Oregon Department of Environmental Quality

Tier 1 Simplified CI Calculators Instruction Manual

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Instruction manual for:

DEQ adapted the content of this manual from the California Air Resources Board's Tier 1 Simplified CI Calculator Instruction Manuals.

Starch and fiber ethanol

A. Introduction

This document provides detailed instructions for using the Simplified CI Calculator for Tier 1 Starch and Fiber Ethanol pathway applications. This calculator calculates the carbon intensity (CI) for ethanol produced from corn, sorghum, or corn/sorghum fiber. Note that all references to sorghum in the Simplified CI Calculator and Instruction manual refer exclusively to grain sorghum. Each required specific input in the Calculator has been numerically labeled (i.e., 1.1, 1.2, etc.) so that users can follow the sequence and enter information as required.

Download the Simplified CI Calculator here:
https://www.oregon.gov/deq/ghgp/cfp/Pages/Clean-Fuel-Pathways.aspx

The Calculator has been automated to perform CI calculations using factors from the OR-GREET3.0 model. The Calculator replaces the existing Tier 1 Calculator and the operational data template in pathway application packages. Applicants must add facility information and verifiable monthly feedstock, energy use, fuel production, co-product data, and transport distances to calculate the CI of Starch and Fiber Ethanol pathways.

The Calculator includes reference material such as greenhouse gas emissions factors used in OR-GREET3.0 and reference fuel specifications. Also included with the Calculator is a detailed breakdown of the calculations used to determine the final CI of each fuel pathway.

The applicant may only enter values or make selections in input fields designated by DEQ for user input/selection and may not change any other values or fields in the Calculator.

B. Definition

Conditional Default - A conservative input value option calculated by DEQ staff. Pathway applicants may select a conditional default input value if their operations meet the conditions specified for such a value in this Instruction Manual. Because each conditional default value must be based on reasonable assumptions and be sufficiently conservative to encourage the use of site-specific values when feasible, conditional default values are subject to initial validation during the fuel pathway certification process to confirm that the specified conditions are met and may be subject to subsequent annual verification.

C. Color legend used in the calculator

The Calculator uses the following color legend to differentiate required inputs, calculated values, etc., as described below:

Yellow Cells require user input
Light Blue Cells show CI results
Green Cells show the calculation button
Gray Cells are calculated values

D. Calculator overview

The following table provides an overview of the tabs used in the Simplified CI Calculator.

Table D.1. Overview of tabs used in the Simplified CI Calculator

Tab Name	Description
EtOH Summary	Summary worksheet. Contains an overall summary of the information entered in the "EtOH" tab of the Calculator and calculated CIs and corresponding denatured ethanol volumes. If desired, **a conservative margin of safety** may be added to the calculated CI in this tab to establish the final CI.
EtOH	Main calculation worksheet: contains an overview of the calculated CIs for a given pathway and the main components of the Calculator with fields requiring user inputs and those calculated by the sheet. For example, calculations in grayed-out cells are automatically calculated but dependent on inputs to yellow cells in the corresponding sections of the Calculator. In addition, this tab includes a detailed sample CI calculation (cells B77 through K111).
EF Tables	This reference worksheet contains emissions factors from the OR-GREET3.0 model used to calculate carbon intensities.
Fuel_Specs	This reference worksheet contains specifications of fuels, global warming potentials of greenhouse gases, land use change, and unit conversion.

EtOH Tab

The EtOH tab contains the main CI calculation worksheet that consists of the following major components:

- Pathway Summary and Estimated CI
- Section 1. Applicant Information
- Section 2. Feedstock Production Data for Ethanol Production
- Section 3. Fuel Production Energy Consumption and Fuel Transport Data
- Section 4. CI Calculation Details

All CI values are calculated based on relevant site-specific inputs, which must be entered in the respective input fields. After all site-specific inputs for a given facility have been entered, the calculated CIs will represent the pathway CIs for the various streams as detailed in this tab and the EtOH Summary tab. Details for entering data in all required fields are described below. As provided, the EtOH tab has blank values for all applicant-specific inputs. Specific input selections (i.e., eGRID subregion) are set to one of the available options in the pull-down menus. Applicants must replace input cell values only for those fields which apply to the ethanol plant. The selection of inputs (i.e., eGRID subregion) must be appropriate to the fuel production pathway.

Section 1: Applicant information

Begin by selecting the EtOH tab and entering information regarding the company, the fuel production facility, and the feedstock production location.

Table E.1. List of input fields for Section 1 of the simplified CI calculator

Field Name	Description
1.1. Company Name	Registered name of the company. Example "ABC Company, LLC" or "ABC Company, Inc."
1.2. Application Number	Enter the application number provided by the AFP.
1.3. Company ID	Enter U.S. EPA Company ID. If not available, contact DEQ staff for CFP Company ID.
1.4. Facility ID	Enter the Company's Facility ID. If not available, contact DEQ for CFP Facility ID.
1.5. Ethanol Production Location	Enter City and State for ethanol production
1.6. Application Description	For starch ethanol pathways, enter feedstock source, fuel type, Dry/Wet Mill, coproducts (WDGS, MDGS, DDGS), and process fuels. Examples: Midwest Corn, Ethanol, Dry Mill, MDGS, DDGS, NG. For corn/sorghum fiber ethanol pathways, enter cellulosic ethanol produced from [list feedstock] using [list ethanol production process].
1.7. Electricity Mix Region for Feedstock	Electricity mix for feedstock; set to a single value: "1-U.S Ave Mix" and cannot be changed by the applicant
1.8. Provisional Pathway?	If available data is less than 24 months, select "Yes," else "No," and click "Calculate." If "Provisional," a minimum of three months of operational dais ta required to meet provisional requirements.

Section 2: Feedstock production data for ethanol production

The following table lists the fields used in Section 2 of the calculator. Additional details are provided below in Table E.2.

Table E.2. List of input fields for section 2 of the Simplified CI Calculator

Field Name	Description
2.1. Monthly Data	Input the months and year(s) corresponding to the operational data provided.
2.2. Beginning Corn Inventory	Input monthly total beginning corn inventory data (in bushels) in this field for all 24 months of operation. The input must be in bushels (with 15 percent standard moisture). If alternate approaches are used to inventory corn, the applicant must provide the conversion factor to report inventory in bushels. Additional details for feedstock production are provided below this table.
2.3. Corn Used (Calculated)	Monthly corn used data (in bushels) is automatically calculated in section 2.3. Therefore, no inputs are required for this field.
2.4. Corn Received	Input monthly corn data (in bushels) received in this field for all 24 months. If alternate approaches are used to inventory corn, the applicant must provide the conversion factor to report inventory in bushels.
2.5. Ending Corn Inventory	Input monthly total ending corn inventory data (in bushels) in this field for all 24 months. If alternate approaches are used to inventory corn, the applicant must provide the conversion factor to report inventory in bushels. Click "**Select**" (green button) in cell J29 after completing Field 2.5.
2.6. Corn Transport Data Category	Field 2.6 provides three options for corn transport in a drop-down menu: 1) Conditional Default for Ethanol Plants in the 9 Midwest States, 2) Conditional Default for Ethanol Plants in OR, and 3) User-Defined for Corn Transport Applicant must select one of these options and click "**Select**" (green button) in cell J29.
2.7. Corn Transport from Collection Center to Ethanol Plant (Monthly weighted average)	Field 2.7 is designated for corn transport. Additional details for feedstock transport are provided below this table.
2.7a Corn Transported	Input the monthly total quantity of corn (in bushels) transported by HDD Truck to the Ethanol Plant if "User-Defined" is selected. If option 1) or 2) is set in field 2.6, no user input is required for this field. Additional details for corn transport are provided below this table.
2.7.b By HDDT, miles	Input monthly weighted average transported mileage if the applicant selects the "User-Defined" option in field 2.6. If option 1) of 2) is set in field 2.6, no user input is required for this field. Additional details for corn transport are provided below this table.
2.7.c Corn Transported	Input the monthly total quantity of corn (bushels) transported by rail to the Ethanol Plant if "User-Defined" is selected. If option 1) or 2) is set in field 2.6, no user input is required for this field. Additional details for

	corn transport are provided below this table.
2.7.d By Rail, miles	Input monthly weighted average transport mileage if the applicant selects the "User-Defined" option in field 2.6. If option 1) or 2) is set in field 2.6, no user input is required for this field. Additional details for corn transport are provided below this table.
2.8. Beginning Sorghum Inventory	Same as field 2.2 if sorghum is used as a feedstock. Additional details for feedstock production are provided below this table.
2.9. Sorghum Used (Calculated)	Monthly sorghum used data in this field will be automatically calculated. Therefore, no inputs are required for this section.
2.10. Sorghum Received	Same as field 2.4 if sorghum is used as a feedstock.
2.11. Ending Sorghum Inventory	Same as field 2.5 if sorghum is used as a feedstock.
2.12. Sorghum Transport Data Category	Same as field 2.6 if sorghum is used as a feedstock. Click the "Update" button in cell R29 after choosing an option in field 2.12.
2.13. Sorghum Transport from Collection Center to Ethanol Plant (Monthly weighted average)	Field 2.13 is designated for sorghum transport. No inputs are required for this section. Additional details for feedstock transport are provided below this table.
2.13.a Sorghum Transported	Input the monthly total quantity of sorghum (in bushels) transported by HDD Truck to the Ethanol Plant if "User Defined" is selected. If option 1) or 2) is set in field 2.12, no user input is required for this field. Additional details for sorghum transport are provided below this table.
2.13.b By HHDT, miles	Input monthly weighted average transport mileage by HDD truck if the applicant selects the "User Defined" option in field 2.12. If option 1) or 2) is set in field 2.12, no user input is required for this field. Additional details for sorghum transport are provided below this table.
2.13.c Sorghum Transported	Input the monthly total quantity of sorghum (in bushels) transported by rail to the Ethanol Plant if "User Defined" is selected. If option 1) or 2) is set in field 2.12, no user input is required for this field. Additional details for sorghum transport are provided below this table.
2.13.d By Rail, miles	Input monthly weighted average transport mileage by rail if the applicant selects the "User Defined" option in field 2.12. If option 1) or 2) is set in field 2.12, no user input is required for this field. Additional details for sorghum transport are provided below this table.
2.14. Dry DG Beginning Inventory	Input monthly total Dry Distiller Grains inventory data (in tons) in this field for all 24 months of operation. If the facility does not produce dry DGS, the applicant must enter zero in fields 2.14–2.19. Additional details regarding coproducts are provided below this table.
2.15. Dry Distiller Grains Produced (Calculated)	Monthly total Dry Distiller Grains produced data (in tons) under section 2.15 will be automatically calculated. Therefore, no inputs are required for this field.
2.16. Dry Distiller Grains Sales	Input monthly Total Dry Distiller Grains sales data (in tons) for all 24 months of operation.

2.17. Dry DG Ending Inventory	Input monthly Total Dry Distiller Grains ending inventory data (in tons) for all 24 months of operation
2.18. Moisture Content	Input monthly weighted average moisture content (in percentage) for dry DGS for all 24 months of operation. Moisture measurements must utilize an industry-standard moisture measurement protocol.
2.19. Drying Energy	Input monthly total drying energy data (MMBtu of NG expressed in HHV) for all 24 months of operation. Dedicated meters must be installed to quantify natural gas used for drying DGS. Dedicated meters are not required if the applicant requests a composite carbon intensity score. The applicant must provide the conversion factor to report NG use in HHV if alternate measurement units are used to quantify natural gas use.
2.20. Modified DG Beginning Inventory	Same as field 2.14 but for Modified DGS.
2.21. Modified Distiller Grains Produced (Calculated)	Same as field 2.15 but for Modified DGS.
2.22. Modified Distiller Grains Sales	Same as field 2.16 but for Modified DGS
2.23. Modified DG Ending Inventory	Same as field 2.17 but for Modified DGS
2.24. Moisture Content	Same as field 2.18 but for Modified DGS
2.25. Drying Energy	Same as field 2.19 but for Modified DGS
2.26. Wet DG Beginning Inventory	Same as field 2.14 but for Wet DGS.
2.27. Wet Distiller Grains Produced (Calculated)	Same as field 2.15 but for Wet DGS.
2.28. Wet Distiller Grains Sales	Same as field 2.16 but for Wet DGS
2.29. Wet DG Ending Inventory	Same as field 2.17 but for Wet DGS
2.30. Moisture Content	Same as field 2.18 but for Wet DGS
2.31. Syrup Beginning Inventory	Input monthly total syrup inventory data (in tons) in this field for all 24 months. If the facility does not produce syrup, the applicant must input zero in Fields 2.31-2.35.
2.32. Syrup Produced (Calculated)	Monthly total syrup produced data (in tons) in field 2.32 will be automatically calculated. Therefore, no inputs are required for this field.
2.33. Syrup Sales	Input monthly total syrup sales data (in tons) for all 24 months of operation.
2.34. Syrup Ending Inventory	Input monthly total syrup ending inventory data (in tons) for all 24 months of operation.

2.35. Moisture Content	Input monthly weighted average moisture content (in percentage) for syrup for all 24 months of operation. Moisture measurements must utilize an industry-standard moisture measurement protocol.
2.36. Beginning Oil Inventory	Input monthly total Corn/Sorghum Oil inventory data (in lbs.) in this field for all 24 months. If the facility does not produce corn or sorghum oil, the applicant must enter zero for Fields 2.36-2.39. Corn and sorghum oil are considered equivalent in the Calculator.
2.37. Oil Produced (Calculated)	Monthly total oil produced data in field 2.36 will be automatically calculated. Therefore, no inputs are required for this field.
2.38. Oil Sales	Input monthly total Corn/Sorghum Oil sales data (in lbs.) for all 24 months of operation.
2.39. Ending Oil Inventory	Input monthly total Corn/Sorghum Oil ending inventory data (in lbs.) for all 24 months.
2.40. Co-product Yield (Calculated)	Co-product Yield (dry matter basis, expressed in lbs./gallon of ethanol) data in field 2.40 will be automatically calculated. Therefore, no inputs are required for this field.
2.41. Beginning Undenatured Ethanol	Input monthly total beginning undenatured ethanol inventory data (in gallons at 60F.) for all 24 months of operation. Additional details for ethanol production are provided below this table.
2.42. Denatured Ethanol Sales	Input monthly total denatured ethanol sales data (in gallons at 60F) for all 24 months.
2.43. Undenatured Ethanol Sales	Input monthly total undenatured ethanol sales data (in gallons at 60F) for all 24 months.
2.44. Ending Undenatured Ethanol	Input monthly total undenatured ethanol ending inventory (in gallons at 60F) for all 24 months.
2.45. Undenatured Ethanol Produced (Calculated)	Monthly total undenatured ethanol produced data (in gallons at 60F) in this field will be automatically calculated. Therefore, no inputs are required for this field.
2.46. Denaturant Data Category	Field 2.46 includes two options for denaturant data input in the drop-down: 1) Denaturant as Standard Value and 2) User-Defined Denaturant. Applicant must select one of these options and click the "Update Denaturant" green button in cell AX30. Data must be input in this section only if the user-defined option is selected; the total quantity of denaturant used (in gallons at 60F) must be input in this field for all 24 months of operation.
2.47. Beginning Cellulosic Enzyme	Input monthly total cellulosic enzyme inventory data (in lbs.) in this field for all 24 months of operation. Additional details for inputs related to corn/sorghum fiber ethanol production are provided below this table.
2.48. Cellulosic Enzyme Purchase	Input monthly total cellulosic enzyme purchase data (in lbs.) for all 24 months of operation.
2.49. Cellulosic Enzyme Use (Calculated)	The monthly total cellulosic enzyme uses data (in lbs.) in field 2.49 will be automatically calculated. Therefore, no inputs are required for this field.
2.50. Ending Cellulosic	Input monthly total cellulosic enzyme ending inventory (in lbs.) for all

Enzyme	24 months of operation.
2.51. Corn/Sorghum Fiber Allocation	Input monthly average corn/sorghum fiber percentage data in this section.
2.52. Undenatured Corn/Sorghum Fiber Ethanol (Calculated)	Monthly total undenatured corn/sorghum fiber ethanol production (in gallons at 60F) will be automatically calculated in this field to correspond to the value in field 2.51. No inputs are required for this field. Only the quantity of ethanol produced from corn as feedstock (not including ethanol attributable to sorghum, if used as a feedstock) is used to calculate the total quantity of corn/sorghum fiber ethanol in this field.

Additional details for section 2

Feedstock production (Fields 2.2 to 2.5 for corn and 2.8 to 2.11 for sorghum)

For feedstock production, enter data for site-specific inputs for feedstock (corn or sorghum) inventory to calculate the quantity of feedstock used in ethanol production. Grayed-out cells are calculated values and do not require applicant input. However, the applicant must enter monthly totals for corn or sorghum bushels received (as purchased) and total monthly beginning and ending corn or sorghum inventory in bushels. The monthly totals must include moisture (15% moisture and not to be reported on a dry basis). If corn or sorghum inventory is not quantified in bushels, the applicant must convert to bushels using a conversion factor of 56 lbs./bushel before reporting in these input cells.

Feedstock transport (Fields 2.7 and 2.13)

For both corn and sorghum transport, the calculator offers two conditional-default options. For ethanol production facilities in one of nine corn-growing states as specified by Argonne National Lab (ANL) as "corn belt states" (South Dakota, Minnesota, Iowa, Nebraska, Illinois, Michigan, Ohio, Indiana, and Wisconsin),[1] the conditional default value is 40 miles for corn transport by HDD truck. Sorghum transport from these regions is assigned a conditional default value of 80 miles by HDD truck. If the applicant selects a conditional default value for ethanol plants in Oregon, it will include 50 miles by HDD truck transport and 1,400 miles by rail transport to Oregon. If an ethanol production facility located in Oregon uses this option, transport distance will be subject to one-time validation during initial certification. Applicants selecting one of the conditional default options do not need to enter additional data in fields 2.7a-d or 2.13a-d, respectively. Click the green "Update" button after selecting one of the two conditional default options to see the pre-populated conditional default values.

The calculator also includes a User-Defined option for sorghum transport and the two conditional default options. Applicants who elect to use the user-defined option for sorghum transport must enter the weighted average feedstock transport distance by HDD truck and rail in Fields 2.13a-d, respectively. Inputs will be subject to initial validation and periodic verification.

To facilitate calculation of monthly weighted average transport distance for User-Defined sorghum transport, staff suggests a calculation methodology as detailed below. The monthly weighted

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[1] Shapouri et al. USDA July 2002 - "The Energy Balance of Corn Ethanol: An Update" –Table 2 - Extracted May 2017

average for each mode (feedstock transport in a given month may include more than one mode of transportation) is included in the cell for feedstock transport for a given month. This methodology is suggested for use in the Calculator sheet because it derives the weighted average transport distance calculation for each month.

Actual feedstock sourcing and corresponding mode of transport and miles transported				
	Modes of Transport			
	Truck	Miles	Rail	Miles
1	100,000	50	100,000	1,200
2	200,000	150		
3			200,000	800
4			100,000	200
5			50,000	1,000
The weighted average distance and corresponding quantities to be used for monthly reporting of feedstock				
	300,000	117	450,000	778
Example in the sheet above:				
Entry 1	For the month, the facility received 100,000 bushels by a mode which included 50 miles by truck followed by 1,200 miles by rail.			
Entry 2	For the month, the facility also received 200,000 bushels by truck only with a transport distance of 150 miles.			
Entry 3	For the month, the facility also received 200,000 bushels by rail only with a transport distance of 800 miles.			
Entry 4	For the month, the facility also received 100,000 bushels at a distance of 200 miles away by rail.			
Entry 5	For the month, the facility also received 50,000 bushels using only rail transport for a distance of 1,000 miles.			
For these scenarios, the facility shall report 300,000 bushels with a weighted average distance of 117 miles by HDD truck and 450,000 bushels with a weighted average distance of 778 miles by rail.				

For feedstock transport, applicants must calculate the appropriate mileage for each mode of transportation as described below. For rail transport, mileage must be based on the rail network maps from BNSF Railway[2] or Union Pacific.[3] For facilities not directly located on the BNSF or Union Pacific rail network, applicants may use a publicly available web-based driving distance estimator for the distance between the facility and the nearest rail depot. Truck transport distance between two points may be determined using a publicly available web-based driving distance estimator.

Co-products (Fields 2.14 to 2.40)

These fields contain input information about reporting quantities of co-products produced during ethanol production. The co-products include soluble distillers' grains, corn oil/sorghum oil, and syrup. The Calculator allows producers to account for co-product streams of dry, modified, and wet distillers' grain solubles. Facilities must include only streams applicable to their production cycles over the 24 months for which data is submitted. Facilities that report dry or modified DGS co-product steams must report monthly total drying energy by installing dedicated energy meters in their facilities if applicants want separate CIs for different DGS types. Meters must record

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[2] BNSF railway system: http://www.bnsf.com/ship-with-bnsf/maps-and-shipping-locations/index.page

[3] Union Pacific system: https://www.up.com/aboutup/usguide/index.htm

energy use for the entire duration in which dryers are utilized to dry DGS, and all records to demonstrate energy use for drying must be electronically archived.

Note: If co-product streams or other energy sources are used for drying, the applicant must declare it in the supplemental documentation. The Simplified CI Calculator cannot estimate GHG emissions when energy sources other than natural gas are used for drying energy. Therefore, applicants may be required to use a Tier 2 approach using the OR-GREET3.0 model, and it is recommended that they consult staff regarding the appropriate method of accounting for this parameter in the application.

Inputs for all co-product inventory streams must be reported in tons except for distillers' corn oil/sorghum oil which must be reported in pounds (lbs.). Energy use must be reported in MMBtu using higher heating values (HHV).

The applicant must include the total monthly quantities for all co-products detailed in the input sheet. For all DGS reporting:

- Monthly beginning dry DGS inventory;
- Monthly DGS sales;
- Monthly ending inventory;
- Monthly weighted average moisture content;
- Monthly total drying energy, consistent with the metering requirements listed above for dry and modified DGS streams if applicable to the facility.

The required inputs are similar for the syrup and distiller's corn/sorghum oil co-product streams. Moisture content for corn oil is set to a standard value of 1% and does not require further input. The syrup's monthly weighted average moisture content must be reported in the appropriate field.

Ethanol production (Fields 2.41 to 2.52)
For ethanol production, the applicant must input (at volumes standardized at 60F):

- Monthly beginning inventory for undenatured ethanol;
- Monthly total denatured ethanol sales;
- Monthly total undenatured ethanol sales;
- Monthly ending undenatured ethanol inventory;
- The sheet offers two monthly denaturant volumes (gallons) options: Standard Value or User-Defined. If the user selects Standard Value denaturant, a value of 2.5% is used as denaturant volume blended with ethanol. If a User-Defined denaturant is selected, monthly total denaturant values (in gallons at 60F) must be input in field 2.46. Click the green "Update Denaturant" button after selecting either the Standard or User-Defined option.

  Facilities that have incorporated a Corn/Sorghum Fiber Ethanol Process
  (Fields 2.47 to 2.52)

For facilities that utilize a corn/sorghum fiber conversion technology process to convert corn/sorghum fiber to cellulosic ethanol, the calculator includes fields labeled under the heading, "Cellulosic Ethanol Production." These include fields from 2.47 through 2.52. In addition, applicants must input monthly beginning inventory of cellulosic enzymes, monthly total cellulosic enzyme purchases, and monthly total ending cellulosic enzyme inventories (all enzyme quantities

to be reported in lbs.). Under the Federal RFS program administered by the Environmental Protection Agency (U.S. EPA), entities that perform chemical analysis tests to determine the fraction of fiber that is converted to ethanol are required to demonstrate, upon initiation of cellulosic fiber ethanol production, the percentage of cellulosic ethanol production attributable to their process modification. Applicants must input this value in the corn/sorghum fiber allocation percentage[4] field (i.e., 2.51). All entries must remain the same until updated as part of the periodic validation required under the RFS program.

Corn/sorghum fiber pathways for which cellulosic ethanol yield is determined by a representative sampling and chemical analysis method to determine the converted fraction must include the method with the application for approval by DEQ.

The RFS program requires facilities approved for D3 RINs to demonstrate, at periodic intervals (i.e., every 500,000 gallons or one year, whichever is more frequent), that cellulosic volumes produced to meet or exceed the originally certified level for a given facility. DEQ requires this same demonstration as a condition of pathway certification. At the time of initial registration, applicants must provide a copy of the RFS approval for the facility. In addition, ongoing reports[5] must be submitted to DEQ staff periodically as required by the RFS program. If any periodic demonstration shows that the cellulosic converted fraction is lower than previously calculated, all cellulosic volumes reported after the most recent analysis must be updated to reflect production volumes determined using that most recent analysis.

Section 3: Fuel production, energy consumption, and fuel transport data

Table E.3 lists the fields in section 3 of the calculator.

Table E.3. List of Input Fields for Section 3 of the Simplified CI Calculator

Field Name	Description
3.1. Electricity Mix Region for Fuel	Choose the electricity mix corresponding to the zip code for the region where the ethanol plant is located. The Calculator includes 26 eGRID zone mixes, average Brazilian mix, average Canadian mix, and User Defined Mix in the pull-down menu. For facilities in the U. S., select one of 26 eGRID zones available for the U. S. These are selected based on the zip code of the upgrading facility location. After selecting an electricity mix option, click "**Calculate CI**" in Cell BI30. If a user-defined mix is selected, input is required for the electricity mix emission factor and is detailed in Field 3.6.
3.2. NG Use	Input monthly total natural gas consumption data (in MMBtu HHV) for all 24 months of operation. Additional details for energy consumption are provided below this table.
3.3. Biogas Use	Input monthly Biogas consumption data (in MMBtu HHV) for all 24 months of operation.
3.3.a. Biogas Emission Factor	Consult with DEQ staff to develop an appropriate emission factor (gCO2e/MMBtu.) for the biogas and input in Field 3.3.a. Pipeline transmission distance must be incorporated into the emission factor. The biogas source and all data sources used in calculating

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[4] This value is used to calculate cellulosic ethanol production and is subtracted from total ethanol production to enable attribution of starch ethanol to other streams in the ethanol plant.

[5] Link to section 80.1426 of RFS code: https://www.govregs.com/regulations/expand/title40_chapterI-i18_part80_subpartM_section80.1426#title40_chapterI_part80_subpartM_section80.1426

	emission factors must be described in detail in the Supplemental Documentation submitted with the Simplified CI Calculator.
3.4. Biomass Use	Input monthly Biomass consumption data (in tons) for all 24 months of operation.
3.4.a. Biomass Emission Factor	Consult with DEQ staff to develop an appropriate emission factor (gCO$_2$e/dry ton) for the biomass and input in Field 3.4.a. Alternate fuel sources and data sources used in calculating emission factors must be described in detail in the Supplemental Documentation submitted with the Simplified CI Calculator. This description must, at a minimum, identify the biomass and the source.
3.5. Biomass Moisture	Input monthly weighted average moisture content (in percentage) for all 24 months of operation. Moisture measurements must utilize industry standard moisture measurement protocol.
3.6. Biomass Transportation Distance	Input monthly weighted average transport distance for all 24 months of operation. For additional details, please see additional details for Section 2 – Feedstock Transport.
3.6.a. Biomass Transportation Emission Factor	Consult with DEQ staff to develop an appropriate emission factor (gCO2e/dry ton-mile) for the alternate fuel and input in Field 3.6.a. Alternate fuel sources and data sources used in calculating emission factors must be described in detail in the Supplemental Documentation submitted with the Simplified CI Calculator. This description must, at a minimum, identify the alternative fuel and the source.
3.7. Electricity Use from the grid	Input monthly Electricity use (in kWh) from the utility grid for all 24 months of operation.
3.8. Direct Electricity Use from Co-located Solar or Wind	Monthly total electricity from Solar or Wind data must be input for all 24 months.
3.9. Finished Fuel Transport	Field 3.9 is designated for finished Fuel Transport and Distribution. Additional details for finished fuel transport are provided below this table.
3.9.a. By Rail	Input distance (in miles) by rail transport from the Ethanol plant to Oregon.
3.9.b. By HDD Truck	Input distance (in miles) from the Ethanol plant to Oregon by HDD truck.
3.9.c. By Barge	Input distance (in miles) from the Ethanol plant to Oregon by barge.
.10. Enter Electricity Generation Emission Factor (gCO2e/kWh)	If User-Defined is selected in Field 3.1, consult with DEQ staff, and input an emission factor for the user-defined electricity mix in cell BK29. Data sources for User Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.

Additional details for section 3

Energy consumption (Fields 3.2 to 3.8)

The applicant must input applicable energy inputs in this section. The applicant must input monthly total natural gas usage from utility invoices (in MMBtu reported as higher heating value). The applicant must also input monthly electricity purchased from the grid from utility invoices (in kWh). If renewable electricity from solar generation or wind power is available by the ethanol production facility, appropriate monthly total electricity dedicated for use by the facility must be

input in Field 3.4. Renewable electricity must meet the requirements for such power as detailed in section 95488.8(h)(1) in the regulation.

If a production facility uses biomethane or biogas as process fuel, monthly total biomethane (or biogas) use from invoices must be input in MMBtu reported as a higher heating value. The landfill or other source of biomethane must be physically delivered to the ethanol production facility to be eligible for consideration as a process fuel. The applicant must also provide details if the biogas is processed at a purification plant before transport to the ethanol facility. The transmission distance from the landfill (or another source of biomethane or biogas) to the ethanol production facility must be provided to DEQ staff in the supplemental documentation for use in the emission factor. For facilities that use biomass as a process fuel, monthly totals from invoices must be input in dry tons. The applicant must also input the monthly weighted average moisture content of the biomass. The monthly weighted average biomass transport distance must be input in miles, and the mode of transport must also be reported. Reporting of miles must conform to the calculation methodology described in the additional details for feedstock transport, detailed below in Table E.2.

Fuel transport (Field 3.9)

For transport of finished fuel to Oregon, applicants must input the appropriate transport distance by HDD truck, barge, and rail transport as applicable. Emissions from transport modes are additive to reflect all legs of transport of finished fuel to Oregon.

Note: For applicants who expect to use various transport modes to ship fuel to Oregon, staff suggests calculating the CIs for each combination and inputting the mix with the highest CI in the Simplified CI Calculator to prevent unintentional exceedance of the pathway CI. The supplementary documentation provided with the application must include the CIs for each of the anticipated modes and combinations used in the Calculator.

For Columbia and Pacific Northwest River barge and river miles transportation distances, please use the miles provided in the appropriate datasets as needed, for example: https://geo.wa.gov/datasets/fff25ee77f9e43ff9539688ba8ab3af3_0

https://www.arcgis.com/home/webmap/viewer.html?url=https://services.arcgis.com/6lCKYNJLvwTXqrmp/ArcGIS/rest/services/WAECY_River_Miles/FeatureServer&source=sd

Emission factors and CO_2e calculation details

Applicant inputs are matched to corresponding emission factors (in CO_2e) derived from the OR-GREET3.0 model. Total GHG emissions are calculated for each discrete input, and all emissions are summed, including ones for standard inputs, under Sections 2 and 3.

Section 4. CI calculation details

This section contains an example pathway CI calculation with a detailed breakdown of all calculations used for CI determination based on information entered by the user and applicable reference data.

Sugarcane-derived ethanol

A. Introduction

This document provides detailed instructions for using the Simplified CI Calculator for Tier 1 Sugarcane-derived Ethanol pathway applications. This Calculator will be used to calculate a composite carbon intensity (CI) for Sugarcane-derived Ethanol from sugarcane-based juice or molasses feedstocks in Brazil. Each required specific input in the Calculator has been numerically labeled (i.e., 1.1, 1.2, etc.) so that users can follow the sequence and enter information as required.

Download the Simplified CI Calculator here:
https://www.oregon.gov/deq/ghgp/cfp/Pages/Clean-Fuel-Pathways.aspx

The Calculator has been automated to perform CI calculations using factors from the OR-GREET3.0 model. The Calculator replaces the existing Tier 1 Calculator and the operational data template in pathway application packages. Applicants must add facility information and verifiable monthly feedstock, operational energy use, fuel production, co-product data, and transport distances used in calculating the CI of Sugarcane-derived Ethanol. The Calculator is designed to work independently of the OR-GREET 3.0 model but will still require operational and production data from the mill to be entered for the previous 24 months, including, at a minimum, two sugarcane harvest cycles of at least nine months duration each.

B. Color legend used in the calculator

The Calculator uses the following color legend to differentiate required inputs, calculated values, etc., as described below:

Yellow Cells require user input
Light Blue cells show CI results
Green Cells show the calculation button
Gray Cells are calculated values

C. Calculator overview

The following table provides an overview of the main tabs used in the calculator.

Table C.1. Overview of tabs used in the Simplified CI Calculator

Tab Name	Description
Summary	Summary worksheet. Contains an overall summary of the information entered in the "Calculator" tab of the Calculator and the calculated CI for Sugarcane-derived Ethanol. If desired, a **conservative margin of safety** may be added to the calculated CI in this tab to establish the final CI.
Calculator	The main calculation worksheet contains fields requiring user input and some parameters calculated by the worksheet. This worksheet's product is a composite CI calculation for a sugarcane-based ethanol pathway. Calculations in light gray and light blue cells are automatically calculated but depend on user input in the yellow cells. This tab also includes a detailed sample CI calculation illustrating the aggregation of impacts. Some input fields have a drop-down list of options for the user to select.
EF Tables	Reference worksheet. It contains greenhouse gas emissions factors (EF) from the OR-GREET3.0 model used in calculating carbon intensities. No user interface is necessary for this tab.
EF General	Generalized worksheet for developing EFs for GHG and aggregation of well-to-wheels impacts assessments. The EFs are developed from OR-GREET3.0 or other equivalent models. No user interface is necessary for this tab.
Fuel_Specs	Reference worksheet for CI Calculations. Includes emissions factors derived from the OR-GREET3.0 model, standard values, and assumptions related to the Calculator. No user interface is necessary for this tab.

D. Calculator Tab

The "Calculator" tab includes pathway inputs used to calculate the CI for sugarcane-derived ethanol. Site-specific parameters must be input/selected by the applicant for all relevant fields in the worksheet. In addition, the Calculator tab requires that the applicant provide facility information, feedstock information, energy use data, fuel and co-product production data, feedstock and finished fuel transport distances for each mode of transport offered, and other pertinent information such as the level of mechanized harvesting implemented over the harvest cycle, and the amount of surplus cogenerated electricity exported to the grid. The Calculator tab consists of the following major components:

- Pathway Summary and Calculated CI (gCO$_2$e/MJ)
- Section 1: Applicant & Mill Specific Information
- Section 2: Finished Fuel Transport Information
- Section 3: Monthly Feedstock, Fuel, and Co-Product Production Data
- Section 4: Calculation of Production Yields and Mass Allocation Ratio
- Section 5: Verify Fuel and Co-Product Production Information
- Emissions Factor-based Aggregated CI Impact Determination for Sugarcane Juice

Feedstock
- Emissions Factor-based Aggregated CI Impact Determination for Sugarcane Molasses Feedstock
- Aggregated CI Calculations

Pathway summary and calculated CI (gCO$_2$e/MJ)

A summary of CIs for juice and molasses-derived ethanol, average yields and volumes of ethanol produced from each of the two feedstocks, and a composite CI is provided in this section. Although CIs are disaggregated between juice and molasses-derived ethanol streams, for certification, only a composite CI will be available for a given plant for all sugarcane-derived ethanol. Therefore, no user interface is required for this section.

Section 1: Enter applicant and mill-specific information

In this section, input applicant and mill-specific information. Details are provided in Table D.1.

Table D.1. List of input fields for Section 1 of the Simplified CI Calculator

Field Description	Value
1.1 Company Name	Registered name of the company. Example "ABC Company, LLC" or "ABC Company, Ltda."
1.2 Company or Facility ID	Input U.S. EPA Company and Facility ids. If not available, contact DEQ for LCFS Company and Facility ids.
1.3 Application Number	Enter the application number provided by the AFP.
1.4 Mill Location, including State/Country	Input mill address, including State and Country (e.g., Sao Paulo, Brazil)
1.5 Harvest Cycle(s)	Input period for which harvest data is valid (e.g., January 2015 to December 2017)
1.6 Provisional Application?	Select "Yes" if Provisional or "No" if not "Provisional." Then, click the "SELECT" button after filling out Field 1.6.
1.7 Credit for Export of Net Surplus Cogenerated Electricity	Select "Yes" if surplus cogenerated electricity is exported to the grid or "No" if no electricity is exported from the production facility. Then, click the "SELECT" button after filling out Field 1.6.
1.8 Electric Transmission and Distribution Loss	Standard value and fixed at 8.1% for Brazil. No input is required.
1.9 Regional Electric Mix (Feedstock/Fuel)	29-Brazilian Mix (Standard for Brazil). No input is required.
1.10 Choose Applicable Burn Area Evaluation for Cane Farms, then Click the "SELECT" button	Choose from the drop-down menu based on location, Standard for Sao Paulo State or Standard for the Non-Sao Paulo States. Additional details are provided below in Table D.1. Click the "SELECT" button after making a selection.
1.11 Reference Year for Burn Area Evaluation (Calculated)	Cell shows the harvest year upon which the Burn Area Evaluation was based. No input is required.
1.12 Applicable Mechanized Harvesting Credit (Calculated)	Field 1.12 will appear gray with standard mechanized harvesting credits if either of the standard options is selected in Field 1.10. No input is required.

Additional Details for Section 1

Fields 1.10 and 1.11

Mechanized harvesting is used to offset the impact of straw burning emissions proportionally. It is based on the percentage of mechanized harvesting on applicant-owned, leased, or partnership sugarcane farms. The applicant may select one of two options for mechanized harvesting for sugarcane sourced for their facility:

    a) The standard for Sao Paulo State, or
    b) The standard for the Non-Sao Paulo States

In the Field 1.10 drop-down menu selection, select "Standard for Sao Paulo State" if the ethanol plant/sugar mill sources all of its sugarcane from the State of Sao Paulo, for which a standard mechanized harvesting level of 80 percent is applied. Next, select "Standard for the Non-Sao Paulo States" if the ethanol plant/sugar mill sources all of its feedstock from the non-Sao Paulo States, for which a standard mechanized harvesting level of 65 percent is applied. Click the "SELECT" button to clear the previous value after making the selection. Selecting either of these options exempts verification of mechanized harvesting levels implemented at applicant-sourced sugarcane farms during initial validation and periodic verification reviews of this parameter.

Section 2: Enter fuel transport information

This section requires only input of fuel transport modes and distance. Many of the parameters in this section are derived from input data in Section 3. These are calculated parameters based on user-provided specific information in Section 3. Details are included in Table D.2 below.

Table D.2. List of input fields for section 2 of the Simplified CI Calculator

Field Description	Value
2.1 Anhydrous Ethanol Volume Transported by Truck (dry gal) (Calculated)	This field lists the ethanol volume transported by HDD Truck direct to Port. It is derived from Section 3, Field 3.18, Cell S59, and does not require user input here.
2.2 Anhydrous Ethanol Transport Distance (km) by Truck to Port	Transport distance of ethanol from the production facility to port by HDD truck.
2.3 Anhydrous Ethanol Ocean Transport Route to Oregon	Select an intended shipping route for ethanol transport by Ocean Tanker from a port in Brazil to Oregon. Three choices are offered in a pull-down menu: "Via Panama Canal," "Via Strait of Magellan," or "Via Cape Horn."
2.4 Anhydrous Ethanol Transport Distance by Ocean Tanker to Oregon (km)	Input transport distance to Oregon Port from Brazilian Port (km).
2.5 Ethanol Transport Distance by Truck from Oregon Port to Terminal (miles)	The standard distance of 40 miles and does not require user input.
2.6 Ethanol Transport Distance by Truck from Oregon	The standard distance of 50 miles and does not require user input.

Terminal to Refueling Station (miles)	

Section 3: Enter monthly feedstock, fuel, and co-product production data

Section 3 requires the applicant to enter inputs related to monthly feedstock inventory and transport, ethanol, sugar production, and electricity cogenerated or procured from the grid. The input data must span 24 months, including two sugarcane harvest cycles of at least nine months each. For provisional pathway applications, include a minimum of 3-months of data. An explanation of the fields in this section is described in Table D.3.

Table D.3. List of input fields for section 3 of the Simplified CI Calculator

Field Description	Value
3.1 Reporting Month (MM/YYYY)	Input the months and year(s) corresponding to the operational data provided.
3.2 Cane Sourced from Applicant-owned Farms (Propria Farms)	Input monthly total quantity of sugarcane sourced from applicant-owned (Propria) sugarcane farms (metric tonnes).
3.3 Transport Distance of Cane Sourced from Applicant-Owned Farms	Enter monthly weighted average sugarcane transport distance by HDD Truck to mill from applicant-owned farms (km).
3.4 Cane Purchased from Partnership Farms (Terceiros Farms)	Enter the monthly quantity of sugarcane sourced from partnership (Terceiros) sugarcane farms (metric tonnes).
3.5 Transport Distance of Cane Sourced from Partnership Farms (weighted average)	Enter monthly weighted average sugarcane transport distance by HDD Truck to mill from partnership farms (km)
3.6 Total Sugarcane Procured (Calculated)	Total sugarcane is sourced by the mill from applicant-owned and partnership farms (metric tonnes). This is a calculated value and does not require additional input.
3.7 Filter Cake Transport & Distribution Distance (Calculated)	This field includes filter cake transport distance to the fields and is a calculated standard value (cane transport plus two miles). No user input is necessary.
3.8 Amount of Externally Acquired or Purchased Bagasse[1]	Input monthly total quantity of additional sugarcane bagasse sourced from external sources for cogeneration (metric tonnes). Input is required if additional bagasse is sourced from external sources or intra-mill transfer.
3.9 Amount of Electricity Generated from Externally Acquired or Purchased Bagasse (Calculated)	This is a calculated parameter and is dependent upon the physical properties of steam exiting the generator (kWh). Therefore, input is not required for this field.

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[1] Includes externally acquired biomass (cane straw, wood chips, etc.) for use in the biomass boilers.

3.10 Amount of Externally Acquired or Purchased Molasses	Input monthly total quantity of sugarcane molasses sourced (or purchased) from external mills for ethanol production purposes (metric tonnes).
3.11 Amount of Ethanol Produced from Externally Acquired or Purchased Molasses	Input monthly total quantities of ethanol produced from externally purchased or acquired molasses (m^3). This volume shall be estimated based on the quality and quantity of every batch of external molasses acquired for ethanol production. See Additional Details for Section 3 below.
3.12 Amount of Purchased Electricity from the Grid	Input monthly total electricity purchased from the public grid (kWh).
3.13 Surplus Electricity Cogenerated and Exported	Input monthly total surplus cogenerated electricity exported from the mill (kWh).
3.14 Juice Allocated to Sugar Production (weighted average)	Input monthly weighted average share (%) of sugarcane juice allocated to finished sugar production. This number must be verifiable by enterprise production/data collection systems.
3.15 Fraction Sucrose Entering Sugar Production (monthly weighted average)	Input monthly weighted fraction of sucrose (fermentable or crystalline sugars) in the juice that enters the sugar production process (tonne per metric tonne cane). Values must be verifiable from batch laboratory samples and recorded in enterprise production systems (ATR or TRS). See additional details below in Table D.3.
3.16 Anhydrous Ethanol Production (Reported at 20 C / 68 F)	Input monthly total volume of anhydrous ethanol produced (m^3).
3.17 Moisture Content (Anhydrous Ethanol)	Input monthly weighted average moisture content (%) in anhydrous ethanol produced.
3.18 Adjusted Anhydrous Ethanol Production (Calculated)	Anhydrous ethanol produced less calculated ethanol from externally acquired molasses (m^3). Additional details are provided below in Table D.3.
3.19 Hydrous Ethanol Production (Reported at 20 C / 68 F)	Input monthly total volume of hydrous ethanol produced (m^3).
3.20 Moisture Content (Hydrous Ethanol)	Input monthly weighted average moisture content (%) in hydrous ethanol produced. Must specify the frequency of sampling for continuous production (batch, daily, or random).
3.21 Adjusted Hydrous Ethanol Production (Calculated)	Hydrous ethanol produced less calculated ethanol from externally acquired molasses (m^3). No user input is necessary. Additional details are provided below in Table D.3.
3.22 Amount of Finished/Table Sugar Produced	Input monthly total quantity of finished or table sugar produced (metric tonnes).
3.23 Total Ethanol Production (Reported at 20 C / 68 F) (Calculated)	The monthly total volume of anhydrous and hydrous ethanol produced (m^3). This is a calculated value and does not require user input.

Additional details for section 3

Field 3.11

The volume of ethanol produced from externally purchased or sourced molasses ("external molasses") shall be determined for every batch of external molasses used in ethanol production. This volume can be estimated from the quality and quantity of every batch of externally acquired molasses.[2] The amount of fermentable sugars in the external molasses per metric tonne of standard molasses must be determined (batch-specific value). The overall sugars-to-ethanol conversion efficiency must also be known. Commonly called "eta_e or ηe," the sugar-to-ethanol conversion factor is empirically determined in the Simplified CI Calculator and is mill or site-specific. This empirically determined value is depicted in Cell O75 of the Calculator! Tab, and is a site-specific value. The volume of ethanol derived from external molasses is then calculated as follows:

Sample calculation for determining the volume of ethanol produced from external molasses:

Quality of external molasses acquired = metric tonnes of fermentable sugars in external molasses / metric tonne of standard molasses

Quality of External Molasses Acquired:	=	0.50 (1)
Metric tonnes of external molasses acquired:	=	995.40 tonnes (2)
Therefore, amount of fermentable sugars:	=	0.50 x 995.4 (1 x 2)
Amount of fermentable sugars:	=	497.70 metric tonnes (3)
Sugar-to-ethanol conversion factor:	=	0.42 (Eta _e or ηe) (4)
Dry tonne of ethanol produced:	=	207.04 metric tonnes (3 x 4)
Dry tonne of ethanol produced:	=	207,043.20 kg ethanol
Dry Volume of ethanol produced:	=	69,291.57 gal ethanol (2,988 g/gal)
Dry Volume of ethanol produced:	=	**262.31 m³ ethanol**

Field 3.15

The amount of sucrose (a proxy for crystalline and fermentable sugars in sugarcane juice) in the sugar production process is not the same as the amount of sucrose in the juice measured after the sugarcane crush (ART). This is because some process losses associated with pre-treatment and dilution of the juice may occur before the juice enters the sugar production process. These losses have been estimated to be approximately one percent of the total amount of sucrose. Therefore, if the sucrose measured at the crush is 0.15 or 15 percent, the mill can expect the amount of sucrose at sugar production to be approximately 0.14 or 14 percent in enterprise

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[2] Records shall be made available to the Third-party Verifier upon request.

production systems such as ATR or TRS (or total reduced sugars after losses). The Calculator refers to the monthly weighted average value as the "eta_j" parameter.

Field 3.18 and 3.21

If ethanol is produced from externally-sourced molasses, the quantity produced is split equally between adjusted ethanol production calculated in fields 3.18 and 3.21. The adjustment subtracts half of the ethanol produced from externally-sourced molasses from the anhydrous ethanol produced and the other half from hydrous ethanol produced.

Section 4: Calculation of production yields and mass allocation ratio

Section 4 in the Calculator worksheet uses the fuel ethanol production yields from juice and molasses and calculates the mass allocation ratio (used to attribute upstream GHG impacts from sugarcane farming and transport to molasses-derived ethanol). To calculate yields, mill-specific parameters need to be input. These parameters are called the Gopal-Kammen Model Parameters and are illustrated and discussed in Table D.4 below. Once these parameters are input, the CI Calculator uses an iterative process to calculate ethanol yields from each feedstock using total production quantities of ethanol and finished sugar and the mass allocation ratio. Details of the inputs required are described in Table D.4. Other calculated parameters and outputs are discussed in Table D.5.

The Simplified CI Calculator requires that the "Solver" Add-in functionality be installed into the version of Microsoft Excel run by the applicant. Instructions to install the Add-in function are provided below.

Instructions to install "solver" add-in functionality

1. Click or go to "File" in the Header Menu
2. Click or select "Options" on the far Left Side Menu
3. A new window, "Excel Options," opens up. Select "Add-ins" on the Left Side Menu.
4. In the Dialogue Box, select "Solver Add-in" either in the "Active Application" or "Inactive Application Add-ins." Click OK.
5. If you don't see the "Solver Add-in," do the following:
6. At the bottom of the Dialogue Box, Select or Manage "Excel Add-Ins" from the Drop-down Menu. Then Select "Go."
7. An "Add-Ins" Window will Open. In the Window, Select or Check the Box for "Solver Add-in" and the Box for "Analysis ToolPak." Then Click OK.
8. Go to the Excel Header Menu and select "Data." The "Solver" function is located far right in the "Analyze" box.

Table D.4. Description of calculator worksheet inputs for section 4

G-K Model Parameter	Description
4.1 ŋj (tonnes of fermentable sugars in juice/tonne of cane) (Calculated)	eta_j is a monthly weighted average parameter assigned to the fraction of sucrose in the juice that enters the finished sugar or ethanol production process. Due to some process losses associated with pre-treatment and pH adjustment, eta_j is not the same as the amount of sucrose measured after the cane crush or at the gate. No user input is necessary.

4.2 ηs (tonnes of sucrose in final sugar/tonne of sucrose into the sugar factory) (Calculated)	eta_s, this is the fraction of sucrose that enters sugar production and is converted into finished sugar. It is a calculated parameter, and no user input is necessary.
4.3 Sucrose in molasses (tonnes sucrose in molasses/tonne of sugarcane) (Calculated)	This is the ratio of the amount of sucrose in molasses per tonne of sugarcane available for conversion (fermentation) to ethanol. It is a calculated parameter, and no user input is necessary.
4.4 ηe (dry tonnes of EtOH/tonne of fermentable sugars into distillery) (Calculated)	eta_e represents the conversion efficiency of a sugar molecule into ethanol. Assuming "sucrose" is a simple C6 sugar, the theoretical conversion efficiency of sugar is 0.51. In reality, this efficiency is in the range of 0.43-0.48. It is a calculated parameter, and no user input is necessary.
4.5 LHV of anhydrous Ethanol (MMBtu/dry ton EtOH)	LHV of ethanol (MMBtu/dry ton). This is a standard value, and no user input is necessary.
4.6 Choose ms (tonnes of sucrose in final sugar/tonne of final sugar product)	ms represents the purity of the finished sugar product. The input value for facility weighted average over 24 months of production. The user may choose the "User Defined" option in Cell E77, input a Site Specific value in Cell F77, or use the standard value in Cell E77. After choosing either option (and entering a user-defined value if the User-Defined option was selected), click F9 to update the sheet. The User-Defined input must be described in the Supplementary Documentation attached with the Simplified CI Calculator.
4.7 Choose mm (tonnes of fermentable sugars in standard molasses/tonne of standard molasses)	mm represents the amount of fermentable sugars in standard molasses per tonne of standard molasses. The input value for facility weighted average over 24 months of production. The user may choose the "User Defined" option in Cell E78 and input a site Specific value in Cell F78 or the standard value in Cell E78. After choosing either option (and entering a user-defined value if the User-Defined option was selected), click F9 to update the sheet. The User-Defined input must be described in the Supplementary Documentation attached with the Simplified CI Calculator.
4.8 Modeled ethanol production (dry gal) (Calculated)	This is a calculated value and is used as a check between reported and modeled values. It is based upon the yield of ethanol determined in the G-K table (Cells F85 and G85). Additional details are provided below in Table D.4. No user input is necessary.
4.9 Adjusted reported ethanol production number (dry gal) (Calculated)	This is a calculated value and is used to compare modeled ethanol production quantities with input data provided by the applicant. Additional details are provided below in Table D.4. No user input is necessary.
4.10 Differences between modeled and adjusted reported ethanol production numbers (dry gal) (Calculated)	This is a calculated value based upon the difference between the modeled and adjusted reported ethanol production numbers. The objective is for this value to be zero. This cell will report an imbalance when a "Solver" solution cannot be found. Additional details are provided below in Table D.4. No user input is necessary.

4.11 Modeled finished sugar production (metric tonnes) (Calculated)	This cell is a calculated value based upon the yield of finished sugar predicted in the G-K parameters table (Cell F81).
4.12 Reported finished sugar production (metric tonnes) (Calculated)	This cell is a calculated value based upon the monthly weighted average finished sugar production numbers reported by the applicant.
4.13 Differences between modeled and reported finished sugar production (metric tonnes) (Calculated)	This is a calculated value based on the differences between the modeled and reported production values of finished sugar production. The objective is set for this value to be near zero. This cell will report an imbalance when a "Solver" solution cannot be found. No user input is necessary.
4.14 Mass Allocation Ratio (Calculated)	The ratio used to apportion upstream GHG emissions associated with sugarcane production, harvest, transport, filter cake transport, and sugar production to molasses-based ethanol. This is a calculated value, and no user input is necessary.

Once the G-K parameters are input in Section 4, the sugarcane juice-to-sugar share (Field 3.14) and the reported 24-month finished sugar and ethanol production data are utilized to compare modeled production quantities of finished sugar and ethanol and to calculate fuel yields and the mass allocation ratio, as detailed below:

1. Select "Data" from the spreadsheet header menu above. Then Click the "Solver" icon menu above to the far right of the Header. A "Solver Parameters" window opens up. Ensure that the "Set Objective" refers to **cell E88** and is set to a value of 0.0.

2. The variable cells "eta_s" and "eta_e" must be specified (separated by a comma) in the next sub-window entitled "By Changing Variable Cells." Do not change any of the constraints defined in the "Subject to the Constraints" window (0.38 > eta_e < 0.48, and eta_s < = 0.99). Cell F90 must include inputs with a constraint less than or equal to 1.0.

3. Check the box "Make Unconstrained Variables Non-Negative." Next, choose "GRG Nonlinear" for the Solving Method. Then click the "Solve" button at the bottom.

4. The Solver will go through several iterations to find a solution. Finally, a new "Solver Results" window will open up. The solver will display the message that a solution has been found and all constraints and optimality conditions have been satisfied. Choose to keep the Solver Solution.

5. Click OK. The mass allocation ratio has been calculated to determine upstream impacts.

6. If a solution has not been found, then check the data in Section 3 and Section 4 for accuracy until a solution has been found and all constraints and optimality conditions have been satisfied. Use the imbalance between modeled and reported production quantities of ethanol and finished sugar to refine the parameters.

7. If a solution has not been found, check the juice shares in Field 3.14 (fraction of juice allocated to sugar production) and the amount of sucrose in Field 3.15 that enters sugar production (fraction of sucrose in the cane juice that enters sugar production). The level of sucrose (eta_j), input 4.1, could be lower due to process losses even if measured higher at the gate or after the cane crush. Process losses must be empirically determined. The juice shares allocate the juice between finished sugar and ethanol production. Therefore if the output cannot be matched, the juice shares may be checked to boost the production of finished sugar or ethanol.

Additional details for Table D.4 calculated parameters

Field 4.10 "Difference between reported and modeled" should be a calculated value of zero (0.0). If a non-zero number exists in this cell, the Solver alerts the applicant to a constraint in output that cannot be increased or decreased due to the G-K parameters and production data entered. For example, Cell E88 may indicate that a difference of 100,000 gallons of ethanol exists between the reported production quantities and the modeled quantity from each feedstock.

Field 4.11, "Modeled finished sugar production (metric tonnes)," shows the modeled quantity of finished sugar based on the G-K parameters and the data entered in Section 3. If this quantity does not match the reported finished sugar production number (Section 3, Field 3.22), then it indicates that some of the parameters could be incorrect, leading to an imbalance in the modeled quantities obtained from the material balance.

Field 4.14. "Mass Allocation Ratio" apportions upstream GHG emissions associated with sugarcane production, harvest, transport, filter cake transport, and sugar production to the molasses-based ethanol pathway. A well-to-tank CI for each feedstock is calculated, but the composite CI is the CI that will be used for reporting fuel volumes and periodic verification. This CI is depicted in the value for the field "Composite CI, gCO_2e/MJ" shown in the block "Pathway Summary and Calculated CI" at the top of the Calculator worksheet. The Composite CI can also be calculated or updated by clicking on the "Calculate CI" button (green) in Section 4 of the Calculator worksheet. Clicking or selecting this button has the same effect as launching the Data Solver function in the worksheet.

General Note- The applicant should note that if information in the Section 3 table is changed (for example, if the monthly sugarcane throughput or the measured sucrose level entering the sugar production process was to be lowered) after a "Solver" solution has been found, it will likely result in an imbalance in ethanol volume produced being reported in **Cell E88** of the Calculator worksheet. In this case, the applicant must repeat the steps in Section 4 and find a new solution utilizing the "Solver" function. If any other non-production information is changed that warrants a new calculation of the CI value (for example, if the transport distance parameters were to be changed), then the CI value will be updated automatically or may be updated by pressing the F9 function key.

The next block in the Calculator worksheet (Section 5) presents a summary of fuel yields from each feedstock, as well as a summary of modeled finished sugar, ethanol production from each quantity of feedstock, and surplus cogenerated electricity exported to the public grid (Table D.6) for the 24-month or 3+ month (provisional pathway) periods. While the parameters in this block are calculated, the applicant should verify the model's accuracy with actual production data (see Section 3).

Section 5: Verify fuel and co-product production information

Section 5 does not require any user input but presents the intermediate results of the Simplified CI calculator if the monthly production data has been entered correctly and the model has been executed without error. A discussion of each calculated parameter is provided in Table D.5.

Table D.5. List of calculated fields for Section 5 of the Calculator worksheet

Field Description	Value
5.1 Amount of Ethanol Produced from Sugarcane Juice (Calculated)	Ethanol is produced from sugarcane juice feedstock (dry gal). No user input is necessary.
5.2 Sugarcane Juice-to-Ethanol Yield (Calculated)	The ethanol yield from sugarcane processed at the mill (dry gal per wet metric tonne) from cane juice feedstock. No user input is necessary.
5.3 Amount of Ethanol Produced from Molasses (Calculated)	Ethanol is produced from sugarcane molasses feedstock (dry gal). No user input is necessary.
5.4 Molasses-to-Ethanol Yield (Calculated)	The ethanol yield from sugarcane processed at the mill (dry gal per wet metric tonne) from molasses feedstock. No user input is necessary.
5.5 Total Ethanol Volume Produced (Calculated)	Total ethanol produced from cane juice and molasses (dry gal). No user input is necessary.
5.6 Total Amount of Finished Sugar Produced (Calculated)	Calculated quantity of finished sugar produced at the mill; it should match the total production input based on 24-month data (metric tonnes). No user input is necessary.
5.7 Net Surplus Cogenerated Electricity Exported (Calculated)	Net (of purchases) amount of surplus cogenerated electricity exported, in kWh. No user input is necessary.
5.8 Net Electricity Credited to Pathway (Calculated)	Net surplus cogenerated electricity credited to the pathway (kWh) after allocation between co-products. No user input is necessary.
5.9 Electricity Co-Product Credit (Molasses Feedstock) (Calculated)	Net amount of surplus cogenerated electricity credited to the pathway (kWh) per gallon of ethanol produced from Molasses feedstock. No user input is necessary.
5.10 Electricity Co-Product Credit (Cane Juice Feedstock) (Calculated)	Net amount of surplus cogenerated electricity credited to the pathway (kWh) per gal ethanol produced from Sugarcane juice feedstock. No user input is necessary.
5.11 Composite Electricity Co-Product Credit (kWh/gal) (Calculated)	Total electricity co-product credit calculated based on a weighted average of electricity generated from molasses and juice-based production processes. No user input is necessary.

A final composite fuel pathway CI is determined based upon the 24-month production parameters entered in Section 3 of the Calculator worksheet (see "Pathway Summary and Calculated CI (gCO$_2$e/MJ)" block at the top of the worksheet).

Emissions Factor (EF)-based Aggregated CI Impact Determination for Sugarcane Juice Feedstock

For each aggregated impact associated with the well-to-wheels assessment, emissions factors have been developed that determine the GHG impacts per metric tonne of feedstock or gallon of finished ethanol produced (macroscopic factors). The GHG impacts are then divided by the energy value of the finished fuel produced to give the CI impact of the aggregated component of each feedstock-based pathway. These factors were developed for each feedstock, and in this section the CI for the pathway based on sugarcane juice feedstock is determined. The CI of the sugarcane juice-based feedstock is combined with the CI of sugarcane molasses-based

feedstock (see below) to determine a composite CI for all ethanol produced and reported in the section entitled "Pathway Summary and Calculated CI (gCO₂e/MJ)."

Emissions factor (EF)-based aggregated CI impact determination for sugarcane molasses feedstock

For each aggregated impact associated with the well-to-wheels assessment, emissions factors have been developed that determine the GHG impacts per metric tonne of feedstock or per gallon of finished ethanol produced (macroscopic factors). The GHG impacts are then divided by the energy value of the finished fuel produced to give the CI impact of the aggregated component of each feedstock-based pathway. These factors were developed for each feedstock, and in this section the CI for the pathway based on sugarcane molasses feedstock is determined. The CI of the sugarcane molasses-based feedstock is combined with the CI of sugarcane juice-based feedstock (see above) to determine a composite CI for all ethanol produced and reported in the section entitled "Pathway Summary and Calculated CI (gCO₂e/MJ)."

Aggregated CI calculations (for each feedstock)

This section contains a detailed breakdown of the calculations used for the CI determination based on user inputs and applicable reference data in this calculator. Calculations are based upon emissions factors directly adopted from the draft OR-GREET3.0 model proposed for adoption. The CI Calculations provide an aggregation of each GHG impact that results from the application of agricultural inputs, crop harvesting, transport to fuel production facility, fuel production, transportation and distribution of the fuel, and assessments of co-product credits. The CI Calculations further provide an overview of the contribution to the composite CI, by feedstock.

Footnotes

Footnotes are included below the CI Calculations for user reference.

Biodiesel and renewable diesel

A. Introduction

This document provides detailed instructions for using the Simplified CI Calculator for Tier 1 Biodiesel (BD) and Renewable Diesel (RD) pathway applications. This Calculator will be used to determine the carbon intensity (CI) for either BD or RD produced from multiple feedstocks, including soy oil, canola oil, corn oil, used cooking oil (UCO), and tallow/animal fat. Each required specific input in the Calculator has been numerically labeled (i.e., 1.1, 1.2, etc.) so that users can follow the sequence and enter information as required.

Download the Simplified CI Calculator here:
https://www.oregon.gov/deq/ghgp/cfp/Pages/Clean-Fuel-Pathways.aspx

The Calculator has been automated to perform CI calculations using factors from the OR-GREET3.0 model. The Calculator replaces the existing Tier 1 Calculator and the operational data template in pathway application packages. Applicants must add facility information and verifiable monthly feedstock, operational energy use, fuel production, co-product data, and transport distances used to calculate the CI of BD and RD.

This Calculator includes reference material such as greenhouse gas emissions factors used in OR-GREET3.0 and reference fuel specifications. Also included with the Calculator is a detailed breakdown of the calculations used to determine the final CI of each fuel pathway.

The applicant may only enter values or make selections in input fields designated by DEQ for user input/selection and may not change any other values or fields in the Calculator.

B. Color legend used in the calculator

The Calculator uses the following color legend to differentiate required inputs, calculated values, etc., as described below:

Yellow Cells require user input
Light Blue Cells show CI results
Green Cells show the calculation button
Gray Cells are Calculated Values

C. Calculator overview

The following table provides an overview of the tabs used in the Simplified CI Calculator.

Table C.1. Overview of tabs used in the Simplified CI Calculator

Tab Name	Description
BD RD Summary	Summary worksheet. Contains an overall summary of the information entered in the "Soy Oil," "Canola," "Corn Oil," "UCO," and "Tallow" tabs for feedstock production, and the "BD-Production" and "RD-Production" tabs for finished fuel production. This tab also includes calculated CIs and fuel volumes for the various streams. The tab consists of a toggle for the user to select either biodiesel or renewable diesel. If desired, a **conservative margin of safety** may be added to the calculated CIs in this tab to establish final CIs.
Soy Oil, Canola Oil, Tallow, Corn Oil, UCO	These sheets contain fields requiring user inputs for feedstocks (used in biofuel production), calculated values dependent on user inputs to yellow cells in the corresponding sections of the calculator, and other information from OR-GREET3.0. These tabs also include CI calculation details for each corresponding feedstock in the respective tab. Only a single tab each is provided for Soy Oil and Canola Oil used as feedstocks. For UCO and Tallow, three separate tabs for each feedstock are provided in the Calculator. These are labeled UCO1, UCO2, and UCO2 for the three UCO tabs and Tallow1, Tallow2, and Tallow3 for the three Tallow tabs.
BD-Production, RD-Production	These sheets include user inputs for BD or RD production processes, respectively. These include fields requiring user inputs and those calculated by the sheet. Calculations in grayed out cells are automatically calculated but dependent on input to yellow cells in the feedstock and fuel production tabs of the Calculator. Additional information in these tabs is from OR-GREET3.0 required in calculating pathway CIs for BD or RD. These tabs also include CI calculation details.
EF Table	Contains greenhouse gas emissions factors from the OR-GREET3.0 model used in calculation of carbon intensities.
References	This sheet details standard inputs in the Calculator for both soybean and canola farming for BD and RD. These inputs are not subject to change by the applicant. The sheet also contains loss factors related to biodiesel and renewable diesel production.
Fuel_Specs	Contains specifications of fuels, global warming potentials of greenhouse gases, carbon and sulfur ratios of pollutants, unit conversions, and other information used in calculation of CIs for BD or RD.

D. Calculator details– Feedstock tabs: Soy Oil, Canola, Tallow, UCO, and Corn Oil

The feedstock tabs contain the input worksheets for all the feedstocks listed above. This section provides details for the Soy Oil tab only. The other feedstock tabs are similar. The Soy Oil tab consists of the following major components (generally applies to **ALL** feedstock categories above with minor differences for the UCO and Tallow tabs):

- Section 1. Applicant Information for Soy Oil Production
- Section 2. Information for Soy Oil Production
- Section 3. Feedstock Inputs

Section 1: Applicant information for soy oil production

Begin by selecting the appropriate feedstock tab and entering the company and facility information, including the location of the feedstock processing facility. Details for entering data in all required fields are provided below.

Table D.1. List of input fields for Section 1 of the Simplified CI Calculator

Field Name	Description
1.1. Company Name	Registered name of the company. Example "ABC Company, LLC" or "ABC Company, Inc."
1.2. Company ID	Enter U.S. EPA Company ID. If not available, contact DEQ for LCFS Company ID.
1.3. Facility ID	Enter the Company's Facility ID. If not available, contact DEQ for LCFS Facility ID.
1.4. Soy Oil Production Location	Enter City, State, and Country from where Soy Oil is sourced.

Section 2: Information for soy oil production

Table D.2 lists the details of fields in Section 2 of the Soy Oil tab.

Table D.2. List of input fields for section 2 of the Simplified CI Calculator.

Field Name	Description
2.1. Select Source of Feedstock	Field 2.1 (for soybean production) includes two choices in a pulldown menu: U.S. or User-Defined. If U.S. sourced soybean is selected, standard inputs are applied, and no additional inputs are required for soybean farming. If User-Defined is selected, click "Calculate" and Fields 2.2 and 2.3 appear.
2.2. Specify the source of Soybean	If user-defined is selected in field 2.1, input source of Soybeans in field 2.2 (i.e., country).
2.3. User Defined GHG Emission Factor of Electricity Mix for Farming, gCO2e/kWh:	If user-defined is selected in field 2.1, input the GHG emission factor of the user-defined electricity mix where farming practice occurs. This value is used to develop the EF of Farming (or oil extraction/rendering) in the next section 2.4

2. 4. User Defined GHG Emission Factor of Soybean Farming, gCO2e/ton	If user-defined is selected in field 2.1, consult DEQ staff about developing emission factors for soybean farming in gCOe2/ton for the specific region and input in Field 2.4. Click on "Calculate" to update the sheet. Data sources for the User-Defined emission factors must be documented in the Supplemental Documentation attached with the Simplified CI Calculator. **Note: Since farming is not applicable for UCO and Tallow, this option is unavailable on the tabs for these feedstocks**.
2.5.Select Oil Extraction	Field 2.5 allows for selecting either a standard or a User-Defined oil extraction for Soy Oil. If a standard is selected (applies for U. S. Facilities only), no additional input is required for oil extraction. Click on "Calculate" after either selection. For facilities electing to use User-Defined, consult with DEQ staff to develop an emission factor for oil extraction and input the emission factor in field 2.6. **Note: UCO and Tallow tabs have an option for Standard or User-Defined rendering energy in place of oil extraction energy.** Standard applies only to rendering facilities in the U. S. All facilities outside the U. S. must choose the User-Defined option. Facilities in the U. S. which can demonstrate site-specific rendering energy may elect to use the User-Defined option.
2 6. Enter Oil Extraction GHG Emission Factor, gCO$_2$e/lb. oil	This field is available for input only if User-Defined is selected in field 2.5. If User-Defined is selected in field 2.5, consult DEQ staff about developing emission factors for oil extraction in gCOe2/lb oil for the specific region and input in field 2.6. Data sources for the User-Defined emission factors must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
2.7. Enter Oil Extraction Oil Extraction Energy, Btu/lb. oil	This field is available for input only if User-Defined is selected in field 2.4. If User-Defined is selected in field 2.4, consult DEQ staff about developing an oil extraction energy factor in Btu/lb oil for the specific region and input in field 2.7. Data sources for the User-Defined oil extraction energy must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
2.8. Select Ocean Tanker Size for Feedstock (Oil) Transport in Deadweight Ton (DWT)	This field is for applicants to select Standard Values for Ocean Tanker size at 22,500 DWT or User-Defined to define the size and then click the Calculate button. If User-Defined is selected, enter the Ocean Tanker size in DWT.
2.9. Ocean Tanker Size GHG EF, gCO$_2$e/ton-mile	This field is available for input only if User-Defined is selected in field 2.8. If User-Defined is selected in field 2.8, consult DEQ staff about developing an Ocean Tanker oil transport emission factor in gCO$_2$e/ton-mile and input in field 2.9. Data sources for the User-Defined emission factor must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.

Section 3: Feedstock inputs

Table D.3 lists the fields used in Section 3 of the Soy Oil tab in the Calculator.

Table D.3. List of input fields for Section 3 in the Soy Oil Tab of the Simplified CI Calculator

Field Name	Description

3.1. Monthly Data	Input the months and year(s) corresponding to the operational data provided.
3.2. Beginning Feedstock Inventory	Input monthly beginning feedstock inventory data (in lbs.) in field 3.2. Additional feedstock production details are provided below in Table D.3.
3.3. Oil Received	Input monthly total feedstock purchased (in lbs.) in this field for all 24 months of operation.
3.4. Oil Used (Calculated)	The monthly feedstock used (in lbs.) is calculated automatically in field 3.4. No inputs are required for this Field.
3.5. Ending Feedstock Inventory	Input monthly total feedstock ending inventory (in lbs.) in this field for all 24 months of operation.
3.6. Moisture Content	Input monthly weighted average moisture content (in percentage) for feedstock in this field for all 24 months of operation. Utilize an industry standard moisture measurement protocol to report weighted average moisture.
3.7. Weighted average of oil transported by HDD Truck Note: For UCO tab, Field 3.7 reads as: 3.7. Weighted average of raw UCO or rendered oil transported by HDD Truck	Input monthly total feedstock transported by HDD truck (in lbs.) and monthly weighted average transport distance (in miles) by this mode in field 3.7. In the case of UCO, if rendered oil is sourced from a renderer, upstream transport distance to the renderer is not required to be input. If raw UCO is sourced directly from restaurants, only monthly weighted average transport distance from the restaurants to the rendering facility must be input. Additional feedstock transport details are provided below in Table D.3.
3.8. Weighted average of oil transported by Ocean Tanker	Input monthly total feedstock transported by Ocean Tanker (in lbs.) and monthly weighted average transport distance (in miles) by this mode in field 3.8.
3.9. Weighted average of oil transported by Rail	Input monthly total feedstock transported by rail (in lbs.) and monthly weighted average transport distance (in miles) by this mode in field 3.9.
3.10. Weighted average of oil transported by Barge	Input monthly total feedstock transported by barge (in lbs.) and monthly weighted average transport distance (in miles) by this mode in field 3.10.

Additional details for Feedstock-Specific Tab, section 3

Feedstock inputs (Fields 3.2-3.6)

For feedstock inputs, enter data for site-specific inputs for feedstock inventory to enable calculation of the quantity of feedstock used in biofuel production. Cells grayed out are calculated values and do not require applicant input. The first input field is the monthly beginning feedstock inventory (in lbs.). Input monthly totals for feedstock received (as purchased) in lbs. and total monthly ending feedstock inventory in lbs. The total monthly quantities must be inclusive of moisture and not reported on a dry basis. The inventory data are used to determine the total feedstock used for biofuel production.

Feedstock transport (Fields 3.7-3.10)

Given the likelihood that a batch of feedstock transport may entail more than one mode of transportation, staff suggests a calculation methodology detailed below. The example detailed is for Soy Oil transported to a biomass-based diesel production facility. However, the same suggested approach could be used for all feedstocks used by a production facility.

The example lists five different batches of Soy Oil delivered to a biomass-based diesel facility. The Table provides details of individual transport modes for each batch received at the facility. The suggested calculation methodology includes direct transport by a single mode of transportation, which provides for more than one mode of transport to ship feedstock from the source to the biomass-based diesel production facility.

Actual soy (lbs.) transported by the corresponding mode of transport and miles transported						
	Modes of Transport					
	Truck	Miles	Rail	Miles	Barge	Miles
1	100,000	50	100,000	1,200		
2	200,000	150				
3			200,000	800		
4			100,000	200	100,000	250
5			50,000	1,000		
6						
7						
8						
	Weighted average distance and corresponding quantities to be used for monthly reporting of feedstock					
	300,000	117	450,000	778	100,000	250
Example in the sheet above:						
Entry 1	For the month, the facility received 100,000 lbs by a mode which included 50 miles by truck and 1,200 miles by rail.					
Entry 2	For the month, the facility also received 200,000 lbs by truck only with a transport distance of 150 miles.					
Entry 3	For the month, the facility also received 200,000 lbs by rail only with a transport distance of 800 miles.					
Entry 4	For the month, the facility also received 100,000 lbs which included 200 miles by rail and 250 miles by barge.					
Entry 5	For the month, the facility also received 50,000 lbs using only rail transport for a distance of 1,000 miles.					
For these scenarios, the facility shall report 300,000 bushels with a weighted average distance of 117 miles by HDD truck and 450,000 bushels with a weighted average distance of 778 miles by rail.						

For these scenarios, the facility shall report 300,000 lbs. of soy oil with a weighted average distance of 117 miles by HDD truck, 450,000 lbs. of soy oil with a weighted average distance of 778 miles by rail, and 100,000 lbs. of soy oil with a weighted average distance of 250 miles by barge.

For feedstock transport, applicants must calculate the appropriate mileage for each mode of transportation as described below. For rail transport, mileage must be based on the rail network maps from BNSF Railway[1] or Union Pacific.[2] For facilities not directly located on the BNSF or Union Pacific rail network, applicants may use a publicly available web-based driving distance estimator for the distance between the facility and the applicable rail depot. Truck transport distance between two points may be determined using a publicly available web-based driving distance estimator. Barge transport distance must be calculated using a reputable online mapping system, reported in miles.[3] Nautical miles calculated by the online mapping system must be converted to miles using the conversion factor of 1 nautical mile/1.152 miles.[4]

E. Calculator details – BD-Production Tab

The "BD-Production" tab contains the CI calculation worksheet for biodiesel production consisting of the following major components:

- Section 1. Application Information, Pathway Summary, and Estimated CI
- Section 2. Information for Biodiesel Production (FAME)
- CI Calculation Details

All CI values are calculated based on relevant site-specific inputs entered into the respective input fields. After all site-specific inputs for a given facility have been entered, the calculated CIs will represent the pathway CIs for the various streams as detailed in this tab and the "BD RD Summary" tab. Details for entering data in all required fields are included below.

Section 1: Application information, pathway summary, and estimated CI

Table E.1 includes fields requiring inputs related to the applicant and facility location. This section also summarizes pathway CIs corresponding to inputs in the feedstock and BD-Production tab. All CI values are calculated based on relevant site-specific inputs that must be entered in the respective input fields. Only after all site-specific inputs for a given facility have been entered will the calculated CIs represent the pathway CIs for the various streams as detailed in this tab.

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[1] BNSF railway system: http://www.bnsf.com/customers/where-can-i-ship/

[2] Union Pacific system: https://www.up.com/aboutup/usguide/index.htm

[3] Example of an online nautical distance mapping system: https://www.marinetraffic.com/en/voyage-planner

[4] Nautical miles to miles conversion factor source: http://www.metric-conversions.org/length/uk-nautical-miles-to-miles.htm

Table E.1. List of input fields for Section 1 of the BD-Production tab

Field Name	Description
1.1. Applicant	Registered name of the company. Example "ABC Company, LLC" or "ABC Company, Inc."
1.2. Facility Location	Enter City, State, and Country of BD production facility.
1.3. Pathway Summary	Field to include a summary of the BD pathways such as "soy oil and tallow to BD".
1.4. Provisional Application?	If available data is less than 24 months, select "Yes", else "No", and click "Calculate". If "Provisional", input available months of operational data starting in Month 1 of the Calculator (minimum three months of operational data required to meet provisional requirements).
1.5. Application Number	Enter the application number provided by the AFP.
1.6. Facility Number	Enter the Facility ID.
1.7. Application Date	Enter Application Date in the format MM/DD/YYY

This section of the calculator contains the calculated CI results for BD pathways. The final results are displayed here after the data are entered and the user clicks the "Calculate" button.

Section 2: Information for Biodiesel Production (FAME)[5]

The following table lists the fields used in Section 2 of the BD-Production tab.

Table E.2. List of input fields for Section 2 of the BD-Production tab

Field Name	Description
2.1. Regional Electricity Mix for Fuel	Choose the electricity mix corresponding to the zip code for the region where the BD production facility is located. The Calculator includes 26 eGRID zone mixes, U.S average Mix, Brazilian average mix, Canadian average mix and User Defined Mix included in the pull down menu. For facilities in the U. S., select one of 26 eGRID zones available for the U. S. These are selected based on zip code of the fuel production facility. After a selection, click the "Calculate" button. Additional electricity mix details are provided below Table E.2.
2.2 Enter GHG EF of Electricity Mix, gCO₂e/kWh	This field is highlighted only if "User-Defined Mix" is selected in field 2.1. This field requires input of emission factor for electricity mix corresponding to the location of the BD production facility. Consult with DEQ staff to develop a user-defined emission factor for electricity mix. Data sources for User-Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
2.3. Regional Crude Mix	Choose the source of crude mix from the pulldown menu based on location of BD production facility. After a selection, click the "Calculate" button. If selection is "U. S. Average Crude", no additional input is required. If selection is "User Defined Crude", consult with DEQ staff to develop emission factor for crude and input in Field 2.4.

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[5] FAME: Fatty Acid Methyl Esters (FAME) through a transesterfication process by mixing fats and oils with an alcohol and a catalyst to create a reaction that produces biodiesel and other co-products.

2.4. Enter GHG EF of Crude Sources, gCO₂e/MMBtu of Crude	This field is highlighted only if "User-Defined Crude" is selected in field 2.3. This field requires input of emission factor for crude corresponding to the location of the BD production facility. Consult with DEQ staff to develop a user-defined emission factor for crude. Data sources for user-defined crude mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
2.5. Regional Natural Gas (NG) Source	Choose the source of NG from the pulldown menu based on location of BD production facility. If selection is "U. S. Average NG", no additional input is required. If selection is "User-Defined NG", consult with DEQ staff to develop emission factor for NG and input in Field 2.6. After a selection, click the "Calculate" button.
2.6. Enter GHG EF of NG Sources, gCO2e/MMBtu of NG	This field is highlighted only if "User-Defined NG" is selected in field 2.5. This field requires input of emission factor corresponding to the location of the BD production facility. Consult with DEQ staff to develop a site-specific emission factor for natural gas. Data sources for User-Defined NG mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
2.7. Monthly Data	Input the months and year(s) corresponding to the operational data provided.
2.8. Beginning Biodiesel Inventory (Gallons @ 60°F)	Input monthly beginning inventory data for BD (gallons at 60°F) for all 24 months of operation.
2.9. Biodiesel Produced (Calculated) (Gallons @ 60°F)	Monthly fuel produced data (gallons at 60°F) in this field will be automatically calculated. No inputs are required for this field since these are calculated from inputs in fields 2.8 through 2.11.
2.10. Ending Biodiesel Inventory (Gallons @ 60°F)	Input monthly total ending inventory for BD (gallons at 60°F) in this field for all 24 months of operation.
2.11. Biodiesel Sales (Gallons @ 60°F)	Input monthly total sales data of BD (gallons at 60°F) in this field for all 24 months of operation.
2.12. NG Use from Utility Invoices (MMBtu in HHV)	Input monthly total NG consumption data (MMBtu, HHV) in this field for all 24 months of operation.
2.13. Electricity Use from Utility Invoices (kWh)	Input monthly total electricity use (in kWh) in this field for all 24 months of operation.
2.14. Alternate Fuel Use	If another fuel source is used for fuel production, input monthly total use (lbs.) in field 2.14 for all 24 months of operation. This field may be used to adjust a quantity of energy input (such as natural gas) that is entered corresponding to invoices if part of that input energy is exported from the fuel production facility (e.g., as steam exported to a collocated facility); the quantity of fuel exported may be entered with a negative value in field 2.14 to reduce the total energy consumption.
2.14.a. Alternate Fuel GHG Emission Factor	Consult with DEQ staff to develop an appropriate emission factor (gCO₂e/lb.) for the alternate fuel and input in Field 2.14.a. Alternate fuel sources and data sources used in calculating emission factors must be described in detail in the Supplemental Documentation submitted with the Simplified CI Calculator. This description must, at a minimum, identify the alternative fuel and the source.

2.14.b. Conversion Factor from HHV to LHV	Consult with DEQ staff to develop an appropriate conversion factor from HHV to LHV for the alternate fuel and input in Field 2.14.b. Alternate fuel sources and data sources used in this conversion factor must be described in detail in the Supplemental Documentation submitted with the Simplified CI Calculator.
2.15. Beginning Methanol Inventory	Input monthly inventory data for methanol (in lbs).
2.16. Methanol Used (Calculated)	Monthly methanol used data in this field will be automatically calculated. No inputs are required for this field.
2.17. Methanol Purchased	Input monthly total methanol purchased data (in lbs.) in this field for all 24 months of operation.
2.18. Ending Methanol Inventory	Input monthly total methanol ending inventory (in lbs.) in this field for all 24 months of operation.
2.19. Distillate Bottoms Production (moisture corrected)	Input monthly total distillate bottoms production (in lbs.) in this field for all 24 months of operation. To ensure co-product credit, appropriate evidence of end-use of the co-product must be demonstrated in the Supplemental Documentation submitted with the Simplified CI Calculator. If part of the distillate bottoms are used as process fuel, co-product credit will not be offered for the fraction used as process fuel. The exported co-product will be credited provided that there is evidence of its end use disposition for useful purpose.
2.19.a. Energy Density Factors for Coproducts (Btu/lb., LHV)	Consult with DEQ staff to develop the appropriate energy density factor for distillate bottoms, free fatty acids and other co-products, as applicable, for co-product credit (Btu/lb. for LHV). Enter it in Field 2.19.a. below the monthly inputs. To ensure co-product credit, appropriate evidence of end-use of all co-products must be demonstrated in the Supplemental Documentation submitted with the Simplified CI Calculator. Co-product credit will not be offered for any co-products used as a process fuel, and the energy density value for each co-product used as a process fuel must be input as zero.
2.20. Free Fatty Acids Production (moisture corrected)	Input monthly total free fatty acids production (in lbs.) in this field for all 24 months of operation. To ensure co-product credit, appropriate evidence of end-use of the co-product must be demonstrated in the Supplemental Documentation submitted with the Simplified CI Calculator. If part of the free fatty acids is used as process fuel, co-product credit will not be offered for the fraction used as process fuel. The exported product will be credited provided evidence of its end-use disposition for useful purpose.
2.21. Glycerin Production (moisture corrected)	Monthly total glycerin produced (in lbs.) must be input in this field for all 24 months of operation. To ensure co-product credit, appropriate evidence of end-use of all co-products need to be demonstrated in the Supplemental Documentation submitted with the Simplified CI Calculator. If part of the glycerin is used as process fuel, co-product credit will not be offered for the fraction used as process fuel. The exported co-product will be credited provided that there is evidence of its end use disposition for useful purpose.

2.22. Other Co-products (Specify here)	Monthly total "other" co-product production (in lbs.) must be input in this field for all 24 months of operation. Enter the name of the "other" co-product above the monthly inputs in cell P21. To ensure co-product credit, appropriate evidence of end-use of all co-products need to be demonstrated in the Supplemental Documentation submitted with the Simplified CI Calculator. If part of the "Other" co-product is used as process fuel, co-product credit will not be offered for the fraction used as process fuel. The exported co-product will be credited provided that there is evidence of its end use disposition for useful purpose.
2.23. Biodiesel Transportation	No inputs are required for field 2.23. Additional biodiesel transportation details are provided below in Table E.2.
2.23.a. By HDD Truck to port/ rail yard	Input miles transported by HDD truck from BD production facility to either a port or rail yard for further transport.
2.23.b. By HDD Truck to blending terminal	Input miles transported by HDD truck to final blending terminal.
2.23.c. By Rail	Input miles transported by rail to blending terminal. The point of origin for rail transport is either from a loading dock at the BD production facility or a point where BD is transported from the production facility by HDD truck to a railyard (as described in field 2.23.a).
2.23.d. By Ocean Tanker	Select ocean tanker size options of either a standard value (22,500 DWT) or a user-defined tanker size, and then click the Calculate button. Then input miles are transported by Ocean Tanker to a blending terminal in Oregon. If User-Defined is selected, consult DEQ staff about developing an Ocean Tanker BD transport emission factor in gCO_2e/gallon BD-mile and input in field 2.23.d. Data sources for the User-Defined emission factor must be documented in the Supplemental Documentation attached with the Simplified CI Calculator. The point of origin for ocean transport is either from a loading dock at the BD production facility or a point where BD is transported from the production facility by HDD truck to a port (as described in field 2.23.a).
2.23.e. By Barge	Input miles transported by barge to blending terminal. The point of origin for barge transport is either from a loading dock at the BD production facility or a point where BD is transported from the production facility by HDD truck to a port (as described in field 2.23.a).

Additional details for BD Production Tab, section 2

Electricity mix (field 2.1)

The applicant must select a regional electricity mix for biodiesel production from Electricity Mix Region for Fuel". The dropdown menu consists of 30 subregions (26 from the U.S based on eGRID2014v2 [6] one from Brazil, one from Canada, one representing the U.S average, and one for User-Defined region[7]).

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[6] United States Environmental Protection Agency, 11th edition of the Emissions & Generation Resource Integrated Database with year 2014 data (eGRID2014v2, released February 27, 2017): https://www.epa.gov/sites/production/files/2017-02/documents/egrid2014_summarytables_v2.pdf

[7] Applicants must consult CARB staff to develop emission factors for User-Defined electricity.

Biodiesel transportation (field 2.23)

For transport of finished fuel to Oregon, applicants must input the appropriate transport distance by HDD truck, by Rail, by Ocean Tanker, and by Barge, as applicable. Emissions from transport modes are additive to reflect all legs of transport of finished fuel to Oregon.

Note: For applicants who expect to use various combinations of transport modes to ship fuel to Oregon, staff suggests calculating the CIs for each combination and inputting the combination with the highest CI in the Simplified CI Calculator to prevent unintentional exceedance of the pathway CI. The supplemental documentation provided with the application must include the CIs for each of the anticipated combinations and highlight the combination used in the Calculator.

CI calculation details

This section contains an example pathway CI calculation with a detailed breakdown of all calculations used for CI determination based on information entered by the user and applicable reference data. These calculations are included below in section 2 in the BD production tab.

F. Calculator details – RD-Production Tab

The "RD-Production" tab contains the CI calculation worksheet consisting of the following major components:

- Section 1. Application Information, Pathway Summary, and Estimated CI
- Section 2. Renewable Diesel Production Data (via Hydrotreating)
- Section 3: CI Calculation Details

All CI values are calculated based on relevant site-specific inputs entered in the respective input fields. After all site-specific inputs for a given facility have been entered, the calculated CIs will represent the pathway CIs for the various streams as detailed in this tab and the "BD RD Summary" tab. Details for entering data in all required fields are described below.

Section 1: Applicant information, pathway summary, and estimated CI

Table F.1 includes fields requiring inputs related to the applicant and facility location. This section also summarizes pathway CIs corresponding to inputs in the feedstock and RD-Production tab. All CI values are calculated based on relevant site-specific inputs that must be entered in the respective input fields. Only after all site-specific inputs for a given facility have been entered the calculated CIs will represent the pathway CIs for the various streams as detailed in this tab.

Table F.1. List of input fields for Section 1 of the RD-Production Tab

Field Name	Description
1.1. Applicant	Registered name of the company. Example "ABC Company, LLC" or "ABC Company, Inc."
1.2. Facility Location	Enter City, State, and Country of the RD production facility.
1.3. Pathway Summary	Field to include a summary of the RD pathways such as "soy oil and tallow to RD."
1.4. Provisional Application?	If available data is less than 24 months, select "Yes," else "No," and click "Calculate." If "Provisional," available input months of operational data starting in Month 1 of the Calculator (minimum three months of operating data required to meet provisional requirements).
1.5. Application Number	Enter the application number provided by the AFP.
1.6. Facility Number	Enter the Facility ID.
1.7 Application Date	Enter the application date in the format MM/DD/YYY

Section 2: Renewable diesel production data (via hydrotreating)

The following table lists the fields used in Section 2 of the RD-Production tab.

Table F.2. List of input fields for section 2 of the RD-Production tab

Field Name	Description
2.1. Regional Electricity Mix for Fuel	Choose the electricity mix corresponding to the zip code for the region where the RD production facility is located. The Calculator includes 26 eGRID zone mixes, average Brazilian mix, average Canadian mix, and User Defined Mix included in the pull-down menu. For facilities in the U. S., select one of 26 eGRID zones available for the U. S. These are selected based on the zip code of the fuel production facility. After a selection, click the "Calculate" button. Additional electricity mix details are provided below in Table F.2.
2.2. Enter GHG EF of Electricity Mix, gCO2e/kWh	This field is highlighted only if "User-Defined Mix" is selected in field 2.1. This field requires input of emission factor for electricity mix corresponding to the location of the RD production facility. Consult with DEQ staff to develop a user-defined emission factor for electricity mix. Data sources for User-Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
2.3. Regional Crude Mix	Choose the source of crude mix from the pulldown menu based on location of RD production facility. After a selection, click the "Calculate" button. If selection is "U. S. Average Crude", no additional input is required. If selection is "User Defined Crude", consult with DEQ staff to develop emission factor for crude and input in Field 2.4.
2.4. Enter GHG EF of Crude Sources, gCO2e/MMBtu of Crude	This field is highlighted only if "User-Defined Crude" is selected in field 2.3. This field requires input of emission factor for crude corresponding to the location of the RD production facility. Consult with DEQ staff to develop a user-defined emission factor for crude. Data sources for user-defined crude mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.

2.5. Regional Natural Gas (NG) Source	Choose the source of NG from the pulldown menu based on location of RD production facility. If selection is "U. S. Average NG", no additional input is required. If selection is "User-Defined NG", consult with DEQ staff to develop emission factor for NG and input in Field 2.6. After a selection, click the "Calculate" button.
2.6. Enter GHG EF of NG Sources, gCO2e/MMBtu of NG	This field is highlighted only if "User-Defined NG" is selected in field 2.5. This field requires input of emission factor corresponding to the location of the RD production facility. Consult with DEQ staff to develop a site-specific emission factor for NG. Data sources for User-Defined NG sources must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
2.7. Monthly Data	Input the months and year(s) corresponding to the operational data provided.
2.8. Beginning Renewable Diesel Inventory (Gallons @ 60°F)	Input monthly beginning inventory data for RD (gallons at 60°F) for all 24 months of operation.
2.9. Renewable Diesel Produced (Gallons @ 60°F) (Calculated)	Monthly fuel produced data (gallons at 60°F) in this field will be automatically calculated. No inputs are required for this field since these are calculated from inputs in fields 2.8 through 2.11.
2.10. Ending Renewable Diesel Inventory (Gallons @ 60°F)	Input monthly total ending inventory data for RD (gallons at 60°F) in this field for all 24 months of operation.
2.11. Renewable Diesel Sales (Gallons @ 60°F)	Input monthly total sales data of RD (gallons at 60°F) in this field for all 24 months of operation.
2.12. NG Use from Utility Invoices	Input monthly total NG consumption data (in MMBtu, HHV) in this field for all 24 months of operation.
2.13. Electricity Use from Utility Invoices	Input monthly total electricity use (in kWh) in this field for all 24 months of operation.
2.14. Alternate Fuel Use	If another fuel source is used for fuel production, input monthly total use (lbs.) in field 2.14 for all 24 months of operation. This field may be used to adjust a quantity of energy input (such as natural gas) that is entered corresponding to utility invoices if part of that input energy is exported as a co-product from the fuel production facility (e.g., as steam exported to a collocated facility); the quantity of fuel exported may be entered with a negative value in field 2.14 to reduce the total energy consumption.
2.14.a. Alternate Fuel GHG Emission Factor	Consult with DEQ staff to develop an appropriate emission factor (gCO$_2$e/lb.) for the alternate fuel and input in Field 2.14.a. Alternate fuel sources and data sources used in calculating emission factors must be described in detail in the Supplemental Documentation submitted with the Simplified CI Calculator. This description must, at a minimum, identify the alternative fuel and the source.

2.14.b. Conversion Factor from HHV to LHV	Consult with DEQ staff to develop an appropriate conversion factor from HHV to LHV for the alternate fuel detailed in 2.14 and input this value in Field 2.14.b. Alternate fuel sources and data sources used in this conversion factor must be described in detail in the Supplemental Documentation submitted with the Simplified CI Calculator.
2.15. Hydrogen Use	Input monthly Hydrogen use (in cubic feet) from grid data in this field for all 24 months of operation.
2.16. Light Hydrocarbon Production	Input monthly production for light hydrocarbon production (in MMBtu, HHV.) in this field for all 24 months of operation. To ensure co-product credit, appropriate evidence of end-use of the co-product must be demonstrated in the Supplemental Documentation submitted with the Simplified CI Calculator. If part of light hydrocarbons are used as process fuel, co-product credit will not be offered for the fraction used as process fuel. The exported co-product will be credited provided that there is evidence of its end use disposition for useful purpose.
2.16.a Conversion Factor from HHV to LHV for cell J51	Consult with DEQ staff to develop an appropriate conversion factor from HHV to LHV for the light hydrocarbon stream detailed in 2.16 and input this value in Field 2.16.a. Alternate fuel sources and data sources used in this conversion factor must be described in detail in the Supplemental Documentation submitted with the Simplified CI Calculator.
2.17. Renewable Naphtha Production	Input monthly production for renewable naphtha production (in gallons) in this field for all 24 months of operation. To ensure co-product credit, appropriate evidence of end-use of the co-product must be demonstrated in the Supplemental Documentation submitted with the Simplified CI Calculator. If part of the renewable naphtha is used as a process fuel, co-product credit will not be offered for the fraction used as process fuel. The exported co-product will be credited provided that there is evidence of its end use disposition for useful purpose.
2.17.a. Energy Density For Other Co-Products (Btu/gal) in LHV	Consult with DEQ staff to develop the appropriate energy density factor for renewable naphtha, renewable propane, jet fuel or other fuel co-products, as applicable, for co-product credit (Btu/lb. for LHV). Enter it in Field 2.17.a. below the monthly inputs. To ensure co-product credit, appropriate evidence of end-use of all co-products must be demonstrated in the Supplemental Documentation submitted with the Simplified CI Calculator. Co-product credit will not be offered for any co-products used as a process fuel, and the energy density value for each co-product used as a process fuel must be input as zero.
2.18. Renewable Propane Production	Input monthly production for renewable propane production (in gallons) in this field for all 24 months of operation. To ensure co-product credit, appropriate evidence of end-use of the co-product must be demonstrated in the Supplemental Documentation submitted with the Simplified CI Calculator. If part of the renewable propane is used as a process fuel, co-product credit will not be offered for the fraction used as process fuel. The exported co-product will be credited provided that there is evidence of its end use disposition for useful purpose.

2.19. Jet Fuel or Other	Input monthly production for jet or other fuel production (in gallons) in this field for all 24 months of operation. Enter the name of the "other" co-product above the monthly inputs in cell M25. To ensure co-product credit, appropriate evidence of end-use of the co-product must be demonstrated in the Supplemental Documentation submitted with the Simplified CI Calculator. If part of the jet (or other fuel) is used as a process fuel, co-product credit will not be offered for the fraction used as process fuel. The exported co-product will be credited provided evidence of its end use disposition for useful purposes. Users shall input the applicable unit for the "Other" co-products.
2.20. RD Transportation	No inputs are required for field 2.20.
2.20.a. By HDD Truck to port/yard	Input miles transported by HDD truck from the RD production facility to either a port or rail yard for further transport. Additional RD transportation details are provided below in Table F.2.
2.20.b. By HDD Truck to blending terminal	Input miles transported by HDD truck to final blending terminal.
2.20.c. By Rail	Input miles transported by rail to blending terminal. The point of origin for rail transport is either from a loading dock at the RD production facility or a point where RD is transported from the production facility by HDD truck to a railyard (as described in field 2.20.a).
2.20.d. By Ocean Tanker	Select ocean tanker size options of either a standard value (22,500 DWT) or a user-defined tanker size, and then click the Calculate button. Then input miles are transported by Ocean Tanker to a blending terminal in Oregon. If User-Defined is selected, consult DEQ staff about developing an Ocean Tanker RD transport emission factor in gCO_2e/gallon RD-mile and input in field 2.23.d. Data sources for the User-Defined emission factor must be documented in the Supplemental Documentation attached with the Simplified CI Calculator. The point of origin for ocean transport is either from a loading dock at the RD production facility or a point where RD is transported from the production facility by HDD truck to a port (as described in field 2.20.a).
2.20.e. By Barge	Input miles transported by barge to blending terminal. The point of origin for barge transport is either from a loading dock at the RD production facility or a point where RD is transported from the production facility by HDD truck to a port (as described in field 2.20.a).

Additional details for RD production tab, section 2

Electricity mix (field 2.1)

The applicant must select a regional electricity mix for renewable diesel production from Electricity Mix Region for Fuel". The dropdown menu consists of 30 subregions (26 from the U.S based on eGRID2014v2 [8], one from Brazil, one from Canada, one representing the U. S.

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[8] United States Environmental Protection Agency, 11th edition of the Emissions & Generation Resource Integrated Database with year 2014 data (eGRID2014v2, released February 27, 2017): https://www.epa.gov/sites/production/files/2017-02/documents/egrid2014_summarytables_v2.pdf

average, and one for User-Defined region[9]).

Renewable diesel transportation (field 2.20)

For transport of finished fuel to Oregon, applicants must input the appropriate transport distance by HDD truck, by Rail, by Ocean Tanker, and by Barge, as applicable. Emissions from transport modes are additive to reflect all legs of transport of finished fuel to Oregon.

Note: For applicants who expect to use various combinations of transport modes to ship fuel to Oregon, staff suggests calculating the CIs for each combination and inputting the combination with the highest CI in the Simplified CI Calculator. The supplemental documentation provided with the application must include the CIs for each of the anticipated combinations and highlight the combination used in the Calculator.

CI Calculation details

This section contains an example pathway CI calculation with a detailed breakdown of all calculations used for CI determination based on information entered by the user and applicable reference data. These calculations are below Section 2 in the RD production tab.

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[9] Applicants must consult CARB staff to develop emission factors for User-Defined electricity.

LNG and L-CNG from North American Natural Gas

A. Introduction

This document provides detailed instructions for using the Simplified CI Calculator for Tier 1 North American Natural Gas pathway applications. This Calculator is to be used to calculate the carbon intensity (CI) for Liquefied Natural Gas (LNG) and Liquefied and subsequently Compressed Natural Gas (L-CNG) from North American natural gas. Each required specific input in the Calculator has been numerically labeled (i.e., 1.1, 1.2 etc.) so that users can follow the sequence and enter information as required.

Download the Simplified CI Calculator here:
https://www.oregon.gov/deq/ghgp/cfp/Pages/Clean-Fuel-Pathways.aspx

The Calculator has been automated to perform CI calculations using factors from the OR-GREET3.0 model. The Calculator replaces the existing Tier 1 Calculator and the operational data template in pathway application packages. Applicants are required to add facility information and verifiable operational energy use and fuel production data, and transport distances used in calculating the CI of NA NG pathways.

This Calculator also includes additional reference material such as greenhouse gas emissions factors used in OR-GREET3.0 and reference fuel specifications. Also included with the Calculator is a detailed breakdown of the calculations used to determine the final CI of each fuel pathway.

The applicant may only enter values or make selections in input fields designated by DEQ for user input/selection, and may not change any other values or fields in the Calculator.

B. Color legend used in the calculator

The Calculator uses the following color legend to differentiate required inputs, calculated values, etc., described below:

Yellow cells require user input
Light Blue cells show CI results
Green Cells show the calculation button
Gray Cells are calculated values

C. Calculator overview

The following table provides an overview of the tabs used in the Simplified CI Calculator.

Table C.1. Overview of Tabs Used in the Simplified CI Calculator

Tab Name	Description
NA NG Summary	Summary worksheet. Contains an overall summary of the information entered in the "NA NG" tab of the calculator and calculated CIs for NA NG to LNG and L-CNG. If desired, a **conservative margin of safety** may be added to the calculated CI in this tab to establish the final CI.
NA NG	The main calculation worksheet contains the main components of the calculator with fields requiring user inputs and those calculated by the sheet. The calculations in grayed-out cells are automatically calculated but dependent on input to yellow cells in the corresponding sections of the calculator. This tab also includes CI calculations using inputs in this tab. See more detailed instructions below.
EF Table	This reference worksheet contains greenhouse gas emissions factors from the OR-GREET3.0 model used in calculating carbon intensities.
Reference	This reference worksheet contains specifications of fuels (i.e., HHV, LHV, density, carbon ratio), global warming potentials of greenhouse gases, unit conversions, tailpipe emissions, LNG boil-off emissions, and other information used in calculating CIs.

D. NA NG tab

The "NA NG" tab contains the main CI calculation worksheet and consists of the following major sections:

- Section 1. Applicant Information for Fossil LNG Production
- Section 2. Information for Fossil LNG Production
- Section 3. CI Calculation Details

Section 1. Applicant information for fossil LNG production

The following table lists the fields used in Section 1 of the NA NG tab.

Table D.1. List of input fields for section 1 of the Simplified CI Calculator

Field Name	Description
1.1. Company Name	Registered name of the company. Example "ABC Company, LLC" or "ABC Company, Inc."
1.2. Company ID	Enter U.S. EPA Company ID. If not available, contact DEQ for LCFS Company ID.
1.3. Facility ID	Enter the Company's Facility ID. If not available, contact DEQ for LCFS Facility ID.
1.4. LNG Liquefaction Facility Location	Location of the liquefaction facility (Street, City, State).
1.5. Provisional Pathway?	If available data is less than 24 months, select "Yes," or "No." If the application is for a provisional pathway, input the available months of operational data starting in Month 1 (minimum of three months of operating data required to meet provisional requirements).
1.6. Application Number	Enter the application number generated by the AFP.
1.7. LNG Dispensing Station(s) Location	Location of LNG dispensing location (Street, City, State). For multiple stations, calculate a centroid location based on a weighted average of fuel dispensing stations to which LNG is supplied. See additional details for Field 2.7.b. below Table D.2.
1.8. L-CNG Dispensing Station(s) Location	Location of L-CNG station in Oregon (Street, City, State). For multiple stations, calculate a centroid location based on a weighted average of fuel dispensing stations to which L-CNG is supplied. See additional details for Field 2.7.b. below Table D.2.

Section 2. Information for fossil LNG and L-CNG production

Table D.2. provides details of inputs for Fossil LNG and L-CNG pathways. Additional details are included below Table D.2.

Table D.2. List of input fields for section 2 of the Simplified CI Calculator

Field Name	Description
2.1. Select Regional Electricity Mix for LNG Production	Choose the electricity mix corresponding to the zip code for the region where the liquefaction plant is located. The Calculator includes 26 eGRID zone mixes, Brazilian average, Canadian average, and User Defined mix in the pull-down menu. For facilities in the U. S. select one of 26 eGRID zones available for the U. S. If the processing facility is located outside the U.S., select "User Defined Mix." After selecting an electricity mix option, click the "**Calculate**" button. If "User Defined Mix" is selected, consult with DEQ staff to develop an emission factor for the user-defined mix to be input in field 2.8. Data sources for User Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
2.2. Monthly Data	Input the months and year(s) corresponding to the operational data provided.

2.3. NG from NG purchase invoices	Input monthly total fossil NG sourced from a pipeline (or other) in MMBtu from utility invoices (reported in HHV) for 24 months of operation in field 2.3. The input includes fossil NG used as process fuel and liquefied to LNG.
2.4. LNG Production from Production Log	Input monthly total LNG produced in gallons (reported at ambient temperature) for 24 months in field 2.4.
2.5. NG as process fuel (Calculated)	This field calculates NG used as process fuel using inputs in fields 2.3 and 2.4. No user input is required for this field.
2.6. Electricity from Utility Invoices	Input monthly total electricity from the grid in kWh for 24 months in field 2.6.
2.7. LNG Transport and Distribution	This field serves as a label for the LNG transport and distribution section. Therefore, no input is required for field 2.7.
2.7.a. Select to affirm that LNG delivery trucks are equipped with Boil-Off Recovery	If trucks transporting LNG are equipped to recover "Boil-Off," select "Yes" or else "No" in field 2.7.a.
2.7.b. Enter Transport Distance from Liquefaction Plant to station	Input distance from liquefaction facility to the intended LNG or L-CNG dispensing station in Oregon in field 2.7.b. Additional details are included below in Table D.2.
2.8. Specify GHG Emission Factor for Electricity Mix	If "User Defined Mix" is selected in field 2.1, consult with DEQ staff to develop a user-defined mix GHG emissions factor and input in this field in field 2.8. Data sources for User Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.

After inputting all data in Section 2, click the "Calculate" button (cell H21-I21) to calculate pathway CIs for the LNG and L-CNG pathways.

Additional details for section 2

Transport of LNG to dispensing facility (Field 2.7.b)

Driving distance between any two locations may be determined using a publicly available web-based driving distance if fuel is dispensed at a single station. However, if multiple dispensing facilities are utilized, a volume-weighted average transport distance based on 24 months of sales records must be used for LNG distribution to fueling facilities. Alternatively, the applicant could choose to use a more conservative value, such as the distance to the farthest fueling facility, to minimize the risk of exceeding the certified CI due to changes in the supply chain.

Section 3. CI calculation details

This section contains an example pathway CI calculation with a detailed breakdown of all calculations used for CI determination based on information entered by the user and applicable reference data.

Biomethane from North American Landfills

A. Introduction

This document provides detailed instructions for using the Simplified CI Calculator for Tier 1 Landfill Gas (LFG) to Renewable Natural Gas (RNG) pathway applications. This Calculator is to be used to calculate the carbon intensity (CI) for Compressed Natural Gas, Liquefied Natural Gas (LNG), and Liquefied and Subsequently Compressed Natural Gas (L-CNG) from North American landfills. Each required specific input in the Calculator has been numerically labeled (i.e., 1.1, 1.2, etc.) so that users can follow the sequence and enter information as required.

Download the Simplified CI Calculator here:
https://www.oregon.gov/deq/ghgp/cfp/Pages/Clean-Fuel-Pathways.aspx

The Calculator has been automated to perform CI calculations using factors from the OR-GREET3.0 model. The Calculator replaces the existing Tier 1 Calculator and the operational data template in pathway application packages. Applicants must add facility information and verifiable monthly feedstock, operational energy use, fuel production, and co-product data, and transport distances used in calculating the CI of biomethane from North American landfills.

This Calculator includes reference material such as greenhouse gas emissions factors used in OR-GREET3.0 and reference fuel specifications. Also included with the Calculator is a detailed breakdown of the calculations used to determine the final CI of each fuel pathway.

The applicant may only enter values or make selections in input fields designated by DEQ for user input/selection and may not change any other values or fields in the Calculator.

B. Color legend used in the calculator

The Calculator uses the following color legend to differentiate required inputs, calculated values, etc., as described below:

Yellow cells require user input
Light Blue cells show CI results
Green Cells show the calculation button
Gray Cells are calculated values

C. Calculator overview

The following table provides an overview of the tabs used in the Simplified CI Calculator.

Table C.1. Overview of Tabs Used in the Simplified CI Calculator

Tab Name	Description
LFG Summary	Summary worksheet. Contains an overall summary of the information entered in the "LFG" tab of the calculator and calculated CIs for landfill gas to CNG, LNG, and L-CNG. If desired, a **conservative margin of safety** may be added to the calculated CI in this tab in order to establish the final CI.
LFG	Main calculation worksheet. Contains the main components of the calculator with fields requiring user inputs and those calculated by the sheet. Calculations in grayed out cells are automatically calculated but dependent on input to yellow cells in the corresponding sections of the calculator. This tab also includes CI calculations using inputs in this tab. See more detailed instructions below.
EF Table	Reference worksheet. Contains greenhouse gas emissions factors from the OR-GREET3.0 model used in calculating carbon intensities.
Reference	Reference worksheet. Contains specifications of fuels (i.e., HHV, LHV, density, carbon ratio), global warming potentials of greenhouse gases, unit conversions, tailpipe emissions, LNG boil-off emissions and other information used in calculating CIs.

D. LFG tab

The "LFG" tab contains the main CI calculation worksheet and consists of the following major sections:

- Section 1. Applicant Information
- Section 2. Biomethane Production Data
- Section 3. CNG, LNG, and L-CNG Production and Transport Data
- Section 4. CI Calculation Details

Section 1. Applicant information for biomethane production

The following table lists the fields used in Section 1 of the LFG tab.

Table D.1. List of input fields for section 1 of the Simplified CI Calculator

Field Name	Description
1.1. Company Name	Registered name of the company. Example "ABC Company, LLC" or "ABC Company, Inc."
1.2. Company ID	Enter U.S. EPA Company ID. If not available, contact DEQ for LCFS Company ID.
1.3. Facility ID	Enter the Company's Facility ID. If not available, contact DEQ for LCFS Facility ID.
1.4. Landfill Location	Location of the landfill. Example: "AAA Landfill in Salem, OR"
1.5. LNG Liquefaction Facility Location	Location of the liquefaction facility (Street, City, State).
1.6. Application Number	Enter the application number generated by the AFP.
1.7. CNG Dispensing Station(s) Location	Location of Oregon CNG dispensing station (Street, City, State). For multiple stations, use Salem as the endpoint (the Standard Station Centroid location). See additional details for Field 2.13.a. below Table D.2.
1.8. LNG Dispensing Station(s) Location	Location of LNG dispensing station (Street, City, State). For multiple stations, calculate a centroid location based on a weighted average of fuel dispensing stations to which LNG is supplied. See additional details for Field 3.6.b. below Table D.3.
1.9. L-CNG Dispensing Station(s) Location	Location of L-CNG station (Street, City, State). For multiple stations, calculate a centroid based on a weighted average of fuel dispensing stations to which L-CNG is supplied. See additional details for Field 3.6.b. below Table D.3.

Section 2. Biomethane production data

The following table lists the fields used in Section 2 of the LFG tab. Additional details are included below in Table D.2.

Table D.2. List of input fields for biogas processing

Field Name	Description
2.1. Select Regional Electricity Mix for Biomethane	Choose the electricity mix corresponding to the zip code for the region where the landfill biogas upgrading plant is located. The Calculator includes 26 eGRID zone mixes, average Brazilian mix, average Canadian mix, and User Defined Mix in the pull down menu. For facilities in the U. S., select one of 26 eGRID zones available for the U.S. If the upgrading facility is located outside the U.S., select "User Defined Mix." For facilities that use biogas for electricity production, choose the user-defined electricity option in field 2.1. After selecting an electricity mix option, click the "**Calculate**" button. If "User Defined Mix" is selected, consult with DEQ staff to develop an emission factor for the user-defined mix to be input as detailed in field 2.14. Data sources for User-Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator. Additional details are included below in Table D.2.
2.2. Provisional Pathway?	If there is less than 24 months of available data, select "Yes", otherwise choose "No". If the application is for a provisional pathway, input available months of operational data, starting in Month 1 (minimum three months of operational data required to meet provisional requirements).
2.3. Monthly Data	Input the months and year(s) corresponding to the operational data provided.
2.4. Inlet LFG Extraction Flow (metered)	Input monthly dry biogas flow data for 24 months of operation. Specific requirements detailed below in Table D.2.
2.5. Methane Content (% Methane)	Input monthly weighted average methane concentration data (measured in dry biogas) for 24 months of operation. Specific requirements detailed below in Table D.2.
2.6. Facility Use of Utility Sourced NG	Input monthly total buyback fossil natural gas use from a pipeline source (or other) in MMBtu from utility invoices (reported in HHV) for 24 months of operation. If buyback gas is used to boost Btu of biomethane to meet pipeline specifications, do not include this quantity of NG in this field (monthly basis). This will be input separately in Field 2.10. See additional details below in Table D.2.
2.7. Facility Use of Diesel	Input monthly total diesel use (in gallons at ambient temperature) for 24 months in this field.
2.8. Facility Use of Propane (LPG)	Input monthly total propane use (in gallons at ambient temperature) for 24 months in this field. If propane is used to boost Btu of biomethane to meet pipeline specifications, do not include this quantity of propane in this field (monthly basis). This will be input separately in Field 2.11.
2.9. Facility Use Electricity from Grid	Input monthly total electricity use from the grid in kWh from utility invoices for 24 months in this field. If biogas-derived electricity is generated on-site, input metered quantity of electricity in this field and ensure the emission factor for the user-defined mix is included in Field 2.14.

2.10. Buy Back fossil NG to boost Btu before pipeline injection	Input monthly total quantity of buyback fossil NG (in MMBtu, HHV) in field 2.10 if NG is used to boost biomethane energy to meet pipeline specifications. This quantity is not used in CI calculations. Subtract this quantity of fossil NG when reporting pipeline injected biomethane in field 2.12.
2.11. Propane used to boost Btu before pipeline injection	Input monthly total quantity of propane (in gallons at ambient temperature) in field 2.11 if propane is used to boost biomethane energy content to meet pipeline specification. This quantity is not used in CI calculations. Subtract this quantity of propane when reporting pipeline injected biomethane in field 2.12.
2.12. Biomethane injected into the pipeline (metered)	Input monthly total biomethane injected into the pipeline in MMBtu (as HHV) for 24 months in field 2.12. The quantity must be supported by the installation of utility grade meters. Subtract monthly total fossil NG or propane blended with biomethane to meet pipeline specifications from the injected quantity (in MMBtu).
2.13. NG pipeline Transmission	This field includes a label for NG pipeline transmission and does not require an input.
2.13.a. From upgrading facility to CNG Station	Input distance from biogas processing facility to the intended CNG station in Oregon in field 2.13.a. If fuel is sent to multiple stations, use the Standard Station Centroid of Salem as the endpoint. Additional details below in Table D.2.
2.13.b. From upgrading facility to LNG plant	Input distance from biogas processing facility to the liquefaction facility in field 2.13.b. This is required only if the pathway application includes LNG and L-CNG pathways. Additional details below in Table D.2.
2.14. Specify GHG Emission Factor for Electricity Mix	If "User Defined Mix" is selected in field 2.1, consult with DEQ staff to develop a user-defined GHG emissions factor and input in this field in cell M26. Data sources for User-Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
"Calculate" Button	After all data in Section 2 are entered, click the "Calculate" button (cell G22) in Section 2 to calculate CI for the CNG pathway.

Additional details for section 2 and table D.2

Using biogas to generate electricity for biogas upgrading (Field 2.1)

Although the Calculator can accommodate facilities that use biogas to generate electricity for biogas upgrading, applicants must declare the use of on-site electricity generation and consult DEQ staff before submitting a pathway application. A dedicated meter to quantify biogas-derived electricity in kWh must be used to report the use of this electricity in the Calculator sheet.

Inlet raw biogas sourced from the landfill (Field 2.4)

Requires a dedicated flow measurement system with temperature measurement to enable reporting of gas flow at 1 atm. pressure and 60°F (dry gas flow corrected for moisture) to account for monthly total raw biogas volume sourced from the landfill collection system. The flow measurement system must be calibrated per the manufacturer's requirement and scaled to measure the entire range of potential flow of biogas. Measurement must be continuous, and all data must be electronically archived (manual recording is not acceptable). The direct metering of the quantity and percentage methane concentration of biogas captured from the landfill or digester is not used in CI calculations but rather as a check to ensure that total biomethane sales do not exceed the biogas quantity sourced from the landfill. If biogas is used for electricity

generation, the applicant must report the metered used amount of biogas for electricity generation and metered quantity of electricity generated on-site.

Methane content (% Methane in Field 2.5)

Input monthly weighted average methane concentration (dry gas basis). Methane measurement must be recorded every 15 minutes (at a minimum) with instrumentation capable of electronic archival (manual recording will not be acceptable). The methane measurement system requires calibration per manufacturer's requirement and scaled to measure the entire potential range of methane concentration in the biogas.

Dedicated metering of buyback NG and propane (Field 2.6 and 2.8)

For landfill gas upgrading facilities that use buyback natural gas (NG) or propane to boost the Btu of biomethane before pipeline injection (to meet pipeline specifications), dedicated metering must be installed to substantiate quantities of NG or propane used for this purpose. If dedicated metering is not installed or not verifiable, all NG and propane reported in fields 2.10 and 2.11, respectively, will be added to NG and propane reported in fields 2.6 and 2.8, respectively (and considered used for upgrading biogas).

Biomethane injected into the pipeline (Field 2.12)

The monthly quantity of biomethane input in field 2.12 must correspond to the quantity of biomethane (in MMBtu) injected into the pipeline. However, since this quantity may include NG or propane blended with biomethane to meet pipeline specifications, the use of any non-renewable gas must be explicitly disclosed through invoices. The quantity entered in field 2.12 would include only the biomethane quantity; any fossil inputs must be subtracted from the actual quantity injected into the pipeline that was purchased by the local utility or other parties. Staff believes that this reporting is most consistent with quantities reported for RIN generation under the RFS, which is based on the Btu of the biomethane after treatment, and before any blending with non-renewable fuel or injection into a pipeline.

Note: CI calculations for biomethane are performed on a net MMBtu injected by subtracting all fossil NG and propane inputs (including quantities used in a flare, thermal oxidizer, or biogas processing) from renewable biomethane (in MMBtu) injected into the pipeline.

Pipeline transport distance for renewable natural gas (Fields 2.13.a and 2.13.b)

For pipeline transport distance from a biogas processing facility to a CNG dispensing station or to a liquefaction facility, driving distances between the two locations may be determined using a publicly available web-based driving distance estimator. For RNG to CNG pathways that use multiple dispensing stations, applicants may use the driving distance from a landfill in the U.S. or Canada to Salem, OR as the pipeline transmission distance in the Simplified CI Calculator (or Tier 2 if applicable). Alternatively, the applicant could choose to use a more conservative value, such as the distance to the farthest fueling facility, to minimize the risk of exceeding the certified CI due to changes in the supply chain.

Section 3. CNG, LNG, and L-CNG production and transport data

Table D.3. provides details of inputs for LNG and L-CNG pathways. Additional details are included below in Table D.3.

Table D.3. List of Input Fields for Section 3 of the Simplified CI Calculator

Field Name	Description
3.1. Select Regional Electricity Mix for LNG Production	Choose the electricity mix corresponding to the zip code for the region where the liquefaction plant is located. The Calculator includes 26 eGRID zone mixes, average Brazilian mix, average Canadian mix, and User Defined Mix in the pull-down menu. For facilities in the U.S., select one of 26 eGRID zones available for the U. S. If the liquefaction facility is located outside the U. S., select the "User Defined Mix." After selecting an electricity mix option, click the "**Calculate**" button. If "User Defined Mix" is selected, consult with DEQ staff to develop an emission factor for the user-defined mix to be input in field 3.7. Data sources for User-Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
3.2. NG from NG purchase invoices	Input monthly total fossil NG sourced from a pipeline source (or other) in MMBtu from utility invoices (reported in HHV) for 24 months of operation in field 3.2. The input includes fossil NG used as process fuel and liquefied to LNG. Renewable attributes to support renewable biomethane dispensed must be provided to the verifier during the on-site audit.
3.3. LNG Production from Production Log	Input monthly total LNG produced in gallons (reported at ambient temperature) for 24 months in field 3.3.
3.4. NG as process fuel (Calculated)	This field calculates NG used as process fuel using inputs in fields 3.2 and 3.3. No user input is required for this field.
3.5. Electricity from Utility Invoices	Input monthly total electricity from the grid in kWh for 24 months in field 3.5.
3.6. LNG Transport and Distribution	This field serves as a label for LNG transport and distribution section. Therefore, no input is required for field 3.6.
3.6.a. Select to affirm LNG delivery trucks are equipped with Boil-Off Recovery	If trucks transporting LNG are equipped to recover "Boil-Off," select "Yes" or "No" in field 3.6.a.
3.6.b. Enter Transport Distance from Liquefaction Plant to station	Input distance from liquefaction facility to the intended LNG or L-CNG dispensing station in Oregon in field 3.6.b. Additional details are included below in Table D.3.
3.7. Specify GHG Emission Factor for Electricity Mix	If "User Defined Mix" is selected in field 3.1, consult with DEQ staff to develop a user-defined GHG emissions factor and input in this field in cell U28. Data sources for User-Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
"Calculate" Button	After inputting all data in Section 3, click the "Calculate" button (cell T22) to calculate pathway CIs for the LNG and L-CNG pathways.

Additional Details for Section 3

Transport of LNG to dispensing facility (Field 3.6.b)

Driving distance between any two locations may be determined using a publicly available web-based driving distance estimator if fuel is dispensed at a single station. However, if multiple dispensing facilities are utilized, a volume weighted average transport distance based on 24 months of sales records must be used for LNG distribution to fueling facilities. Alternatively, the applicant could choose to use a more conservative value, such as the distance to the farthest fueling facility, to minimize the risk of exceeding the certified CI due to changes in the supply chain.

Section 4. CI calculation details

This section contains an example pathway CI calculation with a detailed breakdown of all calculations used for CI determination based on information entered by the user and applicable reference data.

Biomethane from anaerobic digestion of wastewater sludge

A. Introduction

This document provides detailed instructions for using the Simplified CI Calculator for Tier 1 Wastewater Sludge to Renewable Natural Gas (RNG) pathway applications. This Calculator is to be used to calculate the carbon intensity (CI) for Compressed Natural Gas (CNG), Liquefied Natural Gas (LNG), and Liquefied and subsequently Compressed Natural Gas (L-CNG) produced from biogas (also referred to as digester gas) generated by the anaerobic digestion of wastewater sludge at a publicly-owned treatment works (POTW). Each required specific input in the Calculator has been numerically labeled (i.e., 1.1, 1.2, etc.) so that users can follow the sequence and enter information as required.

Download the Simplified CI Calculator here:
https://www.oregon.gov/deq/ghgp/cfp/Pages/Clean-Fuel-Pathways.aspx

The Calculator has been automated to perform CI calculations using factors from the OR-GREET3.0 model. Applicants must add facility information and verifiable monthly feedstock, operational energy use, fuel production, co-product data, and transport distances used to calculate the CI of biomethane derived from the anaerobic digestion of wastewater sludge at a POTW.

This Calculator includes reference material such as greenhouse gas emissions factors used in OR-GREET3.0 and reference fuel specifications. Also included with the Calculator is a detailed breakdown of the calculations used to determine the final CI of each fuel pathway.

The applicant may only enter values or make selections in input fields designated by DEQ for user input/selection and may not change any other values or fields in the Calculator.

B. Color legend used in the calculator

The Calculator uses the following color legend to differentiate required inputs, calculated values, etc., as described below:

Yellow cells require user input
Light Blue cells show CI results
Green Cells show the calculation button
Gray Cells are calculated values

C. Calculator overview

The following table provides an overview of the tabs used in the Simplified CI Calculator (Calculator).

Table C.1. Overview of Tabs Used in the Simplified CI Calculator

Tab Name	Description
RNG Summary	Summary worksheet. Contains an overall summary of the information entered in the "RNG" tab of the calculator and calculated CIs for wastewater sludge-derived CNG, LNG, and L-CNG. If desired, a **conservative margin of safety** may be added to the calculated CI in this tab to establish the final CI.
RNG	Main calculation worksheet. Contains the main components of the calculator with fields requiring user inputs and other intermediate and final parameters calculated by the sheet. Calculations in grayed out cells are automatically calculated but dependent upon input to yellow cells in the corresponding sections of the calculator. This tab also includes CI calculations using inputs in this tab. Additional detailed instructions are included below.
EF Table	Reference worksheet. Contains greenhouse gas emissions factors from the OR-GREET3.0 model used in calculating carbon intensities.
Reference	Reference worksheet. Contains physical property specifications of fuels (i.e., HHV, LHV, density, carbon ratio, etc.), global warming potentials (GWP) of greenhouse gases, unit conversion factors, tailpipe emissions factors, LNG boil-off emissions factors, and other information used for calculating the CIs of the finished fuels.

D. RNG tab

The "RNG" tab contains the main CI calculation worksheet and consists of the following major sections:

- Section 1. Applicant Information
- Section 2. Biomethane Production Data
- Section 3. CNG, LNG, and L-CNG Production and Transport Data
- Section 4. CI Calculation Details

Section 1. Applicant information for biomethane production

The following table lists the fields used in Section 1 of the RNG tab.

Table D.1. List of Input Fields for Section 1 of the Simplified CI Calculator

Field Name	Description
1.1. Company Name	Registered name of the company. Example "ABC Company, LLC" or "ABC Company, Inc."
1.2. Company ID	Enter U.S. EPA Company ID. If not available, contact DEQ for LCFS Company ID.

1.3. Facility ID	Enter the Company's Facility ID. If not available, contact DEQ for LCFS Facility ID.
1.4. POTW Name and Location	Name and address of the POTW (Street, City, State).
1.5. LNG Liquefaction Facility Location	Location of the liquefaction facility (Street, City, State).
1.6. Application Number	Enter the application number generated by the AFP.
1.7. CNG Dispensing Station(s) Location	Location of Oregon CNG dispensing station (Street, City, State). For multiple stations, use Salem as the endpoint (the Standard Station Centroid location). See additional details for field 2.11.a below Table D.2.
1.8. LNG Dispensing Station(s) Location	Location of LNG dispensing station (Street, City, State). For multiple stations, calculate a centroid location based on a weighted average of fuel dispensing stations to which LNG is supplied. See additional details for field 3.6.b below Table D.3.
1.9. L-CNG Dispensing Station(s) Location	Location of L-CNG station (Street, City, State). For multiple stations, calculate a centroid based on a weighted average of fuel dispensing stations to which L-CNG is supplied. See additional details for field 3.6.b below Table D.3.

Section 2. Biomethane production data

The following table lists the fields used in Section 2 of the RNG tab. Additional details are included below in Table D.2.

Table D.2. List of input fields for biogas processing

Field Name	Description
2.1. Select Regional Electricity Mix for Biomethane	Choose the electricity mix corresponding to the zip code for the region where the biogas upgrading plant is located. The Calculator includes 26 eGRID zone mixes, an average Brazilian mix, an average Canadian mix, and a User Defined Mix to select from in the pull-down menu. For facilities in the U.S., select one of the 26 eGRID zones available. If the upgrading facility is located outside the U.S., select "User Defined Mix." For facilities that use biogas for electricity production, choose the User Defined Mix option in field 2.1. After selecting an electricity mix option, click the "**Calculate**" button. If the "User Defined Mix" is selected, consult with DEQ staff to develop an emissions factor for the User Defined Mix to be input as detailed in field 2.12. Additional details are included below in Table D.2.
2.2. Provisional Pathway?	If there are less than 24 months of available data, select "Yes,"; otherwise, choose "No." If the application is for a provisional pathway, available input months of operational data. A minimum of three months of operational data is required to meet provisional pathway certification requirements.
2.3. Monthly Data	Input the months and year(s) corresponding to the operational data provided.
2.4. Digester Gas Flow (metered)	Input monthly dry digester gas production flow rate data for 24 months of operation. The volume measured must be corrected to 60°F. Specific requirements are detailed below in Table D.2.

2.5. Methane Content (% Methane)	Input monthly volume weighted average methane concentration data (measured as dry biogas) for 24 months of operation. Specific requirements are detailed below in Table D.2.
2.6. Facility Use of Utility Sourced NG	Input monthly total buyback fossil natural gas use from a pipeline source (or other) in MMBtu from utility invoices (reported in HHV) for 24 months of operation. If buyback gas is used to boost the Btu of biomethane to meet pipeline specifications, do not include this quantity of NG in this field (monthly basis). This will be input separately in field 2.8.
2.7. Facility Electricity Use for Digester Gas Upgrading	Input monthly total electricity use from the grid in kWh from utility invoices for 24 months in this field. If biogas-derived electricity is generated on-site, input metered quantity of electricity in this field, in addition to ensuring that the emissions factor for the User Defined Mix is included in field 2.12. Electricity produced by the Combined Heat and Power (CHP) unit and consumed by other units of the wastewater treatment plant is considered to be part of the baseline case and should not be included in the pathway.
2.8. Buy Back fossil NG to boost Btu before pipeline injection	Input monthly total quantity of buyback fossil NG (in MMBtu, HHV) in field 2.8 if NG is used to boost biomethane energy content to meet pipeline specification. This quantity is not used in CI calculations. Subtract this quantity of fossil NG when reporting pipeline injected biomethane in field 2.10. See additional details below in Table D.2.
2.9. Propane used to boost Btu before pipeline injection	Input monthly total quantity of propane (if applicable, in gallons at ambient temperature) in field 2.9 if propane is used to boost biomethane energy content to meet pipeline specifications. This quantity is not used in CI calculations. Subtract this quantity of propane when reporting pipeline injected biomethane in field 2.10. See additional details below in Table D.2.
2.10. Biomethane injected into pipeline (metered)	Input monthly total biomethane injected into the pipeline in MMBtu (as HHV) for 24 months in field 2.10. The quantity must be supported by the installation of utility-grade meters. Subtract monthly total fossil NG, or propane blended with biomethane to meet pipeline specifications from the injected quantity (in MMBtu). See additional details below in Table D.2.
2.11. NG pipeline Transmission	This field includes a label for NG pipeline transmission and does not require input.
2.11.a From upgrading facility to CNG Station	Input distance from biogas processing facility to the intended CNG station in Oregon in field 2.11.a. If fuel is sent to multiple stations, use the Standard Station Centroid of Salem as the endpoint. Additional details can be found below in Table D.2.
2.11.b. From upgrading facility to LNG plant	Input distance from biogas processing facility to the liquefaction facility in field 2.11.b. This is required only if the application includes LNG and L-CNG fuel pathways. Additional details can be found below in Table D.2.
2.12. Specify GHG Emissions Factor for Electricity Mix	If "User Defined Mix" is selected in field 2.1, consult with DEQ staff to develop a user-defined GHG emissions factor and input this field in cell K26. Data sources for User Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
"Calculate" Button	After all data in Section 2 are entered, click the "Calculate" button (cell G22) in Section 2 to calculate CI for the CNG pathway.

Additional details for section 2 and table D.2

Using biogas to generate electricity for biogas upgrading (Field 2.1)

Although the Calculator can accommodate facilities that use biogas to generate electricity for biogas upgrading, applicants must declare the use of on-site electricity generation and consult DEQ staff to determine a user-defined emissions factor. A dedicated meter to quantify biogas-derived electricity in kWh must be used to report the use of this electricity in the Calculator sheet.

Raw digester gas sourced from the anaerobic digester (Field 2.4)

Requires a dedicated flow measurement system with temperature measurement to enable reporting of the total monthly raw digester gas flow quantity at 1 atmosphere pressure and 60°F (dry gas corrected for moisture). The flow measurement system must be installed upstream of the valve used to divert gas flow to the flare, combined heat, and power (CHP) unit, or the feed compressor to the biogas upgrading plant. The system must also be calibrated per the manufacturer's requirement and scaled to measure the entire range of potential flow of biogas. Measurement must be continuous, and all data must be electronically archived (manual recording is not acceptable). The direct metering of the quantity and percentage methane concentration of biogas captured from the digester are not used in CI calculations but rather as a check to ensure that total biomethane sales do not exceed the biogas quantity produced or generated in the digester. If biogas is used for electricity generation, the applicant must report metered quantity of biogas used for electricity generation in the supplemental document and metered quantity of electricity generated on-site.

Methane content (% Methane in Field 2.5)

Input monthly weighted average methane concentration (dry gas basis) in the digester gas. Methane concentration measurement must be recorded every 15 minutes (at a minimum) with instrumentation capable of electronic archival (manual recording will not be acceptable). The methane measurement system requires calibration per the manufacturer's requirement and is scaled to measure the entire potential range of methane concentration in the biogas.

Dedicated metering of buyback NG and propane (Field 2.8 and 2.9)

For biogas upgrading facilities that use buyback natural gas (NG) or propane to boost the Btu of biomethane before pipeline injection (to meet pipeline specifications), dedicated metering must be installed to substantiate quantities of NG or propane used for this purpose. If dedicated metering is not installed or not verifiable, all NG and propane reported in fields 2.8 and 2.9, respectively, will be added to NG reported in field 2.6 (and considered used for upgrading biogas).

Biomethane injected into the pipeline (Field 2.10)

The monthly quantity of biomethane input in field 2.10 must correspond to the quantity of biomethane (in MMBtu) injected into the pipeline. However, since this quantity may include NG or propane blended with biomethane to meet pipeline specifications, the use of any non-renewable gas must be explicitly disclosed through invoices. The quantity entered in field 2.10 would include only the biomethane quantity; any fossil inputs must be subtracted from the actual quantity injected into the pipeline that was purchased by the local utility or other parties. This reporting is consistent with quantities reported for RIN generation under the RFS, based on the Btu of the pipeline quality biogas after treatment and before any blending with non-renewable fuel or injection into a pipeline.

Note: CI calculations for biomethane are performed on a net MMBtu injected by subtracting all fossil NG and propane inputs (including quantities used in a flare or thermal oxidizer) from renewable biomethane (in MMBtu) injected into the pipeline.

Pipeline transport distance for renewable natural gas (Fields 2.11.a and 2.11.b)

For pipeline transport distance from a biogas processing facility to a CNG dispensing station or to a liquefaction facility, driving distances between the two locations may be determined using a publicly available web-based driving distance estimator. For RNG to CNG pathways that use multiple dispensing stations, applicants using multiple dispensing stations may use the driving distance from the POTW in the U.S. or Canada to Salem, Oregon as the pipeline transmission distance in the Simplified CI Calculator (or Tier 2 if applicable). Alternatively, the applicant could choose to use a more conservative value, such as the distance to the farthest fueling facility, to minimize the risk of exceeding the certified CI due to changes in the supply chain.

Section 3. CNG, LNG, and L-CNG production and transport data

Table D.3 provides details of inputs for LNG and L-CNG pathways. Additional details are included below in Table D.3.

Table D.3. List of Input Fields for Section 3 of the Simplified CI Calculator

Field Name	Description
3.1. Select Regional Electricity Mix for LNG Production	Choose the electricity mix corresponding to the zip code for the region where the liquefaction plant is located. The Calculator includes 26 eGRID zone mixes, an average Brazilian mix, an average Canadian mix, and a User Defined Mix in the pull-down selection menu. For facilities located in the U.S., select one of the 26 eGRID zones available. After selecting an electricity mix option, click the "**Calculate**" button. If the "User Defined Mix" is selected, consult with DEQ staff to develop an emissions factor for the User Defined Mix to be input in field 3.7. Data sources for User Defined electricity mixes must be documented in the Supplemental Documentation included during the submission of the Simplified CI Calculator.
3.2. NG from NG purchase invoices	Input monthly total fossil-based NG sourced from a pipeline source (or other) in MMBtu from utility invoices (reported in HHV) for 24 months of operation in field 3.2. The input includes fossil NG used as process fuel and liquefied to LNG. Renewable attributes to support renewable biomethane dispensed must be provided to the verifier during the on-site audit.
3.3. LNG Production from Production Log	Input monthly total LNG produced in gallons (reported at ambient temperature) for 24 months in field 3.3.
3.4. NG as process fuel (Calculated)	This field calculates NG used as process fuel using inputs in fields 3.2 and 3.3. No user input is required for this field.
3.5. Electricity from Utility Invoices	Input monthly total electricity use from the grid in kWh for the 24 months of operation in field 3.5.
3.6. LNG Transport and Distribution	This field serves as a label for the LNG transport and distribution section. No input is required for field 3.6.
3.6.a. Select to affirm that LNG delivery trucks are equipped with Boil-Off Recovery	If trucks transporting LNG are equipped to recover "Boil-Off," select "Yes," else "No" in field 3.6.a.

3.6.b. Enter Transport Distance from Liquefaction Plant to dispensing station	Input distance from liquefaction facility to the intended LNG or L-CNG dispensing station in Oregon in field 3.6.b. Additional details are included below in Table D.3.
3.7. Specify GHG Emission Factor for Electricity Mix	If "User Defined Mix" is selected in field 3.1, consult with DEQ staff to develop a user-defined GHG emissions factor and input this emissions factor into cell S28. Data sources for User Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
"Calculate" Button	After all, data are input in Section 3, click the "Calculate" button (cell R22) to calculate pathway CIs for the LNG and L-CNG pathways.

Additional details for section 3

Transport of LNG to dispensing facility (Field 3.6.b)

Driving distance between any two locations may be determined using a publicly available web-based driving distance estimator if fuel is dispensed at a single station. If multiple dispensing facilities are utilized, a volume-weighted average transport distance based on 24 months of sales records must be used for LNG distribution to fueling facilities. Alternatively, the applicant could choose to use a more conservative value, such as the distance to the farthest fueling facility, to minimize the risk of exceeding the certified CI due to changes in the supply chain.

Section 4. CI calculation details

This section provides a detailed breakdown of CI calculations using inputs in the RNG tab and applicable reference data. In addition, standard inputs and corresponding GHG emissions are detailed in this section.

Biomethane from anaerobic digestion of dairy and swine manure

A. Introduction

This document provides detailed instructions for using the Tier 1 Simplified CI Calculator for Biomethane from Anaerobic Digestion of Dairy and Swine Manure pathway applications. This Calculator is to be used to calculate the carbon intensity (CI) for Compressed Natural Gas, Liquefied Natural Gas (LNG), and Liquefied and subsequently Compressed Natural Gas (L-CNG) from dairy cattle and swine manure anaerobic digesters. In this Calculator, only dairy cattle, swine manure, and co-feedstocks from the same production systems (e.g., milk wastes) are eligible for the offset credits for greenhouse gas (GHG) emission reductions. Pathways for biomethane from other types of manure or organic wastes (such as animal bedding, post-consumer food waste, and green waste) should use the "Tier 1 Simplified CI Calculator for Biomethane from Anaerobic Digestion of Food, Green, and Other Organic Wastes." Each required specific input in the Calculator has been numerically labeled (i.e., 1.1, 1.2, etc.) so that users can follow the sequence and enter information as required.

Download the Simplified CI Calculator here:
https://www.oregon.gov/deq/ghgp/cfp/Pages/Clean-Fuel-Pathways.aspx

The Calculator has been automated to perform CI calculations using factors from the OR-GREET3.0 model. In addition, applicants must add facility information and verifiable monthly feedstock, operational energy use, fuel production, co-product data, and transport distances used in calculating the CI of biomethane from dairy and swine manure digesters.

This Calculator includes additional reference material such as greenhouse gas emissions factors, reference fuel specifications used in OR-GREET3.0, and certain emission factors from the Compliance Offset Protocol Livestock Projects (November 2014). In addition, the Calculator provides a detailed breakdown of the calculations used to determine the CI of each fuel pathway. The CI is not final until certified by DEQ.

The applicant may only enter values or make selections in input fields designated by DEQ for user input/selection and may not change any other values or fields in the Calculator.

B. Color legend used in the calculator

The Calculator uses the following color legend to differentiate required inputs, calculated values, etc., as described below:

Yellow cells require user input
Light Blue cells show CI results
Green Cells show the calculation button
Gray Cells are calculated values

C. Calculator overview

The following table provides an overview of the tabs used in the Simplified CI Calculator.

Table C.1. Overview of tabs used in the Simplified CI Calculator

Tab Name	Description
RNG Summary	The summary worksheet contains an overall summary of the information entered in the "Biogas-to-RNG" tab of the calculator and calculated CIs for livestock manure digester biogas to CNG, LNG, and L-CNG. If desired, a **conservative margin of safety** may be added to the calculated CI in this tab to establish the final CI.
Manure-to-Biogas (LOP Inputs)	This calculation worksheet is based on selected equations from the "Compliance Offset Protocol Livestock Projects"[1] ("LOP" hereafter). The user inputs related to baseline and project methane emissions are indicated in yellow cells, and automatically calculated values are in gray cells.
Avoided Emissions	The avoided methane calculation worksheet contains the values related to baseline and project methane emissions and quantifies avoided methane and diverted CO_2 from land applications.
Biogas-to-RNG	This calculation worksheet contains the user inputs related to fuel production (biogas to biomethane) indicated in yellow, automatically calculated values in gray cells, and estimated CI results in blue.
EF Table	This reference worksheet contains greenhouse gas emissions factors from the OR-GREET3.0 model and the LOP used in calculating carbon intensities.
Reference	This reference worksheet contains specifications of fuels (i.e., HHV, LHV, density, carbon ratio), global warming potentials of greenhouse gases, unit conversions, tailpipe emissions, LNG boil-off emissions, and other information used in calculating CIs. In addition, the relevant tables in the LOP appendix are also listed in this tab.

D. Manure-to-Biogas (LOP Inputs) tab

The "Manure-to-Biogas (LOP Inputs)" tab contains the calculation sheet for selected parameters of the baseline and the project methane emissions ("LOP" is the acronym for ARB's "Compliance Offset Protocol Livestock Projects" in this document). This tab consists of the following major sections:

- Section L1: [Equation 5.3 in LOP] Baseline Methane Emissions from Anaerobic Storage/Treatment Systems ($BE_{CH4,AS}$)
- Section L2: [Equation 5.4 in LOP] Baseline Methane Emissions from Non-Anaerobic Storage/Treatment Systems ($BE_{CH4,nAS}$)
- Section L3: [Equation 5.6-Venting in LOP] Project Methane Emissions from Venting Events ($CH_{4\ vent}$) in the Biogas Control System (BCS)

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[1] California Air Resources Board. Compliance Offset Protocol Livestock Projects – Capturing and Destroying Methane from Manure Management Systems. Adopted on Nov. 14, 2014. https://www.arb.ca.gov/regact/2014/capandtrade14/ctlivestockprotocol.pdf

- Section L4: [Equation 5.8 in LOP] Project Methane Emissions from the BCS Effluent Pond(s) ($PE_{CH4,EP}$)
- Section L5: [Equation 5.9 in LOP] Project Methane Emissions from *Non*-BCS Related Sources ($PE_{CH4,nBCS}$)

Section L1: [Equation 5.3 in LOP] baseline methane emissions from anaerobic storage/treatment systems ($BE_{CH4,AS}$)

This section quantifies the modeled baseline methane emissions from the anaerobic storage/treatment system. Up to six livestock categories that deposit manure to the same baseline system can be modeled in this section. The following table lists the fields for Section L1.

Table D.1. List of input fields for section L1 of the Simplified CI Calculator

Field Name	Description
L1.(1-6).1 Livestock Category (L)	Select a livestock category for each sub-section; each sub-section represents one specific livestock. Users can enter information for up to six livestock categories in six corresponding sub-sections.
L1.(1-6).2 Livestock Average Mass	The average mass of the livestock selected in L1.(1-6).1. See Table A.1 in the LOP.
L1.(1-6).3 Maximum CH$_4$ Potential	The maximum methane potential of the livestock selected in L1.(1-6).1. See Table A.2 in the LOP.
L1.(1-6).4 Livestock Excretion Rate	The daily manure excretion by the livestock selected in L1.(1-6).1, measured in volatile solids. See Table A.2 and A.4 in the LOP.
L1.(1-6).5 Monthly Data	Input the months and year(s) corresponding to the operational data provided.
L1.(1-6).6 Livestock Population	The monthly average population of the livestock selected in L1.(1-6).1
L1.(1-6).7 Calendar Days of the Month	Total calendar days of the reporting month.
L1.(1-6).8 Number of Reporting Days	The number of reporting days in the month.
L1.(1-6).9 Average Temperature	The monthly average ambient temperature (reported in degrees Celsius)
L1.(1-6).10 Van't Hoff-Arrhenius factor	Factor associated with chemical reaction.
L1.(1-6).11 Fraction of Volatile Solids Sent to Anaerobic Storage/Treatment System	The fraction of manure (volatile solids) that would be sent to the anaerobic storage/treatment system for each livestock category, taking into account any volatile solids removed by solid separation equipment in the baseline case, as if the project BCS was never installed. Site-specific data must be used if available. If site-specific data is unavailable, values from Table A.9 of the LOP can be used. This table can also be found in the "Reference" tab.
L1.(1-6).12 Volatile Solids Available for Degradation	Monthly volatile solids are available for degradation from anaerobic manure storage/treatment system 'AS' by the livestock selected in L1.(1-6).1.
L1.(1-6).13 Retention Time and Drainage	Select the appropriate options. The volatile solids retained in the system from the previous month must be set to zero, (1) If the volatile solids retention time in the anaerobic storage or treatment system is less than or equal to 30 days, or (2) if the anaerobic storage or treatment system is completely drained and cleaned.

	The difference between the VS available for degradation and the VS degraded from the previous month. If this is the project's first year, enter zero in the first month; otherwise, enter the VS carried over from December of the previous year.
L1.(1-6).14 Carryover from Previous Month	
L1.(1-6).15 Volatile Solids Degraded	Monthly volatile solids degraded by anaerobic manure storage/treatment system 'AS' by the livestock selected in L1.(1-6).1.
L1.(1-6).16 Baseline Methane Emissions, AS	The modeled baseline methane emissions from anaerobic manure storage/treatment systems.

Section L2: [Equation 5.4 in LOP] baseline methane emissions from non-anaerobic storage/treatment systems (BE$_{CH4,nAS}$)

This section quantifies the baseline methane emissions from non-anaerobic storage/treatment systems. The following table lists the fields for Section L2.

Table D.2. List of input fields for section L2 of the Simplified CI Calculator

Field Name	Description
L2.1 Non-anaerobic Storage/Treatment Systems	Select the non-anaerobic storage/treatment systems that are applicable.
L2.2 Methane Conversion Factor	Methane conversion factor for non-anaerobic storage/treatment system. See Table A.5 in the LOP. This factor is determined by the selection in L2.1.
L2.3 Manure Managed in Non-Anaerobic Storage/Treatment Systems	The fraction of manure (volatile solids) that would be sent to the non-anaerobic storage or treatment system for each livestock category, taking into account any volatile solids removed by solid separation equipment in the baseline case, as if the project BCS was never installed. Site-specific data must be used if available. If site-specific data is unavailable, values from Table A.9 of the LOP can be used to calculate the fraction sent to non-anaerobic systems. This table can also be found in the "Reference" tab.
L2.4 Baseline Methane Emissions, non-AS	The modeled baseline methane emissions from non-anaerobic manure storage/treatment systems.

Section L3: [Equation 5.6-Venting in LOP] project methane emissions from venting events (CH$_{4\ vent}$) in the Biogas Control System (BCS)

This section quantifies the BCS system project methane emissions from venting events only. Other emissions directly associated with the biomethane production in the BCS project this Simplified CI Calculator evaluates in the "Biogas-to-RNG" tab. The following table lists the fields for Section L3.

Table D.3. List of input fields for section L3 of the Simplified CI Calculator

Field Name	Description
L3.1 Monthly Data	Input the months and year(s) corresponding to the operational data provided.
L3.2 Maximum Biogas Storage of the BCS System	The maximum biogas storage of the BCS system must be calculated using project-specific information and design documentation.

L3.3 Average Daily Biogas Production for the 7 Days Preceding the Venting	The quarterly methane concentration is used for the entire month and all subsequent months until a new methane concentration is taken. A weighted average of more frequent samples may also be used.
L3.4 Number of Days for the Uncontrolled Venting	The monthly methane quantity results vented to the atmosphere due to BCS venting events.
L3.5 Quarterly Methane Concentration	The quarterly methane concentration is used for the entire month and all subsequent months until a new methane concentration is taken. A weighted average of more frequent samples may also be used.
L3.6 Project Methane Emissions from Venting	The monthly methane quantity results vented to the atmosphere due to BCS venting events.

Section L4: [Equation 5.8 in LOP] project methane emissions from the BCS effluent pond(s) (PE$_{CH4,EP}$)

This section quantifies the methane emissions from the BCS pond where the effluent from the BCS project is held. The following table lists the fields for Section L4.

Table D.4. List of Input Fields for Section L4 of the Simplified CI Calculator

Field Name	Description
L4.1 Livestock Category	These are the same livestock categories selected in Section L1.
L4.2 Average Population	The average population of each livestock category is based on monthly population data for a given reporting period.
L4.3 Livestock Excretion Rate	The daily manure excretion by the livestock category, measured in volatile solids. See Table A.2 and A.4 in the LOP. These are the same values entered in fields L1.(1-6).4.
L4.4 Maximum CH$_4$ Potential	The maximum methane potential of each livestock category. See Table A.2 in the LOP. These are the same values entered in fields L1.(1-6).3.
L4.5 Fraction of Volatile Solids Sent to BCS System	The fraction of manure (volatile solids) that would be sent to the BCS system for each livestock category, taking into account any volatile solids removed by solid separation equipment. Site-specific data must be used if available. If site-specific data is unavailable, values from Table A.9 of the LOP can be used. This table can also be found in the "Reference" tab.
L4.6 Volatile Solids to Effluent Ponds	Results of the amount of manure (volatile solids) that is sent to the effluent ponds daily by the livestock category.
L4.7 Number of Reporting Days	Total number of reporting days in the reporting period.
L4.8 Methane Conversion Factor	The methane conversion factor for the effluent pond (liquid/slurry uncovered). See Table A.5 in the LOP.
L4.9 Project Methane Emission from Effluent Ponds	Results of the total methane emissions from the project BCS effluent ponds.

Section L5: [Equation 5.9 in LOP] project methane emissions from non-BCS related sources (PE$_{CH4,nBCS}$)

This section quantifies the project methane emissions from waste treatment and storage sources other than the BCS and associated effluent pond. The following table lists the fields for Section L5.

Table D.5. List of input fields for section L5 of the Simplified CI Calculator

Field Name	Description
L5.1.a Other Anaerobic Storage/Treatment Systems	Select other non-BCS anaerobic storage/treatment systems that are applicable.
L5.1.b Non-anaerobic Storage/Treatment Systems	Select the non-anaerobic storage/treatment systems that are applicable.
L5.2 Methane Conversion Factor	Methane conversion factor for non-anaerobic storage/treatment system. See Table A.5 in the LOP. This factor is determined by the selection in L5.1.a and L5.1.b.
L5.3 Manure Managed in Non-BCS (Other) Systems	The fraction of manure (volatile solids) that would be sent to the anaerobic storage/treatment system for each livestock category, taking into account any volatile solids removed by solid separation equipment in the baseline case, as if the project BCS was never installed. Site-specific data must be used if available. If site-specific data is unavailable, values from Table A.9 of the LOP can be used. This table can also be found in the "Reference" tab.
L5.4 CH$_4$ Emission Factor, non-BCS	Methane emission factor for the livestock population from non-BCS related sources.
L5.5 Project Methane Emissions, non-BCS	The modeled project methane emissions from waste treatment and storage sources other than the BCS and associated effluent pond.

E. Avoided Emissions tab

The "Avoided Emissions" tab contains the additional calculation worksheet for avoided methane and CO$_2$ credits and consists of the following major sections:

- Section P1. Results from the "Manure-to-Biogas (LOP Inputs)" tab
- Section P2. Avoided CH$_4$ Emissions Calculation Details
- Section P3. Avoided CO$_2$ Emissions Calculation Details

Section P1. Results from the "Manure-to-Biogas (LOP Inputs)" tab

All the values in this section are calculated values based on the quantification methodology by ARB's "Compliance Offset Protocol Livestock Projects" (detailed calculation can be found in the "Manure-to-Biogas (LOP Inputs)" tab). The following table lists the fields for Section P1 of the "Avoided Emissions" tab.

Table E.1. List of Input Fields for Section P1 of the Simplified CI Calculator

Field Name	Description
P1.1 Select Digester Type	Select either "Covered Lagoon" or "Enclosed Vessel" as the type of livestock manure digester operated.
P1.2 Monthly Data	Input the months and year(s) corresponding to the operational data provided.
P1.3 Baseline methane emissions (BE$_{CH4 Mod}$)	Results of monthly baseline methane emissions calculated using the Equation 5.2 from the LOP.
P1.4 Project methane emissions	This field includes a label for project methane emissions and does not require an input

P1.4.a Venting methane ($CH_{4\ vent}$)	Results of the monthly quantity of methane vented to the atmosphere due to the digester venting events. These are calculated values based on the $CH_{4\ vent,i}$ the formula provided in the "Equation 5.6" section from the LOP.
P1.4.b Effluent ponds methane (PE$_{CH4,EP}$)	Result of monthly methane emissions from the digester effluent pond. This is a calculated value based on Equation 5.8 from the LOP.
P1.4.c Storage/Treatment methane (PE$_{CH4,nBCS}$)	Result of monthly methane emissions from the non-digester sources (waste treatment and storage). This is a calculated value based on Equation 5.9 from the LOP.
P1.4.d Digester leakage	Results of the monthly quantity of methane leakage from the digester.

Section P2. Avoided CH$_4$ emissions calculation details

This section contains an example of calculating the avoided methane emissions from land application.

Section P3. Avoided CO$_2$ emissions calculation details

This section contains an example of calculating the avoided CO$_2$ emissions diverted from land application.

F. Biogas-to-RNG tab

The "Biogas-to-RNG" tab contains the main CI calculation worksheet and consists of the following major sections:

- Section 1. Applicant Information
- Section 2. Biomethane Production Data
- Section 3. CNG, LNG, and L-CNG Production and Transport Data
- Section 4. CI Calculation Details

Section 1. Applicant information for biomethane production

The following table lists the fields used in Section 1 of the Biogas-to-RNG tab.

Table F.1. List of Input Fields for Section 1 of the Simplified CI Calculator

Field Name	Description
1.1 Company Name	Registered name of the company. Example "ABC Company, LLC" or "ABC Company, Inc."
1.2 Company ID	Enter U.S. EPA Company ID. If not available, contact DEQ for LCFS Company ID.
1.3 Facility ID	Enter the Company's Facility ID. If not available, contact DEQ for LCFS Facility ID.
1.4 Digester Location (Street, City, State)	Location of the anaerobic digester. Example: "AAA Livestock Manure Digestion Facility in Salem." Select the state from the drop-down menu.
1.5 LNG Liquefaction Facility	Location of the liquefaction facility (Street, City, State).

Location (Street, City, State)	
1.6 CNG Dispensing Station(s) Location (Street, City, State)	Location of Oregon CNG dispensing station (Street, City, State). For distribution to multiple Oregon stations, use Salem as the endpoint in determining the (Standard Station Centroid location). See additional details below in Table F.2.
1.7 LNG Dispensing Station(s) Location (Street, City, State)	Location of LNG dispensing station (Street, City, State). For multiple stations, calculate a centroid location based on a weighted average of fuel dispensing stations to which LNG is supplied. See additional details for Field 3.6.b. below Table F.3.
1.8 L-CNG Dispensing Station(s) Location (Street, City, State)	Location of L-CNG station (Street, City, State). For multiple stations, calculate a centroid based on a weighted average of fuel dispensing stations to which L-CNG is supplied. See additional details for Field 3.6.b. below Table F.3.
1.9 Digester Type	The digester type is the same selection that appeared on the "Avoided Emissions" tab, section P1.1: either "Covered Lagoon" or "Enclosed Vessel."
1.10 Average Annual Temperature (°C)	Select the closest average annual temperature in °C.

Section 2. Biomethane production data

The following table lists the fields used in Section 2 of the Biogas-to-RNG tab. Additional details are included below in Table F.2.

Table F.2. List of input fields for biogas processing

Field Name	Description
2.1 Select Regional Electricity Mix for Biomethane	Choose the electricity mix corresponding to the zip code for the region where the livestock manure digester biogas upgrading plant is located. The Calculator includes 26 eGRID zone mixes, Brazilian average, Canadian average, and User Defined Mix in the pull-down menu. For facilities in the U. S., select one of 26 eGRID zones available for the U.S. If the upgrading facility is located outside the U.S., select "User Defined Mix." For facilities that use biogas for electricity production, choose the user-defined electricity option in field 2.1. After selecting an electricity mix option, click the "**Calculate**" button. If "User Defined Mix" is selected, consult with DEQ staff to develop an emission factor for the user-defined mix to be input as detailed in field 2.27. Data sources for User-Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
2.2 Provisional Pathway?	If there are less than 24 months of available data, select "Yes." Otherwise, choose "No" if the application is for a provisional pathway, and input available months of operational data, starting in Month 1 (minimum of three months of operating data required to meet provisional requirements).
2.3 Monthly Data	Input the months and year(s) corresponding to the operational data provided.

2.4 Total Raw Biogas Flow (metered)	Input monthly raw dry biogas flow (in Standard Cubic Feet at 60°F, 1 atm) data for 24 months (at least three months of data, if provisional). Specific requirements are detailed below in Table F.2.
2.5 Biomethane Content (% Methane)	Input monthly average methane concentration in raw dry biogas for 24 months (at least three months of data, if provisional) of operation. Specific requirements are detailed below in Table F.2.
2.6 Raw Biogas Flow to Upgrading (metered)	Input monthly raw biogas use (in Standard Cubic Feet at 60°F, 1 atm) for producing transportation fuels. See additional details below in Table F.2.
2.7 Biomethane Content (% Methane)	Input monthly weighted average methane concentration data (measured in raw dry biogas) for 24 months (at least three months of data, if provisional) of operation. Specific requirements are detailed below in Table F.2.
2.8 Diesel (baseline manure transport and handling)	Input monthly total diesel use (in gallons at ambient temperature) to transport and handle manure in the baseline case for 24 months (at least three months if provisional) in this field.
2.9 Utility Sourced NG (baseline)	Input monthly total fossil natural gas use (baseline case) from a pipeline source (or other) in MMBtu from utility invoices (reported in HHV) for 24 months (at least three months if provisional) of operation.
2.10 Grid Electricity (baseline manure pumping and solids separation)	Input monthly total electricity use (baseline case) from the grid in kWh from utility invoices for 24 months (at least three months if provisional) in this field.
2.11 Grid Electricity (for digester heating)	Input monthly total electricity use (digestion process) from the grid in kWh from utility invoices for 24 months (at least three months if provisional) in this field.
2.12 Biomethane (for digester heating)	Input monthly biomethane use (in MMBtu in HHV) for heat generation in a small industrial boiler (10-100 MMBtu/hr input) during digestion.
2.13 Utility Sourced NG (digester project)	Input monthly total fossil natural gas use (digestion process) from a pipeline source (or other) in MMBtu from utility invoices (reported in HHV) for 24 months (at least three months of data, if provisional) of operation.
2.14 Diesel (digester project manure transport and handling)	Input monthly total diesel use (gallons at ambient temperature) in transporting and handling manure for the digestion process for 24 months (at least three months of data, if provisional).
2.15 Utility Sourced NG (upgrading and compression)	Input monthly total fossil natural gas use (biomethane upgrading and compression) from a pipeline source (or other) in MMBtu from utility invoices (reported in HHV) for 24 months (at least three months of data, if provisional).
2.16 Biomethane (as Process Fuel for upgrading and compression)	Input monthly biomethane use (in MMBtu in HHV) as process fuel in a small industrial boiler (10-100 MMBtu/hr input) for the biomethane upgrading and compression process.
2.17 On-Site Electricity from Biogas (upgrading and compression)	Input monthly total electricity use (biomethane upgrading and compression) from the electricity generated on-site from a biogas-fueled reciprocating engine (in kWh).
2.18 Grid Electricity (upgrading and compression)	Input monthly total electricity use (biomethane upgrading and compression) from the grid in kWh from utility invoices for 24 months (at least three months of data, if provisional) in this field.

2.19 Buy Back fossil NG to boost Btu before pipeline injection	Input monthly total quantity of buyback fossil NG (in MMBtu, HHV) if NG is used to boost biomethane energy content to meet pipeline specifications. This quantity is not used in CI calculations. Subtract this quantity of fossil NG when reporting pipeline injected biomethane in field 2.23. Additional details are included below in Table F.2.
2.20 Propane used to boost Btu before pipeline injection	Input monthly total quantity of propane (in gallons at ambient temperature) if propane is used to boost biomethane energy content to meet pipeline specifications. This quantity is not used in CI calculations. Subtract this quantity of propane when reporting pipeline injected biomethane in field 2.23. Additional details are included below in Table F.2.
2.21 Flared gas, including tailgas from upgrading (metered biogas)	Input monthly total volume of biogas flared, which includes the upgrading tailgas.
2.22 Biomethane Content (% Methane in Flared Gas)	Input monthly weighted average methane concentration in flared gas for 24 months (at least three months of data, if provisional) of operation.
2.23 Biomethane Injected into Pipeline for Transportation Fuel Production (metered), (subtract buyback NG and Propane if used to boost Btu)	Input monthly total biomethane injected into the pipeline (in MMBtu) for 24 months (at least three months of data, if provisional). The sales receipts must support the quantity. See additional details below in Table F.2.
2.24 Biomethane to Electricity Production	Input monthly total biomethane (in MMBtu, HHV) used for electricity production on-site for 24 months (at least three months of data, if provisional). Assuming 100% biomethane content.
2.25 On-site Electricity Production	Input monthly total electricity from the biomethane for 24 months (at least three months of data, if provisional).
2.26 Export Electricity	Input monthly total electricity produced from the biomethane and exported for 24 months (at least three months of data, if provisional).
2.27 NG pipeline Transmission	This field includes a label for NG pipeline transmission and does not require input.
2.27.a From upgrading facility to CNG Station	Input distance from the biogas processing facility to the intended CNG station in Oregon. If fuel is sent to multiple stations, use the Standard Station Centroid of Salem as the endpoint. Additional details are below in Table F.2.
2.27.b From upgrading the facility to the LNG plant	Input distance from the biogas processing facility to the liquefaction facility. This is required if the pathway application includes LNG and L-CNG pathways. Additional details are below in Table F.2.
2.28 Specify GHG Emission Factor for Electricity Mix	If "User Defined Mix" is selected in field 2.1, consult with DEQ staff to develop a user-defined GHG emissions factor and input in this field in cell AA28. Data sources for User-Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
"Calculate" Button	After all data in Section 2 are entered, click the "Calculate" button (cell E24) in Section 2 to calculate CI for the CNG pathway.

Additional details for section 2 and table F.2

Inlet raw biogas sourced from the digester (Field 2.4, and 2.6)

Requires a dedicated flow measurement system with temperature measurement to enable reporting of gas flow at 1 atm. pressure and 60°F (dry gas flow corrected for moisture) to account for monthly total raw biogas volume sourced from the digester (Field 2.4) and the raw biogas volume used for upgrading to transportation fuels (Field 2.6). The flow measurement system must be calibrated per manufacturer's requirement and scaled to measure the entire range of potential flow of biogas. Measurement must be continuous, and all data must be electronically archived (manual recording is not acceptable). The direct metering of the quantity and percentage methane concentration of biogas captured from the digester is not used in CI calculations but rather as a check to ensure that total biomethane sales do not exceed the biogas quantity sourced from the digester. If biomethane is used for electricity generation on-site, the applicant must report the metered quantities of (1) biogas used for electricity generation, (2) electricity generated from biomethane, and (3) the exported electricity from biomethane.

Methane content (% Methane in Field 2.5 and 2.7)
Input monthly weighted average methane concentration (dry gas basis). Methane measurement must be recorded every 15 minutes (at a minimum) with instrumentation capable of electronic archival (manual recording will not be acceptable). The methane measurement system requires calibration per the manufacturer's requirement and is scaled to measure the entire potential range of methane concentration in the biogas.

Using biomethane to generate electricity for biogas upgrading (Field 2.16)
Although the Calculator can accommodate facilities that use biomethane to generate electricity for biogas upgrading, applicants must declare the use of on-site electricity generation and consult CARB staff before submission of a pathway application. A dedicated meter to quantify biomethane-derived electricity in kWh (Field 2.16) must be used to report the use of this electricity in the Calculator sheet.

Dedicated metering of buyback NG and propane (Field 2.19 and 2.20)
For digester gas upgrading facilities that use buyback natural gas (NG) or propane to boost the Btu of biomethane before pipeline injection (to meet pipeline specifications), dedicated metering must be installed to substantiate quantities of NG or propane used for this purpose. If dedicated metering is not installed or not verifiable, all NG reported in field 2.19 will be added to NG, and propane reported in field 2.15 (and considered used for upgrading biogas).

Net biomethane injected into pipeline (Field 2.23)
Because the monthly total quantity of the pipeline injection (in MMBtu) may include NG or propane blended with biomethane to meet pipeline specifications, the use of any non-renewable gas must be explicitly disclosed through invoices. The quantity entered in field 2.23 shall include only the net biomethane quantity; any fossil inputs must be subtracted from the quantity injected into the pipeline that the local utility or other parties purchased. This is consistent with quantities reported for RIN generation under the RFS, based on the Btu of the pipeline quality biogas after treatment and before any blending with non-renewable fuel or injection into a pipeline.

Note: CI calculations for biomethane are performed on a net MMBtu injected by subtracting all fossil NG and propane inputs (including quantities used in a flare, thermal oxidizer, or biogas processing) from renewable biomethane (in MMBtu) injected into the pipeline.

Pipeline transport distance for renewable natural gas (Fields 2.27.a and 2.27.b)
For pipeline transport distance from a biogas processing facility to a CNG dispensing station or to a liquefaction facility, driving distances between the two locations may be determined using a

publicly available web-based mapping. For RNG to CNG pathways that use multiple dispensing stations, applicants using multiple dispensing stations may use the driving distance from a digester in the U.S. or Canada to Salem, OR, as the pipeline transmission distance in the Simplified CI Calculator (or Tier 2 if applicable). Alternatively, the applicant could choose to use a more conservative value, such as the distance to the farthest fueling facility, to minimize the risk of exceeding the certified CI due to changes in the supply chain.

Section 3. CNG, LNG, and L-CNG production and transport data

Table F.3. provides details of inputs for LNG and L-CNG pathways. Additional details are included below in Table F.3.

Table F.3. List of input fields for section 3 of the Simplified CI Calculator

Field Name	Description
3.1 Select Regional Electricity Mix for LNG Production	Choose the electricity mix corresponding to the zip code for the region where the liquefaction plant is located. The Calculator includes 26 eGRID zone mixes, average Brazilian mix, average Canadian mix, and User Defined Mix in the pull-down menu. For facilities in the U. S. select one of 26 eGRID zones available for the U. S. If the liquefaction facility is located outside the U. S., select the "User Defined Mix." After selecting an electricity mix option, click the "**Calculate**" button. If "User Defined Mix" is selected, consult with DEQ staff to develop an emission factor for the user-defined mix to be input in field 3.7. Data sources for User-Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
3.2 NG from NG purchase invoices	Input monthly total fossil NG sourced from a pipeline source (or other) in MMBtu from utility invoices (reported in HHV) for 24 months (at least three months of data, if provisional) of operation. The input includes fossil NG used as process fuel and liquefied to LNG. Renewable attributes to support renewable biomethane dispensed must be provided to the verifier during the on-site audit.
3.3 LNG Production from Production Log	Input monthly total LNG produced in gallons (reported at ambient temperature) for 24 months (at least three months of data, if provisional).
3.4 NG as process fuel (Calculated)	This field calculates NG used as process fuel using inputs in fields 3.2 and 3.3. No user input is required for this field.
3.5 Electricity from Utility Invoices	Input monthly total electricity from the grid in kWh for 24 months (at least three months of data, if provisional).
3.6 LNG Transport and Distribution	This field serves as a label for the LNG transport and distribution section. No input is required for this field.
3.6.a Select to affirm that LNG delivery trucks are equipped with Boil-Off Recovery	If trucks transporting LNG are equipped to recover "Boil-Off," select "Yes" or "No" in field 3.6.a.
3.6.b Enter Transport Distance from Liquefaction Plant to station	Input distance from the liquefaction facility to the intended LNG or L-CNG dispensing station in Oregon. Additional details are included below in Table F.3.

3.6.c Select to affirm the LNG storage system is equipped with Boil-Off Recovery	If the LNG storage system is equipped to recover "Boil-Off," select "Yes" or "No" in field 3.6.c.
3.7. Specify GHG Emission Factor for Electricity Mix	If "User Defined Mix" is selected in field 3.1, consult with DEQ staff to develop a user-defined GHG emissions factor and input in this field in cell AI30. Data sources for User-Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
"Calculate" Button	After inputting all data in Section 3, click the "Calculate" button (cell AH24) to calculate pathway CIs for the LNG and L-CNG pathways.

Additional details for Section 3

Transport of LNG to dispensing facility (Field 3.6.b)

Driving distance between any two locations may be determined using a publicly available web-based driving distance if fuel is dispensed at a single station. However, suppose multiple dispensing facilities are utilized. In that case, a volume-weighted average transport distance based on 24 months (at least three months of data, if provisional) of sales records must be used for LNG distribution to fueling facilities. Alternatively, the applicant could choose to use a more conservative value, such as the distance to the farthest fueling facility, to minimize the risk of exceeding the certified CI due to changes in the supply chain.

Section 4. CI calculation details

This section contains an example pathway CI calculation with a detailed breakdown of all calculations used for CI determination based on information entered by the user and applicable reference data.

Biomethane to electricity from anaerobic digestion of dairy and swine manure

A. Introduction

This document provides detailed instructions for using the Tier 1 Simplified CI Calculator for Biomethane to Electricity from Anaerobic Digestion of Dairy and Swine Manure pathway applications. This Calculator is used to calculate the carbon intensity (CI) for biomethane from anaerobic digestion of dairy and swine manure for electricity generation. In this Calculator, only dairy cattle, swine manure, and co-feedstocks from the same production systems (e.g., milk wastes) are eligible for the offset credits for greenhouse gas (GHG) emission reductions. Pathways for biomethane from other types of manure or organic wastes (such as animal bedding, post-consumer food waste, and green waste) should use the "Tier 1 Simplified CI Calculator for Biomethane from Anaerobic Digestion of Food, Green, and Other Organic Wastes." Each required specific input in the Calculator has been numerically labeled (i.e., 1.1, 1.2, etc.) so that users can follow the sequence and enter information as required.

Download the Simplified CI Calculator here:
https://www.oregon.gov/deq/ghgp/cfp/Pages/Clean-Fuel-Pathways.aspx

The Calculator has been automated to perform CI calculations using factors from the OR-GREET3.0 model. Applicants must add facility information and verifiable monthly feedstock, operational energy use, fuel production, co-product data, and transport distances used in calculating the CI of biomethane from dairy and swine manure digesters.

This Calculator includes additional reference material such as greenhouse gas emissions factors, reference fuel specifications used in OR-GREET3.0, and certain emission factors from the Compliance Offset Protocol Livestock Projects (November 2014). In addition, the Calculator provides a detailed breakdown of the calculations used to determine the CI of each fuel pathway. The CI is not final until certified by DEQ.

The applicant may only enter values or make selections in input fields designated by DEQ for user input/selection and may not change any other values or fields in the Calculator.

Applicants should also consider the following:

- RECs generated by biogas generators and used for reporting in the CFP must meet the requirements listed in OAR 340-253-0470(5) such as being in the Western Electricity Coordinating Council region, the new date, and other requirements of the Green-e Standard, and being registered in a recognized REC tracking system such as Western Renewable Energy Generation Information System (WREGIS).
- The applicant must follow all pertinent local operating guidelines and regulations, such as the biogas or biomethane from composting (e.g., in landfills or other facilities) operating guidelines in OAR 340-096-0090.[1]

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[1] OAR 340-096-0090 Special Rules Relating to Composting: Operations Plan Approval. URL: https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=1492

B. Color legend used in the calculator

The Calculator uses the following color legend to differentiate required inputs, calculated values, etc., as described below:

Yellow cells require user input
Light Blue cells show CI results
Green Cells show the calculation button
Gray Cells are calculated values

C. Calculator overview

The following table provides an overview of the tabs used in the Simplified CI Calculator.

Table C.1. Overview of tabs used in the Simplified CI Calculator

Tab Name	Description
Electricity Summary	The summary worksheet contains an overall summary of the information entered in the "Biogas-to-Electricity" tab of the calculator and calculated CIs for livestock manure digester biogas to electricity. If desired, a **conservative margin of safety** may be added to the calculated CI in this tab to establish the final CI.
Manure-to-Biogas (LOP Inputs)	This calculation worksheet is based on selected equations from the "Compliance Offset Protocol Livestock Projects"[2] ("LOP" hereafter). The user inputs related to baseline and project methane emissions are indicated in yellow cells, and automatically calculated values are in gray cells.
Avoided Emissions	The avoided methane calculation worksheet contains the values related to baseline and project methane emissions and quantifies avoided methane and diverted CO_2 from land applications.
Biogas-to-Electricity	This calculation worksheet contains the user inputs related to fuel production (biogas to biomethane) indicated in yellow, automatically calculated values in gray cells, and estimated CI results in blue. In addition, it incorporates emissions from electricity generation and an adjustment factor.
EF Table	This reference worksheet contains greenhouse gas emissions factors from the OR-GREET3.0 model and the LOP used in calculating carbon intensities. In addition, it includes EFs for biogas electricity production using a stationary reciprocating engine (in g/MMBtu of biogas input).

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[2] California Air Resources Board. Compliance Offset Protocol Livestock Projects – Capturing and Destroying Methane from Manure Management Systems. Adopted on Nov. 14, 2014. https://www.arb.ca.gov/regact/2014/capandtrade14/ctlivestockprotocol.pdf

Reference	This reference worksheet contains specifications of fuels (i.e., HHV, LHV, density, carbon ratio), global warming potentials of greenhouse gases, unit conversions, tailpipe emissions, LNG boil-off emissions, and other information used in calculating CIs. In addition, the relevant tables in the LOP appendix are also listed in this tab.

D. Manure-to-Biogas (LOP Inputs) tab

The "Manure-to-Biogas (LOP Inputs)" tab contains the calculation sheet for selected parameters of the baseline and the project methane emissions ("LOP" is the acronym for ARB's "Compliance Offset Protocol Livestock Projects" in this document). This tab consists of the following major sections:

- Section L1: [Equation 5.3 in LOP] Baseline Methane Emissions from Anaerobic Storage/Treatment Systems ($BE_{CH4,AS}$)
- Section L2: [Equation 5.4 in LOP] Baseline Methane Emissions from Non-Anaerobic Storage/Treatment Systems ($BE_{CH4,nAS}$)
- Section L3: [Equation 5.6-Venting in LOP] Project Methane Emissions from Venting Events (*CH$_{4\ vent}$*) in the Biogas Control System (BCS)
- Section L4: [Equation 5.8 in LOP] Project Methane Emissions from the BCS Effluent Pond(s) ($PE_{CH4,EP}$)
- Section L5: [Equation 5.9 in LOP] Project Methane Emissions from *Non*-BCS Related Sources ($PE_{CH4,nBCS}$)

Section L1: [Equation 5.3 in LOP] baseline methane emissions from anaerobic storage/treatment systems ($BE_{CH4,AS}$)

This section quantifies the modeled baseline methane emissions from the anaerobic storage/treatment system. Up to six livestock categories that deposit manure to the same baseline system can be modeled in this section. The following table lists the fields for Section L1.

Table D.1. List of input fields for section L1 of the Simplified CI Calculator

Field Name	Description
L1.(1-6).1 Livestock Category (L)	Select a livestock category for each sub-section; each sub-section represents one specific livestock. Users can enter information for up to six livestock categories in six corresponding sub-sections.
L1.(1-6).2 Livestock Average Mass	The average mass of the livestock selected in L1.(1-6).1. See Table A.1 in the LOP.
L1.(1-6).3 Maximum CH$_4$ Potential	The maximum methane potential of the livestock selected in L1.(1-6).1. See Table A.2 in the LOP.
L1.(1-6).4 Livestock Excretion Rate	The daily manure excretion by the livestock selected in L1.(1-6).1, measured in volatile solids. See Table A.2 and A.4 in the LOP.
L1.(1-6).5 Monthly Data	Input the months and year(s) corresponding to the operational data provided.
L1.(1-6).6 Livestock Population	The monthly average population of the livestock selected in L1.(1-6).1
L1.(1-6).7 Calendar Days of the Month	Total calendar days of the reporting month.

L1.(1-6).8 Number of Reporting Days	The number of reporting days in the month.
L1.(1-6).9 Average Temperature	The monthly average ambient temperature (reported in degrees Celsius)
L1.(1-6).10 Van't Hoff-Arrhenius factor	Factor associated with chemical reaction.
L1.(1-6).11 Fraction of Volatile Solids Sent to Anaerobic Storage/Treatment System	The fraction of manure (volatile solids) that would be sent to the anaerobic storage/treatment system for each livestock category, taking into account any volatile solids removed by solid separation equipment in the baseline case, as if the project BCS was never installed. Site-specific data must be used if available. If site-specific data is unavailable, values from Table A.9 of the LOP can be used. This table can also be found in the "Reference" tab.
L1.(1-6).12 Volatile Solids Available for Degradation	Monthly volatile solids are available for degradation from anaerobic manure storage/treatment system 'AS' by the livestock selected in L1.(1-6).1.
L1.(1-6).13 Retention Time and Drainage	Select the appropriate options. The volatile solids retained in the system from the previous month must be set to zero, (1) If the volatile solids retention time in the anaerobic storage or treatment system is less than or equal to 30 days, or (2) if the anaerobic storage or treatment system is completely drained and cleaned.
L1.(1-6).14 Carryover from Previous Month	The difference between the VS available for degradation and the VS degraded from the previous month. If this is the project's first year, enter zero in the first month; otherwise, enter the VS carried over from December of the previous year.
L1.(1-6).15 Volatile Solids Degraded	Monthly volatile solids degraded by anaerobic manure storage/treatment system 'AS' by the livestock selected in L1.(1-6).1.
L1.(1-6).16 Baseline Methane Emissions, AS	The modeled baseline methane emissions from anaerobic manure storage/treatment systems.

Section L2: [Equation 5.4 in LOP] baseline methane emissions from non-anaerobic storage/treatment systems (BE$_{CH4,nAS}$)

This section quantifies the baseline methane emissions from non-anaerobic storage/treatment systems. The following table lists the fields for Section L2.

Table D.2. List of input fields for section L2 of the Simplified CI Calculator

Field Name	Description
L2.1 Non-anaerobic Storage/Treatment Systems	Select the non-anaerobic storage/treatment systems that are applicable.
L2.2 Methane Conversion Factor	The methane conversion factor for non-anaerobic storage/treatment system. See Table A.5 in the LOP. The selection in L2.1 determines this factor.
L2.3 Manure Managed in Non-Anaerobic Storage/Treatment Systems	The fraction of manure (volatile solids) that would be sent to the non-anaerobic storage or treatment system for each livestock category, taking into account any volatile solids removed by solid separation equipment in the baseline case, as if the project BCS was never installed. Site-specific data must be used if available. If site-specific data is unavailable, values from Table A.9 of the LOP can be used to calculate the fraction sent to non-anaerobic systems. This table can also be found in the "Reference" tab.

L2.4 Baseline Methane Emissions, non-AS	The modeled baseline methane emissions from non-anaerobic manure storage/treatment systems.

Section L3: [Equation 5.6-Venting in LOP] project methane emissions from venting events (CH₄ $_{vent}$) in the Biogas Control System (BCS)

This section quantifies the BCS system project methane emissions from venting events only. Other emissions directly associated with the biomethane production in the BCS project this Simplified CI Calculator evaluates in the "Biogas-to-Electricity" tab. The following table lists the fields for Section L3.

Table D.3. List of input fields for section L3 of the Simplified CI Calculator

Field Name	Description
L3.1 Monthly Data	Input the months and year(s) corresponding to the operational data provided.
L3.2 Maximum Biogas Storage of the BCS System	The maximum biogas storage of the BCS system must be calculated using project-specific information and design documentation.
L3.3 Average Daily Biogas Production for the 7 Days Preceding the Venting	This volume flow must come from the monitored project-specific flow data corrected to standard conditions. See Equation 5.7 in the LOP for the biogas volume correction for temperature and pressure.
L3.4 Number of Days for the Uncontrolled Venting	This data must be monitored and recorded at least daily from the time of discovery; it must date back to the last field check date without any uncontrolled venting events.
L3.5 Quarterly Methane Concentration	The quarterly methane concentration is used for the entire month and all subsequent months until a new methane concentration is taken. A weighted average of more frequent samples may also be used.
L3.6 Project Methane Emissions from Venting	The monthly methane quantity results vented to the atmosphere due to BCS venting events.

Section L4: [Equation 5.8 in LOP] project methane emissions from the BCS effluent pond(s) (PE$_{CH4,EP}$)

This section quantifies the methane emissions from the BCS pond where the effluent from the BCS project is held. The following table lists the fields for Section L4.

Table D.4. List of Input Fields for Section L4 of the Simplified CI Calculator

Field Name	Description
L4.1 Livestock Category	These are the same livestock categories selected in Section L1.
L4.2 Average Population	Average population of each livestock category based on monthly population data for a given reporting period.
L4.3 Livestock Excretion Rate	The daily manure excretion by the livestock category, measured in volatile solids. See Table A.2 and A.4 in the LOP. These are the same values entered in fields L1.(1-6).4.
L4.4 Maximum CH₄ Potential	The maximum methane potential of each livestock category. See Table A.2 in the LOP. These are the same values entered in fields L1.(1-6).3.

L4.5 Fraction of Volatile Solids Sent to BCS System	The fraction of manure (volatile solids) that would be sent to the BCS system for each livestock category, taking into account any volatile solids removed by solid separation equipment. Site-specific data must be used if available. If site-specific data is unavailable, values from Table A.9 of the LOP can be used. This table can also be found in the "Reference" tab.
L4.6 Volatile Solids to Effluent Ponds	Results of the amount of manure (volatile solids) that is sent to the effluent ponds daily by the livestock category.
L4.7 Number of Reporting Days	Total number of reporting days in the reporting period.
L4.8 Methane Conversion Factor	The methane conversion factor for the effluent pond (liquid/slurry uncovered). See Table A.5 in the LOP.
L4.9 Project Methane Emission from Effluent Ponds	Results of the total methane emissions from the project BCS effluent ponds.

Section L5: [Equation 5.9 in LOP] project methane emissions from non-BCS related sources ($PE_{CH4,nBCS}$)

This section quantifies the project methane emissions from waste treatment and storage sources other than the BCS and associated effluent pond. The following table lists the fields for Section L5.

Table D.5. List of input fields for section L5 of the Simplified CI Calculator

Field Name	Description
L5.1.a Other Anaerobic Storage/Treatment Systems	Select other non-BCS anaerobic storage/treatment systems that are applicable.
L5.1.b Non-anaerobic Storage/Treatment Systems	Select the non-anaerobic storage/treatment systems that are applicable.
L5.2 Methane Conversion Factor	Methane conversion factor for non-anaerobic storage/treatment system. See Table A.5 in the LOP. The selections in L5.1a & b are used to determine this factor.
L5.3 Manure Managed in Non-BCS (Other) Systems	The fraction of manure (volatile solids) that would be sent to the anaerobic storage/treatment system for each livestock category, taking into account any volatile solids removed by solid separation equipment in the baseline case, as if the project BCS was never installed. Site-specific data must be used if available. If site-specific data is unavailable, values from Table A.9 of the LOP can be used. This table can also be found in the "Reference" tab.
L5.4 CH$_4$ Emission Factor, non-BCS	Methane emission factor for the livestock population from non-BCS related sources.
L5.5 Project Methane Emissions, non-BCS	The modeled project methane emissions from waste treatment and storage sources other than the BCS and associated effluent pond.

E. Avoided Emissions tab

The "Avoided Emissions" tab contains the additional calculation worksheet for avoided methane and CO$_2$ credits and consists of the following major sections:

- Section P1. Results from the "Manure-to-Biogas (LOP Inputs)" tab
- Section P2. Avoided CH_4 Emissions Calculation Details
- Section P3. Avoided CO_2 Emissions Calculation Details

Section P1. Results from the "Manure-to-Biogas (LOP Inputs)" tab

All the values in this section are calculated values based on the quantification methodology by ARB's "Compliance Offset Protocol Livestock Projects" (detailed calculation can be found in the "Manure-to-Biogas (LOP Inputs)" tab). The following table lists the fields for Section P1 of the "Avoided Emissions" tab.

Table E.1. List of Input Fields for Section P1 of the Simplified CI Calculator

Field Name	Description
P1.1 Select Digester Type	Select either "Covered Lagoon" or "Enclosed Vessel" as the type of livestock manure digester operated.
P1.2 Monthly Data	Input the months and year(s) corresponding to the operational data provided.
P1.3 Baseline methane emissions (BE$_{CH4 Mod}$)	Results of monthly baseline methane emissions calculated using the Equation 5.2 from the LOP.
P1.4 Project methane emissions	This field includes a label for project methane emissions and does not require an input
P1.4.a Venting methane ($CH_{4\ vent}$)	Results of the monthly quantity of methane vented to the atmosphere due to the digester venting events. These are calculated values based on the $CH_{4\ vent,i}$ the formula provided in the "Equation 5.6" section from the LOP.
P1.4.b Effluent ponds methane (PE$_{CH4,EP}$)	Result of monthly methane emissions from the digester effluent pond. This is a calculated value based on Equation 5.8 from the LOP.
P1.4.c Storage/Treatment methane (PE$_{CH4,nBCS}$)	Result of monthly methane emissions from the non-digester sources (waste treatment and storage). This is a calculated value based on Equation 5.9 from the LOP.
P1.4.d Digester leakage	Results of the monthly quantity of methane leakage from the digester.

Section P2. Avoided CH_4 emissions calculation details

This section contains an example of calculating the avoided methane emissions from land application.

Section P3. Avoided CO_2 emissions calculation details

This section contains an example of calculating the avoided CO_2 emissions diverted from land application.

F. Biogas-to-Electricity tab

The "Biogas-to-Electricity" tab contains the main CI calculation worksheet and consists of the following major sections:

- Section 1. Applicant Information
- Section 2. Biomethane Production Data
- Section 3. CI Calculation Details

Section 1. Applicant information for biomethane production

The following table lists the fields used in Section 1 of the Biogas-to-Electricity tab.

Table F.1. List of Input Fields for Section 1 of the Simplified CI Calculator

Field Name	Description
1.1 Company Name	Registered name of the company. Example "ABC Company, LLC" or "ABC Company, Inc."
1.2 Company ID	Enter U.S. EPA Company ID. If not available, contact DEQ for LCFS Company ID.
1.3 Facility ID	Enter the Company's Facility ID. If not available, contact DEQ for LCFS Facility ID.
1.4 Digester Location (Street, City, State)	Location of the anaerobic digester. Example: "AAA Livestock Manure Digestion Facility in Salem." Select the state from the drop-down menu.
1.5 LNG Liquefaction Facility Location (Street, City, State)	Location of the liquefaction facility (Street, City, State).
1.6 CNG Dispensing Station(s) Location (Street, City, State)	Location of Oregon CNG dispensing station (Street, City, State). For distribution to multiple Oregon stations, use Salem as the endpoint in determining the (Standard Station Centroid location). See additional details below in Table F.2.
1.7 LNG Dispensing Station(s) Location (Street, City, State)	Location of LNG dispensing station (Street, City, State). For multiple stations, calculate a centroid location based on a weighted average of fuel dispensing stations to which LNG is supplied. See additional details for Field 3.6.b. below Table F.3.
1.8 L-CNG Dispensing Station(s) Location (Street, City, State)	Location of L-CNG station (Street, City, State). For multiple stations, calculate a centroid based on a weighted average of fuel dispensing stations to which L-CNG is supplied. See additional details for Field 3.6.b. below Table F.3.
1.9 Digester Type	The digester type is the same selection that appeared on the "Avoided Emissions" tab, section P1.1: either "Covered Lagoon" or "Enclosed Vessel."
1.10 Average Annual Temperature (°C)	Select the closest average annual temperature in °C.

Section 2. Biomethane production data

The following table lists the fields used in Section 2 of the Biogas-to-Electricity tab. Additional details are included below in Table F.2.

Table F.2. List of input fields for biogas processing

Field Name	Description
2.1 Select Regional Electricity Mix for Biomethane	Choose the electricity mix corresponding to the zip code for the region where the livestock manure digester biogas upgrading plant is located. The Calculator includes 26 eGRID zone mixes, Brazilian average, Canadian average, and User Defined Mix in the pull-down menu. For facilities in the U. S., select one of 26 eGRID zones available for the U.S. If the upgrading facility is located outside the U.S., select "User Defined Mix." For facilities that use biogas for electricity production, choose the user-defined electricity option in field 2.1. After selecting an electricity mix option, click the "**Calculate**" button. If "User Defined Mix" is selected, consult with DEQ staff to develop an emission factor for the user-defined mix to be input as detailed in field 2.27. Data sources for User-Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
2.2 Provisional Pathway?	If there are less than 24 months of available data, select "Yes." Otherwise, choose "No" if the application is for a provisional pathway, and input available months of operational data, starting in Month 1 (minimum of three months of operating data required to meet provisional requirements).
2.3 Monthly Data	Input the months and year(s) corresponding to the operational data provided.
2.4 Total Raw Biogas Flow (metered)	Input monthly raw dry biogas flow (in Standard Cubic Feet at 60°F, 1 atm) data for 24 months (at least three months of data, if provisional). Specific requirements are detailed below in Table F.2.
2.5 Biomethane Content (% Methane)	Input monthly average methane concentration in raw dry biogas for 24 months (at least three months of data, if provisional) of operation. Specific requirements are detailed below in Table F.2.
2.6 Raw Biogas Flow to Upgrading (metered)	Input monthly raw biogas use (in Standard Cubic Feet at 60°F, 1 atm) for producing transportation fuels. See additional details below in Table F.2.
2.7 Biomethane Content (% Methane)	Input monthly weighted average methane concentration data (measured in raw dry biogas) for 24 months (at least three months of data, if provisional). Specific requirements are detailed below in Table F.2.
2.8 Diesel (baseline manure transport and handling)	Input monthly total diesel use (in gallons at ambient temperature) to transport and handle manure in the baseline case for 24 months (at least three months if provisional).
2.9 Utility Sourced NG (baseline)	Input monthly total fossil natural gas use (baseline case) from a pipeline source (or other) in MMBtu from utility invoices (reported in HHV) for 24 months (at least three months if provisional).
2.10 Grid Electricity (baseline manure pumping and solids separation)	Input monthly total electricity use (baseline case) from the grid in kWh from utility invoices for 24 months (at least three months of data, if provisional).

2.11 Grid Electricity (for digester heating)	Input monthly total electricity use (digestion process) from the grid in kWh from utility invoices for 24 months (at least three months if provisional) in this field.
2.12 Biomethane (for digester heating)	Input monthly biomethane use (in MMBtu in HHV) for heat generation in a small industrial boiler (10-100 MMBtu/hr input) during digestion.
2.13 Utility Sourced NG (digester project)	Input monthly total fossil natural gas use (digestion process) from a pipeline source (or other) in MMBtu from utility invoices (reported in HHV) for 24 months (at least three months of data, if provisional).
2.14 Diesel (digester project manure transport and handling)	Input monthly total diesel use (gallons at ambient temperature) in transporting and handling manure for the digestion process for 24 months (at least three months of data, if provisional).
2.15 Utility Sourced NG (upgrading and compression)	Input monthly total fossil natural gas use (biomethane upgrading and compression) from a pipeline source (or other) in MMBtu from utility invoices (reported in HHV) for 24 months (at least three months of data, if provisional).
2.16 Biomethane (as Process Fuel for upgrading and compression)	Input monthly biomethane use (in MMBtu in HHV) as process fuel in a small industrial boiler (10-100 MMBtu/hr input) for the biomethane upgrading and compression process.
2.17 On-Site Electricity from Biogas (upgrading and compression)	Input monthly total electricity use (biomethane upgrading and compression) from the electricity generated on-site from a biogas-fueled reciprocating engine (in kWh).
2.18 Grid Electricity (upgrading and compression)	Input monthly total electricity use (biomethane upgrading and compression) from the grid in kWh from utility invoices for 24 months (at least three months of data, if provisional) in this field.
2.19 Flared gas, including tailgas from upgrading (metered biogas)	Input monthly total volume of biogas flared, which includes the upgrading tailgas.
2.20 Biomethane Content (% Methane in Flared Gas)	Input monthly weighted average methane concentration in flared gas for 24 months (at least three months of data, if provisional) of operation.
2.21 Biomethane to Electricity Production	Input monthly total biomethane (in MMBtu, HHV) used for electricity production on-site for 24 months (at least three months of data, if provisional). Assumes 100% biomethane content
2.22 On-site Electricity Production	Input monthly total electricity from the biomethane for 24 months (at least three months of data, if provisional).
2.23 Export Electricity	Input monthly total electricity produced from the biomethane and exported for 24 months (at least three months of data, if provisional).
"Calculate" Button	After all data in Section 2 are entered, click the "Calculate" button (cell E24) in Section 2 to calculate CI for the CNG pathway.

Additional details for section 2 and table F.2

Inlet raw biogas sourced from the digester (Field 2.4 and 2.6)

Requires a dedicated flow measurement system with temperature measurement to enable reporting of gas flow at 1 atm pressure and 60°F (dry gas flow corrected for moisture) to account for monthly total raw biogas volume sourced from the digester (Field 2.4) and the raw biogas volume used for upgrading to transportation fuels (Field 2.6). The flow measurement system must

be calibrated per the manufacturer's requirement and scaled to measure the entire range of potential flow of biogas. Measurement must be continuous, and all data must be electronically archived (manual recording is not acceptable). The direct metering of the quantity and percentage methane concentration of biogas captured from the digester is not used in CI calculations but rather as a check to ensure that total biomethane sales do not exceed the biogas quantity sourced from the digester. If biomethane is used for electricity generation on-site, the applicant must report the metered quantities of (1) biogas used for electricity generation, (2) electricity generated from biomethane, and (3) the exported electricity from biomethane.

Methane content (% Methane in Field 2.5 and 2.7)

Input monthly weighted average methane concentration (dry gas basis). Methane measurement must be recorded every 15 minutes (at a minimum) with instrumentation capable of electronic archival (manual recording will not be acceptable). The methane measurement system required calibration per the manufacturer's requirement and was scaled to measure the potential range of methane concentration in the biogas.

Using biomethane to generate electricity for biogas upgrading (Field 2.16)

Although the Calculator can accommodate facilities that use biomethane to generate electricity for biogas upgrading, applicants must declare the use of on-site electricity generation and consult CARB staff before submitting a pathway application. A dedicated meter to quantify biomethane-derived electricity in kWh (Field 2.16) must be used to report the use of this electricity in the Calculator sheet.

Dedicated metering of buyback NG and propane (Field 2.19 and 2.20)

For digester gas upgrading facilities that use buyback natural gas (NG) or propane to boost the Btu of biomethane before pipeline injection (to meet pipeline specifications), dedicated metering must be installed to substantiate quantities of NG or propane used for this purpose. If dedicated metering is not installed or not verifiable, all NG reported in field 2.19 will be added to NG, and propane reported in field 2.15 (and considered used for upgrading biogas).

Section 3. CI Calculation Details

This section contains an example pathway CI calculation with a detailed breakdown of all calculations used for CI determination based on information entered by the user and applicable reference data.

An "adjustment factor" is used to account for the average efficiency of the generator set (or genset) used in natural gas- and biogas-derived electricity in Oregon power plants because no electrical generation system currently converts 100% of the energy in methane or biomethane (or biogas) to electricity.

Therefore, the CFP considers a 50% efficiency factor in the CI calculation for biogas to electricity pathways.

This adjustment serves to reasonably limit the LCFS incentive for negative CI value pathways (i.e., manure pathways that receive a methane emissions avoidance credit), where the facilities operate without higher efficiency electrical generating equipment[3].

We also considered that the energy lost as engine heat, depending on the system design, can be recovered heat to the digester, lowering overall operating costs.[4] Therefore, the recovered heat from the genset is not directly accounted for in the efficiency calculation. However, it is indirectly accounted for as reduced input heat to the digester. Therefore, the total amount of heat available from biogas can be deduced from the higher heating value.

The adjustment factor is applied to the subtotal CI to determine the final CI. This subtotal CI includes net methane from the digester (avoided methane), fugitive methane from biogas cleanup, net CO_2 (engine emissions and CO_2 diverted from the baseline scenario), emissions from energy use (e.g., grid electricity or utility natural gas) are not adjusted.
The adjustment factor is not applicable if the genset operates at more than 50% efficiency.

Calculation:

$$f_{adj} = \frac{\eta_e}{\eta_{reference}} = \frac{kWh_{produced} \times 3{,}412\frac{Btu}{kWh}}{MMBtu_{(HHV)biogas\ consumed} \times \frac{10^6 Btu}{MMBtu} \times 50\%}$$

$$f_{adj} = \frac{\eta_e}{\eta_{reference}} = \frac{23\%}{50\%} = 0.46$$

Where,

η_e represents the electrical efficiency of the generating unit, if less than 50%, determined using the quantity of biogas (in MMBtu, HHV) supplied to the power generating unit and the quantity of electricity generated over the operational data period. Again, the adjustment factor is not applicable if the system operates at a higher than 50% efficiency.

$\eta_{reference}$ represents the genset efficiency of 50%.

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[3] DEQ has aligned its adjustment factor with the recommendations of CARB for continuity between the programs and jurisdictions. Reference LCFS Guidance 19-06.
ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/guidance/lcfsguidance_19-06.pdf
[4] Target digester temperature range between 86–100° F for mesophillic and 122–140° F for thermophilic anaerobic digesters.

Biomethane from anaerobic digestion of organic waste

A. Introduction

This document provides detailed instructions for using the Tier 1 Simplified CI Calculator for Biomethane-derived from the Anaerobic Digestion of Organic Waste. This Calculator is to be used to calculate the carbon intensity (CI) for Compressed Natural Gas (CNG), Liquefied Natural Gas (LNG), and Liquefied and subsequently Compressed Natural Gas (L-CNG) produced from biogas (also referred to as digester gas) generated by the anaerobic digestion of food scraps, urban landscaping waste, and other user-defined organic waste such as agricultural residues, in a dry or wet fermentation process. Each required specific input in the Calculator has been numerically labeled (i.e., 1.1, 1.2, etc.) so that users can follow the sequence and enter information as required.

Download the Simplified CI Calculator here:
https://www.oregon.gov/deq/ghgp/cfp/Pages/Clean-Fuel-Pathways.aspx

The Calculator has been automated to perform CI calculations using factors from the OR-GREET3.0 model. The Calculator replaces the existing worksheets and the operational data templates for high solids-based anaerobic digestion pathways. Applicants are required to add facility information and verifiable monthly feedstock, operational energy use, transport distances, and fuel production and buy-back fossil fuel data used in calculating the CI of biomethane derived from the anaerobic digestion of food scraps, urban landscaping waste, and other organic waste in a dry or wet fermentation process.

This Calculator also includes additional reference material such as greenhouse gas emissions factors used in the OR-GREET3.0 life cycle analysis (LCA) model, and reference fuel specifications. Also included with the Calculator is a detailed breakdown of the calculations used to determine the final CI of each fuel pathway.

The applicant may only enter values or make selections in yellow input fields designated by DEQ for user input/selection and may not change any other values or fields in the Calculator.

B. Color legend used in the calculator

The Calculator uses the following color legend to differentiate required inputs, calculated values, etc., as described below:

Yellow cells require user input
Light Blue cells show CI results
Green Cells show the calculation button
Gray Cells are calculated values
Orange Cells are elements in flow charts that are credited to pathway

C. Calculator overview

The following table provides an overview of the tabs used in the Simplified CI Calculator.

Table C.1. Overview of tabs used in the Simplified CI Calculator

Tab Name	Description
RNG Summary	Summary worksheet. Contains an overall summary of the information entered in the "RNG" tab of the calculator and calculated CIs for organic waste-derived CNG, LNG, and L-CNG. If desired, a **conservative margin of safety** may be added to the calculated CI in this tab to establish the final CI.
RNG	Main calculation worksheet. Contains the main components of the calculator with fields requiring user inputs and those calculated by the sheet. Calculations in grayed out cells are automatically calculated but dependent upon input to yellow cells in the corresponding sections of the calculator. This tab also includes CI calculations using inputs in this tab. See more detailed instructions below.
FS Fate	Worksheet that illustrates the fate of food scraps in a block-flow diagram. No user input is required since all input parameters have been pre-determined. Only GHG emissions depicted in orange are credited to the pathway, the rest being the "business-as-usual" case with no diversion attributes. A feedstock diversion credit for avoided emissions is calculated and applied to the pathway.
ULW Fate	Worksheet that illustrates the fate of urban landscaping waste in a block-flow diagram. No user input is required since all input parameters have been pre-determined. Only GHG emissions depicted in orange are credited to the pathway, the rest being the "business-as-usual" case with no diversion attributes. A feedstock diversion credit for avoided emissions is calculated and applied to the pathway.
OW Fate	This worksheet illustrates the fate of user-defined organic waste that does not fall into the above two categories (food scraps and urban landscaping waste). These may include specific wastes such as industrial food processing waste and agricultural residues. Applicants are urged to consult with staff on defining the fate of user-defined

	organic waste (i.e., landfill, composting, animal feed). Only GHG emissions depicted in orange are credited to the pathway, the rest being the "business-as-usual" case with no diversion attributes. A feedstock diversion credit for avoided emissions is calculated and applied to the pathway.
EF Table	This reference worksheet contains greenhouse gas emissions factors from the OR-GREET3.0 model used in calculating carbon intensities.
Reference	Reference worksheet. Contains physical property specifications of fuels (i.e., HHV, LHV, density, carbon ratio, etc.), global warming potentials (GWP) of greenhouse gases, unit conversion factors, tailpipe emissions factors, LNG boil-off emissions factors, and other information used in calculating CIs.

D. RNG tab

The "RNG" tab contains the main CI calculation worksheet and consists of the following major sections:

- *Pathway Summary and Estimated CI*
- *Section 1. Applicant Information*
- *Section 2. Information for Biomethane Production*
- *Section 3. CNG, LNG, and L-CNG Production and Transport Data*
- *Section 4. CI Calculation Details*

Section 1. Applicant information

The following table lists the fields used in Section 1 of the RNG tab.

Table D.1. List of Input Fields for Section 1 of the Simplified CI Calculator

Field Name	Description
1.1. Company Name	Registered name of the company. Example "ABC Company, LLC" or "ABC Company, Inc."
1.2. Company ID	Enter U.S. EPA Company ID. If not available, contact DEQ for LCFS Company ID.
1.3. Facility ID	Enter the Company's Facility ID. If not available, contact DEQ for LCFS Facility ID.
1.4. Digester Name and Location	Name and address of the Anaerobic Digester Facility (Street, City, State).
1.5. LNG Liquefaction Facility Location	Location of the liquefaction facility (Street, City, State).
1.6. Application Number	Enter the application number generated by the AFP.
1.7. CNG Dispensing Station(s) Location	Location of Oregon CNG dispensing station (Street, City, State). For multiple stations, use Salem as the endpoint (the Standard Station Centroid location). See additional details below in Table D.2.

1.8. LNG Dispensing Station(s) Location	Location of LNG dispensing station (Street, City, State). For multiple stations, calculate a centroid location based on a weighted average of fuel dispensing stations to which LNG is supplied. See additional details below in Table D.3.
1.9. L-CNG Dispensing Station(s) Location	Location of L-CNG station (Street, City, State). For multiple stations, calculate a centroid based on a weighted average of fuel dispensing stations to which L-CNG is supplied. See additional details below in Table D.3.
1.10 Provisional Pathway	If there are less than 24 months of available data, select "Yes,"; otherwise, choose "No." If the application is for a provisional pathway, available input months of operational data. A minimum of three months of operational data is required to meet provisional pathway certification requirements.

Section 2. Information for biomethane production

The following table lists the fields used in Section 2 of the RNG tab. Additional details are included below in Table D.2.

Table D.2. List of Input Fields for Biogas Processing

Field Name	Description
2.1 Select Regional Electricity Mix for Biomethane	Choose the electricity mix corresponding to the zip code for the region where the biogas upgrading plant is located. The Calculator includes 26 eGRID zone mixes, an average Brazilian mix, an average Canadian mix, and a User Defined Mix to select from in the pull-down menu. For facilities in the U.S., select one of the 26 eGRID zones available. If the upgrading facility is located outside the U.S., select "User Defined Mix." Facilities that use biogas for electricity production must also choose the "User Defined Mix" option in field 2.1. If "User Defined Mix" is selected, consult with DEQ staff to develop an emissions factor for the User Defined Mix to be input as detailed in field 2.22. Data sources for User-Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator. Additional details are included below in Table D.2.
2.2 Monthly Data	Input the months and year(s) corresponding to the operational data provided.
2.3 Food Scraps Throughput	Input source-separated food scraps feedstocks received for each month of operation (in wet short ton). If the waste feedstock is not source-separated, then evidence must be provided supporting the monthly estimate in the Supplemental Documentation. In addition, the methodology used to derive the estimate or proportion that is food scraps must also be provided.
2.4 Food Scraps Weighted Mean Transport Distance by HDT (miles)	Enter monthly weighted average food scraps feedstock transport distance from the source to the digester facility for each month of operation.

2.5 Urban Landscaping Waste Throughput (wet, short tons)	Input source-separated urban landscaping waste feedstocks received monthly for each month of operation (in wet short tons). If the waste feedstock is not source-separated, then evidence must be provided in support of the monthly estimate in the Supplemental Documentation, and the methodology used to derive the estimate or proportion that is urban landscaping waste must also be provided
2.6 Urban Landscaping Waste Weighted Mean Transport Distance (miles)	Enter monthly weighted average urban landscaping waste feedstock transport distance from the source to the digester facility for each month of operation.
2.7 Other Organic Waste Throughput (wet, short tons)	Input source-separated "other organic waste" feedstocks received for each month of operation (in wet, short tons) if the wastes cannot be otherwise classified as food scraps or urban landscaping waste. If the waste feedstock is not source-separated, then evidence must be provided in support of the monthly estimate in the Supplemental Documentation, and the methodology used to derive the estimate or proportion that is "other organic waste" must also be provided. In addition, the characteristics of "other organic waste" must be profiled in subsequent fields.
2.8. Other Organic Waste Weighted Mean Transport Distance by HDT (miles)	Enter monthly weighted average other organic waste feedstock transport distance from the source to the digester facility for each month of operation.
2.9. User Defined Factors for Other Organic Waste	This field is a label for defining the characteristics of the "Other Organic Waste" category (see 2.9.a through e below). No User input is required in this cell.
2.9.a Diversion Rate of Other Organic Waste (%)	Input the fraction of other organic waste disposed of by landfill (in the absence of anaerobic digestion). The fraction from other treatments is assumed to be the total not diverted from a landfill (calculated value).
2.9.b Degradable Organic Carbon (DOC), wet basis (fraction)	Input the fraction of carbon in other organic waste that is a degradable organic fraction (DOC). Some materials have pre-determined values and can be found in the worksheet "OW Fate." Alternative methods in determining the DOC factor of a unique waste not depicted in the tables are also provided in the same tab.
2.9.c Fraction of DOC that decomposes (DOC$_f$), (fraction)	Input the fraction of DOC in other organic waste that decomposes (DOC$_f$). Some materials have pre-determined values and can be found in the worksheet "OW Fate." Alternative methods in determining the DOC$_f$ factor of a unique waste not depicted in the tables are also provided in the same tab.
2.9.d Moisture Content (%)	Input the weighted average moisture content of the other organic waste for the entire reporting period. The value may be used to estimate the DOC factor of such waste. The value must represent all organic waste throughput during the reporting period.
2.9.e Volatile Solids, dry basis(%, dry basis)	Input the weighted average volatile solids content of the other organic waste for the entire reporting period. The value may be used to estimate the DOC factor of such waste. The value must represent all organic waste throughput during the reporting period.

2.10. Diesel Fuel Use in Material Handling Equipment (Hydrolysis Loading) (gallons)	Input monthly diesel fuel use data for each month of operation. The volume measured must be corrected to 60°F. Diesel fuel is commonly used in equipment such as front-end loaders. For delivery of feedstocks by truck, only the transport distance is required. Diesel fuel used for digestate or compost load out and the fuel used for windrow compost systems or to work compost piles should be excluded from this field.
2.11. Digester Gas Flow (metered) (scf at 60°F, 1 atm)	Input monthly metered digester gas flow data for each month of operation. The volume of digester gas measured must be corrected to 60° F. Information must be backed by metered and measured process data output. Additional details are provided below in Table D.2.
2.12. Methane Content (% Methane)	Input monthly volume weighted average methane concentration data (measured as dry biogas) for each month of operation. Additional details are provided below in Table D.2.
2.13. Digester Gas Use in Facility Boiler or Bypass to Flare/TO (scf at 60°F, 1 atm)	Enter metered amounts of digester gas consumed by the facility boiler, or destroyed by the flare or thermal oxidizer (TO) in the event the facility cannot process or upgrade the gas.
2.14. Biogas Upgrading - Tail Gas to Flare/TO (MMBtu, HHV)	Enter metered amounts of tail gas methane destroyed by the flare or thermal oxidizer (TO) before releasing it into the atmosphere as CO_2.
2.15. Facility Consumption of Utility-sourced NG (MMBtu, HHV)	Input monthly total buyback fossil natural gas use from a pipeline source (or other) in MMBtu from utility invoices (reported in HHV) for each month of operation. If buyback gas is used to boost the Btu of biomethane to meet pipeline specifications, do not include this quantity of NG in this field (monthly basis). This will be input separately in field 2.17.
2.16. Facility Consumption of Grid Electricity (kWh)	Input monthly total electricity use from the grid in kWh from utility invoices for each month in this field. If biogas-derived electricity is generated on-site, input metered quantity of electricity in this field, in addition to ensuring that the emissions factor for the User Defined Mix is included in cell U26.
2.17. Buy Back fossil NG to boost Btu before Pipeline Injection (MMBtu, HHV)	Input monthly total quantity of buyback fossil NG (in MMBtu, HHV) if NG is used to boost biomethane energy content to meet pipeline specifications. This quantity is not used in CI calculations. Instead, subtract this quantity of fossil NG when reporting pipeline injected biomethane in field 2.19. See additional details below in Table D.2.
2.18. Propane used to boost Btu before Pipeline Injection (gallons)	Input monthly total quantity of propane (in gallons at ambient temperature) if propane is used to boost biomethane energy content to meet pipeline specifications. This quantity is not used in CI calculations. Subtract this quantity of propane when reporting pipeline injected biomethane in field 2.19. See additional details below in Table D.2.
2.19. Biomethane Injected into Pipeline (metered) (MMBtu, HHV)	Input monthly total biomethane injected into the pipeline in MMBtu (HHV) each month. The installation of utility grade meters must support the quantity. Subtract monthly total fossil NG or propane blended with biomethane to meet pipeline specifications from the injected quantity (in MMBtu). See additional details below in Table D.2.
2.20. NG Pipeline Transmission	This field includes a label for NG pipeline transmission and does not require input.

2.20.a From upgrading facility to CNG Station	Input pipeline distance from biogas processing facility to the intended CNG station in Oregon. For onsite dispensing, assume that the pipeline distance is 1 mile. If fuel is sent to multiple stations, use the Standard Station Centroid of Salem as the endpoint. Additional details can be found below in Table D.2.
2.20..b From upgrading facility to LNG plant	Input pipeline distance from the biogas processing facility to the liquefaction facility. This is required if the application includes LNG and L-CNG fuel pathways. Additional details can be found below in Table D.2.
2.21. Specify GHG Emissions Factor for Electricity Mix (or User Defined Parameters)	If "User Defined Mix" is selected in field 2.1, consult with DEQ staff to develop a user-defined GHG emissions factor and input this field in cell U 26. Data sources for User Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
"Calculate" Button	After all data in Section 2 are entered, click the "Calculate" button (cell G22) in Section 2 to calculate CI for the CNG pathway.

Additional details for section 2 and table D.2

Using biogas to generate electricity for biogas upgrading (Field 2.1)

For self-generated electricity onsite using digester gas, the "User Defined Mix" option must be selected in Field 2.1. Although the Calculator can accommodate facilities that use biogas to generate electricity for biogas upgrading, applicants must declare the use of on-site electricity generation and consult with DEQ staff before submission of a pathway application for the appropriate emissions factor. In addition, a dedicated meter to quantify biogas-derived electricity in kWh must be used to report quantities of electricity consumed in this Calculator sheet.

Raw digester gas sourced from the anaerobic digester (Field 2.11)

Requires a dedicated flow measurement system with temperature measurement to enable reporting of the total monthly raw digester gas flow quantity at 1 atmosphere pressure and 60°F (dry gas corrected for moisture). The flow measurement system must be installed upstream of the valve to divert gas flow to the flare, boiler, or combined heat and power (CHP) unit or the feed compressor to the biogas upgrading plant. The system must also be calibrated per the manufacturer's requirement and scaled to measure the entire range of potential flow of biogas. Measurement must be continuous, and all data must be electronically archived (manual recording is not acceptable). The direct metering of the quantity and percentage methane concentration of biogas captured from the digester is not used in CI calculations but rather as a check to ensure that total biomethane sales do not exceed the biogas quantity produced or generated in the digester. If biogas is used for electricity generation, the applicant must report the metered quantity of biogas used for electricity generation and metered quantity of electricity generated on-site.

Methane content (% Methane in Field 2.12)

Input monthly weighted average methane concentration (dry gas basis) in the digester gas. Methane concentration measurement must be recorded every 15 minutes (at a minimum) with instrumentation capable of electronic archival (manual recording will not be acceptable). The methane measurement system requires calibration per the manufacturer's requirement and is scaled to measure the entire potential range of methane concentration in the biogas.

Dedicated metering of buyback NG and propane (Field 2.17 and 2.18)
For biogas upgrading facilities that use buyback natural gas (NG) or propane to boost the Btu of biomethane before pipeline injection (to meet pipeline specifications), dedicated metering must be installed to substantiate quantities of NG or propane used for this purpose. If dedicated metering is not installed or not verifiable, all NG and propane reported in fields 2.17 and 2.18, respectively, will be added to NG reported in field 2.15 (and considered used for upgrading biogas).

Biomethane injected into the pipeline (Field 2.19)

The monthly quantity of biomethane input must correspond to the quantity of biomethane (in MMBtu) injected into the pipeline. However, since this quantity may include NG or propane blended with biomethane to meet pipeline specifications, the use of any non-renewable gas must be explicitly disclosed through invoices. Therefore, the quantity entered would consist of only the biomethane quantity; any fossil inputs must be subtracted from the quantity injected into the pipeline that the local utility or other parties purchased. Staff believes this reporting is most consistent with quantities reported for RIN generation under the RFS, based on the Btu of the pipeline quality biogas after treatment and before any blending with non-renewable fuel or injection into a pipeline.

Note: CI calculations for biomethane are performed on a net MMBtu injected by subtracting all fossil NG and propane inputs (including quantities used in a flare or thermal oxidizer) from renewable biomethane (in MMBtu) injected into the pipeline.

Pipeline transport distance for renewable natural gas (Fields 2.20.a and 2.20.b)

For pipeline transport distance from a biogas processing facility to a CNG dispensing station or to a liquefaction facility, driving distances between the two locations may be determined using a publicly available web-based driving distance estimator. For RNG to CNG pathways that use multiple dispensing stations, applicants may use the driving distance from the digester facility in the U.S. or Canada to Salem, Oregon, as the pipeline transmission distance in the Simplified CI Calculator (or Tier 2 if applicable). Alternatively, the applicant could choose to use a more conservative value, such as the distance to the farthest fueling facility, to minimize the risk of exceeding the certified CI due to changes in the supply chain.

Section 3. CNG, LNG, and L-CNG production and transport data

Table D.3 provides details of inputs for LNG and L-CNG pathways. Additional details are included below in Table D.3.

Table D.3. List of Input Fields for Section 3 of the Simplified CI Calculator

Field Name	Description
3.1. Select Regional Electricity Mix for LNG Production	Choose the electricity mix corresponding to the zip code for the region where the liquefaction plant is located. The Calculator includes 26 eGRID zone mixes, an average Brazilian mix, an average Canadian mix, and a User Defined Mix in the pull-down selection menu. For facilities located in the U.S., select one of the 26 eGRID zones available. If the liquefaction facility is located outside the U.S., select the "User Defined Mix." After choosing an electricity mix option, click the "**Calculate**" button. If "User Defined Mix" is selected, consult with DEQ staff to develop an emissions factor for the User Defined Mix to be input in field 3.7. Data sources for User Defined electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.

3.2. NG from NG purchase invoices	Input monthly total fossil-based NG sourced from a pipeline source (or other) in MMBtu from utility invoices (reported in HHV) for 24 months of operation in field 3.2. The input includes fossil NG used as process fuel and liquefied to LNG. Renewable attributes to support renewable biomethane dispensed must be provided to the verifier during the on-site audit.
3.3. LNG Production from Production Log	Input monthly total LNG produced in gallons (reported at ambient temperature) for 24 months in field 3.3.
3.4. NG as Process Fuel (Calculated)	This field calculates NG used as process fuel using inputs in fields 3.2 and 3.3. No user input is required for this field.
3.5. Grid Electricity Consumption from Utility Invoices	Input monthly total electricity use from the grid in kWh for the 24 months of operation in field 3.5.
3.6. LNG Transport and Distribution	This field serves as a label for the LNG transport and distribution section. Therefore, no input is required for field 3.6.
3.6.a. Select to affirm that LNG delivery trucks are equipped with Boil-Off Recovery	If trucks transporting LNG are equipped to recover "Boil-Off," select "Yes," else "No" in field 3.6.a.
3.6.b. Enter Transport Distance from Liquefaction Plant to Dispensing Station	Input distance from liquefaction facility to the intended LNG or L-CNG dispensing station in Oregon in field 3.6.b. Additional details are included below in Table D.3.
3.7. Specify GHG Emissions Factor for Electricity Mix	Displayed when "User Defined Mix" is selected in field 3.1. Consult with DEQ staff to develop a user-defined GHG emissions factor and input this emissions factor into cell AD28. Data sources for User Defined Electricity mixes must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.
"Calculate" Button	After inputting all data in Section 3, click the "Calculate" button (cell AC22) to calculate pathway CIs for the LNG and L-CNG pathways.

Additional details for section 3

Transport of LNG to dispensing facility (Field 3.6.b)

Driving distance between any two locations may be determined using a publicly available web-based driving distance estimator if fuel is dispensed at a single station. However, if multiple dispensing facilities are utilized, a volume-weighted average transport distance based on 24 months of sales records must be used for LNG distribution to fueling facilities. Alternatively, the applicant could choose to use a more conservative value, such as the distance to the farthest fueling facility, to minimize the risk of exceeding the certified CI due to changes in the supply chain.

Section 4. CI Calculation details

This section provides a detailed breakdown of CI calculations using inputs in the RNG tab and applicable reference data. In addition, standard inputs and corresponding GHG emissions are detailed in this section.

Waste characterization tabs

There are three wastes characterization tabs to help determine the baseline emissions (including avoided emissions) associated with the diversion of the organic material from its "business-as-usual" fate to its use as a biofuel feedstock; one for food scraps (FS Fate), one for urban landscaping waste (ULW Fate), and one for all other organic waste and residues (OW Fate) which cannot be characterized into the previous two categories of food scraps or urban landscaping waste.

The term "food scraps" in this calculator is characterized as the portion of municipal solid waste (MSW) (including intentionally separated from MSW or separately collected) that consists of wastes derived from plants or animals for the explicit preparation or consumption of food for humans and animals. This includes those foods and scraps processed or produced at residences, hospitality facilities (hotels, restaurants, amusement parks, stadiums, special events, etc.), institutions (hospitals, schools, prisons, etc.), grocery stores, and food distributors. In Oregon, the business-as-usual fate of 97.5% (by mass) of these wastes is landfill disposal, and the business-as-usual fate of the remaining 2.5% is recycling into compost.

The term "urban landscaping waste" in this calculator is characterized as the portion of MSW (including intentionally separated from MSW or separately collected) that consists of materials resulting from any public or private landscaping activities such as leaves, grass clippings, plants, prunings, shrubs, branches, and stumps. In Oregon, the business-as-usual fate of 35.9% (by mass) of these wastes is landfill disposal, and the business-as-usual fate of the remaining 64.1% is recycling into compost. Therefore, based on the Oregon state-average MSW characterization,[1] the calculator assumes that ULW consists of 2/3 yard trimmings (including leaves, grass clippings, plants, prunings, and shrubs) and 1/3 wood (including branches and stumps).

The "other organic waste" category is intended to be a User-Defined category in which the applicant provides information on the moisture content of the material, a fraction of degradable organic carbon, a fraction of DOC that is decomposed, and whether the material is typically disposed of in a landfill, compost facility, combusted at a biomass power plant, or used as animal feed, for example. To facilitate the application process, the calculator includes the DOC and the DOC_f of a list of common organic wastes. If a particular organic waste cannot be classified into any categories provided in the list, the applicant may use the following methods to determine the DOC and the DOC_f of such feedstock:

1. For DOC,
   a. The total organic carbon (TOC) content of one unit of the feedstock can be measured by a TOC test (or an equivalent method approved by DEQ) and used to determine the DOC of such feedstock.
   b. If the analytical tests cannot be performed, the applicant may estimate the feedstock-specific DOC using the equation[2] below:

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[1] California Department of Resources Recycling and Recovery. 2014 Disposal-Facility-Based Characterization of Solid Waste in California. October 6, 2015. Publication # DRRR-2015-1546. Available at: https://www2.calrecycle.ca.gov/Publications/Details/1546

[2] The Code of Federal Regulations, 40 CFR Part 98, Subpart TT, Section 98.464

$$DOC = F_{DOC} \times \frac{\text{\% Volatile Solids}}{100\%} \times \frac{\text{\% Total Solids}}{100\%}$$

Where:

F_{DOC} is the fraction of the volatile residue that is degradable organic carbon (weight fraction); use the default value of 0.6.

% Total Solids = 100% - % Moisture Content.

2. For DOC_f,
   a. The TOC content of one unit of the feedstock before and after a biochemical methane potential (BMP)[3] test (or an equivalent method approved by DEQ) can be used to determine the DOC_f of such feedstock.[4]
   b. If the analytical tests cannot be performed, use the default value of 0.5.

All user-defined values must meet the monitoring plan requirements for entities required to validate or verify according to OAR 340-253-0700.

No user input is required in any three of these waste characterization tabs. Feedstock diversion credits for avoided emissions are calculated based on the specific parameters for each feedstock type.

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[3] Moody, L. 2014. Using Biochemical Methane Potentials & Anaerobic Toxicity Assays. https://www.epa.gov/sites/production/files/2014-12/documents/moody_final.pdf

[4] Lee, U., Han, J., Wang, M. 2017. Evaluation of landfill gas emissions from municipal solid waste landfills for the life-cycle analysis of waste-to-energy pathways. Journal of Cleaner Production. 166, 335-342