	Rail Model	1
Input	AZ91	Transloading	No
Input	AZ92	Rail distance to Vcr	3,000
Input	AZ96	Truck Distance	0
Input	AZ98	Rail Mode	1
Input	CD241	year	2023
Input	CD243	Electricity	0.05
Input	CC245	NG	0.2
Input	CD248	Feedstock, kg	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	BB135	LPG co-product	0.02
Coprods	BB137	Naphtha	0.03
Coprods	A154	Operations order	“after displacement”

US Central Emissions

Stage	Emissions, g CO_2eq/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	11,322
Fuel coproducts production	-1,524
Fuel distribution and storage	1,246

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An Example – BC Run Inputs

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

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BC Results

Stage	Emissions, g CO_2eq/GJ (HHV)
Fuel distribution and storage	395
Fuel dispensing	82
Vehicle or Vessel operation	1,524

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An Example – Combined Results

Stage	US Central Emissions	BC Emissions	Total Emissions
	g CO_2eq/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	11,322		11,322
Fuel coproducts production	-1,524		-1,524
Fuel distribution and storage	1,246	395	1,641
Fuel dispensing		82	82
Vehicle or Vessel operation		1,524	1,524
Total	21,095	2,001	**23,096**
Total, g CO_2eq/MJ	21.10	2.00	**23.10**

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Questions?

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Second Example

- Tallow in US central.
- RD in US West.
- Unfortunately the energy allocation for the naphtha still needs to be calculated outside of the model.

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Feedstock Inputs

Sheet	Cell	Description	Value
Input	B4	Region	US Central
Input	B7	Year	2023
Input	B53	Feedstock	Tallow
Input	X76	Rail Distance	2,000
Input	X80	Truck Distance	0
Input	X82	Rail Mode	1
Input	CD241	Year	2023
Input	CD248	RD Feedstock	0.95

Feedstock Emissions

Stage	Emissions, g CO_2eq/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

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RD Production Inputs

Sheet	Cell	Description	Value
Input	B4	Region	US West
Input	B7	Year	2023
Input	B53	Feedstock	Tallow
Input	AZ91	Transloading	No
Input	AZ92	Rail distance	2,000
Input	AZ96	Truck Distance	0
Input	AZ98	Rail mode	1
Input	CD241	Year	2023
Input	CD243	Electricity	0.05
Input	CD245	NG	0.2
Input	CD248	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	BB135	Propane	0.02
Coprods	BB137	Naphtha	0

US West Emissions

Stage	Emissions, g CO_2eq/GJ (HHV)
Fuel production	11,285
Fuel coproducts production	-961
Fuel distribution and storage	838

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Naphtha Co-product Allocation

- Enter naphtha volume in cell BB137 on the Coprods sheet.
- Check that the allocation in cell is set to Energy.
- Get the value in BB159
  - 0.0266 in this case.

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Naphtha Calculation

Stage	US Central Emissions	US West Emissions	Energy Coproduct
	g CO_2eq/GJ (HHV)		
Direct land use change	USC	USW	
Feedstock production or cultivation	0		
Feedstock upgrading	0		
Feedstock transport	19,248		
Feedstock coproducts production	2,442		
Avoided emissions	-10,460		
Fuel production	0		
Fuel coproducts production		11,285	
Fuel distribution and storage		-961	-573
Fuel dispensing		838	
Vehicle or Vessel operation			
Total			
Total, g CO_2eq/MJ	11,231	11,162	-573

11,231+10,324=22,393*0.0266=573

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An Example – BC Run Inputs

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

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BC Results

Stage	Emissions, g CO_2eq/GJ (HHV)
Fuel distribution and storage	395
Fuel dispensing	82
Vehicle or Vessel operation	1,524

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Combined Results

	US Central Emissions	US West Emissions	Energy Coproduct	BC Emissions	Total Emissions
	g CO_2eq/GJ (HHV)				
Direct land use change	USC	USW		BC	Total
Feedstock production or cultivation	0				0
Feedstock upgrading	0				0
Feedstock transport	19,248				19,248
Feedstock coproducts production	2,442				2,442
Avoided emissions	-10,460				-10,460
Fuel production	0				0
Fuel coproducts production		11,285			11,285
Fuel distribution and storage		-961	-573		-1,535
Fuel dispensing		838		395	1,233
Vehicle or Vessel operation				82	82
Total				1,524	1,524
Total, g CO_2eq/GJ	11,231	11,162	-573	2,000	23,821
Total, g CO2/MJ					**23.82**

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Questions?

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Biodiesel

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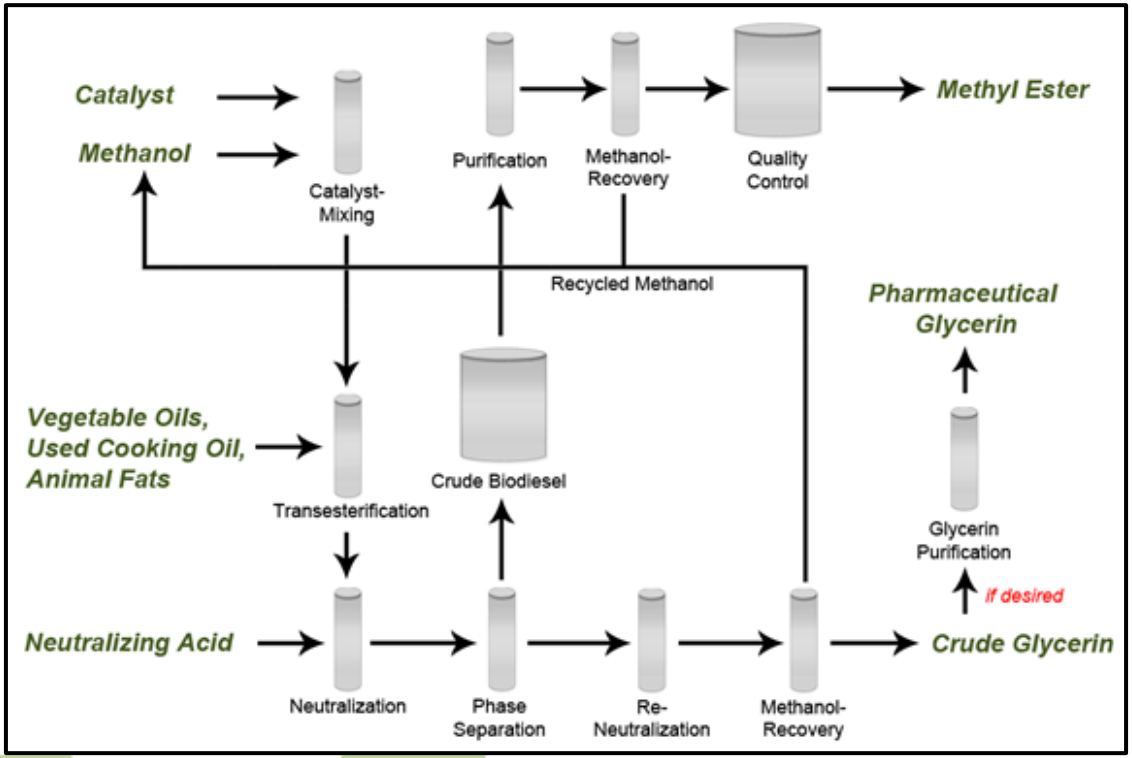
4.03 vs 5.02

- The same feedstocks for RD can be used for Biodiesel.

Biodiesel Process



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Biodiesel Plants

- The US EIA lists 84 biodiesel plants in 32 states with a production capacity of 9.4 billion litres.
- The top ten producing states are shown in the next slide.

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US Biodiesel Plants

PADD	Number of Plants	Production Capacity, million litre/year
1	10	464
2	33	5,531
3	9	1,127
4	0	0
5	7	775
Total	59	7,897

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Co-products

- The BD plants produce
  - Glycerine of varying grades
  - Sometimes distillation bottoms
  - Sometimes free fatty acids.
- The co-products get a displacement credit based on how they are used.
  - Refined glycerine has the highest displacement value
  - Crude glycerine for chemical production or for offsite upgrading is half of the displacement of refined.
  - Glycerine for feed or fuel purposes has a low displacement value.

Co-products

- Distillation Bottoms and FFA are treated as glycerine and used for feed or fuel.
- Co-product value is quite low.

Biodiesel Transportation

- No more adjustment for double counting!
- On the Input sheet in row 91 there is a switch (yes/no) for including transloading.
- Transloading is when the product is transferred from one mode of transport to another.
- For BD plants that load directly into a rail car or a ship, AD91 is set to “No”. This eliminates the electricity use that is built into the model for product storage.
- There may be some biodiesel plants that don’t have rail access and practice transloading.

BD Storage

- When the BC region is run for the fuels storage, fuel dispensing and fuel use emissions, the value in AD 91 is set to “Yes”.
- This accounts for the electricity use at the distribution and blending facility is BC.

Sequestration

- There is not an option for CO_2 sequestration for this pathway.
  - Energy use is low making CCS unlikely.
  - Not had a biodiesel plant ask about CCS.

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First Example

- BD plant located in US Central and feedstock from Alberta.
  - Processing canola
- Three model runs
  - Alberta
  - US Central
  - BC

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Alberta Inputs

Sheet	Cell	Description	Value
Input	B4	Region	Alberta
Input	B7	Year	2023
Input	L76	Oil transportation rail distance	2,000
Input	L80	Truck distance	0
Input	L81	Rail mode	1
Input	AZ241	Year	2023
Input	AZ248	BD Feedstock requirements	0.9

Alberta Emissions

Stage	Emissions, g CO_2eq/GJ (HHV)
Direct land use change	0
Feedstock production or cultivation	15,024
Feedstock upgrading	5,083
Feedstock transport	781
Feedstock coproducts production	-11,668
Avoided emissions	0

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US BD Inputs

Sheet	Cell	Description	Value
Input	B4	Region	US Central
Input	B7	Year	2023
Input	AM91	Transloading	No
Input	AM92	BD Rail distance	3,000
Input	AM96	Truck distance	0
Input	AM98	Rail Mode	1
Input	AZ241	Year	2023
Input	AZ243	Electricity	0.05
Input	AZ245	NG	0.7
Input	AZ248	Feedstock	0.9
Alt Fuel Prod	BC36	Citric acid	0
Alt Fuel Prod	BC43	Hydrochloric acid	0.01
Alt Fuel Prod	BC51	Methanol	0.12
Alt Fuel Prod	BC53	NaOH	0.0005
Alt Fuel Prod	BC56	Nitrogen	0.02
Alt Fuel Prod	BC62	Phosphoric acid	0.0005
Alt Fuel Prod	BC67	Sodium Methylate	0.01
Coprods	X123	Glycerine for feed	0.01
Coprods	X125	Crude glycerine	0.08

US Emissions

Stage	Emissions, g CO_2eq/GJ (HHV)
Fuel production	4,317
Fuel coproducts production	-15,006
Fuel distribution and storage	1,507

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BC Inputs

Sheet	Cell	Value
Input	B4	BC
Input	AS91	Yes
Input	AS92	0
Input	AS96	80
Input	AN102	1

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BC Emissions

Stage	Emissions, g CO_2eq/GJ (HHV)
Fuel distribution and storage	479
Fuel dispensing	99
Vehicle or Vessel operation	1,532

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Combined Emissions

Stage	Alberta Emissions	US Central Emissions	BC Emissions	Total Emissions
	g CO_2eq/GJ (HHV)			
Direct land use change	0			0
Feedstock production or cultivation	15,024			15,024
Feedstock upgrading	5,083			5,083
Feedstock transport	781			781
Feedstock coproducts production	-11,668			-11,668
Avoided emissions	0			0
Fuel production		4,317		4,317
Fuel coproducts production		-15,006		-15,006
Fuel distribution and storage		1,507	479	1,986
Fuel dispensing			99	99
Vehicle or Vessel operation			1,532	1,532
Total	9,220	-9,182	2,110	2,148
Total, g CO_2eq/MJ	9.22	-9.2	2.11	2.15

Questions?

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Second Example

- Tallow from Brazil
- Processed in US Central
- Used in BC

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Inputs for Brazil Tallow

Sheet	Cell	Description	Value
Input	B4	Region	Brazil
Input	B7	Year	2023
Input	X78	Ship Distance	10,000
Input	X80	Truck Distance	100
Input	X84	Ship mode	1
Input	X86	Truck mode	1
Input	BG241	Year	2023
Input	BG248	BD Feedstock	0.95

Brazil Emissions

Stage	Emissions, g CO_2eq/GJ (HHV)
Direct land use change	0
Feedstock production or cultivation	0
Feedstock upgrading	19,479
Feedstock transport	5,900
Feedstock coproducts production	-10,381
Avoided emissions	0

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US BD Emissions

Sheet	Cell	Description	Value
Input	B4	Region	US Central
Input	B7	Year	2023
Input	AS91	Transloading	No
Input	AS92	Rail distance	4,500
Input	AS96	Truck Distance	0
Input	AS98	Rail mode	1
Input	BG241	Year	2023
Input	BG243	Electricity	0.1
Input	BG245	NG	3
Input	BG248	Feedstock	0.95
Alt Fuel Prod	BO36	Citric acid	0
Alt Fuel Prod	BO43	Hydrochloric acid	0.01
Alt Fuel Prod	BO51	Methanol	0.12
Alt Fuel Prod	BO53	NaOH	0.0005
Alt Fuel Prod	BO56	Nitrogen	0.02
Alt Fuel Prod	BO62	Phosphoric acid	0.0005
Alt Fuel Prod	BO67	Sodium Methylate	0.01
Coprods	X123	Glycerine for feed	0
Coprods	X125	Crude glycerine	0.08

US Emissions

Stage	Emissions, g CO_2eq/GJ (HHV)
Fuel production	9,225
Fuel coproducts production	-14,893
Fuel distribution and storage	2,261

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BC Inputs

Sheet	Cell	Description	Value
Input	B4	Region	BC
Input	AS91	Transloading	Yes
Input	AS92	Rail Distance	0
Input	AS96	Truck Distance	80
Input	AS102	Truck mode	1

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BC Emissions

Stage	Emissions, g CO_2eq/GJ (HHV)
Fuel distribution and storage	479
Fuel dispensing	99
Vehicle or Vessel operation	1,524

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Combined Emissions

Stage	Brazil Emissions	US Central Emissions	BC Emissions	Total Emissions
	g CO_2eq/GJ (HHV)			
Direct land use change	0			0
Feedstock production or cultivation	0			0
Feedstock upgrading	19,479			19,479
Feedstock transport	5,900			5,900
Feedstock coproducts production	-10,381			-10,381
Avoided emissions	0			0
Fuel production		9,225		9,225
Fuel coproducts production		-14,893		-14,893
Fuel distribution and storage		2,261	479	2,741
Fuel dispensing			99	99
Vehicle or Vessel operation			1,524	1,529
Total	14,998	-3,406	2,108	13,700
Total, g CO_2eq/MJ	15.00	-3.41	2.11	**13.70**

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Questions?

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BC LCFS Questions

- If you have questions related to the BC LCFS program you can e-mail them to LCFS@gov.bc.ca.
  - Someone from the Ministry will respond.

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Thank You

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GHGenius Website

- www.ghgenius.ca
- There is a Forum for asking questions.
  - We try to answer questions in a timely manner.
  - Anyone can answer the question.
- The Thursday session is planned to be just Q and A session. If you have questions on any of topics covered today you can e-mail the questions to admin@ghgenius.ca.