CARB LCFS FUEL PATHWAY REPORT
RENEWABLE DIESEL

Prepared For:

Artesia Renewable Diesel Company LLC
501 East Main
Artesia, New Mexico
United States 88210

Prepared By

(S&T)^2 Consultants Inc.
11657 Summit Crescent
Delta, BC
Canada, V4E 2Z2

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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 and by the beginning of 2021 all plants will have to resubmit applications.

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 is the potential for multiple pathways for the same feedstock, one which receives oil directly from oil producers and one where the oil is first pretreated to reduce the phosphorus in the pretreatment unit at the facility.

Artesia Renewable Diesel Company LLC started production of renewable diesel fuel in the summer of 2022. Provisional pathways have been granted for soybean oil, corn oil and tallow that are pretreated at the facility. Other applications are in process. This report accompanies a CARB Provisional Application for a Carbon Intensity determination for pre treated Used Cooking Oil.

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

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

Feedstock	Pre treated UCO
Stage	gCO_2e/MJ
Feedstock Production	[redacted]
Fuel Production	
Indirect Land Use	0.00
Tailpipe Emissions	0.76
RD	20.83

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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 and by the beginning of 2021 all plants will have to resubmit applications.

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 is the potential for multiple pathways for the same feedstock, one which receives oil directly from oil producers and one where the oil is first pretreated to reduce the phosphorus in the pretreatment unit at the facility.

Artesia Renewable Diesel Company LLC ("ARDC") started production of renewable diesel fuel in the summer of 2022. This report accompanies a CARB Provisional Application for a Carbon Intensity determination for the products produced from used cooking oil by the plant.

1.1 ARTESIA RENEWABLE DIESEL COMPANY LLC

HF Sinclair operates the Navajo Refinery located in Artesia, New Mexico. [redacted] The Navajo refinery serves markets in the southwestern United States and northern Mexico.

The Artesia Renewable Diesel facility has been built on the site of the Navajo Refinery. The design mass balance determined maximum that the facility is designed to produce up to [redacted] barrels per day of renewable diesel and up to [redacted] barrels per day of renewable naphtha. This flow rate corresponds to [redacted] gallons per year of renewable diesel and [redacted] gallons per year of naphtha.

One unique feature of the facility is that it has a pretreatment unit which is capable of pre-treating the feedstock to remove phosphorus for feedstocks for this facility and for sale to other renewable diesel plants. The emissions associated with the pretreatment are determined in a separate calculator that uses all of the emission factors associated with the process from other CARB calculators.

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

ARDC receives feedstock by rail and truck. The feedstocks are first processed in a pretreatment unit. The pretreated feedstock can be sold to other renewable diesel producers or process in the ARDC facility.

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

Renewable naphtha and light fuel gases are used in the Navajo refinery.

The block flow schematic is shown in the following figure.

Figure 1-2 Block Flow Schematic

1.2 MODEL 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 SPSO eGrid and the model input is 9 SPSO Mix.[1]
2. The regional crude oil mix is US Average Crude
3. The regional natural gas source is US Average NG.

The facility uses hydrogen produced by the refinery so it is necessary to correct the hydrogen energy density and the hydrogen emission factor. These are CARB approved changes. The hydrogen density is changed to 274 in cell B24 on the Fuel Specs tab. This is the energy density at 60F rather than at 32F. The hydrogen volume is to be entered into the calculator at 60F. The hydrogen emission factor is 105,612 g CO_2eq/MM BTU which is entered in cell C37 on the EF Table sheet. This removes 150 miles of pipeline transportation for the hydrogen.

Other model inputs are entered on other sheets in the model. 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

Most of the feedstock that is processed by ARDC is pretreated. However, the pre-treatment facility also supplies other RD plants so the impact of the pre-treatment unit must be calculated outside of the main CARB calculator and each pathway will use user defined parameters.

2.1 PRE-TREATMENT

The pretreatment facility consumes electricity, natural gas and citric acid all of which are metered and recorded. The feedstock transportation distance is also recorded in the calculator. The default emissions associated with each feedstock are added to the calculated transportation emissions and then the sum of those two emissions is adjusted for the change in mass through the pretreatment facility and added to the emissions associated with the operation on the pretreatment facility.

The values used in the PTU calculator are summarized in the following table. There are two electricity meters for the PTU, one for the main process and one for the rail car unloading area. They are added together for the value here. The unit consumes steam. The natural gas is calculated based on the mass of steam consumed, and energy content of the steam of 1000 BTU/pound and an assumed steam production efficiency of 80%.

Table 2-1 PTU Inputs

Month	Pretreated Product Produced	Citric Acid	Electricity	Natural gas
	Pounds	Pounds	kWh	MM BTU (HHV)
09-2022	[redacted]			
10-2022				
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				
Total				

The carbon intensity adder for the PTU is [redacted] g CO_2eq/pound of oil produced.

2.2 USED COOKING OIL

The used cooking oil for the Artesia pre-treatment unit has been received by rail and truck for the period of the application. HF Sinclair's rail group works with the railroads to determine the distance from each origin. Some oil is moved by rail and truck.

Table 2-2 Used Cooking Oil Feedstock Transportation

Month	Used Oil				
	Pounds Received Rail	Miles	Pounds Receive Truck	Miles	Moisture %
02-2024	[redacted]				
03-2024					
04-2024					
05-2024					
06-2024					
07-2024					
08-2024					
Total					

The incoming transportation emissions amount to [redacted] g CO_2eq/pound of pretreated used cooking oil.

The opening and closing inventories for the feedstock tanks are recorded and along with the feedstock receipts are used to calculate the feedstock processed. The tank volumes are temperature corrected and then converted to mass. Feedstocks density samples shows that all feedstocks have a weight of 7.7 lbs per gallon, +/- 1%.

Table 2-3 Used Cooking Oil Processed

Month	Opening Inventory	Oil Received	Oil Processed	Closing Inventory
	pounds			
02-2024	[redacted]			
03-2024				
04-2024				
05-2024				
06-2024				
07-2024				
08-2024				
Total				

The total emissions for the pretreated UCO are [redacted] g CO_2eq/pound. This includes the incoming transportation emissions and the pre-treatment emissions. This is the user defined value used in the calculator.

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.

3.1 FEEDSTOCK

There is pre-treated feedstock storage at the RD unit. This data is used to determine the feedstock processed. There are transportation distances input into the RD calculator as these have already been accounted for in the pre-treatment calculator. [redacted] The feedstocks used in the process are shown in the following tables.

Table 3-1 PTU UCO Processed for RD

Month	Beginning Inventory	Oil Received	Oil Used	Ending Oil Inventory
	lbs.	lbs.	lbs.	lbs.
03-2024	[redacted]			
04-2024				
05-2024				
06-2024				
07-2024				
08-2024				

3.2 PROCESS

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

3.3 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] Each rail car loading spot has an [redacted]. The load temperature, pressure and observed API are collecting in [redacted], which calculates the temperature corrected gravity, and converts from gross to net gallons using ASTM 6B with corrected gravity and observed temperature, and the correct pressure coefficient. The data is shown in the following table.

Table 3-2 Renewable Diesel Inventory Data

Month	Opening Inventory	RD Produced	Closing Inventory	RD Sold
	Gallons			
09-2022	[redacted]			
10-2022				
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				
Total				

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

3.4 ENERGY REQUIREMENTS

There are only three external energy inputs into the process. These are supplied by the adjacent refinery. The streams are:

1. Natural Gas
2. Electricity
3. Hydrogen

3.4.1 Natural Gas

Natural gas consumption is determined from the steam flow for process heat and from a small amount of natural gas used from time to time.

Table 3-3 Natural Gas Usage

Month	Total NG
	MM BTU (HHV)
09-2022	[redacted]
10-2022	
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	
Total	

3.4.2 Electricity

The electricity consumption is metered from [redacted] The power consumption is recorded daily. The net power consumption is shown in the following table.

Table 3-4 Electricity Usage

Month	Total Power
	kWh
09-2022	[redacted]
10-2022	
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	
Total	

3.5 HYDROGEN

Hydrogen is supplied from the refinery. It is metered by an [redacted] meter. There is also some hydrogen in the fuel gas stream that is not consumed in the process. This hydrogen is subtracted from the hydrogen consumed in the process and it is removed from the fuel gas produced by the process.

Table 3-5 Hydrogen Usage

Month	Total Hydrogen
	Cubic Feet
09-2022	[redacted]
10-2022	
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	
Total	

3.6 CO-PRODUCTS

The ARDC plant has two co-product streams, fuel gas and the renewable naphtha.

3.6.1 Naphtha

There is some renewable naphtha that is produced in the process. The volume of Naphtha produced is determined by a mass flow meter which also produces the density for conversion of the mass to gallons. [redacted]

Table 3-6 Naphtha Production

Month	Naphtha Produced
	Gallons
09-2022	[redacted]
10-2022	
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	
Total	

The energy content of the naphtha is 106,928 BTU/gal (LHV). This the average value of monthly samples taken at the facility between September 2022 and August 2024.

3.6.2 Fuel Gas

The fuel gas produced is measured by a mass meter and the energy content is calculated from daily GC determinations of the composition of the product. [redacted]

Table 3-7 Fuel Gas Production

Month	Fuel Gas Produced
	MM BTU
09-2022	[redacted]
10-2022	
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	
Total	

3.7 MASS BALANCE

The overall mass balance, excluding the produced water for the 18-month period is summarized in the following table.

Table 3-8 Mass Balance

	Input	Output
	Pounds	
Soy Oil	[redacted]	
Corn Oil		
Tallow		
Canola Oil		
Ragassa Soy Oil		
UCO		
Hydrogen		
Renewable Diesel		
Naphtha		
Fuel Gas (estimated)		
Water (estimated)		
Total		

The process also produces water, which is not included in the above table. The feedstock contains about 11% oxygen by weight. This oxygen is removed by the process and ends up mostly as H_2O. Using the 11% oxygen the mass of water can be estimated. There is a small loss of mass shown in the table but it is reasonable.

4. RENEWABLE DIESEL TRANSPORT

Artesia 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 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 wheels 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

There is no ILUC charge for used cooking oil.

7. SUMMARY

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

Table 7-1 Lifecycle GHG Emissions – ARDC Renewable Diesel

Feedstock	Pre treated UCO
Stage	gCO_2e/MJ
Feedstock Production	[redacted]
Fuel Production	
Indirect Land Use	0.00
Tailpipe Emissions	0.76
RD	20.83