CARB LCFS FUEL PATHWAY REPORT
RENEWABLE DIESEL

Prepared For:

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EXECUTIVE SUMMARY

The California Air Resources Board approved the original LCFS regulation in April 2009 as a discrete early action measure under the California Global Warming Solutions Act of 2006 (AB 32). In addition, the Board subsequently approved amendments to the LCFS in 2011, 2015, and in late 2018. For 2019 CARB have developed new simplified calculators for determining the CI of transportation fuels. The new calculator for biodiesel and renewable diesel is much more flexible than the CA GREET 2.0 Tier 1 calculator. The new calculators are required to be used from January, 1, 2019.

The new calculator presents the CI for multiple feedstocks simultaneously. It also presents a CI for naphtha and propane that are co-produced with the renewable diesel. The new calculator does require input data in a different format than the previous CA GREET 2.0 Tier 1 and Tier 2 calculators.

The expanded tab version of the CA GREET calculator is used for this application as there are two soybean oil and canola oil pathways, one which receives oil directly from oil producers and one where the oil is first pretreated to reduce the phosphorus at a HF Sinclair facility in Artesia, New Mexico before being shipped to Cheyenne.

Cheyenne Renewable Diesel Company LLC started production of renewable diesel fuel in the spring of 2022. This report accompanies a CARB Provisional Application for a Carbon Intensity determination for two of the fuels produced by the plant.

The emissions calculated for the individual stages are summed to determine the fuel cycle CI. The results for the Cheyenne Renewable Diesel Company LLC renewable diesel pathways are shown in the following table.

Table ES- 1 Lifecycle GHG Emissions – Cheyenne Renewable Diesel Company LLC Renewable Diesel

Feedstock	Corn Oil	PTU Canola Oil
Stage	gCO_2e/MJ	
Feedstock Production	[redacted]	
Fuel Production		
Indirect Land Use	0.00	14.50
Tailpipe Emissions	0.76	0.76
RD	39.76	63.50

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1. INTRODUCTION

The California Air Resources Board approved the original LCFS regulation in April 2009 as a discrete early action measure under the California Global Warming Solutions Act of 2006 (AB 32). In addition, the Board subsequently approved amendments to the LCFS in 2011, 2015, and in late 2018. For 2019 CARB have developed new simplified calculators for determining the CI of transportation fuels. The new calculator for biodiesel and renewable diesel is much more flexible than the CA GREET 2.0 Tier 1 calculator. The new calculators are required to be used from January, 1, 2019.

The new calculator presents the CI for multiple feedstocks simultaneously. It also presents a CI for naphtha and propane that are co-produced with the renewable diesel. The new calculator does require input data in a different format than the previous CA GREET 2.0 Tier 1 and Tier 2 calculators.

The expanded tab version of the CA GREET calculator is used for this application as there are two soybean oil and canola oil pathways, one which receives oil directly from oil producers and one where the oil is first pretreated to reduce the phosphorus at a HF Sinclair facility in Artesia, New Mexico before being shipped to Cheyenne.

Cheyenne Renewable Diesel Company LLC ("CRDC") started production of renewable diesel fuel in early 2022. This report accompanies a CARB Provisional Application for a Carbon Intensity determination for the products produced by the plant.

1.1 CHEYENNE RENEWABLE DIESEL COMPANY LLC

In 1944, Frontier Refining Company completed construction of the Cheyenne Refinery in Cheyenne, WY. Originally, this refinery was designed to produce 100 octane gasoline for America's bomber fleet during WWII. In 1968, Frontier Refining was purchased by Husky Oil Co of Cody WY. Husky sold the refinery to RMT Properties in 1984, who changed the name to Frontier Oil Co. In 1991, the refinery was bought by Wainoco Oil Corporation.

In July 2011, Holly Corporation and Frontier Oil Corporation merged to become HollyFrontier Corporation. At this time, the Cheyenne refinery had capacity to refine 52,000 barrels per day of heavy crude to supply refined products to eastern Colorado and Wyoming.

In June of 2020, HollyFrontier shut down the Cheyenne Refinery as a petroleum refinery for conversion into a Renewable Diesel Unit. The waste water treatment plants, boiler processing area and two hydrogen plants were incorporated into the new unit.

HF Sinclair ("Sinclair") is a publicly listed company (NYSE: DINO) based in Dallas, TX. HF Sinclair was formed in March of 2022 when HollyFrontier Corporation purchased Sinclair Oil. Sinclair is a diversified, innovative energy company that manufactures and sells products such as gasoline, diesel, jet fuel, renewable diesel, specialty lubricant products, specialty chemicals and specialty and modified asphalt. In addition, Sinclair owns a majority of Holly Energy Partners (NYSE: HEP), which provides petroleum product and crude oil transportation, terminalling, storage and throughput services in the US.

HF Sinclair Renewables operates one feedstock pretreatment facility and three renewable diesel facilities in the US with a combined capacity of [redacted] barrels per day.

Cheyenne Renewable Diesel Company is a Haldor Topsoe two stage unit designed to convert soybean oil and tallow into a low sulfur diesel product and a sweet naphtha product for off-site sales. The unit is designed to run up to [redacted] barrels of feedstock per day, and

commenced operations in late February, 2022.The site and plant are shown in the following figure.

Figure 1-1 Aerial View – Cheyenne Renewable Diesel Company LLC

CRDC receives refined bleached deodorized (RBD) soybean oil via rail, refined bleached (RB) soybean oil and canola oil via rail from the Artesia pretreatment unit, canola oil, Distiller's Corn Oil (DCO) and technical tallow via rail and truck into storage tanks on site. Using inputs of natural gas and electricity, CRDC creates hydrogen to process the fats into renewable diesel and renewable naphtha. In addition, the process produces lighter hydrocarbons that are used as fuel gas in the renewable diesel plant.

The renewable diesel is mixed with approximately [redacted]% ULSD in storage tanks on site, before being loaded into railcars for delivery [redacted]

Renewable naphtha is stored on site and loaded into [redacted]

The block flow schematic is shown in the following figure.

Figure 1-2 Block Flow Schematic

1.2 CALCULATOR SET-UP

The simplified calculator that has been used has been provided by CARB and is identified as the Tier 1-BDRD-calculator-expanded.

The values that are location dependent and are set with drop down menus are:

1. The plant zip places the plant in the RMPA eGrid and the calculator input is 6 RMPA Mix.[1]
2. The regional crude oil mix is US Average Crude
3. The regional natural gas source is US Average NG.

Since there are no direct hydrogen inputs to the process there is no need to correct the hydrogen energy density and emission factor in the calculator.

Other calculator inputs are entered on other sheets in the calculator. These are described in the following sections.

[1] https://www.epa.gov/sites/production/files/2018-08/power_profiler_zipcode_tool_2016_6_14_18._v8.xlsx

2. FEEDSTOCK

Each feedstock for the plant is entered on a separate sheet in the calculator. For CRDC the feedstock data is entered on the following sheets.

1. Soy Oil
2. Canola
3. CornSorghum Oil
4. Tallow 1
5. PTU Soybean
6. PTU Canola
7. Non LCFS Feed

There are [redacted] feedstock receiving tanks, [redacted] The monthly opening and closing inventories are recorded but they are allocated to the different feedstocks. The quantity of feedstock that is used for the production of renewable diesel is the sum of the opening inventory and the feedstock received less the closing inventory.

2.1 SOYBEAN OIL

Soybean oil is shipped directly to CRDC from the soybean oil suppliers. The weights are recorded from the Bills of Lading. Transportation distances are assigned for each supplier and a monthly average calculated for the feedstock. The rail transportation distances are assigned to each supplier. [redacted].

The soybean oil has all been received by rail for the period of the application. HF Sinclair's rail group works with the railroads to determine the distance from each origin.

Table 2-1 Soy Oil Feedstock Transportation

Month	Soybean Oil		
	Pounds Received	Miles	Moisture %
10-2022	[redacted]		
11-2022			
12-2022			
01-2023			
02-2023			
03-2023			
04-2023			
05-2023			
06-2023			
07-2023			
08-2023			
09-2023			
10-2023			
11-2023			
12-2023			
01-2024			
02-2024			
03-2024			
04-2024			
05-2024			
06-2024			
07-2024			
08-2024			
09-2024			

The opening and closing inventories for the feedstock tanks are recorded and along with the feedstock receipts are used to calculate the feedstock processed. For feedstock volumes, the quantities in the net production report, which are in barrels, are multiplied by 42 (to convert to gallons) and then by [redacted] for tallow and [redacted] for Soybean Oil and Canola Oil, which came from CRDC's 2023 density test of the two tanks.

Table 2-2 Soybean Oil Processed

Month	Opening Inventory	Closing Inventory	Oil Received	Oil Processed
	pounds			
10-2022	[redacted]			
11-2022				
12-2022				
01-2023				
02-2023				
03-2023				
04-2023				
05-2023				
06-2023				
07-2023				
08-2023				
09-2023				
10-2023				
11-2023				
12-2023				
01-2024				
02-2024				
03-2024				
04-2024				
05-2024				
06-2024				
07-2024				
08-2024				
09-2024				

The default energy use and GHG emission factor is used for the direct soybean oil emission calculations.

2.2 PTU SOYBEAN OIL

CRDC purchases pretreated soybean oil from a HF Sinclair facility in Artesia, New Mexico. This facility is adjacent to a renewable diesel plant at that refinery. The facility purchases crude soybean oil, crude canola oil, tallow, and corn oil. The facility processes the oils to remove contaminants (including phosphorus) that would reduce the catalyst life of the RD process.

The pretreatment process uses [redacted] There can also be a small loss of mass though the process. A calculator has been developed which records the feedstock receipts, the opening and closing inventories for each feedstock, [redacted] This data is used to calculate the additional emissions that must be added to the standard values in the CARB standard calculator.

Data for the period of October 2022 to September 2024 is used. The incoming soybean oil transportation for the period is [redacted] of soybean oil. The pretreatment

emissions were [redacted] g CO_2eq/pound of pretreated oil. The total emission factor for pretreated soybean oil is 328.86 g CO_2eq/pound of pretreated oil. This includes the CARB standard value and the incoming transportation emissions both adjusted for the yield loss plus the pretreatment emissions.

On the PTU soybean sheet "User Defined" is selected in cell D11 and the value in G11 is linked to cell D57 on the new Oil Extraction sheet. Cell D57 is the new emission factor for the pretreated soybean oil.

The calculator data is shown in the following table.

Table 2-3 PTU Soybean Oil Feedstock Transportation – Rail

Month	Soybean Oil		
	Pounds Received	Miles	Moisture %
10-2022	[redacted]		
11-2022			
12-2022			
01-2023			
02-2023			
03-2023			
04-2023			
05-2023			
06-2023			
07-2023			
08-2023			
09-2023			
10-2023			
11-2023			
12-2023			
01-2024			
02-2024			
03-2024			
04-2024			
05-2024			
06-2024			
07-2024			
08-2024			
09-2024			

[redacted]

Table 2-4 PTU Soybean Oil Processed

Month	Opening Inventory	Closing Inventory	Oil Received	Oil Processed
	pounds			
10-2022	[redacted]			
11-2022				
12-2022				
01-2023				
02-2023				
03-2023				
04-2023				
05-2023				
06-2023				
07-2023				
08-2023				
09-2023				
10-2023				
11-2023				
12-2023				
01-2024				
02-2024				
03-2024				
04-2024				
05-2024				
06-2024				
07-2024				
08-2024				
09-2024				

2.3 TALLOW

Tallow has been received directly at the facility for the period in question. The weights are recorded from the Bills of Lading. Transportation distances are assigned for each supplier and a monthly average calculated for the feedstock. [redacted] The quantities and distances are shown in the following tables.

Table 2-5 Tallow Feedstock Transportation – Rail

Month	Tallow		
	Pounds Received	Miles	Moisture %
10-2022	[redacted]		
11-2022			
12-2022			
01-2023			
02-2023			
03-2023			
04-2023			
05-2023			
06-2023			
07-2023			
08-2023			
09-2023			
10-2023			
11-2023			
12-2023			
01-2024			
02-2024			
03-2024			
04-2024			
05-2024			
06-2024			
07-2024			
08-2024			
09-2024			

Table 2-6 Tallow Feedstock Transportation – Truck

Month	Tallow		
	Pounds Received	Miles	Moisture %
10-2022	[redacted]		
11-2022			
12-2022			
01-2023			
02-2023			
03-2023			
04-2023			
05-2023			
06-2023			
07-2023			
08-2023			
09-2023			
10-2023			
11-2023			
12-2023			
01-2024			
02-2024			
03-2024			
04-2024			
05-2024			
06-2024			
07-2024			
08-2024			
09-2024			

[redacted] The data for the calculator is shown in the following table.

Table 2-7 Tallow Processed

Month	Opening Inventory	Closing Inventory	Oil Received	Oil Processed
	pounds			
10-2022	[redacted]			
11-2022				
12-2022				
01-2023				
02-2023				
03-2023				
04-2023				
05-2023				
06-2023				
07-2023				
08-2023				
09-2023				
10-2023				
11-2023				
12-2023				
01-2024				
02-2024				
03-2024				
04-2024				
05-2024				
06-2024				
07-2024				
08-2024				
09-2024				

2.4 CANOLA OIL

Canola oil has been received by [redacted] at the facility. The receipts started in [redacted]. The quantities and distances are shown in the following table.

Table 2-8 Canola Oil Transportation

Month	Canola Oil		
	Pounds Received	Miles	Moisture %
[redacted]			

The inventory and quantities received and processed are shown in the following table.

Table 2-9 Canola Oil Processed

Month	Opening Inventory	Closing Inventory	Oil Received	Oil Processed
	pounds			
[redacted]				

2.5 CORNSORGHUM OIL

Corn oil started to be processed in [redacted]

Table 2-10 Corn Oil Rail Transportation

Month	Corn Oil		
	Pounds Received	Miles	Moisture %
[redacted]			

Table 2-11 Corn Oil Truck Transportation

Month	Corn Oil		
	Pounds Received	Miles	Moisture %
[redacted]			

The inventory and quantities received and processed are shown in the following table.

Table 2-12 Corn Oil Processed

Month	Opening Inventory	Closing Inventory	Oil Received	Oil Processed
	pounds			
[redacted]				

2.6 PRETREATED CANOLA OIL

The pretreated canola oil is processed the same way as the pretreated soybean oil. [redacted]

[redacted]e

Table 2-13 Pretreated Canola Oil Rail Transportation

Month	Pretreated Canola Oil		
	Pounds Received	Miles	Moisture %
[redacted]			

The inventory and quantities received and processed are shown in the following table.

Table 2-14 Pretreated Canola Oil Processed

Month	Opening Inventory	Closing Inventory	Oil Received	Oil Processed
	pounds			
[redacted]				

2.7 NON LCFS FEEDSTOCK

There was a small amount of non LCFS feedstock process in the 24-month period. This quantity must be included in the calculator in order for the processing yield to be calculated correctly, but no other information is required. The mass processed was [redacted] pounds.

3. RENEWABLE DIESEL PRODUCTION

The production of renewable diesel requires energy and chemical inputs. The calculator has a number of required inputs for renewable diesel production. These include data on the co-products. These are discussed below. Data for the period of October 2022 to September 2024 is used for the renewable diesel portion of the calculator.

3.1 PROCESS

The facility consumes feedstock as documented in the previous section, natural gas, and electricity.

3.2 MASS INPUTS AND OUTPUTS

The feedstock processed is automatically calculated by the calculator based on receipts and changes in the inventory levels. Process chemicals are a standard value in the CARB calculator.

Renewable Diesel is sold in railcars to various destinations, [redacted] The railcars are loaded at CRDC's [redacted] load spots. [redacted] The data is shown in the following table.

Table 3-1 Renewable Diesel Inventory Data

Month	Opening Inventory	Closing Inventory	RD Sold	RD Produced
	Gallons			
10-2022	[redacted]			
11-2022				
12-2022				
01-2023				
02-2023				
03-2023				
04-2023				
05-2023				
06-2023				
07-2023				
08-2023				
09-2023				
10-2023				
11-2023				
12-2023				
01-2024				
02-2024				
03-2024				
04-2024				
05-2024				
06-2024				
07-2024				
08-2024				
09-2024				

The yield is calculated from the input data. The co-product production is discussed later.

3.3 ENERGY REQUIREMENTS

There are only three external energy inputs into the process. The streams are:

1. Natural Gas
2. Electricity
3. Renewable fuel gases from the process

The hydrogen required for the process is produced on site from natural gas and the renewable fuel gas and LPG co-products

3.3.1 Natural Gas

Natural gas consumption is determined from the utility's meters. The volumes are measured by 4 meters that are owned and operated by Black Hills Energy. [redacted] feed all of the natural gas into the unit that is used to produce heat and hydrogen. [redacted]. Volumes are tracked by meter

by day by HF Sinclair's natural gas representative and saved on a company Sharepoint. The location of the meters is shown in the following figure.

Figure 3-1 Location of NG Meters

Table 3-2 Natural Gas Usage

Month	Total NG
	MM BTU (HHV)
10-2022	[redacted]
11-2022	
12-2022	
01-2023	
02-2023	
03-2023	
04-2023	
05-2023	
06-2023	
07-2023	
08-2023	
09-2023	
10-2023	
11-2023	
12-2023	
01-2024	
02-2024	
03-2024	
04-2024	
05-2024	
06-2024	
07-2024	
08-2024	
09-2024	
Total	

3.3.2 Electricity

All of the electricity that is used to power the plant runs through two meters. EL[redacted] are maintained by Black Hills Energy, the electricity provider for CRDC. These two meters are invoiced monthly on account[redacted], and the monthly metered total is used for LCFS Calculations.

Table 3-3 Electricity Usage

Month	Total Power
	kWh
10-2022	[redacted]
11-2022	
12-2022	
01-2023	
02-2023	
03-2023	
04-2023	
05-2023	
06-2023	
07-2023	
08-2023	
09-2023	
10-2023	
11-2023	
12-2023	
01-2024	
02-2024	
03-2024	
04-2024	
05-2024	
06-2024	
07-2024	
08-2024	
09-2024	
Total	

3.4 FUEL GAS USE

The renewable fuel gases that are produced in the process are used to supplement the purchased natural gas. The consumption data is shown in the following table.

Table 3-4 Fuel Gas Usage

Month	Total Fuel Gas
	MM BTU
10-2022	[redacted]
11-2022	
12-2022	
01-2023	
02-2023	
03-2023	
04-2023	
05-2023	
06-2023	
07-2023	
08-2023	
09-2023	
10-2023	
11-2023	
12-2023	
01-2024	
02-2024	
03-2024	
04-2024	
05-2024	
06-2024	
07-2024	
08-2024	
09-2024	

The methane and N_2O emissions from the combustion of this gas are assumed to be the same as the CA GREET values for the combustion of propane in boilers. The emission factor is 1,478 g CO_2eq/MM BTU (LHV).

3.5 CO-PRODUCTS

The CRDC plant has only one co-product streams that is sold, the renewable naphtha. The other streams from the process, the fuel gas and the LPG are consumed internally for process heat and hydrogen production.

3.5.1 Naphtha

There is some renewable naphtha that is produced in the process. The volume of Naphtha produced is determined by monthly tank gauges. The production number is the ending inventory less the beginning inventory, plus the naphtha truck shipments for the month. Naphtha shipments are measured using a Faure Herman Coriolis meter that corrects measures volume, temperature and API to correct to net gallons using ASTM table 6B.

Table 3-5 Naphtha Production

Month	Naphtha Produced
	Gallons
10-2022	[redacted]
11-2022	
12-2022	
01-2023	
02-2023	
03-2023	
04-2023	
05-2023	
06-2023	
07-2023	
08-2023	
09-2023	
10-2023	
11-2023	
12-2023	
01-2024	
02-2024	
03-2024	
04-2024	
05-2024	
06-2024	
07-2024	
08-2024	
09-2024	
Total	

Based on the operating conditions and sampling plan provided to CARB, the plant tests the naphtha energy content no less than every four weeks, and the average for the period of the calculator is reported. The result was [redacted]

3.6 MASS BALANCE

The overall mass balance is summarized in the following table.

Table 3-6 Mass Balance

	Input	Output
	Pounds	
Soy Oil	[redacted]	
PTU Soy Oil		
Tallow		
Canola Oil		
Corn Oil		
PTU Canola Oil		
Non LCFS feedstock		
Renewable Diesel		
Naphtha		
Fuel gas (estimated)		
Water (estimated)		
Total		

The process also produces water, which is estimated in the above table. The feedstock contains about [redacted] oxygen by weight. This oxygen is removed by the process and ends up mostly as H_2O. Using the [redacted] oxygen the mass of water can be calculated.

[redacted]

4. RENEWABLE DIESEL TRANSPORT

Cheyenne Renewable Diesel Company LLC distributes their renewable diesel by rail from the plant to California. There have been a number of delivery points in California. The average distance from the plant to the delivery locations for the 24-month period has been [redacted] miles. This has been calculated from the sales report and the mileage to each delivery point that has been provided by the HF Sinclair rail logistics group.

5. TANKS TO WHEELS

The tank to wheel emissions are the same for all renewable diesel fuels. This emission category calculates the methane and nitrous oxide emissions associated with the combustion of renewable diesel in the vehicle. The value in CA GREET 3.0 is 0.76 g CO_2eq/MJ.

6. INDIRECT LAND USE CHANGE

The indirect land use change charge for canola oil is 14.5 g CO_2eq/MJ. There is no ILUC value for corn oil.

7. SUMMARY

The emissions calculated for the individual stages are summed to determine the fuel cycle CI. The results for the CRDC renewable diesel pathways are shown in the following table.

Table 7-1 Lifecycle GHG Emissions – CRDC Renewable Diesel

Feedstock	Corn Oil	PTU Canola Oil
Stage	gCO_2e/MJ	
Feedstock Production	[redacted]	
Fuel Production		
Indirect Land Use	0.00	14.50
Tailpipe Emissions	0.76	0.76
RD	39.76	63.5